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ABSTRACTBOOK



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KEYNOTE SPEAKERS

The 24-hour revolution in activity assessment

Prof. dr. Tim Olds

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The way we use our time (sleep, physical activity, sitting, social interactions, cognitive behaviours) affects our health and wellbeing, from diabetes to depression, from anxiety to eczema. Most studies regress some outcome (say depression) against a single activity (such as screen time). With appropriate adjustment for covariates, in an intervention design, a positive association might lead us to believe that screen time causes depression. We would be wrong to assume this. This is because every day has 24 hours, and any change in the time spent in one behaviour (e.g. an increase in screen time) entails an equal and opposite change in the other behaviours (sleep, PA ...) collectively. It's not even a question of not knowing whether it's increased screen time or decreased sleep, for example, which causes depression. It's that the question is incorrectly framed for this study design. We can only talk about different mixes of activities, different activity compositions.

This simple idea has led to a paradigm shift in how we conceptualise time-use epidemiology, how we analyse time-use data, the kind of data we collect, and how we structure interventions. To analyse all components of a 24-hour day, we need a new analytical approach, compositional data analysis or CoDA, which works with a different topology. Using CoDA, we can model the effects of time reallocations between domains; work out the effects of trade-offs in time spent across any two domains using equivalence curves; calculate the Goldilocks Day, the best possible mix of activities for any given outcome in a specified population; and identify the best overall activity composition across a number of diverse outcomes. Future interventions should target not just one activity, but the activity composition as a whole to ensure optimal shifts in time use.

Wija's will: reflections and perspectives, inspired by Wija van Staveren

Prof. dr. Lisette de Groot & Prof. dr. Edith Feskens

Division of Human Nutrition & Health, Wageningen University & Research, The Netherlands

Professor Wija van Staveren (1939) started her career as a research dietitian in 1962. She joined the Wageningen faculty in 1972. It was at London University that she received her MSc, followed by her doctorate at Wageningen University in 1985. Her thesis was entitled 'Food intake measurements, their validity and reproducibility'. Only three years later she became Professor of Nutrition and Gerontology and started the longitudinal research study SENECA (Survey in Europe on Nutrition and the Elderly, a Concerted Action). She was the second Dutch dietician to obtain a PhD degree, and the first dietician to be appointed as professor and chair.

She steered the nutritional field in the Netherlands as chair or member of committees of the Health Council of the Netherlands, the national Food Consumption Survey and the board responsible for the Dutch food composition database (NEVO). At the University Medical Centre in Utrecht she was holding a part-time position since 1997, as chair on Nutrition and Dietetics.

She was not only involved in studies on nutrition of the elderly, she also investigated the dietary intake of pregnant and lactation mothers, growth and development of children, eating behavior and international nutrition. Her work was brought into the open by over 200 peer reviewed papers, numerous books/manuals and by over 30 PhD-students. In particular, her expertise in dietary assessment methods was widely acknowledged, and she organized the ICDAM in the Netherlands in 1998.

Wija van Staveren passed away on Feb 24, 2019, and with this we not only lost a great mentor and colleague but even more, a warm and wise friend.

Scaling Up Dietary Assessment Globally: Challenges, Inroads, and Future Opportunities

Dr. Jennifer Coates

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Dietary data are needed to inform policies that will lead to greater food security, health and nutrition, sustainable agriculture, food safety, and planetary well-being. Whereas many high income countries have implemented effective systems for routinely assessing their populations' dietary intake, low and middle-income countries (LMICs) typically collect such data only infrequently. Barriers include the high cost and complexity of intermittent dietary data collection and analysis, lack of sufficient infrastructure (such as food composition data), and insufficient technical capacity. Yet, global momentum has shifted dramatically and positively over the past five years, with new institutions, databases, guidance, and data collection tools now available to support multiple aspects of dietary assessment in LMICs. Future high priority investments should include: 1) a publicly available repository of global food reference data, 2) regional dietary surveillance networks, 3) adoption of a simple diet quality metric for global monitoring, 4) normative methodological guidance for LMIC-specific assessment issues, and 5) global and/or regional dietary guidelines.

Measuring the quantity and quality of physical activity, where's the balance?

Prof. dr. Gareth Stratton

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Physical activity research is 70 years old, whereas scientific interest in methodological accelerated about 40 years ago (Laporte, 1979). Almost all measures of physical activity are based on estimating energy expenditure, and methodological developments have been driven by the academic community to improve the tools used to measure physical activity (and more latterly sedentary time). This has resulted in over 30 methods that are now available to researchers in the field. These tools have either been directly or indirectly validated against energy expenditure or metabolic equivalents (METs). Outcomes of these measures are then used to estimate the benefits of physical activity and its dose-response relationship with cardiovascular disease or all-cause mortality. The dose is generally reported as the “area under the curve” capturing the “quantity” of physical activity or sedentary time.

The epidemiological “risk model” described above occupies almost all the scientific literature in the discipline, and an amazing amount of valuable research continues unabated in this space. However, there is very little research related to methodological developments measuring the “quality” of physical activity. Professor M.C. Schraefel Southampton University, has been promoting the principle of the “Inbodied5.” The tenet behind the “Inbodied 5” is not one of risk but one of “thriving and flourishing”... a staple in performance science domain, getting the best out of life, investing in things that improve quality of life, Olympic games and “marginal gains” come to mind. Why would the principle of “marginal gains” only be applicable to athletes? Why not the young child seeking to master a physical skill, and older person maintaining effective functional capacity (psychosocial and physical) or a working aged adult seeking social groups and friendships, being grateful for what a physically active lifestyle brings everyday? The question is where is the research in this area and what can researchers do to implement research designs and methods that focus on the “quality” of physical activity. This has never been more relevant than during the current COVID19 pandemic. It is particularly interesting that in nutrition research, both the “quantity and quality” of diet are equally prevalent in the scientific literature. Research into the “Quality” of physical activity lags behind and this balance needs to be addressed. This keynote will aim to share research developments and the need for interdisciplinary research in this area and what may need to be done to achieve a balance between measures of quantity and quality of physical activity

SYMPOSIUM

S1. Methodological issues related to measurement error in assessing diet and physical activity

Chair: dr. Victor Kipnis and dr. Sharon Kirkpatrick

Symposium description

Measurement error in assessing diet and physical activity often leads to substantial biases in the corresponding epidemiological studies. The symposium will address methodological issues related to estimation of the structure and the effects of such measurement error. In dietary studies, assessment instruments are primarily based on self-report. One of the ways to mitigate the effect of measurement error in self-report instruments is to complement such instruments by biomarkers of dietary intake. The first talk entitled “Integration of dietary assessments with biomarker measurements in aetiological models” will demonstrate how to do this integration using self-report and serum measurements of folate and vitamin-B6 from two nested case-control studies within the European Prospective Investigation into Cancer and Nutrition (EPIC) study. The methodology is based on a Bayesian hierarchical model to explore the measurement error structure of the data and relate dietary exposures to risk of site-specific cancer.

In nutritional epidemiology, dietary intake is often categorized into quantiles. Given that dietary assessment is subject to considerable measurement error, categorization will produce differential misclassification that will bias diet – disease associations. Despite the frequent use of such procedures, the consequences for inference have not yet gotten much attention. The second presentation titled “Categorizing variables measured with error” will review the effects of such categorization.

The last talk entitled “New insights into the effects of time-varying error-prone exposure in the analysis of longitudinal studies of physical activity” will address the structure of measurement error in assessing dynamic, i.e., time-varying physical activity. The presentation is based on a large longitudinal validation study (IDATA) of several assessment instruments, including both self-report and accelerometer measurements. The study also included an unbiased reference biomarker of energy expenditure, doubly labelled water. Due to the dynamic nature of physical activity, its associations with health outcomes are better estimated in longitudinal studies allowing for short-term variation in both the physical activity and outcome. The presentation demonstrates that the impact of measurement error in longitudinal studies depends not only on the assessing instrument but also on a particular (out of three possible) effect of interest.

Integrate dietary assessments with biomarker measurements in aetiological models

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In nutritional epidemiology, self-reported assessments of dietary exposure are prone to measurement errors, which is responsible for bias in the association between dietary factors and risk of disease. In this study, self-reported dietary assessments were complemented by biomarkers of dietary intake. Dietary and serum measurements of folate and vitamin-B6 from two nested case-control studies within the European Prospective Investigation into Cancer and Nutrition (EPIC) study were integrated in a Bayesian model to explore the measurement error structure of the data, and relate dietary exposures to risk of site-specific cancer. A Bayesian hierarchical model was developed, which included: 1) an exposure model, to define the distribution of unknown true exposure (X); 2) a measurement model, to relate observed assessments, in turn, dietary questionnaires (Q), 24-hour recalls (R) and biomarkers (M) to X measurements; 3) a disease model, to estimate exposures/cancer relationships. The marginal posterior distribution of model parameters was obtained from the joint posterior distribution, using Markov Chain Monte Carlo (MCMC) sampling techniques in JAGS.

Keywords: Bayesian model, B-vitamins, errors

Categorizing variables measured with error

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In nutritional epidemiology, dietary intake is often categorized into quantiles, such as tertiles or quintiles. An important reason to do so is that this accommodates potential non-linear relationships between dietary intake and the outcome studied, and categorization facilitates presentation of non-linear effects. Some argue that when measurement error is present, using a continuous variable implies an accuracy that is not present. Categorization, however, also has drawbacks: most importantly, one loses information and therefore power is reduced.

Dietary intake is subject to considerable measurement error. In the presence of measurement error, categorization will produce differential misclassification: A high risk of disease correlates with high intake, and high intakes are more often misclassified to lower intakes than low intakes, and thus diseased individuals are more often misclassified to lower intakes than healthy individuals. To date, there has been surprisingly little attention to the consequences of categorization of intake that is subject to measurement error.

This presentation will show results of a simulation study on the effects of categorization of intake subject to classical measurement error. For interpretability, a concrete example is used, namely the effect of protein intake on systolic blood pressure (SBP). Protein intake data are simulated based on a measurement error model fitted on the Duplo data (Trijsburg, de Vries et al. 2015). The simulations assume a linear relationship between protein intake and SBP. Protein intake (with or without error) was divided into quintiles, and its effects on SBP were compared between simulations with and without measurement error. As in the continuous case, effects were attenuated when measurement error was present. Furthermore, unbiased reference measurements were simulated, and used to obtain calibrated intakes (via regression calibration). With this, the average calibrated intake per quintile is calculated, and used to calculate the slope of the relationship between protein intake and SBP from the difference between the first and each other quintile. In the simple case without confounding this procedure can mostly recover the true slope. However, when a confounder is added this is no longer the case. In the presentation effects in more complex situations (e.g. non-linear models) will also be presented and discussed.

Keywords: measurement error, simulation, categorization, dietary assessment

New insights into the effects of time-varying error-prone exposure in the analysis of longitudinal studies of physical activity

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Both self-report and objective measures of physical activity are known to have substantial measurement error, which can lead to biased estimation of associations between physical activity and health. Statistical methods have been developed to adjust estimated associations for bias due to measurement error, but these methods typically focus on risk models that relate habitual physical activity to health. Such models are appropriate for observational cohorts where physical activity is assessed only at baseline but may not be appropriate for longitudinal studies in which physical activity and health status vary over time. In this paper, we evaluate the abilities of three physical activity instruments, the ActiGraph GT3X, the ACT24 24-hour recall and the CHAMPS questionnaire, to estimate three possible (within-person, between-person, and marginal) effects of physical activity on health in longitudinal studies, using doubly labeled water as a reference measure for total energy expenditure. We show that the bias and loss of power due to measurement error in these instruments is substantially greater for within-person than for between-person or marginal effects, highlighting the continuing need for better assessment methods.

Keywords: physical activity, longitudinal effects, energy expenditure, measurement error

S2. Free data! NIH-sponsored physical activity measures: MoTrPAC and NHANES

Chair: Rick Troiano and Stephanie George

Symposium description

This symposium will discuss two large NIH-funded data resources that are rich in accelerometer and other activity-related data and are ripe for exploration of questions on physical activity measurement and health. Both resources are primed for exploration of scientific questions involving combining methods to enhance measurement of physical activity and sedentary behavior. The nationally representative 2011-2014 National Health and Nutrition Examination Survey (NHANES) included device-based assessment of physical activity on more than 15,000 participants ages 3 years and older. This component allowed for up to seven days of 24-hour raw (80Hz) data capture from a triaxial wrist-worn accelerometer. This symposium will discuss the NHANES physical activity assessment methodology, cloud-based analytical processing applied to the accelerometer data, summary data files and how to access them.

The Molecular Transducers of Physical Activity Consortium (MoTrPAC) is a national research consortium designed to discover and perform preliminary characterization of the range of molecular transducers (the "molecular map") that underlie the effects of physical activity in humans. The program's goal is to study the molecular changes that occur during and after exercise and ultimately to advance understanding of how physical activity improves and preserves health. MoTrPAC allows for 28 days of 24-hour raw (60Hz) data capture from a triaxial wrist-worn accelerometer among 1,980 sedentary adults and seven days from 300 highly active individuals. Among adults, a subsample of 375 sedentary participants in the adult study will have 28 days of activPAL wear time. Among pediatric study participants, 320 will have seven days of Actigraph wear time, and 170 of those will have 28 days.

The symposium will also provide information on the variety of data on other variables available for analysis in the data sets, such as dietary assessment, grip strength, cardiorespiratory fitness, minute-by-minute heart rate monitoring, and biomarkers.

Free physical activity data! The MoTrPAC story

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The Molecular Transducers of Physical Activity Consortium (MoTrPAC) is a national research consortium designed to discover and perform preliminary characterization of the range of molecular transducers (the "molecular map") that underlie the effects of physical activity in humans. The program's goal is to study the molecular changes that occur during and after exercise and ultimately to advance understanding of how physical activity improves and preserves health. The six-year program is the largest targeted NIH investment of funds into the mechanisms of how physical activity improves health and prevents disease. This presentation in the symposium will provide an overview of the multi-site Molecular Transducers of Physical Activity Consortium study, the device-based assessment of physical activity and sedentary behavior data being collected, and the future availability of this federally-funded data resource for addressing physical activity and health hypotheses.

MoTrPAC is rich in accelerometer data and stands as a data resource primed for exploration of scientific questions involving combining methods to enhance measurement of physical activity and sedentary behavior. The study allows for 28 days of 24-hour raw (60Hz) data capture from a triaxial wrist-worn accelerometer among 1,980 sedentary adults and seven days from 300 highly active individuals. Among adults, as currently planned, a subsample of 375 sedentary participants in the adult study are envisioned to have 28 days of activPAL wear time as well. Among pediatric study participants, 320 will have seven days of Actigraph wear time, and 170 of those will have 28 days.

Details about device-based data collection methods and opportunities for combining methods of assessment will be covered. The symposium will also provide information on the variety of data on other related variables that will be available for analysis in the MoTrPAC data set, such as dietary assessment, grip strength, cardiorespiratory fitness, minute-by-minute heart rate monitoring, and biomarkers.

Keywords: Accelerometer, physical activity, sedentary behavior

Free physical activity data! The NHANES story

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The National Health and Nutrition Examination Survey (NHANES) is a program of studies designed to assess the health and nutritional status of adults and children in the United States. The survey combines interviews and physical examinations on a nationally representative population sample. NHANES is a major program of the National Center for Health Statistics (NCHS), a component of Centers for Disease Control and Prevention (CDC) that has the responsibility for producing vital and health statistics for the Nation. NHANES included device-based assessment of physical activity in cycles from 2003-2006 and 2011-2014. This symposium presentation will focus on the NHANES 2011-2014 device-based assessment of physical activity.

The 2011-2014 National Health and Nutrition Examination Survey (NHANES) included device-based assessment of physical activity on more than 15,000 participants ages 3 years and older. This component allowed for up to seven days of 24-hour raw (80Hz) data capture from a triaxial wrist-worn accelerometer on the non-dominant wrist. This symposium session will discuss the NHANES physical activity assessment methodology, cloud-based analytical processing applied to the accelerometer data, summary data files and how to access them.

Accelerometer data were processed to provide selected summary outcomes (wear vs. non-wear vs. sleep estimates, activity volume) at the day, hour, and minute levels; high-resolution raw data will also be available. The summary data are available for download from NCHS, while higher resolution data may require processing within a cloud environment. These accelerometer data have value for epidemiological analyses, as well as potential for algorithm development, testing and application. The symposium will also provide information on the variety of other related NHANES data available, such as dietary assessment, grip strength, and multiple biomarkers.

Keywords: Keywords: accelerometer, cloud computing, machine learning, algorithms

S6. Innovative advances in dietary patterns that can help inform population guidelines

Chair: dr. Jill Reedy

Symposium description

Dietary guidance in many countries is focused on food-based eating patterns, and research is expanding to examine optimal dietary patterns for health outcomes. Recognizing that dietary intake is both multidimensional (i.e., it is a complex, multi-layered exposure and behavior) and dynamic (i.e., it varies over time and the life course), methodological advances are required to include these attributes of dietary data in dietary patterns research. Given the growing interest in this area of research, there is much to be learned about how to use innovative methods and further advance these concepts when modeling dietary data to inform population health guidelines.

This session will include three speakers who will highlight advances in dietary patterns methods that incorporate multidimensionality (i.e., combining index and cluster analyses) and dynamism (i.e., machine learning for temporal dietary patterns). Three panelists will then bring their unique perspectives to address a series of questions related to how to: 1) expand innovation in methods; 2) build capacity; and 3) connect methods across diverse populations. Discussion with the speakers, panelists, and attendees will center on opportunities for research, including methodological and analytic advances that can strengthen future research studies designed to build evidence to inform guidelines across the lifespan.

Are there different ways to eat a healthy diet? Variations in healthy dietary patterns defined by Healthy Eating Index 2015 in the Dietary Patterns Methods Project

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Purpose: The Dietary Patterns Methods Project (DPMP) demonstrated a high-quality diet, characterized by the Healthy Eating Index (HEI) quintile 5 (Q5), is associated with lower mortality. Whereas the Dietary Guidelines for Americans (DGAs) point to several possible healthy eating patterns, what is not known is the diversity within high-quality dietary patterns in the United States.

Methods: Cluster analyses were conducted in HEI 2015 Q5 in random-half samples of men and women in the NIH-AARP Diet and Health Study and the Women's Health Initiative Observational Study (WHI-OS). Sample sizes ranged from 6,211 to 24,184. Cubic clustering criterion and the pseudo F-method suggested the optimal number of clusters was 3 in each sample. Characterizations incorporated overall and component-specific percent adherence levels, using both truncated (maximum 100%) and un-truncated values. Three evaluative labels were assigned: "below goal" (<65%), "beyond goal" (150-200%), "excessive" (>200%). Clusters were compared qualitatively and by calculating the sums of squared distances (SSD) between the maximum score (100%) and observed component-specific (truncated) adherence scores. Given the 13 HEI 2015 components, SSD could theoretically range from zero to 130,000, with zero indicating achieving the maximal allowable scores.

Results: Comparison of the clusters revealed commonalities as all were characterized by excessive total and whole fruit intake and below goal sodium scores. Clusters exhibited the following four patterns: Pattern 1 (61% of AARP women; 53% of AARP men; 23% of WHI-OS; SSD-range: 5,287-5,987) had, relatively speaking, the best sodium and dairy scores and worst fatty acid ratios. Pattern 2 (59% of WHI-OS, SSD=7,024) uniquely met the dairy goal but was below goal on greens and beans. Group 3 (24% of AARP women; 17% of AARP men; SSD-range: 7,687-7,715) was characterized by excessive total vegetables, beyond goal/excessive greens & beans, and below goal sodium and dairy. Pattern 4 (15% of AARP women, 30% of AARP men, 18% of WHI-OS; SSD-range: 8,100-9,616) was characterized by excessive seafood & plant proteins and below goal whole grain.

Conclusions: These findings highlight differences in consumption patterns in people consuming high-quality dietary intake. Further exploration of these patterns will be most informative for future DGA development.

Keywords: diet patterns, diet quality

Temporal Dietary Patterns Identified by a Two-stage Hierarchical Clustering

Method

Yikyung Park

Washington University in St. Louis

Numerous studies have examined the effects of dietary patterns on health outcomes using a dietary pattern defined by a priori diet score/index or a pattern derived by a statistical method such as factor analysis. These dietary patterns were based on the variety or combinations of different foods and beverages consumed and the amount with which they are habitually consumed. Accumulating evidence suggests that not only what we eat but also when we eat are important in maintaining health. However, little effort has been made to incorporate the concept of eating time into dietary patterns, which named “temporal” dietary patterns. It is, in part, due to a lack of statistical methods to recognize patterns in the multidimensional time-based dietary intake data. We, therefore, developed a novel machine learning method to identify temporal dietary patterns based on temporal distribution of energy intake throughout a day and characterized the temporal dietary patterns. We used the National Health and Nutrition Examination Survey from 2005 to 2010, which is a nationally representative sample of the civilian, non-institutionalized US population. Participants included in the analysis were adults 20 years old and older. People on rotating shift work schedule or pregnant women were excluded. Diet was assessed using two non-consecutive 24-hour dietary recalls that asked times, types, and amounts of foods and beverages consumed during the 24-hour period before the interview. For each 24-hour recall, energy intake from foods consumed at each eating occasion was estimated, then aggregated into one-hour unit, and divided by total daily energy intake. We used a two-stage hierarchical clustering method that integrates optimal transport and the dynamic time warping distances to learn the distributional and dynamic shape-based dissimilarity at the respective stage. We identified five distinctive patterns in this US adult population. Details of each temporal dietary pattern will be presented during the talk.

Keywords: dietary patterns; temporal dietary patterns; eating time; machine learning

Reproducibility of diet-disease associations for exploratory dietary patterns

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Exploratory methods, such as principal component analysis and cluster analysis, or mixed approaches such as reduced rank regression, have been widely used to evaluate associations between dietary patterns and health outcomes. However, these approaches result by definition in population-specific dietary patterns with likely limited comparability. Heterogeneity in the pattern structure limit attempts to meta-analyze evidence. Given that single-study findings are unlikely to inform dietary recommendations, the lack of replication of dietary pattern-disease associations remains a major limitation.

The presentation will highlight methodological approaches to replicate diet-disease associations for exploratory patterns using examples from the large multi-center EPIC study, where patterns derived by reduced rank regression and principal component analyses have been investigated.

Furthermore, attempts to characterize temporal changes in dietary patterns in longitudinal studies face several methodological problems, including potential changes in dietary instruments and frequently unknown reproducibility of dietary patterns at single time points.

Keywords: exploratory dietary patterns, reproducibility, principal component analysis, reduced rank regression

S9. Understanding and adjusting for the impact of Berkson error arising from prediction equations in nutritional and physical activity epidemiology

Chair: dr. Pamela Shaw

Symposium description

There are many settings in epidemiology where a hard to measure exposure or outcome is replaced in analyses with a predicted value. Examples include Schofield's prediction equation for Resting Energy Expenditure (REE) and usual nutrient intake values that are predicted from calibration equations derived from objective biomarker studies. The latter example involves regression calibration, which is one of the most common methods to address measurement error in association studies involving dietary intake and physical activity exposures.

The values derived from prediction equations have Berkson error. Although this type of measurement error does not always lead to biased estimation, there are many situations in which it does, a fact not widely appreciated. Consideration of this prediction error on standard errors also needs consideration for correct inference. This session will examine some of the analysis pitfalls (and ways to avoid them) that can occur when working with predicted values in study analyses. There will be three talks representing different uses of prediction equations, the biases that can arise in these situations, and methods of adjustment to reduce or eliminate the bias. The three situations are: 1) use of a prediction equation variable to estimate a probability distribution; 2) use of a prediction equation variable as an explanatory variable in a regression model; and 3) use of a prediction equation variable as an outcome variable in a regression model. Each of these talks will draw from real data examples in nutritional or physical activity epidemiology.

Methods of analysis when an outcome variable is a prediction with Berkson error

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For many epidemiologic settings, the outcome of interest can only be imprecisely measured and the gold-standard measure may be too expensive to obtain on all subjects. In an attempt to address measurement error, sometimes the analyst will estimate the outcome, say through a calibration or prediction equation, and use the resulting predicted value in the analysis in place of an observed value. Errors in continuous outcomes are often treated as ignorable. This is justified if the errors are classical, i.e. not correlated with the true value. However, these predicted values have Berkson error, which are correlated with the true value, and therefore can bias regression coefficients if analyses are not appropriately adjusted. Buonaccorsi (1991,1996) developed an adjustment procedure to eliminate this bias for non-differential Berkson error in the outcome variable for the linear model. Using a real data example from the Hispanic Community Health Study/Study of Latinos, we present a method to check whether Buonaccorsi's non-differentiability condition applies, and examine the results of the check in a variety of situations. The main question addressed was whether sodium and potassium dietary intake is associated with sociodemographic and acculturation factors. Sodium or potassium intake is therefore the outcome of interest in a regression model. In this large cohort study, only error-prone self-reported diet (two 24-hour recalls) was available for all participants and the nutrient outcomes of interest were calibrated with regression equations fit using intake recovery biomarkers available on a subset. The performance of Buonaccorsi's adjustment method is studied and compared to the naive analysis that ignores the error. The sensitivity of the Buonaccorsi method to mild departures from non-differentiability is also studied using simulations.

Keywords: Berkson error, Calibration equations, Measurement error, Prediction equations, Regression analysis

Estimating the distribution of usual nutrient intake using predicted values from a calibration equation in a complex survey design

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Estimating the distribution of usual nutrient intakes is important to monitor in order to evaluate the percentage of the population meeting dietary recommendations. Because dietary instruments (e.g., 24hr dietary recalls) are self-reported and measured with random and systematic error, additional information and statistical methods are used to correct for these errors. There are a handful of biomarkers that can recover nutrient intake but these have a high burden on the participant and are expensive, making them unfeasible to collect on all participants in large epidemiologic studies. Some of these studies conduct validation studies to measure these biomarkers and the self-reported instrument in a small subsample ($n \sim 450$), and then construct calibration equations that predict the usual nutrient intake of an individual from the individual's self-reported intake and personal characteristics. We will estimate the distribution of usual sodium intake using these predicted intakes derived from the self-reported dietary data available in the large sample. Uncertainty in the predicted intakes will be accounted for in the analysis, which is necessary to avoid biased estimates of the desired percentiles of usual intake. We will illustrate the method using data from HCHS/SOL, the largest community-based cohort study of Hispanic/Latino adults in the US. For this analysis, we will also account for the probability based sampling design of HCHS/SOL.

Keywords: biomarker, measurement error, calibration equation, usual intake, HCHS/SOL

Berkson error with outcome model misspecification: Bias when using predicted values in place of observed covariates

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In studies where data has not been collected for an explanatory variable of interest the substitution of values generated by a prediction model is an appealing technique. Justification for such methods can be found by noting that, with standard assumptions, this is equivalent to fitting a regression model when at least one risk factor is measured with Berkson error. Under this setting, it is known that unbiased or nearly-unbiased inference can be obtained under many linear and non-linear outcome models. In this work, we focus on the linear regression model and show that this unbiasedness property does not hold when the outcome model is misspecified (e.g., there are missing confounders), in which case the marginal inference based on an explanatory variable measured with Berkson error differs from the same inference based on observed values. Since outcome model misspecification is ubiquitous in applications, this severely limits the practical use of such measurements, and, in particular, the substitution of predicted values for unmeasured explanatory variables. These issues are illustrated using data from the National Health and Nutrition Examination Survey to study the joint association of total percent body fat and BMI with HbA1c. It is shown that using predicted total percent body fat in place of measured percent body fat yields inferences which often differ significantly, in some cases suggesting opposite relationships among factors.

Keywords: Berkson error, measurement error, prediction equations

S10. Conducting dietary surveys in low-and middle-income Countries: Challenges, experiences and strategies for improvement

Chair: dr. Edwige Landais

Symposium description

This symposium aims to increase our understanding of the challenges faced when assessing dietary intake in low- and middle-income countries (LMICs) and to discuss initiatives to overcome these challenges by bringing international experts together with extensive experience in this area.

Rationale: Dietary intake is a strong determinant of nutritional and health status of individuals. Hence, such data are essential to design adequate and relevant food and public health nutrition policies. Yet, assessing food consumption remains a great challenge, especially in LMICs. Thus, in these countries there is a lack of accurate and adequate individual dietary data, mainly because these data are costly and time consuming to collect and process, and require a high level of expertise.

Objectives: The objectives of the present symposium are: i) to highlight challenges when conducting individual dietary surveys in LMICs; ii) to describe the concept of FAIR (Findable, Accessible, Interoperable, and Reusable) data and its application to dietary data ; iii) to provide an overview of two international initiatives namely, INDDEx and Intake-Center for Dietary Assessment, which work towards facilitating and improving dietary assessment in LMICs.

Summary: The session will start with a brief description of specific challenges encountered when conducting individual dietary survey in LMICs, such as the lack of dietitians within countries, the lack of food composition tables and of standardized recipes... Then, a presentation will summarise current efforts and tools to standardise data descriptors to make dietary intake data FAIR (Findable, Accessible, Interoperable, and Reusable). After discussing challenges and issues, the symposium will give an overview of two international initiatives that aim at enhancing individual dietary data: INDDEx and Intake. A description of INDDEx24, a tablet based 24 hour dietary recall specifically design to use in LMICs, the problems that it seeks to solve, and how it can be scaled up for global use, will be discussed. Lastly, a description of the services provided by Intake-Center for Dietary Assessment in relation to population-based surveys will be expounded. After the presentations, there will be an open discussion with symposium participants.

INDDDEX24: A new global dietary assessment platform to scale up the availability, access, and use of dietary data

Jennifer Coates PhD, Brooke Colaiezzi MS, Sarah Wafa MPH RD, Winnie Bell MS MPH, Jerome Some PhD, Cathleen Prata MPH, Hallie Perlick, Beatrice Rogers PhD

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Information on populations' diets is essential to design effective nutrition programs, but availability is hindered by perceived high costs, complexity, and delays in obtaining results. INDDDEX24 is a dietary assessment platform designed to reduce the time and cost associated with generating dietary data, particularly among users in low- and middle-income countries (LMICs).

INDDDEX24 relies on the 24-hour recall method and is comprised of a mobile application (app) for dietary data collection that is linked to a web app for managing and sharing dietary data inputs (i.e. food composition data, recipes, food descriptors, and portion conversions). INDDDEX24 allows users to search for and customize dietary data inputs to their research context, translate questionnaire text, add survey modules, conduct real time monitoring of data collection efforts, and match items reported during the survey to food composition data and other dietary data inputs such as standard recipes and conversion factors.

To inform development of the INDDDEX24 platform, experts with dietary assessment experience in LMICs were consulted and a structured literature review of existing dietary assessment platforms was performed. An initial version of INDDDEX24 was developed and tested in feasibility studies Viet Nam and Burkina Faso to identify areas of the platform that required further testing. In addition, webinars with potential users of INDDDEX24 and international experts were conducted, and feedback solicited. Following additional development rounds to implement the feedback received, formal validation studies were conducted in Viet Nam and Burkina Faso. The platform's relative validity, time, and cost were evaluated by comparing INDDDEX24 to 24-hour dietary recalls using pen and paper.

The extensive consultative process and evidence driven design based on the feasibility and validation studies has resulted in a high-quality dietary assessment platform that balances flexibility of adaptation to a range of contexts with quality control and standardization. INDDDEX24 is an innovative contribution to global dietary assessment research infrastructure. This presentation will highlight the challenges encountered and key lessons learned from this process.

Keywords: Dietary assessment, innovative technology, 24-hour dietary recall

Technical assistance for dietary surveys in low- and middle-income countries: Intake – Center for Dietary Assessment

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1) Intake - Center for Dietary Assessment, FHI Solutions, 2) Independent Consultant

To date, relatively few low- and middle-income countries (LMICs) have carried out national or large-scale dietary surveys. Where dietary data do exist, in many cases, these data are now quite old and may not reflect current dietary practices in the country. Yet, time-relevant data on diets are needed for countries to make evidenced-based policy and programmatic decisions to address key nutrition, agriculture, and food systems challenges.

To help increase the availability, reliability, comparability, and use of dietary data in LMICs, Intake was established at FHI Solutions in 2016. Intake works in collaboration with LMICs that do not have time-relevant national-level dietary data but have identified a need to collect dietary data for national policy and programmatic use.

Intake partners with countries to provide no-cost technical assistance according to expressed country-specific need. Intake's work aims to build capacity in countries for dietary survey planning and design; and for dietary data collection, analysis and use; and to provide countries with a no-cost technical resource partner throughout the country-led survey process and related country-led survey activities.

This presentation describes the technical assistance services that Intake provides, the way in which Intake works, and key learnings from Intake's technical assistance work across LMICs to date.

Keywords: Intake, dietary survey, LMICs, technical assistance, capacity building

Towards FAIR food and nutritional data

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Present efforts to track the assessment of human diets have focused mostly on increasing the availability of new data. Much less attention has been devoted to the effective use of existing data. The presentation will introduce the concept of FAIR data in dietary assessment, give examples of current developments and summarise key actions that are required to better collect, share and use existing dietary assessment data. In 2016, the FAIR principles were proposed as guidance for scientific data management and stewardship. FAIR principles foster “Findability, Accessibility, Interoperability, and Reusability of scholarly data. FAIR principles have been adopted gradually and will enable the development of next-generation infrastructure (i.e. open science applications) to advance food and nutrition research.

FAIR data implies that (meta)data should be indexed in a searchable system with registered identifiers. Through the registered identifiers, both data and metadata should be retrievable by machines using open queries that include authentication and authorization procedures. Furthermore, the metadata should always be accessible even if the data itself is absent.

Ontologies for nutrition research are proposed for this purpose and include “FoodOn” (the food ontology), “ONE” (the Ontology for Nutritional Epidemiology) and “ONS” (the Ontology for Nutritional Studies). However, to be truly interoperable (meta)data, ontologies should be applied to build formal descriptions and their linkages for knowledge representation. Unfortunately, most of the proposed ontologies are isolated, poorly used and without the engagement of the research community that is active in dietary assessment.

Currently, various tools are available to collect, handle and store dietary assessment data, but only a few of them meet the FAIR data standards. Building on the Strengthening the Reporting of Observational Studies in Epidemiology—Nutritional Epidemiology (STROBE-nut), scholars have developed an ontology for a minimum set of items to report in nutrition research and a set of descriptors for nutrition and dietary assessment data. Efforts to achieve FAIR data in food and nutrition research, however, will rely on the engagement of the research community. Specific training efforts are needed to build a new generation of nutritionists versed in open science and FAIR data.

Keywords: Data, ontology, FAIR, dietary data, metadata

S13. Novel approaches to assessing dietary quality in the food system: combining methods to enhance measurement for dietary surveillance and interventions

Chair: dr. Niyati Parekh and dr. Maya Vadiveloo

Symposium description

Dietary patterns are dynamic and are shaped by numerous interwoven personal and environmental factors. As technological advancements are more broadly integrated into society, compelling opportunities exist to innovate within dietary assessment- for example, by combining measurements at varying levels of the food system with existing individual-level measures. Developing synergies between different assessment methods is essential to enhance dietary interventions aimed at improving diet quality, particularly because even small changes to dietary quality are associated with improved health outcomes.

By using multiple methods to enhance precision in the field of dietary assessment, it becomes more feasible to capture smaller levels of responsiveness among individuals in relation to dietary interventions. The proposed symposium will highlight recent innovation in dietary assessment and demonstrate how measurement of dietary quality at the environmental- and individual-level can enhance the sensitivity of dietary assessment to detect small, but meaningful changes in dietary quality. Following the symposium, participants will understand how to leverage grocery purchase data to analyze diet quality and changes in diet quality, how to apply newer diet quality indices (i.e. NOVA) to sources of nationally-representative dietary data, and how to combine traditional diet assessment methods with individual-level biomarkers to inform understanding of the smallest detectable differences that can be achieved through dietary interventions.

Maya Vadiveloo, PhD RD will present research from a recently completed randomized controlled cross-over trial exploring the use of grocery purchase data collected from loyalty cards to evaluate and intervene on overall dietary quality through applications of the newly developed and validated Grocery Purchase Quality Index-16. Because food processing level has also recently emerged as a potential dietary risk factor apart from overall diet quality, Filippa Juul, MS will present methodology applicable to researchers interested in creating the NOVA food groups in nationally-representative data sets- using both individual-level and purchase-level data. Finally, Mercedes Sotos Prieto, PhD will provide insights from her recent clinical trial, which used a combination of self-reported dietary intake and selected biomarkers to enhance dietary measurement. Dr. Niyati Parekh, PhD will moderate the discussion.

These three talks will lay the foundation for further discussion and engagement with conference attendees around how to design observational and intervention studies that validly measure dietary patterns and diet quality by harnessing technological advancement, and multiple methods at different levels of the food system to evaluate the role of diet and dietary interventions in health promotion.

Evaluating the effect of targeted food incentives on grocery purchases: The Smart Cart Study protocol for a randomized controlled cross-over trial

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Introduction: Measuring and intervening on grocery purchase quality may improve dietary quality, yet routinely evaluating grocery purchases is challenging. Using an adaptive algorithm, the Smart Cart Study tested the feasibility of using data collected from customer loyalty cards to evaluate grocery purchase quality and deploy targeted healthy food incentives based on purchase history and other participant information.

Methods: Randomized controlled crossover pilot trial of 224 adults who shopped at an independent supermarket for ≥50% of their groceries, participated in the store's loyalty program, and completed diet and sociodemographic/behavioral questionnaires; all participants received a 5% discount for using their loyalty card. Research staff categorized >10,000 foods at baseline into 11 Grocery-Purchase Quality Index-2016 (GPQI-16) categories— a validated tool for assessing grocery purchase quality. Loyalty-card linked purchase data was collected daily and participant GPQI-16 scores were updated monthly. Research staff used Guiding Stars® to develop healthy food coupons, and the study algorithm allocated targeted coupons to participants' loyalty cards based on monthly grocery purchase quality, dietary preferences/allergies, and baseline diet quality measured using the Healthy Eating Index. For the first 13-weeks, the intervention group received targeted weekly coupons (valued up to \$10) with brief nutrition education to improve grocery purchase quality. Control participants received weekly untargeted nutrition education and occasional generic coupons. Following a brief washout period, the two groups crossed over. The primary study outcomes were purchases of targeted products and GPQI-16 scores the study was powered to detect a 3% difference in purchase quality.

Results: The Smart Cart Study demonstrated preliminary feasibility of using a semi-automated approach to evaluate grocery purchase quality and deliver targeted healthy food incentives informed by those purchases and other participant information. Most participants (93%) completed the 9-month study and had valid data. However, scaling this program for larger supermarkets requires greater automation, as researchers are currently needed to categorize point-of-purchase information.

Conclusions: Greater use of data analytics in dietary assessment has the potential to enhance delivery of dietary interventions by integrating numerous sources of information that influence people's purchasing and eating decisions. Such approaches may enhance the development of multi-level interventions to improve diet.

Keywords: Grocery purchase quality, algorithm, automated, randomized controlled trial

Application of the NOVA framework to enhance assessment of diet quality in US nationally representative surveys of dietary intake and grocery purchases

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Introduction: Food processing may influence dietary quality, eating behaviors and health outcomes by altering foods' nutritional and non-nutritional characteristics, but has traditionally been overlooked in nutrition research and dietary guidance. The NOVA framework enables a more complete assessment of diet quality by distinguishing between processing levels. We discuss methodology for applying NOVA to nationally representative survey-data of individual-level dietary intake and household grocery purchases.

Methods: NOVA categorizes foods as unprocessed/minimally processed foods, culinary processed ingredients, processed foods and ultra-processed foods, based on the extent and purpose of processing. We applied NOVA to a) 24hr-recall data from the National Health and Nutrition Examination Survey (NHANES) 2005-2014 (N=15,977;20-64y) and b) household-level grocery-purchasing data from the National Household Food Acquisition and Purchase Survey (FoodAPS) 2012-2013 (N=3,961 households). Processing level was determined by considering the Food and Nutrient Database for Dietary Studies description of food codes and ingredients of branded products in the USDA Branded Food Products Database. The NHANES-variables "SR Code Description" describing food code ingredients, "Combination Food Type" (e.g. frozen meal) and "Source of Food" (e.g. vending machine) were also considered. We calculated the energy contribution (%kcal) of each NOVA group to dietary intakes (NHANES) and grocery purchases (FoodAPS) and compared intake/grocery nutrient profiles across quintiles of ultra-processed food intake/purchases using linear regression.

Results: Ultra-processed foods provided the majority of energy in the average US diet (55.8%kcal) and grocery purchases (56.1%kcal), followed by minimally processed foods (NHANES:29.3%kcal, FoodAPS:28.4%kcal) and processed foods (NHANES:9.2%kcal, FoodAPS:10.5%kcal). Diets and household purchases higher in ultra-processed foods were higher in carbohydrates and total sugar, while lower in protein, fiber, vitamin C, calcium, zinc and potassium (p -trend<0.05). In NHANES, women consumed more high-sugar ultra-processed foods (e.g. cookies/ready-to-eat-desserts/ice cream) than men (p <0.02).

Discussion: We successfully estimated food processing level in the US diet and grocery purchases. NOVA identifies food groups with similar nutritional (e.g. added sugar) and non-nutritional attributes (e.g. additives, food matrix), thereby enabling the assessment of an additional dimension of diet quality. Information regarding food processing level may complement existing measures of diet quality to provide a more comprehensive understanding of food consumption, purchasing behaviors and diet-disease relationships.

Keywords: NOVA, diet quality, FoodAPS, NHANES, ultra-processed foods

Assessing Validity of Self-Reported Dietary Intake within a Mediterranean Diet Clinical Trial Intervention

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Collecting dietary intake data is associated with challenges due to the subjective nature of self-administered instruments. Biomarkers may objectively estimate the consumption of specific dietary items or help assess compliance in dietary intervention studies. Our aim was to use a panel of plasma and urine biomarkers to assess the validity of self-reported dietary intake using a modified Mediterranean Diet Scale (mMDS) among firefighters participating in Feeding America's Bravest (FAB), an MD cluster-randomized controlled trial. In our nested biomarker pilot study, participants were randomly selected from both the MD intervention group (n = 24) and the control group (n = 24) after 12-months of dietary intervention. At baseline data collection for the pilot study (t = 12-months of FAB), participants in the control group crossed-over to receive the MD intervention (active intervention) for 6-months. Participants in the intervention group continued in a self-sustained continuation phase (SSP) of the intervention. Food frequency questionnaires (FFQ), 13-item-mMDS questionnaires, 40 plasma fatty acids, inflammatory biomarkers and urinary hydroxytyrosol and tyrosol were analyzed at both time points. Spearman's correlation, t-tests and linear regression coefficients were calculated using SAS software. Overall, the mMDS derived from the FFQ was highly correlated with the specific 13-domain-mMDS (r = 0.74). The concordance between the two questionnaires for low and high adherence to MD was high for all the participants in the parent trial ($\kappa = 0.76$). After 6 months of intervention in the pilot study, plasma saturated fatty acid decreased in both groups (active intervention: -1.3 ± 1.7 ; p = 0.002; SSP: -1.12 ± 1.90 ; p = 0.014) and oleic acid improved in the SSP (p = 0.013). Intake of olive oil was positively associated with plasma omega-3 (p = 0.004) and negatively with TNF- α (p < 0.001) at baseline. Choosing olive oil as a type of fat was also associated with higher levels of plasma omega-3 (p = 0.019) at baseline and lower TNF- α (p = 0.023) at follow up. Intake of red and processed meats were associated with lower serum omega-3 (p = 0.04) and fish consumption was associated with lower IL-6 at baseline (p = 0.022). The overall mMDS was associated with an increase in plasma omega-3 (p = 0.021). Good correlation was found between nutrient intake from the FFQ and the

corresponding plasma biomarkers (omega-3, EPA and DHA). In this MD randomized controlled trial, some key plasma biomarkers were significantly associated with key MD diet components and the overall mMDS supporting the validity of the mMDS questionnaire as well as compliance with the intervention.

Keywords: mediterranean diet; biomarkers; validation; compliance

S14. Measures of dietary patterns and food environments for diverse populations and settings

Chair: dr. Sharon Kirkpatrick and dr. Leslie Lytle

Symposium description

There is a push toward standardization of measures to improve the comparability of evidence to inform policies relevant to dietary patterns and food environments. Indeed, it may be desirable to use standardized measures so that findings can readily be synthesized across studies. However, data captured using a given measure in different contexts may not be equivalent due to differences in the construct being measured (e.g., common sources of specific dietary components such as fruits and vegetables or variation in characteristics of food environments), differentials in understanding of questions and probes, misalignment between the cognitive demands of the tool and the characteristics of the target groups, and culturally inappropriate questions, probes, or protocols. Further, there are research and surveillance needs that require measures tailored to and well tested for a given population and setting.

While the need for measures to assess dietary patterns and food environments with high validity and reliability is well recognized, little attention is given to the external validity or generalizability of measures across diverse population groups and settings. Simply translating a given measure into multiple languages or shifting the mode of administration to account for differences in cognitive development is unlikely to be sufficient. However, many measures are developed for general populations, most are not tested in diverse populations and settings, and guidance on processes for adapting them for unique populations and for examining external validity is lacking. Culturally adapted tools are necessary to move the field forward in order to provide better estimates of risk factors in populations as well as improved metrics for intervention assessment.

This symposium will examine processes for adapting tools to assess dietary intake and food environments to be culturally relevant and useful in diverse populations. The presenters range in terms of career stage and include researchers adapting measures for diverse populations within high-income countries and those working with international non-profit organizations to tailor and validate measures for use in low- and middle-income contexts.

Development and validity of a novel food-based Global Diet Quality Score

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BACKGROUND: Dietary imbalances are a major driver of malnutrition and contribute a greater fraction of global mortality than any other category of disease risk factor. Most countries face overlapping burdens of undernutrition and overweight, yet there exists no global standard metric for assessing and monitoring the joint contributions of diet to both nutrient adequacy and noncommunicable disease (NCD) risk.

OBJECTIVE: To develop an easy-to-use metric for capturing nutrient adequacy and diet-related NCD in diverse populations.

METHODS: Beginning with the Prime Diet Quality Score (PDQS) as a basis for metric development, we undertook secondary analysis of cross-sectional and cohort data on non-pregnant non-lactating women of reproductive age in ten African countries, China, India, Mexico, and USA to (1) develop novel metrics of diet quality; (2) evaluate associations between metrics and nutrient intake and adequacy, anthropometry and other nutritional biomarkers, and incident type 2 diabetes; (3) implement iterative modifications to metric design to improve performance; and (4) statistically compare performance of the final developed metric with that of existing metrics: the original PDQS, Minimum Dietary Diversity - Women (MDD-W), and Alternative Healthy Eating Index - 2010 (AHEI-2010).

RESULTS: We developed the Global Diet Quality Score (GDQS), a food-based metric incorporating a modestly expanded list of food groups relative to most existing metrics, and a simple means of scoring consumed amounts. These features allow the GDQS to account for a wide range of foods of nutritional importance in diets across the world and capture the collective contributions of these foods to both nutrient adequacy and NCD risk while avoiding the need for food composition data. In predicting outcomes associated with nutrient adequacy and NCD risk, the GDQS performed well in comparison with the MDD-W and AHEI-2010, respectively, each of which are designed to capture one of these two domains.

CONCLUSIONS: The flexibility and ease-of-use of the GDQS render it a promising candidate for use in global monitoring platforms. Further research is warranted to validate easily-operationalized methods for assessing the GDQS as part of national surveys, including a novel 24-hour recall-based data collection system that we also developed as part of the current project.

Keywords: diet quality, dietary assessment, nutrition surveillance, nutrition transition, nutritional epidemiology

Application and refinement of the Prime Diet Quality Score for different contexts

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The Prime Diet Quality Score (PDQS) was developed as a potential metric for tracking progress of global dietary goals. Previously, we have validated the PDQS in relation to multiple NCDs in large U.S. cohorts, while preliminary findings from LMICs suggested its moderate correlations with intake of some key nutrients. The next important step includes development of a standalone PDQS-based tool. Short-form diet quality screener was developed using expert knowledge and food consumption tables to include frequently consumed foods in each country version. Participants were invited to complete two nonconsecutive 24-hour diet recalls (24HRs) and short-form screeners (PDQS-24h, PDQS-30d-short, PDQS-30d-long). The U.S. participants were recruited via Amazon MTurk, and completed web-based ASA24 and PDQS-based screeners. In Tanzania, we interviewed a subset of DUCS cohort participants in Dar es Salaam during household visits, using locally developed 24HR. Short questionnaires included 22 (US) and 24 (TZ) food-based questions. The answer options were either frequency (e.g. once, twice) (US) or amount-based (e.g. one cup, two cups) (TZ). The Spearman rank correlation and linear regression were used to evaluate correlations and associations between the usual nutrient intakes and the total PDQS scores. Individual nutrient intakes were derived from foods using the USDA and Tanzanian food composition tables. Usual nutrient intakes were calculated from two days of 24HR data using the “NCI method”. Energy-adjusted intakes were calculated using the residual method. Several PDQS score calculation options were developed for comparison, from dichotomous (1,0) to a more granulated one. Finally, ‘healthy’ and ‘unhealthy’ PDQS components were grouped and separately evaluated in relation to nutrient intakes. The final samples included 291 U.S. and 262 Tanzanian women.

Median time required for completing the U.S. questionnaire was 4.9 minutes, compared to 21 minutes for required for completing ASA24. In Tanzania, all 6 enumerators and all participants reported that completing the questionnaires was easy. Preliminary results from the U.S. suggest varying rank correlations of the PDQS-24h with energy-adjusted intakes of some key nutrients: 0.18 (PUFAs), -0.37 (added sugar), 0.53 (fiber), 0.36 (folate), 0.34 (vitamin C), 0.39 (vitamin E), 0.49 (beta-carotene), 0.26 (zinc), 0.20 (iron), 0.49 (potassium) and 0.51 (magnesium). We will present the process and the findings of our current work, and discuss further steps in evaluating the PDQS-based screener as a potential tool for measuring and tracking diet quality.

Keywords: diet quality index, dietary assessment, nutrition surveillance, diet metrics, validation

A comprehensive approach for adapting and evaluating a Home Food Inventory to meet the cultural needs of diverse populations

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Heart disease, cancer and diabetes are three of the top 10 leading causes of death in the United States (US) and all are diet-related diseases. Latinos are the largest US immigrant population but they share an uneven burden of chronic disease. Understanding disease risk factors and developing culturally-appropriate population-level interventions are critical to reduce health disparities. Yet, such research is often stymied by the lack of measurement tools that are specific, appropriate, and valid for diverse populations. Poor measurement tools cloud our understanding of disease-risk factors and may lead to inaccurate conclusions regarding the impact of interventions. High-quality measurement tools are part of the essential infrastructure needed for understanding and evaluating population health and advance the science of diet-related diseases. While myriad factors influence diet-related chronic disease risk, food consumed at home accounts for half of all adult US food expenditures and represent the most proximal and modifiable factors that influence the foods and nutrients people consume on a daily basis. Unfortunately, few valid home food environment assessment tools exist and none have been validated with large, immigrant or low-literacy populations. In 2008, our team developed and validated a Home Food Inventory (HFI) to assess the healthfulness and obesity risk of home food environments using a checklist format. The HFI showed good reliability and construct validity and it has been used extensively in the field for NIH-funded studies by our team and many others. Yet, the original HFI can only be used with English-speaking populations, is quite lengthy and is paper-based. We will present our process for developing an accessible home food environment assessment toolkit for use in Latino populations. The toolkit will include paper and multi-media electronic tools targeting foods known to impact diet-related health and will be valid and reliable across literacy levels for both English and Spanish speaking users. We will describe our goal to facilitate broad use of the instruments through a permanent and easily-accessible storage platform and provision of a technological assistance platform for future language adaptations and testing.

Keywords: diversity, home, availability, dietary, validity

Adapting a home food inventory for an urban Minnesota Somali and Latina population

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Overweight or obesity during early childhood persists into adolescence and adulthood, carrying with it risk factors for cardiovascular disease, diabetes, psychological distress and other health consequences. Children of color from low-income families are more likely to be overweight or obese and face more obesity-related risk in general. This disparity is partially attributed to limited home access to healthy foods. As children's diets fall short of meeting dietary recommendations across food groups, the home food environment is an important environment to target for improvement. The Home Food Inventory (HFI) is a valid tool that assesses the healthfulness and obesity risk of the home food environment; however, it had not been validated in low-income families of color and non-English speaking households. We conducted research to extend the utility and cultural relevance of the HFI for families of color and test its validity. First, two focus groups were held with Spanish speaking and Somali speaking adults, two large immigrant populations in the area. The focus group process refined the HFI tool to represent availability of cultural foods. Few food item additions were needed and some deletions were requested by Somali participants. The HFI was revised, translated and underwent instrument validation in participants' homes using criterion validity. Thirty low-income families with preschool-aged completed the HFI simultaneously but independently with a trained staff member. Most validity indices were within an acceptable range. While the revised HFI was determined useful and replicable with other population groups, it became clear that not all participants were literate in English or in their native language. Thus, we partnered with an engineering firm to pilot a tablet-based application of the HFI (eHFI) that included visual and auditory support. The application allowed the user to select their preferred language (English or Somali) and each HFI item had a hyperlink to a photograph of the food item and a hyperlink to an audio file that read the item aloud in the selected language. eHFI feasibility and acceptability was tested in a Somali speaking community and deemed feasible and acceptable. Further development of the eHFI is proposed in future funding.

Keywords: culturally tailored, Spanish, Somali, home food inventory, application

S17. Closing the gap with digital dietary assessment

Chair: dr. Alison Eldridge

Symposium description

New technology-based dietary assessment tools facilitate dietary intake data collection by allowing users to capture food intake at the moment of consumption. Advancements in food identification and portion size estimation, along with personalized feedback make these tools attractive to consumers.

With these advancements, how close are we to closing the gap between new technology-based tools and traditional methods of dietary intake data collection? This symposium aims to Close the Gap on digital dietary assessment and features four presentations:

Current reality and gaps. Dr. Anne-Kathrin Illner (UniLaSalle, France) will lead with an evaluation of features of digital dietary assessment tools that facilitate accurate dietary intake data collection. She will discuss existing gaps in current technologies related to food identification, portion estimation, validation, and usability by different population groups. Dr. Illner will also provide guidance on how to assess performance of digital tools.

Closing the gap on 24-h recalls. Dr. Sai Das (Tufts University, USA) will discuss the state of the art of current dietary intake assessment technologies. She will share results from a recent study to compare real-time recording, image-assisted self-reported 24-h recalls, and traditional interview-assisted 24-h recalls with measured dietary intakes. She will also compare developer, researcher and end user perspectives and challenges using technology for assessment of energy balance.

Closing the gap on individualized feedback. Dr. Eileen Gibney (University College Dublin, Ireland) will provide insights on individualized feedback and personalization from digital assessment tools. She will address the issue of how to tailor messages to best respond to individual needs, based on dietary, phenotypic and genetic information. She will also examine how digital tools can facilitate behavioral change based on frequent feedback and personalized recommendations.

The future of digital dietary assessment. Damian Mehers (Nestlé Research, Switzerland) will explore technology tools to carry us into the future. Dietary intake data collection can be improved with better food recognition and quantification tools. These, along with sensors, 3-D cameras and other technologies, could improve the accuracy of dietary intake data collection over current methods.

New technologies are closing the gap on dietary intake assessment and show real promise for improving dietary intake measures compared to current methods.

Current reality and gaps in digital dietary assessment tools

Anne-Kathrin Illner 1)

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Introduction

Over the past decade, new technological advances, such as smartphones or wearables have opened innovative avenues for dietary assessment. These digital tools relate to new or improved ways to collect, handle, disseminate, exchange and analyse dietary data. While traditional dietary methodologies are relatively limited, the rapid evolution of new digital tools might confuse users' evaluation of their respective features and challenge the choices made.

Methods

This presentation gives an overview about the historical evolution and current reality of digital dietary assessment tools. Focus will be given on the evaluation of features, functions and uses of these tools aiming to outline different lines of evidence on food identification, portion estimation, validation, and usability by different population groups. Reference will be made to recently published reviews between 2011 and 2019.

Results

The use of new technologies to collect and process dietary data is especially, but not exclusively, promising for children, adolescents and younger adults who are familiar with such technologies in their daily lives. Since the early 2000s, digital tools reported in the literature have included both technically advanced approaches to traditional (self-report) methods (e.g. web-based FFQ) and technically new devices integrating objective identification and measurement features. A recent review from the International Life Sciences Institute (ILSI) Europe Dietary Intake and Exposure Task Force showed that among 43 tools evaluated, 33% used digital images to help identify foods. Fewer than 50% contained any features of customization and about half generated automatic reports. Most tools reported on usability or reported relative validity (77%). Different technology types can have overlapping features and quality standards may clarify the evaluation of their performance by clearly reporting on: (1) the specific purpose, (2) the measures, (3) the appropriate technology, (4) the customization features, and finally (5) on the design, pretest and validation of a given tool.

Discussion

Overall, dietary methodologies should benefit from new technologies, for example for personalized rapid feedback or cost-savings for large-scale studies. However, errors in data quality of self-administered tools remain. Best practice guidelines have therefore potential to provide valuable information identifying current gaps and harmonizing the reporting on digital tools.

Keywords: dietary assessment, digital, performance, best practice guidelines

Closing the gap on 24-h recalls

Sai Krupa Das

Jean Mayer, USDA, Human Nutrition Research Center on Aging at Tufts University, Boston, USA

Introduction: Technology has the potential to revolutionize nutrition research by enhancing, complementing, or even replacing traditional methods of dietary assessment. Current and emerging tools—from mobile applications (apps), to wearable sensors—aim to facilitate the collection of objective data and combat issues that diminish data quality. A major source of these issues is self-report, a method limited by social desirability bias and human memory. As a result, tools that rely solely on self-report are natural targets for improvement. Our team recently evaluated the accuracy of a new mobile app (PIQNIQ™) in capturing dietary intake. While PIQNIQ™ relies on self-reported data, it combines novel features with a streamlined interface for a low-burden user experience. Most notably, PIQNIQ™ includes a visual portion size selector with a slider to increase or decrease the amount of food on a virtual plate.

Methods: To evaluate the overall accuracy of PIQNIQ™ in estimating dietary intake, we used a provided-food protocol with three menus and randomly assigned participants (N = 132) to one of three “food capture” methods: real-time entry using PIQNIQ™, photo-assisted recall using PIQNIQ™, and traditional 24-hour recall.

Results: Reported nutrients using both PIQNIQ™ methods were, on average, overestimated in comparison to the consumed intakes. In comparison, only a few micronutrients were overestimated with the traditional 24-hour recall. However, in general, data capture using both PIQNIQ™ methods were highly comparable to 24-hour recall.

Discussion: Our results suggest that intuitive, low-burden methods of dietary data capture are well suited to the modern consumer and, with proper execution, can be just as accurate as non-invasive traditional methods. Moving forward, researchers and developers must join forces to understand the user perspective and overcome barriers to capturing high quality data. In developing new tools, experts should consider issues such as accessibility and customization, maintenance of linked databases, validation with biomarkers, and enhanced features for food recognition. All tools, regardless of type, also should perform optimally with a wide variety of food items.

Keywords: dietary-recall, technology, digital tools, intake assessment, mobile applications

Closing the Gap with Digital Dietary Assessment - Closing the gap on individualised feedback.

Associate Prof. Eileen Gibney

UCD Institute of Food and Health, University College Dublin, Ireland

Introduction - Personalised Nutrition allows individual differences in dietary, lifestyle, anthropometry, phenotype and/or genomic profile to be used to direct specific dietary advice. For personalised nutrition advice to be effective both sides need to be considered; firstly, that factors influencing variation in response to dietary intervention are identified and appropriate advice can be derived and secondly; that these are then used effectively in the provision of nutrition advice, resulting in positive dietary and / or lifestyle behaviour change. There is considerable evidence demonstrating genetic and phenotypic influence on the biological response to the consumption of nutrients and/or foods. Evidence examining the impact of using this information to derive personalised advice and effect behaviour change however is more mixed, with some studies demonstrating no effectiveness and others showing a significant impact.

Methods - To this end, the Food4me project examined whether provision of personalised nutrition advice based on information of an individual's diet, lifestyle, phenotype and/or genotype would promote larger, more appropriate, and sustained changes in dietary behaviour than general healthy eating advice.

Results - Results demonstrated that the provision of personalised advice did result in greater improvements in dietary intake in the personalised groups, compared to the control (general healthy eating guidelines) group, but that the level of personalisation (diet, diet + phenotype, diet + phenotype + genotype), had no effect. In essence to the participant, personalisation of advice was important, but not how that advice was derived.

Discussion - Digital tools and technological developments offer the potential to facilitate behavioural change based on feedback and personalised recommendations. However, for personalised nutrition to be effective, work is needed to develop feedback strategies and embrace that will suit the individual in terms of content, format, timing and frequency, and understand their impact on behavioural change.

Keywords: personalised, change, food4me, digital, feedback

The future of digital dietary assessment

Mehers D, Eldridge A

Nestle, Switzerland

Networked mobile devices, wearable sensors and “big data” are changing the world around us at a pace never experienced before. We will explore how advances in three parallel areas of development can be combined to render digital dietary assessment increasingly accurate: machine learning, augmented reality and context.

Firstly, significant increases in prediction and classification accuracy from cloud-based machine learning, especially in the visual field, are already happening in a general-usage context. While major technology providers have yet to release food-oriented specialized recognition models, this is likely to change soon and will address some of the limitations of the current state-of-the-art.

Secondly, the push towards augmented reality means that advanced sensors are becoming ubiquitous on mobile devices. We will explore how the latest generation of devices incorporate technological solutions, including multi-camera clusters and on-device radar, to attempt to address the issues of depth perception and volume estimation. Food quantification directly benefits from the drive to accurately map our environment in order to create realistic AR experiences.

Finally, we address the need for context in providing valuable insight into the problems of technology-assisted intake capture. We will discuss the impact of the availability, ease and scale of data that can be aggregated from seemingly disjointed sources such as time of day, geolocation, proximity of other people or other cues, crowdsourcing and open data initiatives.

Combining contextual information, machine learning and AR technologies means that digital dietary assessment, both in terms of recognizing food, and the assessing the quantity is increasingly capable and accurate. This presentation will review and present the state of the art in all three domains, focusing on the capabilities of the latest generation of mobile phones and the visual recognition offerings from the major cloud players including Microsoft, Amazon and Google.

Keywords: Digital, Augmented Reality, Context, Machine Learning

S18. Biomarkers for food and beverage intake – results from the FoodBall project

Chair: Prof. dr. Edith Feskens

Symposium description

The Foodball project is the largest project so far working on discovery and validation of biomarkers of food and beverage intake: 22 institutes of 11 countries were involved. State of the art metabolomics techniques were used, and were based on a fruitful collaboration with renown experts such as Prof Wishart, Canada, the founder of the human metabolome database. Common protocols were developed to test > 10 foods, and guidelines and SOPs are available. Blood and urine samples were analysed using various techniques (NMR, GC, LCMS) and important steps in data analyses were made as well. The results will be presented including new biomarkers discovered (example coca cola, dairy and others), the combination of biomarkers (fingerprints), the resulting toolbox (freely accessible, open science), and an outlook for use in future nutrition studies. We close with a further discussion on the use of biomarkers in nutrition, and the needs to maintain and further develop the toolbox .

Finding and Validating Biomarkers of Food and Beverage Intake by Metabolomics

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Background: Assessing food intake is fundamental to the field of nutritional research but relies on subjective dietary instruments. The extent of misreporting by these instruments is difficult to estimate. Biomarkers of Food Intake (BFIs) may provide an objective alternative to dietary instruments and help to estimate misreporting as well as compliance. Using more than one BFI may additionally help to evaluate sources of error.

Methods: Systematic literature reviews and metabolic profiling of meal studies were used in the FoodBall project to identify putative BFIs for all major food groups and many single foods. Combined biomarkers were constructed by using patterns of metabolites uniquely associated with specific foods or food groups. Validation of the simple or combined BFIs was performed according to a published standard protocol. Comparisons of candidate BFIs related to intake of alcoholic beverages, some protein-rich foods or fruit with intakes based on 24hr recalls, interviews or diaries/food records were subsequently carried out cross-sectionally in the PREVIEW (New Zealand), NU-AGE (Netherlands) and KarMeN (Germany) studies.

Results: Candidate BFIs were identified for more than 20 foods and food groups. Extended validation studies of fruit (e.g. banana) and some meats indicate good agreement with 24hr recalls with AUROCs \geq 0.9. However, 24hr recalls and dietary interviews are not always sufficiently detailed to allow comparison with BFIs for specific foods. For total alcohol intake, the concordance between BFIs and 24hr recalls was lower while concordance between independently measured alcohol markers was high.

Conclusion: The 24hr recall or dietary interviews show high concordance with novel BFIs for recent intake of some well-defined foods. For others such as alcohol, the concordance is lower indicating a particular need for BFIs to support dietary assessment instruments. Additional food intake examples indicate that lack of appropriate biomarker validation as well as misreporting variably contribute to failures in intake assessment. Further validation of dose-response and inter-laboratory comparisons are still needed for most BFIs.

Keywords: biomarkers, metabolomics

Biomarkers for Cola beverage consumption identified by untargeted GC-MS-based metabolomics approaches

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Introduction: Sugar sweetened beverages (SSB), among others cola beverages, substantially contribute to the consumption of sugar and excessive energy intake. A high sugar intake has been linked to, among others, weight gain/obesity, type 2 diabetes, heart disease, non-alcoholic liver disease and tooth decay. Nonetheless, these associations are not always consistent between different studies. This has been suggested to be a result of the limitations of traditional dietary assessment tools such as recall biases, accurate estimation of ingested amounts and in the case of SSB underreporting due to social desirability. Therefore, our aim within the FoodBALL project was the identification of biomarkers of cola beverage consumption, as one prominent example for SSB.

Methods: A randomized, crossover intervention study with a cola beverage and water as control was performed. Eleven participants (5 males, 6 females; age: 21-33 years) completed the study. Urine samples were collected at different time points and intervals: 0 h, 0-1 h, 1-2 h, 2-4 h, 4-6 h, 6-12 h, 12-24 h and 48 h. Samples were analyzed with the following untargeted metabolomics approaches: untargeted GC×GC-Scan-MS, semitargeted GC×GC-SIM-MS sugar profiling and untargeted HS-SPME-GC-MS profiling of volatile compounds.

Results: Using the untargeted GC×GC-Scan-MS metabolomics approach, around 25 compounds were found to increase after cola beverage consumption. Some of these compounds occurred frequently in urine (e.g. alanine and α -ketoglutaric acid) and are therefore unlikely as specific biomarkers, while other compounds (e.g. terpinol-like compounds) were rarer. As expected, both fructose and sucrose increased after the intervention with cola, but also an increase in more rare sugars (e.g. tagatose) could be observed using the semitargeted sugar profiling. In addition, more than 30 volatile organic compounds, measured using HS-SPME-GC-MS, increased after cola beverage consumption i.a. fenchol and eucalyptol.

Discussion: Using a combination of different GC-MS based untargeted metabolomics approaches several potential biomarker candidates for cola beverage consumption were discovered. Some of these compounds might in future be used individually or as a panel to assess cola beverage intake. Future work has to address validation criteria of these candidates and also the question whether these biomarker candidates might serve as biomarkers of SSB in general.

Keywords: biomarkers of food intake, cola, metabolomics, GC-MS, human urine

Non-targeted and targeted metabolomics to identify and validate biomarkers of fermented dairy intake

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Consumption of fermented dairy products have been associated with improved cardiometabolic health. However, conclusive evidence for this association is lacking, in part due to the limitations of traditional, subjective dietary assessment tools that may not accurately capture the “true” intake of these foods. Therefore, establishing validated biomarkers of fermented dairy intake is warranted. We aimed to identify and validate biomarkers of fermented dairy intake in a Dutch prospective cohort study (NQplus). The study comprised 2048 participants aged 20-77 years, with extensive data collected on dietary intake, cardiometabolic health, as well as blood and urine samples. A subcohort of 535 participants were selected for metabolomics analysis using criteria of complete dietary data and blood/urine samples collected within 14 days of dietary assessment. Fermented dairy intake was estimated from food frequency questionnaires and 24-hour recalls, and divided into energy-adjusted tertiles (g/day and g dry matter/day) for total, high-fat, and low-fat fermented dairy, cheese, and yoghurt. Plasma were analyzed by non-targeted and targeted metabolomics using liquid chromatography-mass spectrometry (LC-MS) and gas chromatography-mass spectrometry (GC-MS). The targeted panel consisted of ~50 candidate biomarkers selected from a systematic literature search, and includes compounds specific to foods (e.g., 3-phenyllactic acid for cheese), food groups (e.g., pentadecanoic acid for dairy), and dietary pattern (e.g., tyramine for fermented foods). Following initial pre-processing of the raw LC-MS data, 403 compounds were detected in plasma, and metabolome data from 456 participants were further analysed using orthogonal partial least squares discriminant analysis (OPLS-DA). OPLS-DA models were not valid for high versus low tertiles of fermented dairy intake. From the targeted panel, five initial compounds were identified using GC-MS (3-phenyllactic acid, pentadecanoic acid, indole-3-acetic acid, indole-3-propionic acid, indole-3-lactic acid). Of these, pentadecanoic acid showed a positive association with high-fat fermented dairy intake, with significant effects comparing low- versus mid-intake, and low- versus high-intake tertiles (Kruskal-Wallis and Conover-Iman; $p < 0.05$). Ongoing non-targeted and targeted metabolomics on urine samples will further supplement these analyses, and help improve overall dietary assessment of fermented dairy products.

Keywords: Fermented foods, metabolomics, biomarkers.

Metabolomics-based dietary biomarkers in nutritional epidemiology - current status and future opportunities

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Applications of metabolomics in nutrition research has increased in recent years. The applications can be generally be grouped into one of the following: (1) Applications to identify dietary biomarkers for single foods or for dietary patterns (2) Applications to dietary intervention studies to help understand metabolic alterations following certain diets and (3) Applications to diet-related diseases. With respect to dietary biomarkers there has been a proliferation of publications in this field: these biomarkers have the potential to act as objective measures of dietary intake thus overcoming some of the key issues with traditional assessment methods. To date, metabolomic profiling has been successful in identifying a number of putative biomarkers of food intake. Recently, we used an acute study design where participants consumed standardized breakfasts for three consecutive days over three weeks: the quantity of the food of interest was varied over the weeks. Calibration curves were constructed with the urinary proline betaine concentration against the known orange juice intake (g/day). Importantly, we then applied these calibration curves to biomarker measurement in a cross-sectional study and estimated citrus intake. Good agreement with the self-reported data indicated that this approach could be used in large epidemiology studies to estimate intake. Similarly, use of combination of biomarkers can be employed to study dietary patterns. While significant progress has been made in this field a number of challenges remain and will be discussed.

Keywords: biomarkers, metabolomics

S21. Statistical considerations for the use of biomarkers to assess dietary intake

Chair: dr. Pamela Shaw and dr. Lorraine Brennan

Symposium description

Diet is an important modifiable risk factor for many chronic diseases but remains difficult to measure due to the complexity of this exposure and due to the error and bias inherent in the usual self-reported instruments for dietary assessment. Objective dietary biomarkers offer the potential to improve our understanding of diet and disease but they also have statistical challenges related to accuracy and bias in their measurement. This session presents a number of statistical issues that arise in the assessment of usual intake with biomarkers, as well as analytical methods to address these issues and ultimately improve our understanding of associations between dietary intake and health. Dietary biomarkers considered in this session include: carbon stable isotope ratio markers, which have been shown to have promise as biomarkers of sugar, meat and fish intakes; urinary biomarkers of calcium, potassium and sugar intake; and serum blood concentration markers as measures of several nutrient intakes, including folate, alpha tocopherol and beta carotene. The first talk presents a method that makes use of both internal and external standards to calibrate carbon isotope ratio biomarkers to address measurement error, including systematic and random errors from batch-to-batch variability. The second talk considers the potential of using external information about the within : between person variability ratio to correct the distribution for within-person variability in a cohort with only single day information, using 24-hr urinary salt excretion as an example. Our third speaker will present prediction equations for several serum biomarkers and explore the added value that predicted serum biomarkers, multiply imputed from a subset, can have on improving the assessment of usual diet in a larger cohort that would otherwise rely on self-reported intake. Finally, our fourth speaker examines the use of urinary sucrose and fructose for validation of self-reported intake and presents general considerations for use of urinary biomarkers to adjust diet-health associations for measurement error. Common themes include how dietary assessment would be improved over the naïve method that ignores measurement error adjustments. Limitations to these methods, such as the degree to which a particular biomarker captures the relevant aspect of diet, will also be considered.

Calibration of Amino Acid Stable Carbon Isotope Ratios As Biomarkers of Human Diet

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Introduction: Stable isotope ratios are well established tools for assessing diet in animal ecology and there is growing interest in their use in nutritional epidemiology. The carbon isotope ratios of amino acids (CIR-AA) are promising candidate biomarkers for meat and sugar-sweetened beverage intake. The measurement of CIR-AA has technical challenges, including batch and run order effects. Use of internal and external standards run alongside experimental samples allows for the calibration of the measured values to adjust for this measurement error.

Methods: We developed a linear mixed-effects regression approach to develop a calibration equation that adjusts for the measurement error in CIR-AA predicted by run order and the variation in internal standards that were added to each sample. Batch effects were adjusted for using random effects for the intercept and slope for run order. The calibration equation coefficients are fit using external standards. Standard errors and confidence intervals were based on the bootstrap procedure. We evaluated the method using a hypothetical, computer simulated data comparing CIR-AA between two diet groups, where the true underlying measurement error structure and difference between groups was known. Our approach was compared to the naive method with no adjustment for measurement error. For further illustration we applied the method to data from a human feeding study.

Results: The numerical simulation study showed the method was unbiased and had valid type I error rates and 95% confidence intervals for large (>25) numbers of batches. For small batch numbers, there was a slight underestimation of standard errors and overestimation of confidence interval widths that were largely fixed by using the bootstrapped-t confidence interval. The naïve method produced inflated standard errors and confidence intervals that were too large. In the real data example, the proposed method reduced the standard errors over the naïve for CIR-AAs with larger effect sizes.

Conclusion: The calibration procedure is able to correct for additive measurement error introduced by batch and run order effects. The use of internal standards in the calibration model improved the precision of the diet comparisons over the unadjusted naïve method, which may improve the performance of this candidate biomarker.

Keywords: biomarker; calibration; carbon isotope ratio; measurement error

Estimating habitual salt intake distribution from 24-h urinary sodium excretion and the potential of the use of external within-person variance

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Introduction

There is growing interest in using biomarkers to assess a population's prevalence of inadequate nutrient intake. However, as repeated data collections are considered costly and burdensome, within-person variation is generally ignored. In this study the aim was to show the importance of correcting repeated 24-h urine collections for within-person variance to estimate the habitual salt intake and to explore the potential of using the ratio within:total variance from an external source (W:T variance) with single 24-hr urine collection.

Methods

Salt intake was predicted from data for 24-h urinary sodium excretion in adult kidney transplant recipients in 1992-1997 (n = 432) and 2006-2011 (n = 1159). The salt intake distribution of single-day measurements was compared with estimates from multiple 24-h urine collections, which were statistically corrected for within-person variance (National Cancer Institute method). Habitual salt intake was also estimated using single-day measurements and external variance estimates. From each distribution, the proportion below specified cut-off values was estimated

Results

In 2006-2011 the average habitual salt intake was 10.6 g/d (men) and 8.5 g/d (women); in 1992-1997 these values were 8.6 g/d and 7.5 g/d, respectively. The proportion with salt intake <6 g/d for men was 5% in 2006-2011 and 22% in 1992-1997. For women these proportions were 13% in 2006-2011 and 28% in 1992-1997. After correction for within-person variance the salt intake distribution was significantly narrowed. As a result, the proportion with salt intake <6 g/d was overestimated by 3-13 percentage points using single-day data. Using external W:T variance components and single 24-h urine collection resulted in similar habitual salt intakes as using repeated 24-h urine collections. However, sensitivity analyses showed the importance of a sufficient sample size for estimating variance components. Variation of the W:T variance showed up to 40 percentage points deviation in the proportion with intakes below a specified cut-off value.

Discussion

To estimate a population's salt intake distribution, it is important to correct 24-h urinary sodium excretion for within-person variance. Predicting habitual salt intake distribution using single-day measurements with external variances is promising; however a sensitivity analysis is recommended to show the effect of different external variances.

Keywords: biomarker of intake, within person variation, salt, external variance

Prediction equations for blood concentration markers for carotenoids, tocopherols, retinol, vitamin B12 and folate in the HCHS/SOL Nutrition and Physical Activity Assessment Study

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Introduction

Measurement error is a major issue in self-reported diet and this error, observed to have subject-specific and random components, can distort diet-disease relationships. Serum biomarkers present the opportunity to measure diet objectively, but their potential requires further study. These biomarkers are typically only practical to obtain in a subset of participants in a large cohort study. We developed prediction equations for the serum biomarker level for several nutritional intakes assessed in the Study of Latinos: Nutrition and Physical Activity Assessment Study (SOLNAS) and examined whether the predictive accuracy would be high enough to reliably detect an underlying diet-disease association in the larger Hispanic Community Health Study/Study of Latinos (HCHS/SOL) cohort, for which the majority would have a predicted exposure.

Methods

In SOLNAS, blood concentration biomarkers and participant characteristics were collected at baseline for 447 participants from the multi-center HCHS/SOL cohort ($n = 16,415$), namely for alpha-carotene, beta-carotene, alpha-tocopherol, gamma-tocopherol, vitamin B-12, beta-cryptoxanthin, retinyl palmitate, folate, lycopene, retinol, and zeaxanthin. We build regression-based prediction equations for these 11 biomarkers based on participant characteristics, including self-reported 24-hour dietary recalls. We used computer simulation to generate a hypothetical outcome, for which a true association between the concentration marker was modeled, to determine if this association was reliably detected when using the predicted biomarker level.

Results

Based on preliminary regressions, we observe R^2 values ranging from 0.504 to 0.101. Correlations between the concentration biomarker and self-reported measures ranged from 0.409 to 0.047, the highest being for beta- cryptoxanthin and lowest for vitamin B-12. When using predicted intake, power reduced from 89% for the true underlying biomarker level to 65% when the calibration-model $R^2=0.50$ and to 19% with the calibration-model $R^2=0.17$.

Discussion

For several concentration biomarkers, there were important predictive associations, but the accuracy was not high enough for predicted intakes to provide reasonable power in the larger cohort study. For these biomarkers to fulfill their promise as measures for dietary intake for outcome-diet association studies they would need to be measured in more individuals or predictive accuracy improved.

Keywords: biomarker, chronic disease, diabetes, diet, measurement error, prediction

Spot urine biomarkers and 24-hour dietary recalls: validation and measurement error correction

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In principle, daily diet can be recorded by 24-hour dietary recalls (24HDR). However, daily self-reported data are subject to daily variation and measurement error (ME). Both lead to biased estimation of associations between dietary exposures and health outcomes. Often these associations cannot be corrected using repeated measurements because of systematic or differential MEs. Here, objectively measured biomarkers are a promising approach to correct for these errors. However, only a few dietary biomarkers exist and the available correction methods are not fully exploited.

Hence, we investigated two recently proposed biomarkers: sugar and sodium-potassium ratio (Na:K) measured in morning urine for validation of 24HDR-reported sugar intake and for correction of associations between Na:K and blood pressure. To this end, different statistical methods were applied to the data of children and adolescents from the pan-European IDEFICS/I.Family cohort. Correlation coefficients, the method of triads and linear regression models were used for validation purposes (based on $n=228$ children). The naïve method was compared with the so-called NCI-method and the classical regression calibration approach using 24HDR and/or urine data to assess the effect of the method-specific corrections (based on $n=13.553$ children).

The maximum correlation between 24HDR-reported sugar intake and urinary sugar was 0.38. The method of triads revealed validity coefficients for the 24HDR from 0.64 to 0.87. Linear regression models showed statistically significant positive associations between sugar intake and urinary sugar.

The fitted error model used in the regression calibration approach revealed an increase of 0.94 urinary Na:K per one unit of 24HDR-reported Na:K. Nevertheless, the different correction methods led to contradictory estimates for the association between Na:K and blood pressure depending on whether the biomarker or 24HDR was used as reference instrument.

In conclusion, the validation analysis supported the relative validity of sugar intake assessed by self-reported 24HDRs in children and adolescents. The correction analysis revealed that careful interpretation of error-corrected associations is needed since these can still be affected by differential error or random error due to daily and spot urine variation. To overcome this, combined and repeated 24-hour urine and 24HDR data are necessary.

Keywords: fructose, NCI-method, potassium, sodium, sucrose

ORAL PRESENTATIONS

S3. Comparison and validation research

Validation of the Web-Based Self-Administered 24-hour Dietary Recall myfood24-Germany: comparison with a weighed dietary record and biomarkers

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Introduction: Web-based self-administered 24-hour dietary recalls (24HDR) are promising to facilitate dietary assessment in large-scale studies. myfood24 (Measure Your Food on One Day) is a fully automated web-based 24HDR that has been adapted for Germany. Our aim was to validate myfood24-Germany by comparing its performance with a weighed dietary record (WDR) and urinary biomarkers.

Methods: A convenience sample of 97 adults (77% female) aged 17-78 years completed a 24HDR with myfood24-Germany, a WDR and a 24-hour urine collection for the same day. First, intake of energy and 32 nutrients assessed by myfood24-Germany and WDR were compared (method comparison). For the method comparison, Spearman's correlation coefficients and percentage difference between intake values were calculated and a paired t-test for ratios was performed. Second, intakes of protein and potassium assessed by myfood24-Germany/WDR were compared with intake estimated from urinary biomarkers (biomarker comparison). For the biomarker comparison, Lin's concordance correlation coefficients (ρ_c), percentage difference and weighted kappa coefficients (κ) were calculated. Enhanced Bland-Altman plots were generated in order to identify biases.

Results: Method comparison: Significant correlations were found for energy and all nutrients (range: 0.45 for iodine to 0.87 for cholesterol). There was no significant difference between both methods in the assessed mean energy and macronutrient intake. However, myfood24-Germany significantly underestimated mean intake of 15 nutrients (range: -8% for SFA/calcium/total sugar to -42% for VitB12) and overestimated intake of MUFAs by 57%. Biomarker comparison: Protein intake reported by myfood24-Germany/WDR was on average 10%/8% lower than protein intake estimated by biomarker. There was no significant difference in mean potassium intake assessed by myfood24-Germany/WDR and biomarker. However, enhanced Bland-Altman plot revealed a shared bias in the assessment of potassium intake that seemed partly responsible. Concordance correlation and weighted kappa coefficients confirmed good agreement with biomarker for myfood24-Germany/WDR in case of protein ($\rho_c = 0.58/0.66$, $\kappa = 0.51/0.53$) and moderate agreement in case of potassium ($\rho_c = 0.44/0.51$; $\kappa = 0.30/0.33$).

Conclusion: myfood24-Germany showed good agreement with a WDR in short-term assessment of energy and nutrient intake. Both methods showed a similar extend of measurement error compared to biomarkers. Our results suggest that myfood24-Germany is of comparable validity to traditional dietary assessment methods.

Keywords: dietary assessment, 24-hour recall, myfood24, validation study

Relative validity of a food frequency questionnaire for assessing dietary patterns and food group intake in older New Zealand adults: The REACH study

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Dietary pattern analysis considers the overall dietary intake and combinations of foods eaten. Valid dietary patterns are necessary to assess diet-disease relationships with confidence.

This study evaluated the relative validity of a food frequency questionnaire (FFQ) designed to assess a posteriori dietary patterns and food group intake in older adults. Participants were a subset of the Researching Eating, Activity, and Cognitive Health (REACH) study (n=294, 37% men) aged 65-74 years, living in Auckland, New Zealand. Participants completed a 109-item FFQ and a 4-day food record (4-DFR) to assess validity. Foods from both dietary assessment tools were assigned to 57 food groups. Principal component analysis and varimax rotation was applied to the food group consumption reported in the dietary assessment tools to derive dietary patterns. Agreement of dietary pattern loadings was assessed using Tucker's congruence coefficient. Agreement of dietary pattern scores and food group intakes was assessed using Spearman correlation coefficients, weighted kappa statistic, and Bland-Altman analysis including limits of agreement, plots, and slope of bias.

Three similar dietary patterns were identified by both dietary assessment methods: 'Mediterranean', 'Western', and 'prudent', explaining 14-18% of the variation in the diet. When the two methods were compared, congruence coefficients between factor loadings ranged from 0.54 to 0.80; whereas correlations of dietary pattern scores ranged from 0.33 to 0.43 (all $p < 0.001$), weighted kappa scores from 0.27 to 0.37, and limits of agreement from ± 2.09 to ± 2.27 . A negative slope of bias was seen for the 'prudent' pattern ($p < 0.001$).

The REACH FFQ generated dietary patterns with acceptable validity and is suitable for examining diet-disease associations in older New Zealand adults.

Keywords: Dietary patterns, validity, principal component analysis, dietary assessment, congruence coefficient

Evaluation of the New Zealand Women's Food Frequency Questionnaire to assess nutrient intakes in women: the PROMISE Study

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Background: Food frequency questionnaires (FFQ) are commonly used for dietary intake assessment due to their ease of administration, low cost and ability to assess nutrient intake over an extended period. All FFQ's are not free of error and need to be evaluated for use in their intended population.

Aim To validate the semi-quantitative New Zealand (NZ) women's FFQ (NZWFFQ) in 18-45-year-old NZ European (NZE) and Pacific women participating in the PROMISE study, in Auckland.

Methods: Participants were premenopausal NZ women (n=287) of NZE (n=161) and Pacific (n=126) ethnicities. Women completed the NZWFFQ designed to assess the dietary intake of 31 nutrients over the previous month, and a five-day estimated food record (5d-FR). We assessed relative validity by comparing the nutrient intakes of both tools using Wilcoxon signed rank test, Spearman's correlation coefficients, cross-classification, weighted kappa statistic and Bland-Altman analysis. Validity was evaluated for energy adjusted data for the total group and independently for each ethnicity.

Results Overall, the intake from the NZWFFQ was higher than the 5d-FR for all nutrients (6%-113% difference), except iodine (-16%). For the total group, energy-adjusted correlation coefficients ranged from 0.17 to 0.66, and were highest for the NZE group (0.27-0.73) and lowest for the Pacific group (0.05-0.42). Correct classification into same and adjacent quartiles of intake, and gross misclassification into opposite quartiles, were respectively 65.6-87.5% (average 77.5%) and 1.0-9.8% (average 5.41%) for the total group, and on average 81% and 3.6% for the NZE group, and 71.2% and 7.6% for the Pacific group. The weighted kappa showed slight to moderate agreement for both the total group (0.12-0.47) and for NZE (0.16-0.54), and slight to fair agreement (-0.10-0.28) for Pacific women. Bland-Altman analysis showed wide limits of agreement for nutrients in each group, with wider limits of agreement and larger mean differences for the Pacific group.

Conclusion: The NZWFFQ overestimated intake of most nutrients. While not suitable for assessing absolute nutrient intakes, the NZWFFQ demonstrates validity and is suitable for ranking NZ women by nutrient intake. However, it differed in performance between ethnic groups, performing well for NZE women, but less so for Pacific women.

Keywords: Food frequency questionnaire, dietary assessment, validity, multi-ethnic, women

The Cancer Prevention Study-3 Food Frequency Questionnaire is a Reliable and Valid Measure of Nutrient Intakes among Racial/Ethnic Subgroups, Compared with 24-Hour Recalls and Biomarkers

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Introduction: Valid assessment of dietary intake in diverse populations is important for studies of chronic disease risk in the U.S. We evaluated the reproducibility and validity of a food frequency questionnaire (FFQ) modified for the American Cancer Society's Cancer Prevention Study-3 (CPS-3) prospective cohort, using multiple 24-hour recalls (24HRs) and biomarkers in a racially/ethnically diverse subgroup.

Methods: The Diet Assessment Substudy included 677 CPS-3 participants (64% women; 61% non-Hispanic white, 24% non-Hispanic black, 15% Hispanic), aged 31-70, who completed two FFQs one year apart (FFQ1, FFQ2), 4-6 telephone-administered 24-hour recalls (24HRs), and two fasting blood samples and 24-hour urine collections approximately 6 months apart in the interim. Spearman rank correlation coefficients (ρ) were used to evaluate FFQ reproducibility and validity compared with 24HRs for 67 nutrient exposures. For 18 of these nutrients, we used the method of triads to calculate validity coefficients (VC, ρ) from pairwise correlations of FFQ2, 24HRs and biomarkers. Analyses were stratified by sex, race/ethnicity, education and body mass index (BMI).

Results: Mean FFQ reproducibility correlations were $\rho=0.65$ (0.50-0.91) for men and $\rho=0.63$ (0.37-0.89) for women; mean energy-adjusted, deattenuated correlations of FFQ2 with 24HRs were $\rho=0.60$ (0.33-0.84) for men and $\rho=0.55$ (0.21-0.79) for women. Among men, FFQ2 VCs (ρ) ranged from 0.42 for β -cryptoxanthin to 0.91 for omega-3 fatty acids, and among women, from 0.41 for sodium to 0.79 for total vitamin D. Mean FFQ reproducibility and validity, respectively, were highest among white ($\rho=0.68$, $\rho=0.58$) and slightly lower among black ($\rho=0.57$, $\rho=0.49$) and Hispanic ($\rho=0.59$, 0.55) participants. FFQ reproducibility and validity were slightly lower among those with less than a four-year college degree, and those with a BMI \geq 30 kg/m².

Discussion: Reproducibility and validity of the CPS-3 FFQ was comparable to similar studies for most nutrients, among all subgroups. These findings support future dietary analyses using this FFQ in the contemporary CPS-3 cohort.

Keywords: reproducibility, validity, food frequency questionnaire, race/ethnicity, biomarkers

Accuracy of Tablet vs. Paper Based 24-Hour Individual Dietary Recall Compared to Weighed Food Records in Burkina Faso and Viet Nam

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Objective:

Information on populations' diets is essential to design effective nutrition programs, but availability is hindered by perceived high costs, complexity, and delays in obtaining results. The International Dietary Data Expansion (INDDEX) Project is developing a tablet-based system (INDDEX24) for conducting individual 24-hour dietary recalls (24HR), linked to a set of web-based dietary data inputs to facilitate analysis. Our objectives were to compare the relative accuracy of a 24HR using the traditional pen-and-paper (PAPI) approach vs. INDDEX24 approach in low- and middle-income country contexts.

Methods:

We conducted a 24HR on adult women in Burkina Faso (n=234) and Viet Nam (n=234) to assess the relative accuracy of INDDEX24 versus PAPI compared to a weighed food record (WFR) for measuring energy intake, macronutrients, vitamin A, iron, calcium, zinc, vitamin C, dietary fiber, and phytate, and food groups such as animal source foods. The analyses also examined potential sources of any differences in accuracy between modalities.

Results:

INDDEX24 was as accurate as the traditional PAPI 24HR across these key nutrients and food groups. Portion size estimation, food away from home, less commonly consumed foods, and nonstandard recipes introduced some inaccuracies across both modalities as did respondent omissions, which are recognized limitations of the 24HR method. Qualitative feedback from the enumerators showed that they generally preferred using INDDEX24 compared to conducting the 24HR using PAPI.

Conclusions:

Dietary assessment in low- and middle-income countries is successfully facilitated using a validated, integrated system on a tablet linked to a web data base housing country-specific inputs such as food composition data, standard recipes, and conversion factors.

Keywords: Validation study, dietary assessment, innovative technology, low- & middle-income countries

The dynamic food metabolome: implications for dietary assessment and nutrition research

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The dynamic nature of the food metabolome is well known, but often ignored. Food composition, especially of plant-based foods, is highly variable and depends on numerous factors such as cultivar, growing conditions, storage and processing. However, in nutrition research, this variability is often dealt with by a brief statement under "limitations", but otherwise food composition is assumed to be constant and point estimates are used to calculate intakes of individual compounds. This is likely to introduce a considerable measurement error: for example, tea, a major source of bioactive flavan-3-ols, contains between 10 to 330 mg/100g flavan-3-ols.

Research into the limitations of self-reported dietary assessment methods has thus far focused on misreporting, but the impact of the variability in food content has been largely ignored. Regression calibration, often used to address errors introduced by misreporting, relies on a known relationship between reported and true intake. As the variability in food composition is random and not predictable, this method is not suitable here.

In order to investigate the impact of the variability of food composition on dietary assessment and nutrition research, we have used three bioactives for which detailed dietary and biomarker data were available and which are known to affect health endpoints: the individual compounds nitrate and (-)-epicatechin, and flavan-3-ols as an example for a compound class. We have used food composition databases that include data on the distribution of food content to estimate possible dietary intakes based on 7-day food diary data and compared these results with data from nutritional biomarkers in up to 25,000 participants of EPIC Norfolk.

Our results show very little agreement between intakes estimated using dietary data and biomarker estimated intakes. Moreover, there is very little agreement between intakes calculated using mean food content, as is common practice, and intakes calculated using minimum, maximum or simulated food content. In further analyses, we have explored how the variability in food content affects estimated cross-sectional associations between bioactive and blood pressure. Our results show that, depending on food composition, observed associations varied considerably. Indeed, using the self-same dietary data, we could find positive and negative associations depending on food content.

Our results show that the variability in food composition makes the reliable assessment of intake based on dietary data alone impossible and estimated associations between intake and health endpoints are unreliable.

Keywords: Nutritional biomarker, dietary assessment, bioactives

S4. Usual intake analysis

Within-person variation in nutrient intakes across populations and settings: implications for the use of external estimates in modeling usual nutrient intake distributions

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Introduction: To determine the prevalence of inadequate or excessive nutrient intakes in a population, repeated 24-hour dietary intake measurements per subject allow for adjustment of modeled usual nutrient intake distributions for the proportion of total variance attributable to within-individual variation (WIV:total). When only single-day dietary data are available, an external adjustment factor can be used, but there is no formal guidance for selecting this value. We described variation in WIV:total across populations and settings and investigated implications of this variation on modeled prevalence of inadequate nutrient intake.

Methods: Reported ratios of within- and between-individual variance components of nutrient intake (as WIV:total) were compiled from the literature, and new values were calculated from analyses of existing data sets using a linear mixed model, adjusting for weekend (where available) and interview sequence. Nutrients assessed included total energy intake, total vitamin A, retinol, carotenoids/beta-carotene, folate, vitamin B12, thiamin, vitamin C, iron, and zinc. The potential impact of variation in WIV:total (from 0.05 to 0.99) on estimates of prevalence of inadequacy was assessed through simulation analyses of datasets from Cameroon and Bangladesh using the NCI 1-d method.

Results: Variance component values were extracted from 37 publications from 23 countries, and additional values were calculated from 15 datasets from 11 countries. Wide variation in WIV:total (from 0.02 to 1.00) was observed in publications and reanalyzed datasets. WIV:total varied by nutrient, across studies, by age in children and between rural vs. urban settings. Simulation analyses indicated that the estimated prevalence of zinc and vitamin A inadequacy were sensitive to the selected ratio (e.g. WIV:total values of 0.05 versus 0.99 yielded a difference of 37 percentage points for zinc in Cameroon), while prevalence of folate inadequacy remained largely unchanged.

Discussion: Given wide variation of observed ratios with few discernible patterns, the collection of repeated days of intake data in population dietary studies is strongly encouraged. When analyzing single-day dietary studies, selection of an external WIV:total estimate should consider comparability of population characteristics, study design and statistical methods. Sensitivity analyses are recommended to determine the robustness of prevalence estimates to changes in the variance ratio.

Keywords: measurement error, within-individual variation, micronutrients, usual nutrient intake distribution

Estimation of habitual dietary consumption with a multiple-source method and validation of its utility against nutritional biomarkers: the United Kingdom National Diet and Nutrition Survey

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Introduction: In population-based research, the multiple-source method (MSM) is considered advantageous to estimate habitual dietary consumption by accounting for within-individual dietary variation and related variables of sociodemographic and behavioural characteristics. However, empirical evidence for the validity of using MSM remains unestablished. We aimed to examine the validity of using MSM against nutritional biomarkers in a nationally-representative survey.

Methods: We estimated habitual consumption of major foods and nutrients of 6733 adults in the rolling programme of the United Kingdom National Diet and Nutrition Survey (2008-2017) in two ways. First, we crudely averaged dietary estimates from 4-day diet records. Second, we further modelled hierarchical regression to adopt the MSM and incorporate seasonal and weekday-weekend variations of dietary intakes, and interview-based characteristics of sociodemographic, behavioural, and dietary (e.g. vegetarian diet) factors. Using the estimates from each of the two approaches in linear regression analysis, we examined multivariable-adjusted associations of the estimated dietary intakes with their corresponding biomarkers. For example, in our primary analysis, we compared dietary intakes of carotenoids (sum of β -carotene, α -carotene and β -cryptoxanthin) and green-leafy vegetables with biomarker measures of circulating carotenoids that are known to reflect habitual consumption of carotenoids and their food sources. We also evaluated other pairs of nutrient intakes and their corresponding biomarkers: for example, B-vitamin intakes and homocysteine concentrations; intakes and 24-hour urinary concentrations of sodium and potassium; and protein intakes and 24-hour urinary nitrogen concentrations.

Results: MSM shrank the distribution of the estimated intakes of total carotenoids from 2125 (321.5-9526) $\mu\text{g}/\text{day}$ to 1336 (489.0-3250) $\mu\text{g}/\text{day}$ on average (5th to 95th percentiles). MSM strengthened the associations of carotenoid and green-leafy vegetable intakes with circulating carotenoids, with β s (95% confidence intervals; partial correlation r) per 1000 $\mu\text{g}/\text{day}$ of carotenoid intakes of 0.037 (0.033-0.042; $r=0.27$) and 0.21 (0.19-0.23; $r=0.40$) $\mu\text{mol}/\text{L}$ before and after employing MSM, respectively; and 100 g/day of green-leafy vegetables, 0.36 (0.28-0.43; $r=0.16$) and 1.3 (1.1-1.5; $r=0.22$). MSM also strengthened associations of the other nutrient-biomarker pairs.

Conclusions: This study evaluating nutritional biomarkers provides new empirical evidence for the validity of using MSM at least to characterise between-individual differences in habitual dietary consumption in population-based research.

Keywords: Biomarker, habitual intake, statistical analysis, nutritional epidemiology, multiple source method

A new statistical method for estimating usual intakes of nearly-daily consumed foods and nutrients using only one 24-h dietary recall

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Background: To estimate usual intake distributions of dietary components, collection of non-consecutive repeated 24-h dietary recalls is recommended, but resource limitations sometimes restrict data collection to a single-day dietary data per person.

Objective: We developed a new statistical method, the NCI 1-day method, that uses single-day dietary data and an external within- to between-person variance ratio to estimate population distributions of usual intake of nearly-daily consumed foods and nutrients.

Methods: We used NHANES 2011-2014 data for men (n=4938 and n=4293 for the 1st and 2nd 24-h recalls) to compare nutrient intake distributions of vitamin A, magnesium, folate, and vitamin E generated by the 1-day method (using only the first recall per person) with those from the NCI amount-only method (using all days of dietary intake per person). The within- to between-person variance ratio from the amount-only model was used as the unbiased “external” estimate for the 1-day method. We also examined the effect of mis-specification of variance ratios on usual intake distributions.

Results: The amount-only and 1-day methods estimated statistically equivalent median (25p, 75p): 647 (459, 890) vs 648 (461, 886) µg retinol activity equivalents/d, 338 (268, 420) vs 334 (266, 417) mg magnesium/d, 595 (458, 762) vs 589 (456, 758) µg dietary folate equivalents/d, and 9.7 (7.3, 12.6) vs 9.6 (7.3, 12.7) mg vitamin E/d. As the external variance ratios increased from 25% to 200% of the unbiased ratios, the prevalence of inadequate intake ranged from 53% to 43% for vitamin A, 57% to 55% for magnesium, 16% to 2% for folate, and 70% to 73% for vitamin E.

Conclusion: The 1-day method is a viable statistical method for estimating usual intakes of nearly-daily consumed dietary components when the variance ratio is unbiased. Results are sensitive to variance ratio selection, so researchers should still collect replicate data where possible.

Keywords: Usual intake, statistical method

Reducing measurement error and strengthening diet-disease associations by combining baseline and repeated dietary intake data: a case-study of fruit intake and IHD risk in UK Biobank

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Introduction

Measurement error is an important issue in nutritional epidemiology that may lead to underestimation of the magnitude of diet-disease relationships. One method to correct for this ‘regression dilution bias’ is to measure diet repeatedly over follow-up and combine baseline and follow-up information. The aim of this study was to compare the association between fruit intake and risk of ischemic heart disease (IHD) using a single dietary measurement and an additional repeated dietary measurement.

Methods

We used data for 432,785 participants from UK Biobank with information on fruit intake collected via a touchscreen questionnaire at baseline (2006-2010) and linked hospital admissions and mortality data for IHD. For a sub-sample (n=154,430), dietary intakes were re-measured (2011-2012) using an online 24-hour dietary questionnaire. We used two different exposures, both adjusted for potential confounders: 1) mean intakes of fruit at baseline divided into quartiles; 2) mean intakes from each participant’s latest 24-hour-dietary questionnaire during follow-up assigned to the baseline fruit intake quartiles of all participants. We calculated trends in risk of IHD using multivariable-adjusted Cox regression for these two different approaches.

Results

The mean intakes of fruit by quartiles were 58, 160, 262, and 364 g/day using the touchscreen survey, and 102, 174, 242, and 310 g/day using the repeated 24-hour-dietary questionnaire. Over a mean follow-up of 8 years, 12,088 participants were diagnosed with or died from IHD. Higher fruit intake using baseline data only was associated with a 5% lower IHD risk per 200 g/day higher intake (Hazard ratio 0.95, 95% Confidence Interval 0.92-0.98), while higher fruit intake using the assigned means from the latest 24-hour-dietary questionnaire was associated with a 7% lower IHD risk (0.93, 0.88-0.98).

Discussion

We describe the difference between using a single versus a combination of baseline and a repeated measurement of dietary intake to investigate the association between fruit intake and risk of IHD in UK Biobank. Our findings suggest that using repeat measurements in a subsample reduces regression dilution bias and thereby improves the accuracy of the estimated associations between diet and disease.

Keywords: measurement error, prospective cohort, regression dilution bias, diet, risk

Correcting the effects of salt and alcohol intake on blood pressure using simulation extrapolation for 24-hour dietary recall data

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New dietary assessment tools require appropriate correction methods since dietary data are commonly error prone. Otherwise, the naïve approach, ignoring the inherent measurement error, would lead to biased effect estimates when investigating the association between dietary exposures and health outcomes. In recent years the 24-hour dietary recall (24HDR) has become the primary instrument to assess diet in epidemiological studies. The 24HDR intake data are characterised by skewed and zero-inflated distributions with a high proportion of intra-individual variance caused by daily variation and erroneous self-reports. The recommended correction method for 24HDR, the so-called NCI method, is based on the regression calibration approach. However, a recent review revealed that available error correction methods are applied too rarely in nutritional epidemiology.

We introduce a new correction method for 24HDR data based on the simulation extrapolation (SIMEX) approach. The idea of SIMEX is to (1) generate remeasurements of the original data with additional measurement error to obtain even more biased estimates and (2) to estimate the functional association between the measurement error and effect estimates which is then extrapolated to the hypothetical case of zero measurement error.

We apply this method to 24HDR data from 878 participants of the I.Family study to correct the association of blood pressure with salt and alcohol intake. The SIMEX algorithm leads to an estimated increase of 0.7 (0.8) mmHg in systolic blood pressure per 1 gram daily salt intake (per 10g daily alcohol intake), which is 2.7 (2.3) times higher than ignoring the measurement error.

Furthermore, we compare the proposed SIMEX algorithm with the NCI method in a simulation study. The SIMEX algorithm leads to an estimate with either lower MSE or nearly unbiased estimates.

In conclusion, SIMEX is a promising alternative for modelling associations between dietary exposures assessed using a 24HDR and a health outcome. Its advantages are the easy implementation, a lower MSE compared to the NCI method and the provision of a comprehensible illustration showing consequences of measurement error which could be beneficial especially for non-statisticians.

Keywords: measurement error, NCI method, SIMEX

Comparing different latent transition models to estimate the usual prevalence of dietary patterns

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Background: Procedures to handle with the day-to-day variation of dietary intake and the estimation of the usual prevalence of dietary patterns are often discarded.

Objective: This study aims to compare different latent transition models to derive habitual dietary patterns from two 24-hour dietary recalls.

Design: Participants are from the National Food, Nutrition and Physical Activity Survey of the Portuguese population, 2015-2016 (2029 women; 1820 men aged ≥ 18 years). Diet was collected by two 24-hour dietary recalls (8-15 days apart). Dietary patterns were derived by: 1) latent transition model assuming measuring invariance, with and without concomitant variables (age and sex); 2) latent transition model assuming measuring variance with and without concomitant variables (age and sex). The latent transition model allows the transition from one pattern to another, with the same concomitant variables.

Results: By using a latent transition model assuming measuring invariance, three patterns were identified: “Diet-in-transition” (higher red meat and alcohol intake; followed by middle-aged men), “Western” (higher meats/eggs and energy-dense foods intake; followed by younger men), and “Traditional-Healthier” (higher intake of fruit, vegetables and fish, characteristic of older women). Most individuals followed the same pattern in both days, but around 26% transitioned between “Diet-in-transition and “Western”. The prevalence of the dietary patterns using a single recall day (40%, 27%, 33%, respectively) is considerably different from the usual prevalence (at the long-run) obtained by the latent transition probabilities (48%, 36%, 16%). The results were similar when assuming latent transition model with measuring variance.

Conclusions: The transition probabilities allowed estimating the usual prevalence (at the long-run) of dietary patterns that are deviating from traditional habits. Three dietary patterns, largely dependent of age and sex, were identified by the latent transition model, but two (out of five) groups of subjects have the usual intake transient between patterns.

Keywords: Feeding behavior, latent class analysis, latent transition analysis, usual intake.

S7. Combining methods

Activity tracking smartphone apps: characterising temporal patterns in app usage and physical activity behaviour.

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Background: Commercial fitness and activity tracking smartphone apps are becoming ever more ubiquitous and generating a large volume of physical activity data. Utilisation of this data has the potential to provide new insights into physical activity behaviours. However to successfully utilise these app data to assess population activity levels we need to understand patterns of app usage alongside the patterns of physical activity behaviour they record.

Aim: To use commercial app data which incentivised activity to identify temporal physical activity behaviour patterns and patterns of app usage, characterising the sociodemographic features of these behaviours.

Methods: Daily activity data from 30,804 app users with 7 or more days of recorded activity over the course of 2016 were used. Activity data included step count, activity duration, activity speed and distance for each different type of activity recorded e.g. walking, cycling, running, as well as daily totals for every day users recorded activity in 2016 (median= 218 days). Corresponding sociodemographic data was available for each user. A range of unsupervised machine learning methods were applied and evaluated including k-means, DBSCAN and Gaussian mixed methods. Levels of association between app usage and recorded activity behaviours were explored to further identify key sociodemographic participant characteristics.

Results: Machine learning methods were evaluated in the context of real-world insights and most applicable methods utilised. Seven main clusters of app usage across 2016 were identified using k-means clustering. These clusters included: 'low-intermittent users', 'multi-activity continued usage', 'increasing incentivised' and 'decreasing usage'. Patterns in activity intensity e.g. activity duration and step count were observed to differ between clusters. Descriptors of the behaviours identified by the machine learning methods were created to indicate the real-world behavioural patterns identified by the unsupervised methods and compared to physical activity behavioural patterns identified in primary data collection studies.

Conclusion: Fitness and activity tracking apps are valuable as data sources of activity over long temporal periods, allowing identification of patterns, characteristic of different socioeconomic groups, unseen in shorter duration studies. Caution must be taken to consider patterns of app usage alongside observed patterns in activity behaviour as the two are not mutually exclusive.

Keywords: Physical Activity, Machine Learning, Smartphone, Big Data, Activity behaviours

Evaluation of a photographic food record to assess evening meal intake of 18-month-old children in the Baby's First Bites Study

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Introduction: Assessing dietary intake in toddlers is challenging. The acquirement of dietary intake information for this age group is dependent upon adults, e.g. parents or caregivers. To overcome challenges such as recall bias and underreporting, and reduce the burden on participants and researchers the use of photographs in addition to a food record to assess intake more objectively may be a solution. Previous validation studies of this method, mostly performed among adults in controlled settings, showed promising results. However, there is a lack of studies validating this tool in toddlers in a home-setting. **Objective:** To evaluate the relative validity of a photographic food record (PFR) to assess evening meal intake in 18-month-old children in a home-setting.

Methods: A sub-sample of 15 mother-child dyads participating in the Baby's First Bites study were included. The PFR consisted of a detailed description of the meal provided by the mother, total weight of the meal, and photographs of the meal before and after consumption. A weighed food record (WFR) was used as a reference method. The methods were performed independently by two researchers during the same home visit at dinner time. Portion sizes were estimated or weighed and converted into energy and macronutrient intakes. Paired t-tests, Pearson correlation coefficients, joint-percent agreement and Bland-Altman plots were used to compare the methods.

Results: Mean differences between energy and macronutrient intakes assessed by the PFR and WFR were non-significant ($p > 0.05$). For energy and macronutrients, Pearson correlation coefficients ranged between 0.93 and 0.99 and percentage of individuals classified into the same tertile of intake ranged between 73.3%-93.3%. Bland-Altman 95% limits of agreement for energy, carbohydrate, protein and fat intake ranged from -102.5kJ to 114.7 kJ, -4.4 to 3.8 en%, -1.2 to 1.6 en% and -5.1 to 5.5 en% respectively. Thereby, the plots showed consistent bias over different levels of intake.

Conclusion: The PFR is comparable to a WFR, to assess evening meal intake among 18-month-old children, at group level, and for ranking the children according their intake, but not to assess their absolute level of energy and macronutrient intake.

Keywords: dietary intake, food record, children, photo

Combination of assessment methods for intake of fatty fish and fruit/vegetables and validation against objective biomarkers

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Introduction: Irregular diet impairs estimations from food records. Combination of assessment methods and objective biomarkers may improve dietary data. Our aim was to examine reproducibility and compare self-reported intake of fatty fish and fruit/vegetables from two assessment methods, and to validate intake data using objective biomarkers of fatty fish and fruit/vegetables.

Methods: The Malmö Offspring Study (MOS) is since 2013 an ongoing study in southern Sweden including children and grandchildren (18-71y, 55% women) of the Malmö Diet and Cancer-Cardiovascular Cohort. Two dietary assessment methods were used: a 4-day food record (4DFR) and a short semi-quantitative food frequency questionnaire (SFFQ) with 32 selected foods. Spearman correlations were calculated to examine reproducibility and relative validity of self-reported intakes. We compared repeated intakes obtained 1.6 years apart (n=180), intakes from the two methods (n=1601) and self-reported intakes of fatty fish and fruit/vegetables with plasma biomarkers (n=1433); intakes obtained from each assessment method, and intake scores obtained by combining the methods using principal component analysis (PCA) were evaluated. Biomarkers were measured by liquid chromatography-mass spectrometry (3-carboxy-4-methyl-5-propyl-2-furanpropanoic acid [CMPF] and β -carotene) using blood drawn the day before diet was assessed.

Results: Moderate correlations were seen between repeated intakes from the 4DFRs for total vegetable intake ($\rho=0.47$) and for total fruit and berries ($\rho=0.51$), but lower for subgroups, e.g. vegetables ($\rho=0.21-0.30$). Fatty fish intake showed a correlation of only $\rho=0.08$. Correlations between repeated subgroup intakes from SFFQ were in the same range as those for overall food groups, e.g. fatty fish ($\rho=0.56$) and total fish intake ($\rho=0.54$); specific vegetables ($\rho=0.55-0.66$) and total vegetable intake ($\rho=0.58$).

Between-method correlations were $\rho=0.34$ for total vegetable intake, $\rho=0.50$ for fruit and berries and $\rho=0.26$ for fatty fish. The fruit/vegetable-score obtained when combining intakes from the two methods showed highest correlation with β -carotene in plasma ($\rho=0.39$), whereas fatty fish intake from the SFFQ per se showed highest correlation with CMPF ($\rho=0.46$).

Discussion: Reproducibility of SFFQ-data was superior to 4DFR-data regarding subgroups of fruit/vegetable intake and fatty fish intake. Method combination can slightly improve fruit and vegetable estimates in MOS, whereas SFFQ data give most valid fatty fish intake.

Keywords: Food intake, diet assessment methods, biomarker, reproducibility, validation

Associations between estimated dietary pesticide residue exposure and mortality in a population-based prospective cohort of men and women

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Background: Pesticides residues are regularly detected in foods and there is a concern that this might pose a risk to the consumer, but epidemiological evidence is almost lacking. We assessed the associations between dietary exposure to pesticide residues and mortality as well as their influence on the benefits of fruit and vegetable consumption in a large population-based prospective cohort.

Methods: Food consumption was assessed through a 96-item food frequency questionnaire (FFQ) at baseline (1997) in 69,498 participants (36,546 men and 32,952 women), aged 45–83 years from the Swedish Mammography Cohort and the Cohort of Swedish Men (www.simpler4health). Pesticide residues detected 1996-1998 in foods on the Swedish market (fruits, vegetables and cereals) were obtained via monitoring programs. For each food item, we summed the ratios of each single pesticide residue concentration divided by its acceptable daily intake to create a pesticide residue risk index (~hazard index, HI), which was expressed per kg body weight and adjusted to the total energy intake for each participant. Multivariable-adjusted hazard ratios (HR) with 95% confidence intervals (CI), were estimated using Cox regression.

Results: During 15 years of follow-up (1998-2014), a total of 16,776 deaths occurred, of which 6,338 were caused by cardiovascular disease (CVD) and 5,421 by cancer. Comparing extreme quintiles, the highest category of the dietary pesticide residue risk index, after confounding adjustments, was inversely associated with CVD mortality HR, 0.83 (95% CI, 0.75-0.93) and with cancer mortality HR, 0.91 (95% CI 0.83-1.00). In analyses stratified by exposure to the dietary pesticide residue risk index, fruit and vegetable consumption was inversely associated with mortality at low (<median) but not a high pesticide residue exposure (>median).

Conclusions: We observed no indications that exposure to pesticide residues was associated with increased mortality. However, we observed some indications that the health benefits of fruit and vegetable consumption may be compromised at a high pesticide residue exposure, while at a low exposure, servings of up to 5 per day of fruits and vegetables was associated with lower mortality.

Keywords: *Dietary pesticide residue exposure, all-cause and cause-specific mortality*

Potential calcium biomarkers - a systematic review and meta-analysis

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Introduction: There is no established calcium biomarker. The circulating calcium concentration is tightly controlled, and use of other biomarkers or functional endpoints has been suggested.

Methods: We reviewed systematically the effectiveness of markers of calcium metabolism (urinary calcium [U-Ca], circulating parathyroid hormone [PTH], ionized and total calcium) or bone turnover as biomarkers of calcium intake. Searches in PubMed and EMBASE (October 2020) provided 2398 abstracts for screening after removal of duplicates: 128 studies were selected for a full-text review. Data were extracted from 39 full-texts of randomized trials with a controlled parallel or cross-over design. Meta-analysis on PTH and U-Ca was done with RevMan 5.4.1 based on the studies providing quantitative endpoint data.

Results: The calcium doses were 400-2000 mg/d, the duration of the studies varied from 3 days to 5 years, and the participants were aged 8-to-97 years (M,F). Of the 30 studies on PTH, thirteen showed a significantly lower PTH in the supplemented group (SUPPL) vs. control (CTRL); in thirteen there was no difference; in two studies SUPPL did not differ from or was lower than in CTRL depending on the time point; two studies: results unclear. Of the 25 studies on U-Ca, in seventeen U-Ca was higher in SUPPL vs. CTRL; in six there was no difference; in one study the result was either non-significant or higher in SUPPL depending on the time point; one study: results unclear. Meta-analysis showed significant but highly heterogeneous responses to calcium supplementation: PTH was significantly lower (mean difference -6.99 pg/ml [95% CI -10.22, -3.77], 12 studies, n=1000, I² 93%) and U-Ca excretion higher (standardized mean difference 1.09 [95% CI 0.47, 1.71], 11 studies, n=783, I² 94%) in SUPPL than in CTRL.

Discussion: The meta-analysis showed PTH and U-Ca to respond to calcium supplementation. The lack of quantitative data in studies not included may cause bias in the results and on the total effect of calcium supplementation. Effects on bone turnover markers and ionized and total calcium will be analyzed later. The work was commissioned by WHO to support the work of updating the FAO/WHO nutrient requirements for children aged 0-36 months.

Keywords: biomarkers, calcium, nutrient intake, systematic review, meta-analysis

S8. Technological advances

Ten years of research on the feasibility and validity of the Automated Self-Administered 24-hour Dietary Assessment Tool: Lessons for the implementation of technology-enabled assessment

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The web-based Automated Self-Administered 24-hour Dietary Assessment Tool (ASA24) enables comprehensive dietary assessment in large studies. Introduced as a Beta version enabling 24-hour recalls in the US in 2009, ASA24 has expanded to include food record functionality and Canadian, Australian, and Polish adaptations. The tool has been used in >6,000 studies to collect >450,000 recalls and >20,000 records in diverse samples. Feasibility has been demonstrated among adults and older adults in the US and Canada, with considerations regarding internet access and computer literacy (Thompson et al., *Am J Epi* 2015; Gilsing et al., *Nutrients* 2018; Solbak et al., submitted). The validity of recall data relative to true intake ascertained using biomarkers and feeding studies has been evaluated among adults, including women affected by low socioeconomic status. These studies indicate that ASA24 recalls completed in English perform well, with a comparable level of accuracy to interviewer-administered recalls (Kirkpatrick et al., *AJCN* 2014, *J Nutr* 2016, 2019; Park et al., *AJCN* 2018). Proxy-reported recalls for preschool-aged children also show reasonable validity relative to observation, with some indications of portion size overestimation (Wallace et al., *Nutrients* 2018). The self-reported intake of children aged 11-13 years was less accurate than that observed for adults, with further work needed to understand the age at which most children can independently complete ASA24 or how it can be modified to support their completion (Raffoul et al., *J Nutr* 2019). Work is also needed to examine validity of ASA24 food records given the potential for reactivity in response to real-time monitoring. Collectively, these studies suggest that although ASA24 is feasible for use with diverse samples, practical strategies such as the use of quick start guides or tutorials may be needed to optimize completion rates and data quality. Continued technological evolution and refinement of the user interface is likely to further reduce researcher and respondent burden.

Complementary research clarifying factors that predict reporting error may inform enhancements to improve data quality. Overall, web-based tools such as ASA24 have expanded possibilities for comprehensive dietary assessment in large-scale studies and low-resource settings in which interviewer-administration is not feasible.

Keywords: 24-hour recalls, food records

Recent and upcoming enhancements to the Automated Self-Administered 24-hour Dietary Assessment Tool (ASA24)

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Background: The National Cancer Institute (NCI) introduced the Automated Self-Administered 24-hour Dietary Assessment Tool (ASA24) in 2009. The ASA24 is a freely available, web-based tool that enables collection of multiple, automatically coded, self-administered 24-hour recalls and/or single or multi-day food records. The U.S. version is available in English, Spanish, and Polish, and country-specific versions are available for Canada (English and French) and Australia (English). Based on researcher feedback and user testing, NCI continually enhances ASA24 to increase functionality.

Objectives: To describe 1) updated features for respondents, including the ingredient database, recipe function, updated food code and nutrient values, and updated Respondent Nutrition Report (RNR), and 2) enhancements for researchers, including real-time analytic capability, redesign of the researcher site, and migration to a cloud platform.

Results: A recipe module based on the U.S. Department of Agriculture's SuperTracker ingredient database was integrated to allow respondents to create and reuse their own recipes. NCI user tested a redesigned RNR to ensure that updates were well understood by respondents. In 2020, researchers will be able to provide the redesigned RNR to respondents. Researcher access to output data files was improved with real-time analysis, allowing immediate download of nutrient and food group intakes. In the upcoming release, ASA24-2020 will include updated food lists, nutrients, food groups, and supplements based on the Food and Nutrient Database for Dietary Studies 2015-2016. Also, in 2020, the researcher website will be redesigned to facilitate improved study setup and respondent monitoring. To support growing usage of ASA24, migration to a cloud platform will occur in early 2020.

Conclusion: Since its release, ASA24 has been used to collect over 500,000 days of dietary intake, with over 100+ studies registering per month in 2019. NCI and other NIH institutes are continually enhancing ASA24 to maintain relevance and usability to support the collection of high-quality dietary intake data.

Keywords: diet assessment, cloud migration, feedback, recipes, website

A comparison of food portion size estimation methods: 3D food models vs an online tool using food portion photos (Intake24)

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Introduction

The Northumberland middle schools study is a cross-sectional dietary study led by Newcastle University in the UK. Dietary data were collected from 11-12 year olds from the same schools in Northumberland in 1980, 1990, 2000, and 2010 using three-day food diaries with 3D food models used to estimate portion sizes. However, the foods children consume have changed over the years, and technology has advanced bringing new cost-effective methods to measure food intake such as, Intake24. It is imperative to examine the potential impact of a change in dietary collection method prior to dietary data collection in 2020/21. The objectives of the study were to compare mean individual daily food weight and nutrient intakes obtained using a two-day estimated food diary (original method) with Intake24 (new method), and to examine if levels of agreement were sufficient to replace the estimated food diaries.

Methods

Pupils from four schools completed a two-day food diary recording everything they had to eat and drink. The food diary was reviewed by the researcher and pupil to obtain any missing information. Pupils estimated portion sizes consumed using 3D food models and food portion photographs. During the interview pupils completed Intake24 for the same two days; the order (i.e. whether the food diary interview was first or Intake24) was randomised.

Results

Seventy 11-12 year olds participated in the study. There was good agreement in portion size estimations between the two methods (geometric mean ratio 1.00), with limits of agreement ranging from minus 35% to plus 53%. Intake24 provided estimates of energy intake that were 1% lower on average than estimates of energy intake from food diaries, and limits of agreement ranged from minus 38% to plus 57%. Mean intakes of all macro and micronutrients using Intake24 were within 6% of the food diary estimates.

Discussion

The findings indicate good agreement between 2-day food diaries and Intake24 for food weight, energy (kJ) and nutrient intakes. This suggests that a change in dietary assessment method for the data collection in 2020 will have minimal impact on the nutrient data collected, and will remain comparable with data from previous years.

Keywords: Dietary assessment, Children, Portion estimation, Intake24, Food models

Relative validity of The Eetmeter - a food diary app to provide healthy diet advice

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Objectives. This study aimed to evaluate relative validity of intake of energy, nutrients and food groups assessed with MijnEetmeter food diary as compared to interviewer-administered 24hr dietary recalls, and if this differed between experienced and new users.

Methods. One hundred men and women aged 18-70 y participated, of whom 47 had prior experience with the tool. Participants kept MijnEetmeter on three non-consecutive days. Trained dieticians called them three times for a 24hr dietary recall interview, once performed about the same day as MijnEetmeter. Systematic differences and correlations were assessed and Bland Altman plots were created; both for 3-day mean intakes and for intake on the same day.

Results. Relative to 24 dietary recalls, MijnEetmeter underestimated consumption of drinks, added fat, cereal products, and potatoes. Relative underestimation was observed for energy intake (6%) and about half of the nutrients, and was largest for water (16%) and vitamin E (11%). Experienced MijnEetmeter users underestimated intake the least. There was a range of 1900 kcal in the 95% limits of agreements for energy intake. For intake of energy and six key nutrients, correlations between 3-day mean intakes were above 0.7 except for sodium intake.

Conclusion. At the group level, MijnEetmeter moderately underestimates intakes of energy and some nutrients and food groups, with large individual variability. To improve the tailored dietary advice, it is recommended that consumers record several days and are stimulated to complete food recording, particularly for added fats and beverages.

Keywords: relative validity, food diary, 24-h dietary recall, application, webbased

Selection of an automated dietary assessment tool for use in the UK National Diet and Nutrition Survey (NDNS) Rolling Programme (RP)

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Introduction: Nutritional surveillance relies on collection of detailed, quantitative, population-representative high quality dietary data. Such surveillance programmes constitute a considerable undertaking in terms of cost, logistics and participant burden and are under pressure to modernize to address falling response rates, funding pressures and concerns regarding dietary data quality and timeliness. Recent emergence of digital dietary assessment methods offers great potential to address some of these issues, including the ability to increase the scale of surveillance programmes. We are leading on the change from paper diary to online 24-hour recall for the UK National Diet and Nutrition Survey (NDNS). We describe here our approach to identify, screen and evaluate potential tools to select a new dietary assessment tool for implementation in the programme.

Methods: Initially we carried out a rapid identification and screening of the breadth of automated dietary assessment tools available. Secondly, short-listed candidate tools meeting initial screening criteria were fully evaluated using a comprehensive framework we developed, based on an approach by Illner et al . The framework encompassed broad criteria to assess overall suitability for NDNS, including technical capabilities, potential to meet data requirements, operational feasibility, contracting/partnering basis and costs, as well as scientific evidence for validity and reliability of the tool.

Results: 142 tools were identified, seven fully met screening criteria and ultimately three tools were fully evaluated: ASA24, Intake24 and MyFood24. All three tools were based on the multiple pass 24-hour recall method, and had evidence demonstrating validity against objective biomarkers and traditional dietary assessment methods. Our evaluation showed that all tools offered potential for NDNS, however, each needed further development before implementation in NDNS. Ultimately Intake24 was selected, developed and launched in the NDNS (<https://ndns.intake24.org/>).

Discussion: Our review approach provides a useful framework to rapidly assess the feasibility of the use of automated dietary assessment tools in surveillance and large studies. This model can be used by others considering moving from traditional dietary assessment methods to automated tools.

Keywords: automated tools, survey, NDNS, evaluation, dietary assessment

Validity of an innovative 2-hour recall smartphone app

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Background: Accurate dietary assessment is essential in nutrition research. The mainstay of dietary assessment consists of food records (FRs), 24-hour recalls (24hRs), and food frequency questionnaires (FFQs). However, they are charged with a range of drawbacks such as measurement error and a large burden on participants. Therefore, there is a growing interest in more technology-based dietary assessment methods (e.g. online tools, smartphone applications), which have the potential to improve accuracy and reduce participant's burden. To collect food intake data in a faster, more flexible, and more reliable manner, within the Smart Food Intake project, we developed an innovative 2-hour recall (2hR) smartphone app (i.e. 'Traqq'). A 2-hour reporting period should minimize the reliance on memory thus increasing accuracy of the reports. This should also lower participant burden as only a few items have to be recorded at once. The main objective of the present study was to evaluate the ability of Traqq to accurately assess the actual and usual intake of food groups, foods, energy and nutrients (i.e., macro- and micronutrients) while using different interval schemes.

Methods: The validation study had a cross-over design with two experimental conditions divided over six groups; i.e. measuring actual intake and habitual intake. The participants were randomly assigned to one of six groups. The groups differed in the measurements that were conducted when measuring actual intake. There was no difference in the groups when measuring habitual intake. For the app, two interval schemes were used:

1. Actual intake was measured with a 'full-day scheme' (i.e. 3 full days of 2hRs divided over a 4 week period)
2. Habitual intake was measured with a 'random scheme' (i.e. 24 random 2hRs divided over a 4 week period)

Actual intake was measured in 220 participants (18-70 years) by using 2hRs and 24hRs (i.e. either web-based or telephone-based). Habitual intake was assessed in all participants by using 2hRs and a FFQ. In addition, chemical biomarkers from blood and urine were gathered from 100 of the 220 participants. Demographics and total energy expenditure (i.e. measured with an accelerometer) was assessed in all participants.

Results/Conclusion: Will be available early 2020.

Keywords: Smartphone-based dietary assessment, validity

S11. Diet quality and patterns

A systematic review of dietary pattern assessment methods

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Background: Dietary pattern assessment methods can be broadly classified as index based or data driven. Each method requires researchers to make subjective decisions that may influence results. Individual studies can only be compared and synthesised when dietary pattern assessment methods are described in sufficient detail. The aim of this systematic review was to analyse the methods used to assess and report dietary patterns.

Methods: A systematic review of dietary patterns and health outcomes formed the dataset. Literature searches were conducted in 2018 using three electronic databases (Medline, Embase, and Global Health). Observational studies (cohort and nested case control studies) published in English between 1980 and 2018 were eligible for inclusion in this analysis. A data extraction tool was designed to capture study design characteristics, dietary assessment methods, and details of the index based and data driven dietary pattern assessment methods that were used.

Results: A total of 423 studies were included. Based on preliminary analysis, 263 studies (62%) used index based methods and 163 studies (38%) used data driven methods. Some studies used multiple methods. Of the 163 studies that used at least one data driven method, the majority used factor analysis or principal component analysis (78%). A smaller proportion used cluster analysis (14%) or reduced rank regression (13%). Within studies that used similar methods, variation in the methodology existed. For example, indices that measured adherence to a Mediterranean dietary pattern varied in terms of the nature of dietary components (e.g. foods only or foods and nutrients), the cut-off points that were used (e.g. dichotomous or proportional), and the rationale behind the cut-off points (e.g. absolute or data driven). The level of detail used to describe each dietary pattern assessment method also varied, and in some cases, important methodological details were omitted.

Discussion: There was considerable variation in the methods used to assess and report dietary patterns. To ensure evidence from dietary patterns research can be synthesised, standardised approaches for the reporting of dietary pattern assessment methods are needed. The challenges associated with synthesising evidence from dietary patterns research may have implications for evidence use in dietary guideline development.

Keywords: *dietary patterns, systematic review, methods, evidence synthesis*

Identifying dietary patterns using novel supermarket transaction data

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Introduction

Novel methods for dietary assessment are emerging rapidly, reflecting the increasingly digital era in which we live. Assessment methods employing online collection, smart phone apps or handheld scanning devices in supermarkets all facilitate more timely data collection, at greater scale and automated processing to obtain nutrient estimates. However, they retain challenges around reporting and participation biases. Supermarket transaction records offer objective data, with no participant burden, for food and drink purchases at an unprecedented scale. The aim of this work is to: (i) link these transaction data to nutrient composition information; and (ii) identify common purchasing patterns in a comprehensive sample of typical shoppers in a UK region.

Methods

The study sample includes all loyalty card transaction records for purchases made at one large UK supermarket, by residents of Yorkshire and the Humber region, during 2016. We identified 'typical shoppers' as loyalty card holders that purchased foods from 7 of 11 Living Cost and Food Survey (LCFS) categories or ready meals, on ten or more occasions throughout the year. Nutrient composition information for the eight back of pack nutrients was acquired and matched using the SKU identifier. Where no match was possible, manual data processing took place. Dietary patterns, including both foods and beverages, were identified using k means cluster analysis.

Results

Over 300,000 loyalty card holders, collectively purchasing over 300 million items, were included in our sample, with large numbers of males, females and all age groups represented, from a range of area-based socioeconomic classes. Over 97% of all products, equivalent to over 99% of transactions have a successful match to nutrient composition information. Ten distinct purchasing behaviour clusters were identified: Meat free, Comfort foods, Quick cuisine, "I like beer", Wine, Fruity and teetotal, Fine dining, Spirited, and Family foods. Profiling these patterns by nutrient content revealed substantial variations.

Discussion

Using Supermarket transaction records to better understand population level dietary patterns and variation in nutrient intake is a feasible and an exciting new method in dietary research. These data reveal dietary patterns using objectively measured data, generating novel insight at a scale that was previously impossible.

Keywords: Transactions, big data, diet

Socioeconomic inequities in diet quality among adults living in Canada: A nationally representative analysis of trends between 2004 and 2015

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Background: Diet quality is a key determinant of chronic disease and shares a similar socioeconomic patterning. Evidence indicates that inequities in diet quality are widening in the US, however it is not clear whether these findings are indicative of broader regional or global trends. Moreover, prior studies have only examined trends in absolute dietary gaps between more and less advantaged groups. Quantifying change in absolute and relative dietary gaps and gradients according to multiple indicators of socioeconomic position (SEP) can provide a more comprehensive perspective of trends, enabling a more informed and nuanced assessment of optimal points of intervention. **Objectives:** The purpose of this study was to quantify trends in absolute and relative gaps and gradients in diet quality between 2004 and 2015 according to three indicators of SEP (household income, educational attainment and area-level disadvantage) among adults (≥ 18 years) living in Canada. **Methods:** Adults who participated in the nationally representative, cross-sectional Canadian Community Health Survey - Nutrition in 2004 ($n=21,200$) or 2015 ($n=14,300$) were included. In each year, participants were classified into five SEP categories based on each of the following: equivalized annual household income, educational attainment and residential address (i.e. area-level disadvantage). Self-reported dietary intake in the previous 24 hours was used to derive a Healthy Eating Index-2015 score from 0-100 representing diet quality at each time point. Bootstrap survey-weighted t-tests and multivariate linear regression models, adjusted for age and day of data collection examined trends in diet quality over time. **Results:** There were absolute and relative gaps and gradients in diet quality for all SEP groups in 2004 and 2015. Between 2004 and 2015, diet quality improved in all SEP groups, however, gaps and gradients in diet quality remained stable over time. **Conclusions:** Absolute and relative gaps and gradients in diet quality remained stable between 2004 and 2015 in Canada. Findings demonstrate that dietary inequities remain an ongoing concern in Canada and indicate that novel policies are needed to tackle these avoidable inequities. Proportionate universalism may help to reduce dietary inequities by providing universal access to resources with a scale and intensity proportionate to need.

Keywords: diet quality, dietary inequities, Healthy Eating Index, adults

Secular trends in diet-related greenhouse gas emission estimates in Sweden since 2000 – evidence of a shift towards more sustainable food patterns

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Introduction

In recent decades, dietary intakes in Europe have been impacted by considerations regarding health, ethics, and climate change. In view of the European Commission's roadmap for reduced carbon emission reductions by 2050, it is of interest to observe dietary trends that have occurred during this millennium in western Sweden and particularly, the potential impact of these trends on climate change.

Methods

A repeated cross-sectional study was conducted in 2001-3 and again in 2014-7, each time with participation rates around 40%. At both time periods (referred to as T1 and T2), an 86-item food frequency questionnaire (FFQ) was embedded in a survey on lifestyle and health. In total, 4569 adults aged 24-75 participated in the two surveys following random selection from the population registry. Greenhouse gas emission estimates (GHGE, kg CO₂e/year) were derived from the two FFQs, using age-standardized portion estimates together with lifecycle analysis data from the Food Climate Database, Research Institutes of Sweden. Analyses were stratified into 5 age bands, each of which was compared over time. Multivariable regression was used to study GHGE as a function of time, with adjustment for sex, age in years, BMI, and education. Time by sex interactions were tested to understand if men and women changed in different ways.

Results

Each age band (24-34y, 35-44y, 45-54y, 55-64y, 65-75y) was compared at T1 versus T2. The dietary GHGE decreased over time by 13% in the youngest age band and by 6% in the oldest. No such differences were seen within any other age groups. There was no evidence that the time trends were moderated by sex. At T2, GHGE/g food consumption was significantly elevated in individuals with overweight.

Discussion

Over circa 14 years, younger (24-35y) Swedish men and women showed the largest decreases their dietary GHGE, primarily due to consuming less animal-based and more plant-based foods. Similar but smaller differences were seen in the oldest ages (65-75y). Results among other age groups were less promising. The modest overall magnitude of the secular trends underscores the need for effective policies to improve dietary sustainability, together with methodological developments in monitoring climate impact of diets.

Keywords: diet pattern, secular trends, greenhouse gas emissions, sustainable diets

Multidimensional characterization of alcohol consumption in the Framingham Offspring Study (FOS) – Longitudinal trends 1971-2014 and association with diet quality

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Introduction: Alcohol consumption is highly prevalent in the US. Existing studies have focused on frequency of consumption assessed over short time-periods, and thus do not capture the multidimensionality of drinking patterns, including frequency, binge drinking, and beverage preference, and changes in these measures across the adult life-course. We examined longitudinal trends in drinking patterns over 4 decades and evaluated their association with dietary intake in an aging American population.

Methods: Analyses were conducted within the Framingham Offspring Study (FOS;1971-2014;n=3326; exam 1 mean age:36.2years). Alcohol intake (drinks/day, drinking frequency, beverage-specific consumption, drinks/occasion) was assessed quart-annually from exams 1-8(mean follow-up:45years). Participants were classified as binge drinkers, moderate drinkers and heavy drinkers (4+ and 5+ drinks/occasion; ≤ 1 and ≤ 2 drinks/day; and > 7 and > 14 drinks/week for women and men). Dietary data was collected by a food frequency questionnaire from exam 5-8. We evaluated trends in drinking patterns using linear mixed effect model and compared dietary intake across drinking patterns using heterogeneous variance models.

Results: Total alcohol consumption decreased from 1971 to 2014 (3.7 vs. 2.2 ounces/week; $p < 0.05$). Proportion of moderate drinkers (85% vs. 69.8%), heavy drinkers (18.4% vs. 10.5%) and binge drinkers (40.0% vs. 12.3%) declined over the study period($p < 0.05$). While average wine consumption increased (1.4vs.2.2 drinks/week), intake of beer (3.4vs.1.5 drinks/week) and cocktails (2.8 vs.1.2 drinks/week) decreased. Compared to non-binge drinkers, binge drinkers consistently consumed less fruits and vegetables (F&V; 3.8vs.3.5 servings/day), whole grains(1.2vs.1.1 servings/day) and plant foods(3241vs.3075g/day) but more processed foods(75vs.88g/day), red meat(317vs.326g/day) and fats(56.3vs.60g/day) across all exams ($p < 0.05$). Similarly, non-drinkers and moderate drinkers consistently had higher intakes of F&V, whole grains, total grains and plant foods and less red meat and processed foods compared to heavy drinkers($p < 0.05$).

Discussion: Our study provides a longitudinal multidimensional evaluation of drinking patterns during adult life and indicates that alcohol-drinking patterns are not stable over time and that dietary attributes are differentially associated with drinking patterns, generally being unhealthy with higher alcohol intakes. Nuanced characterization of alcohol consumption is needed to better understand the role of alcohol, in the context of broader diet, in chronic disease etiology and to guide public health recommendations for alcohol intake.

Keywords: Alcohol drinking patterns, Diet quality, Longitudinal trends

The development of a short food frequency questionnaire to assess diet quality in UK adolescents

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UK adolescents have poorer diets than other age groups. Established dietary assessment techniques can be difficult to use with adolescents due to high participant burdens. This study aimed to identify the key indicator foods that contribute most to better quality dietary patterns in UK adolescents for use in a short food frequency questionnaire (FFQ).

Data from 2587 adolescents aged 11-18 years from waves 1-8 of the National Diet and Nutrition Survey rolling programme were used. Principal component analysis (PCA) was applied to 139 food groups to identify the key patterns within the data. 139-group and 20-group diet quality scores were calculated using the PCA results for each food group and multiplying by their standardised reported frequency of consumption. The foods with the 10 strongest positive and 10 strongest negative coefficients from the PCA results were used to create the 20-group score. Scores were standardised to a mean of zero and a standard deviation (SD) of one. The association and agreement between the two scores were calculated using Spearman's correlation coefficient and Bland-Altman limits of agreement, respectively. Spearman's correlations were used to examine the associations between the two diet quality scores and nutritional biomarkers.

The first PCA component explained 3.0% of variance in the dietary data. It represented a high-quality diet characterised by greater consumption of fruit, vegetables, beans, pulses, wholegrains, nuts, seeds, and water, plus lower consumption of sugar-sweetened beverages, chips, processed meats, white bread, crisps, whole milk, baked beans and sugar.

A correlation of 0.86 was observed between the two diet quality scores with the difference between being 0 SDs. Bland-Altman 95% limits of agreement were -0.98 to 0.98 SDs. Correlations, in the expected direction, were seen between the 139-group score and all nutritional biomarkers (25-hydroxyvitamin D ($r_s=0.14$), vitamin C ($r_s=0.30$), total carotenoids ($r_s=0.25$), total serum folate ($r_s=0.42$), homocysteine ($r_s=-0.25$) and vitamin B12 ($r_s=0.21$)). Correlations with the 20-group score were only slightly attenuated. The 20-group diet quality score showed reasonable agreement with the 139-item score. Both scores were correlated with nutritional biomarkers. A short 20-item FFQ can provide a meaningful and easy-to-implement tool to assess diet quality in adolescents.

Keywords: Adolescents, Diet Quality, Assessment, FFQ

S12. Machine learning

Development of a machine-readable knowledge base for nutritional and dietary assessment data

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Background: Machine-learning in nutrition research has mostly focussed on dietary intake data. Without information on study designs, however, the inference of dietary intake data for population health and nutrition remains elusive. Compared to a database, a knowledgebase enables machines to process information at a higher level of abstraction (e.g., semantic information). Here, we present a knowledgebase that combines semantic information of both dietary assessment and study-level data to enable a virtual infrastructure for nutrition research.

Methods: First, a scoping review was conducted to identify existing ontology terms to annotate dietary intake data. Second, we developed an Ontology for Nutritional Epidemiology (ONE) from authoritative guidelines for reporting the minimal information and quality description of dietary data. Third, a data format to store semantic information in the knowledgebase was developed according to the DIKW pyramid (Data, Information, Knowledge, and Wisdom). Fourth, a Web Crawler was developed to analyze and extract information from nutritional epidemiologic manuscripts through the Springer Nature application programming interface portal. Finally, the extracted information was stored in the knowledgebase, and case studies are used to illustrate potential applications on the interoperability of the extracted semantic information in Python Virtual Environment (v3.7.4).

Result: Existing ontologies for "food and nutrition" (n=37), "disease and specific population" (n=100), "data description" (n=21), "research description" (n=35), and "supplementary (meta)data description" (n=44) were reviewed and listed. ONE consists of 339 classes: 79 new classes to describe data and 24 new classes to describe the content of manuscripts. A DIKW pyramid was developed using the ontologies to construct the nodes and edges of the knowledgebase. The extracted information was stored in Neo4j KB and visualized through Neo4j Browser. Python functions were developed to process the stored machine-readable semantic information and generate corresponding statistics on data characteristics.

Discussion: The proposed knowledgebase provides nutritional findings that can be read by machines. The knowledgebase can improve data searching and has the potential to inform nutritional recommendations using real-time inferencing of research findings in nutrition.

Keywords: nutritional data, knowledgebase, ontology, semantics

Development of Machine Learning Prediction Models to Explore Nutrients Predictive of Cardiovascular Disease Using Canadian Linked Population-Based Data

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Introduction:

Machine learning may improve use of observational data to understand the nutritional epidemiology of cardiovascular diseases (CVD) through better modelling of non-linearity, non-additivity, and dietary complexity. The objective of this study was to develop machine learning prediction models for exploring how detailed dietary features are related to CVD risk prediction and evaluating their predictive performance.

Methods:

A population-based cohort study was established using linked data from a national health survey, hospital discharge database, and death registry. Nutrition variables were measured using 24-hour dietary recalls from the 2004 Canadian Community Health Survey. CVD incidence and mortality were prospectively measured over a 13-year follow-up period. Conditional inference forests were used to build models. A total of 75 predictors, including macro- and micronutrients, food groups, and non-dietary covariates were selected a priori. A random stratified sample of 70% of participants was used to train the model with 10-fold cross-validation before testing on the remaining 30%. Permutation-based variable importance and accumulated local effects were computed.

Results:

12 130 individuals were included in our study with a median age of 50.0 (IQR=34.0 – 65.0) and 6850 were female (56.5%). 1120 (9.2%) individuals developed ischemic heart disease or stroke. Twenty-three (37.7%) nutrition features had a positive median permutation feature importance (PFI). Supplement-use (PFI= 4.09×10^{-4} , IQR= 8.25×10^{-7} – 1.11×10^{-3}) and caffeine (PFI= 2.79×10^{-4} , IQR= -9.11×10^{-5} – 5.86×10^{-4}) had the highest PFIs for nutrition-related features. Supplement-use was associated with decreased predicted risk of CVD (accumulated local effects range (ALER)= -3.02×10^{-4} – 2.76×10^{-4}) and caffeine was related to increased predicted risk (ALER= -9.96×10^{-4} – 0.035). A mix of non-linear dose-response curves was observed. The model had a c-statistic of 0.821 (95% CI: 0.801 – 0.842) and was well-calibrated.

Discussion:

Our study is one of the first to apply machine learning techniques to the prediction of CVD using detailed population-based dietary data and showed competitive prediction performance. Machine learning models identified a mix of linear and non-linear relationships in exploratory analyses. More research applying machine learning to the nutritional epidemiology of CVD may help elucidate risks and improve predictive models.

Keywords: Cardiovascular Disease, Machine Learning, Diet, Random Forest, Conditional Inference Tree

Addressing Truncation in Diet Quality Index Scoring

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Introduction. Diet quality indices, including the US Healthy Eating Index (HEI), assess diets according to standards set a priori. For adequacy components, the score typically does not change with increased intake once adequacy has been achieved. For moderation components, any intake less than the standard receives maximum points; any intake greater than the zero-score standard receives zero points. Consequently, the scores reflect intakes through a limited range. Information from observations outside this range is truncated. In addition, the piecewise linear formulations used are brittle mathematically and statistically. The objective of this work was to develop modified scoring functions which address this truncation and which are more friendly to statistical operations.

Methods. Six desirable properties of a new scoring function were identified: (1) avoid truncations in component scoring to avoid information loss and to provide scoring sensitivity in the previously truncated regions; (2) possess desirable mathematical properties, specifically (a) a continuous first derivative (i.e., defined slope) everywhere and (b) a unique inverse everywhere in the scoring range; (3) be plausibly related to biological processes; (4) be represented parsimoniously and with the least embedded content as measured by Shannon information theory; (5) be simple to calculate; and (6) otherwise closely follow the existing HEI-2015 scoring.

Results. The best replacement for the piecewise linear scoring was a set of functions based on exponentials. For adequacy components, a single exponential function is proposed. For moderation components, the functions are a concave-convex mirrored pair of exponentials and are first-derivative-matched where they join. The proposed functions have the six desired properties and do not dramatically depart from HEI-2015 scoring.

Discussion. The proposed scoring functions will improve the usefulness of the HEI by avoiding loss of information that may be useful in epidemiological studies, interventions, and surveillance. Compared to the current functions, the new functions are more sensitive to differences in diet and less sensitive to meeting precise adequacy and moderation standards. They may even improve the predictions of health outcomes. The new functions will certainly be more mathematically and statistically friendly. Other diet quality indexes could also benefit by using this approach to avoid truncation.

Keywords: Dietary assessment methods, diet quality, Healthy Eating Index, truncation

Feasibility and validity of the Consumer Price Index to measure diet costs in Canada

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Introduction: The cost of food is a key influence on diet. A growing literature has examined how diet cost predicts diet quality. The majority of studies derive diet costs by matching intake data from population-based surveys to a single source of food supply prices (e.g. the Consumer Price Index (CPI)). No methodological studies have examined the validity of using the CPI to price intakes. Our objective was to examine the feasibility and validity of using the Canadian CPI to price dietary intakes.

Methods: We examined food groups and nutrients in dietary intakes captured by direct and indirect match to CPI. For prices, we used 2015 Canadian CPI national average monthly item prices. For dietary intakes, we used reported intakes from the 2015 Canadian Community Health Survey (CCHS)–Nutrition, 1st 24-hour recall (n=20,487), the largest population-representative national dietary intake survey. i) 2015 CPI item prices (\$/g) were matched to the 156 food items from the 2015 CCHS-Nutrition; ii) CPI capture was calculated for each respondent by dividing total food and beverage intake (g) for which CPI price data was a direct or indirect match, with and without water; iii) differences in mean CPI capture were calculated for Canadian Nutrient File food groups, v) descriptive statistics and ANOVA ($\alpha=0.05$) were used to compare CPI capture by province; descriptive statistics and quantile regression ($\alpha=0.05$) were used to compare intakes of food groups and nutrients of interest/concern by quantile of CPI capture.

Results: The CPI directly captured on average 74% of total dietary intake (g) without water. CPI capture varied significantly by province ($p=0.000$). Intakes of beef and breakfast cereals had among the best direct match; snack foods and legumes had among the worst. Individuals in the poorest CPI capture quantile consumed the greatest fibre (g), carbohydrates (g), total sugar (g), fat (g), protein (g), and energy (kcal) as compared to those with best CPI capture.

Discussion: The CPI monitors staple foods, not a healthy dietary pattern. The poorest quantile of direct CPI capture largely reflects individuals with high intakes of nutrients of concern; potential bias in estimating fibre and protein intake was also detected.

Keywords: diet cost, food prices, retail food environment, dietary intake, validation

Joint Temporal Dietary and Physical Activity Patterns Associate with Health Status Indicators

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Introduction: Diet and physical activity (PA) are independent risk factors for obesity and chronic diseases such as type 2 diabetes and metabolic syndrome. However, few studies have been conducted to jointly pattern these data considering the temporal sequence of these exposures in relation to health outcome indicators.

Methods: A random day of physical activity from PA accelerometry data and the first-day 24-hour weekday dietary recall, collected in the cross-sectional National Health and Nutrition Examination Survey (NHANES) years 2003-2006, were used to pattern absolute PA intensity, absolute energy intake and the time of these activities using data driven methods. Constrained dynamic time warping (CDTW), coupled with kernel-k means clustering algorithm, were used to develop joint temporal dietary and PA patterns using data from 1,836 non-pregnant US adults ages 20-65 years. Four clusters were created and multivariate regression models determined associations between joint temporal dietary and PA patterns and outcomes of body mass index (BMI), waist circumference (WC), fasting plasma glucose, hemoglobin A1c, triglyceride, HDL-C, total-cholesterol, systolic and diastolic blood pressure along with disease categories for obesity, type 2 diabetes, and metabolic syndrome controlling for potential confounders and adjusted for multiple comparisons.

Results: A cluster, representing joint temporal dietary and PA patterns with proportionally equivalent average energy consumed at two main eating occasions from 8:00-23:00 including energy intake peaks of 254.8 kcal and 280.2 kcal at 13:00 and 20:00 respectively, and the highest PA counts of all clusters (peak of $2.9e4-4.1e4$ cph from 8:00-20:00), was associated with significantly lower BMI ($p<0.0001$), WC ($p=0.0002$), total-cholesterol ($p=0.0127$) and odds of obesity ($OR=0.26$, $p<0.0001$) compared to a cluster with greater energy consumed at two main eating occasions with energy peaks of 316.8 kcal and 380.9 kcal at 13:00 and 20:00, and lower PA counts reaching $2.4e4$ cph at 10:00.

Discussion: The temporally and jointly patterned sequence of diet and physical activity can be used to cluster individuals with meaningful associations to BMI, WC, total-cholesterol and obesity. Temporal patterns are linked with health and hold promise for the future development of lifestyle patterns that integrate additional temporal and contextual activities.

Keywords: temporal, physical activity patterns, dietary patterns, obesity, blood pressure

S15. Methods on diet quality

Dietary diversity indicators and their associations with nutritional adequacy of the diet and health outcomes – a systematic review

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Introduction. Dietary diversity has long been recognized as a key component of diet quality. Because the implementation of measurements of dietary diversity can be quite simple, many indicators have been developed and used in the literature. The purposes of this work are (i) to present a state-of-the-art inventory of dietary diversity indicators (DDIs) developed for adolescents and adults, and (ii) to review to what extent DDIs relate to nutritional adequacy of the diet and are associated with various health outcomes.

Methods. A structured search strategy was developed to identify peer-reviewed articles published in English up to June 2018 and was applied to three databases (Medline, Web of Science, and Scopus). A two-stage screening process was employed to select the final studies to be reviewed.

Results. Two main types of DDIs have been identified among the 161 articles included in this review: the “Food Group based Indicator” (n=110) and the “Food Item based Indicator” (n=51). We found 50 studies evaluating the relationship between DDI and measure of nutritional adequacy of the diet. While almost all found positive associations, only 15 reported results regarding how DDIs were associated with nutrients of which intake should be limited and mixed results were observed on this point. We found 137 studies evaluating the relationship between DDI and various health outcomes. The most frequently studied outcome was body weight (n=60) and the results were largely inconsistent. Another frequently studied outcome was non-communicable diseases (n=41), half of the studies reporting dietary diversity as protective while others reported no association or mixed results. For other health outcomes, DDIs showed the most consistent associations with favorable outcome such as a lower risk of anemia and lower risk of mortality.

Discussion. A large variety of DDIs is available in the literature. While all indicators are good proxies of nutrient adequacy, they fail to account for unsuitable excessive intake of some nutrients. This limits their validity as overall proxies of diet quality. The mixed results on their relationships with health outcomes could be ascribed to the design of the DDIs themselves, but also to the design and context of the studies.

Keywords: diversity, nutrition, health, adolescents, adults

The Healthy and Sustainable Diet Index: a novel theoretically derived index, applied and evaluated using images collected with the mobile food record.

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Environmental sustainability and health are often considered in isolation, yet both would benefit from evidence-based policies that support both behaviours. Current methods to assess how dietary patterns adhere to a healthy and sustainable diet have significant limitations. This study aimed to construct a theoretically derived Healthy and Sustainable Diet Index (HSDI), and apply the index to images captured using a 4-day mobile food record (mFRTM) in young adults.

A HSDI was developed and applied to the 4-day mFRTM collected from 247 adults (18-30 years) during a 6-month dietary intervention. The HSDI contained 12 individual components, including cut-off points for: the intake of animal and non-animal based protein containing foods; fruits and vegetables (including seasonality); ultra-processed energy-dense nutrient-poor foods and beverages; the use of individually packaged foods and beverages and; food (plate) waste behaviours. The influence of dietary behaviours on human health was given the highest weighting, followed by impact on the environment. The HSDI used a continuous scale with a maximum score of 90 points. Regression analyses were conducted to determine whether specific variables determined overall HSDI score. Test-retest reliability was assessed by comparing individual components and overall HSDI score of mFRTM collected twice (baseline and 6 months).

The mean overall HSDI score was 42.7(SD 9.3) points. Participants who ate ruminant meat and pigs were less likely to eat vegetables ($p < 0.001$), and those who ate non-animal protein foods (e.g. legumes/tofu/nuts/seeds) were more likely to eat more fruit ($p < 0.001$), vegetables ($p < 0.05$) and milk/yoghurt/cheese ($p < 0.05$). Participants who reported taking vitamin supplements were more likely to have a higher HSDI score than those who reported not taking supplements ($p < 0.005$). After adjusting for age, sex and Body Mass Index, multivariate regression found the strongest predictor of the likelihood of being in the highest tertile for total HSDI scores was dietary health consciousness (how much attention people paid to the health aspects of their diet).

This study provides a new reference standard in the HSDI. This prediction model can be applied to other population groups, along with refinements to the mFRTM, to further evaluate its ability to measure adherence to a healthy and sustainable diet.

Keywords: Healthy, Sustainable, Diet, Index, mFR

Associations between eating behaviors according to Canada's Food Guide, diet quality score and cardiometabolic risk markers: insights from the PREDISE study

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Introduction: The 2019 edition of Canada's Food Guide (CFG) provide guidance on food choice, but also eating habits and other behaviors related to food choice. There is currently no scale to assess adherence to these behavior-related recommendations. Therefore, as a first step towards the development of an eating behaviors adherence index, our objective was to describe associations between CFG recommendations on eating behaviors, diet quality and cardiometabolic risk markers.

Methods: Data collected as part of the cross-sectional PREDISE study (conducted in 2015-2017) were used. The PREDISE study is based on an age- and sex-representative sample of 1147 respondents from 5 regions of the province of Quebec in Canada. Respondents completed three web-based 24-hour recalls and multiple questionnaires pertaining to eating habits and behaviors on the web. The Alternative Healthy Eating Index 2010 was used as a diet quality score. Most respondents (n=1019) also completed an in-person clinical assessment permitting calculation of an age- and sex-adjusted metabolic syndrome Z-score (MetS). Eating behaviors according to CFG were selected from the "Healthy eating recommendations" made available to the public and were matched as closely as possible to questions available in PREDISE. CFG behaviors included intuitive eating (PREDISE: hunger and satiety signals from the Intuitive Eating Scale-2); cooking more often (PREDISE: frequency of meal preparation at lunch and dinner); enjoying foods (PREDISE: "eating healthy gives me satisfaction"); and the importance of sharing meals (PREDISE: frequency of meal shared with others).

Results: Intuitive eating was correlated with MetS ($rs = -0.28; P < 0.0001$), but not with diet quality ($rs = 0.06; P = 0.10$). Cooking more often was slightly correlated with diet quality ($rs = 0.18; P < 0.0001$) and weakly with MetS ($rs = -0.07; P = 0.04$). Enjoying foods was correlated with diet quality ($rs = 0.42$), and slightly with MetS ($rs = -0.23$; both $P < 0.0001$). The frequency of meals shared with others showed no correlation with diet quality or MetS.

Discussion: Eating behaviors similar to those described in the 2019 CFG are slightly to moderately correlated with diet quality and cardiometabolic risk, suggesting that such behaviors are not trivial dimensions of healthy eating and health. The development of a scale reflecting adherence to specific eating behaviors recommended in CFG is relevant.

Keywords: *Food guide adherence, eating behaviours, scale development, diet quality*

Designing food databases for Indigenous Populations: lessons learned from South-Western Uganda.

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Background. Given high levels of malnutrition and culturally unique approaches to food systems among Indigenous communities, existing generic food databases and collection tools are not satisfactory. Indeed, indigenous food systems are often strictly linked to nature and culture. There are few examples of published methods to develop a locally validated food database to inform nutritional assessment in low-income countries. This paper aims to develop and apply a framework for developing a food database taking into account the local and cultural dimensions of food systems.

Methods. Four Batwa and Bakiga settlements in South-Western Uganda were included. Our approach was: i) survey markets (n=4) and shops (n=10) in Kanungu District to record the brand, cost and weight of food; ii) focus groups to document commonly consumed food lists, portion sizes, cooking/ processing, and storage methods, and availability of food over seasons; iii) food frequency questionnaires with the same individuals participating in the focus groups to pilot the 24-hour recall study; iv) use of existent food composition tables to investigate the nutritional value of each food.

Results. The food list contained 148 different foods of which 32 recipes. Number of meals, portion sizes, and variety of foods varied according to the community, economic situation, adaptation to environmental conditions and cultural context. Products rich in fats or animal proteins were available, but not frequently consumed due to high costs. General seasonality and other climatic factors such as precipitations variability affected individuals' diet. To quantify food, the communities used mostly "kilos" or "pieces" measurements, which were terms used in markets. Traditional food was partially substituted by industrially processed food, especially drinks and sweets.

Discussion. The framework enabled a comprehensive local food database to be systematically constructed among Indigenous and non-Indigenous communities. "Food" is a culturally constructed term with different meanings that need to be clarified before collecting data for food databases.

Conclusion. Designing a nutritional framework tailored on community needs is likely to improve nutritional research among Indigenous populations. This framework would be helpful for policy makers and global public health experts to direct efforts and achieve the "Zero Hunger" goal (Sustainable Development Goals).

Keywords: Food database, Methodology, Indigenous population, framework, Uganda

VALIDA project: Validating the use of photos for food portion quantification

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Introduction: This is a report on the results of the VALIDA Project, which aimed to validate quantification tools for improving dietary assessment in Brazil. This experience could also benefit other countries.

Methods: Four sub-studies were conducted (2016-2019) in the cities of Curitiba/PR or Aracaju/SE. They aimed to evaluate the cognitive abilities of individuals in quantifying the foods with the use of the developed Brazilian photo album. This included the quantitative evaluations of perception, conceptualization and of 24-hour memory of individuals as well as a qualitative assessment of self-perception of interviewees and interviewers. At the perception study participants (N=58) had to match 60 printed and digitized photos (in tablets and computer-screens), with real food portions available in front of them. The conceptualization study evaluated the use of 24 photos showed to participants (N=21), after visualizing the food portions for 30 seconds. The memory study (n=140) evaluated the use of the photos with the GloboDiet software, 24-hours after individuals consumed predefined foods during breakfast and/or lunch. Participants were randomized into two groups: with and without the use of the album. The qualitative study evaluated the self-perception of both individuals with low illiteracy and interviewers, using focus groups and semi-structured interviews.

Results: Perception: the mean error percentage was -1.1% (SD=11.2) for printed photos and -3.6% (SD=14.3) for digital ones ($p=0,27$). However, the evaluations using a tablet provided worse outcomes in low-educated individuals. Conceptualization: there was a larger tendency for underestimation of the portions, with the median error percentage of -20%. Nevertheless, 86% of the evaluated portions were correct. Memory: the chances of correct estimation at $\pm 25\%$ were higher for rice (OR 2.9 (1.4-5.9)) and beans (OR 3.6 (1.5-8.3)) when using the album as compared to the non-use ($P<0,01$). Qualitative: Challenges were suggested to be considered when collecting information from individuals with low education, especially to make them understand what is being asked. Difficulties due to lack of familiarity in using photos were also reported.

Discussion: The results suggest a good performance of the photos but further investigation is needed for improving their use in specific population groups (e.g. low educated group).

Keywords: photos, visual aids, validation, education, bias

Validation of 24-h dietary recall for estimating nutrient intakes and adequacy in adolescents 10-11 and 12-14 y of age in Burkina Faso

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Introduction

Data on dietary nutrient intakes of adolescents in low- and middle-income countries (LMIC) is lacking partly due to the absence of validation studies of the 24-h recall method in adolescents. We addressed this by conducting a validation study of the 24-hr recall (24HR) interview method among adolescents compared to whole day observed weighed records (OWR) (considered as the gold standard).

Methods

Dietary data for adolescents (n=132, 10-11 y; n=105, 12-14 y) were collected for the same day by OWR and 24HR. For OWR, all foods consumed by adolescents from the first to last meal of the day were weighed; for 24HR adolescents reported foods consumed using aids (e.g., replicas, playdough). Food intakes were converted to nutrients using actual weights or conversion factors. Equivalence for nutrient intakes between the methods was tested by comparing the ratios (24HR/OWR) to equivalence margins of within +/- 10%, 15%, and 20% of the ratio. Prevalences of inadequacy (POI) were obtained using the NCI method.

Results

Mean ratios for energy were 0.88 and 0.92, for younger and older adolescents, respectively, and other nutrients ranged between 0.84 and 1.02. Energy intakes were equivalent within the 15% bound, and most nutrients fell within the 20% bound. POI was overestimated by 24HR, but differences were less than 25 percentage points for most nutrients. Half of adolescents omitted foods in recalls, mainly sweet or savory snacks, fruits and beverages.

Conclusions

Adolescents underestimated intakes by 24HR; however, the degree of underestimation was generally acceptable for 12-14 y olds within a bound of 15% and similar to results from validation studies of 24HR with adults in LMIC. Errors could possibly be reduced with further training and targeted probing. Additional validation studies in adolescent LMIC populations are warranted.

Keywords: dietary assessment, 24 hour recall, dietary intake, validation, adolescents

S16. Biomarkers

Twenty-four hour urinary sucrose and fructose is a good measure of total sugars but not added sugars intake in US participants

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Developing methods of obtaining more accurate estimates of intake is crucial for attaining reliable risk estimates for sugars and disease risk. Twenty-four hour urinary sucrose and fructose (24uSF) was developed as a biomarker of sugars intake in two UK-based feeding studies. However, evidence on the performance of this biomarker in the context of a US diet has been lacking. To investigate 24uSF as a biomarker of sugars intake (total and added) among US participants, we conducted a 15-day feeding study involving 100 participants, aged 18-70 years, consuming their usual diet under controlled conditions, and collecting eight nonconsecutive 24-h urines. Sucrose and fructose in urines were measured using colorimetric method. A linear mixed model with 24uSF as dependent variable was run to investigate its association with total and added sugars intake in separate models while controlling for several covariates. Forty-three men and 55 women completed the protocol, and had at least one complete 24-h urine collection based on self-reported missed voids and para-aminobenzoic acid marker of urine completeness. Mean (SD) total sugars and added sugars intake was 115.6 (40.2) g/d and 67.3 (33.7) g/d or 9.8% (6.0) of total energy, respectively. The mean 24uSF was strongly correlated with mean total sugars ($r=0.69$) and added sugars intake ($r=0.67$). In a linear mixed model for total sugars, total sugars intake was the strongest predictor of 24uSF [coefficient=1.01 (SE=0.04); $p<0.0001$]. Age [-0.37 (0.11); 0.001] and sex [-0.26 (0.08); 0.001] explained a significant portion of the variability in the biomarker, and remained in the final model. Although fat and protein intake were also statistically significant predictors, they were less strong than the aforementioned factors [0.13 (0.06); 0.03; and -0.18 (0.07); 0.01; respectively]. In the added sugars model, both added [0.49 (0.02); <0.0001] and naturally-occurring sugars [0.27 (0.03); <0.0001] significantly predicted 24uSF alongside age [-0.40 (0.12); 0.0009] and sex [-0.27 (0.08); 0.001]. These preliminary findings show that similarly to what was found in the UK-based studies, 24uSF is a good measure of total sugars intake in US participants. While 24uSF was strongly correlated with added sugars intake, the biomarker cannot distinguish added from naturally-occurring sugars.

Keywords: dietary biomarkers, sugars, feeding study, 24-h urine

Validity coefficient of urinary marker of sugar intake is comparable to urinary nitrogen as marker of protein intake in free-living individuals

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Introduction: Studies do not show consistent relationships between self-reported intake of free sugar and outcome of disease. To overcome the drawbacks of methods of self-reported intake and often questionable information on sugar content of foods in food composition databases, the use of urinary sucrose and fructose as biomarker of sugar intake has been suggested. Our objective was to investigate whether there is an agreement in ranking of individuals between their self-reported sugar (sucrose) intake and urinary sucrose and fructose.

Methods: We used data of 198 Dutch adults (106 women), aged 20–70 years, from the DUPLO study. Sugar intake was estimated by and by collecting duplicate portions (DP) and two 24-hour recalls – telephone (24hT) and web-based (24hW) –, while sugar excretion was based on two 24-h urine samples. Sugar content of DP and urine were analysed by LC(-MS-MS), and sugar content of 24hT and 24hW were calculated based on a newly developed sugar database. Measurement error models assessed validity coefficients (VC) and attenuation factors (AF) in a hypothetical scenario of infinite biomarker replicates. Coefficients were compared to those of urinary nitrogen, as the latter is considered a recovery marker of protein intake.

Results and discussion: DP, 24hT and 24hW estimated median sucrose intake (IQR) were 19.7g (24.5), 39.6g (29.1), and 21.1g (23.1), respectively. The VC for the BM, using DP as reference, showed comparable to substantially better ranking of participants (0.72 for women and 0.93 for men), than 24hT (0.57 and 0.78) or 24hW (0.70 and 0.78) as reference. The VC of the sugar models was within 10 % of the nitrogen models, except for the model with 24hT as reference, among women. The AF roughly followed a similar pattern as the VC. Urinary sucrose and fructose as biomarker of sugar intake had a ranking performance comparable to urinary nitrogen as biomarker of protein intake.

Keywords: Sugar, Biomarker, Validity, Dietary assessment

Continuous glucose variations as biomarker for the relation between food intake, glucose health status, and wellbeing. Lessons learned and preliminary results from a real-world study.

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Introduction: Post-meal glucose responses can be predicted for an individual on basis of microbiome, clinical features, dietary habits, and other personal factors, also enabling personalized dietary advice to lower post-prandial glucose (Zeevi et al., Cell, 2015). The ability to continuously monitor glucose levels thus provides new opportunities for biomarker-driven personalized lifestyle advice systems for health optimization. Here we aim to 1) explore metrics of continuous glucose variations to predict glucose related health status; 2) predict continuous glucose variations on basis of food intake; and 3) investigate how data collection intensity can be reduced while sustaining predictive ability.

Methods: For two weeks, 24 healthy individuals (m/f) with affinity for nutrition and health research time-logged their food intake, monitored their glucose (Freestyle Libre Pro, Abbott), heart rate, sleep, and activity (Health watch, Philips), filled out ecological momentary assessment questions on wellbeing, performed an oral glucose tolerance test (OGTT), and consumed 8 standard glucose-rich snacks under standardized conditions in their daily life setting. Glucose variation was defined by summarizing continuous glucose levels into relative time spent under low, medium, or high variation. Canonical correlation analysis was performed between the glucose variation and response to the oral glucose tolerance test, as well as between overall variation and macronutrient profile of food consumed.

Results: Initial exploration of the data showed high compliance to collection of food intake data (7023 points, 71% coverage), glucose (27031 points, 98% coverage), OGTT (22 points, 92% coverage), well-being (3815 points, 100% coverage), and reasonable participant satisfaction on collecting these data. The first data analysis revealed high within-individual variations in response to the standard snack, associations between glucose variations and response to the oral glucose tolerance test, as well as associations between macronutrient profiles and glucose variations, in particular related to fiber.

Discussion & conclusion: Based on the data collected we conclude that further understanding of within-individual variation is warranted and the burden of collecting data for the participant needs to be reduced for successful implementation in a real-world setting. The initial analysis suggests that continuous glucose variations may serve as a biomarker for glucose health in relation to food intake.

Keywords: continuous glucose monitoring, food intake, health status, compliance, real-world

Measuring micronutrient intake in children: comparison of 24-hour diet records, 24-hour urine, and duplicate diets for estimating potassium, sodium, and iodine

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Introduction: Accurately estimating nutrient intake can be challenging, yet is important for informing policy. While a number of dietary assessment methods are available, there is often a trade-off between validity of the results versus increased expense and participant burden.

Methods: This cross sectional validation study compared the use of three methods for estimating the intake of sodium, potassium, and iodine in healthy children aged 9-11 years in New Zealand (NZ). Over the same 24 hour period participants collected duplicate diets (n= 37), weighed food records (n= 84), and 24 hour urine samples (n= 82). Children and their caregivers were instructed on collection methods. Samples (duplicate diets and urine) were analysed at the University of Otago, and food records were analysed using Kaculator (a food analysis program developed at the University of Otago, based on the NZ food composition database).

Results: Estimates for mean(SD) sodium intake ranged from 1886 (405) mg/day (duplicate diet) to 2119 (439) mg/day (24h urine). Mean(SD) potassium intake ranged from 1414(345) mg/day (24h urine) to 2172 (593) mg/day duplicate diet). Mean(SD) iodine intake ranged from 52(6) µg/day (24h record) to 95 (18) µg/day (duplicate diet). For sodium the duplicate diet appeared to underestimate intake compared to both the other two measures. For potassium the 24-hour urine appeared to underestimate intake compared to food record and duplicate diets, and for iodine the three measures are similar although food records appear to underestimate intake. Bland Altman plots show relatively wide limits of agreement for all measures and nutrients.

Discussion: We found important differences between dietary estimates of sodium, potassium and iodine using the three methods of dietary assessment, suggesting that different methods of assessment have specific limitations for the measurement of these nutrients in children. Results support World Health Organization recommendations to use urinary assessment to measure sodium and iodine intake, while dietary assessment appears to be more accurate for estimating potassium intake in this age group.

*Keywords: sodium*potassium*iodine* children*diet*

Can skin colour spectrophotometry be used as an objective biomarker for fruit and vegetable intake in Kenyan adults?

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Introduction

Objective biomarkers may improve the accuracy of dietary intake assessment. Skin colour spectrophotometry may be used as a non-invasive objective biomarker to evaluate fruit and vegetable intake. Carotenoid intake is associated with the yellow colour tone of the skin and is also closely related to fruit and vegetable intake. Skin colour has been evaluated in the Caucasian population but the evidence in black Africans is limited.

Methods

In 94 Kenyan adults, aged 18-55 years, living in Nairobi, Kenya, skin colour spectrophotometry was evaluated against quantitative 24h recalls. Per respondent 4 recalls were conducted on non-consecutive days spread over a period of 3 weeks to assess fruit, vegetable and β -carotene intake. A portable spectrophotometer was used at a standardized site on the right-hand palm, to measure yellow skin colour (CIE Lab unit: b^* blue-yellow). An average of 5 measurements was recorded and duplicate measurements were conducted after 3 weeks. Associations between intake and skin colour were calculated using Spearman correlation coefficient and linear regression.

Results

The study population consisted of 61% women, and 76% of the participants were younger than 34 years, 26% were obese, 26% overweight and 3.2% underweight. Median intake of fruit (28% watermelon, 26% banana), vegetables (35% green leafy vegetables, 27% tomato) and fruit plus vegetables was 99g, 226g and 339g, respectively. Median intake for β -carotene was 2718 μ g/day. Intake of fruit and vegetables correlated positively with intake of β -carotene ($r=0.66$, $P<0.001$). β -carotene intake was stronger correlated to vegetable intake ($r=0.65$, $P<0.001$) than to fruit intake ($r=0.25$, $P=0.017$). Intake of fruit, vegetables or β -carotene was not correlated with b^* values for yellow colour tone. Fruit, vegetable, fruit plus vegetable or β -carotene intake could not predict the b^* value in linear regression.

Discussion

In this study, skin yellowness was not associated with fruit, vegetable and β -carotene intake in Kenyan adults. Limitations that need further attention are the relatively low intake of β -carotene, the type of fruit and vegetables consumed and the relatively small sample size.

Keywords: Skin colour spectrophotometry, 24h recalls, biomarker, fruit & vegetables, β -carotene

The carbon isotope ratios of serum amino acids in combination with participant characteristics can be used to estimate added sugar intake in a controlled feeding study of US postmenopausal women.

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Introduction: The carbon isotope ratio (CIR) is a proposed biomarker for added sugar (AS) intake in the United States (US); however, because the CIR is also associated with meat intake in most populations the need for specificity remains. The CIR of amino acids (AA) have the potential to differentiate sugars from meat intakes, as essential AA must derive from dietary protein whereas certain nonessential AA can be synthesized from sugars. We tested whether serum CIR-AA in combination with participant characteristics could meet a pre-specified biomarker criterion for AS intake in the Nutrition and Physical Activity Assessment Study Feeding Study (NPAAS-FS) of the Women's Health Initiative (clinical trial registry: NCT00000611), a population in which the whole-serum CIR was not associated with AS intake.

Methods: Postmenopausal women (n = 145) from Seattle, WA were provided individualized diets that approximated their habitual food intakes for 2 wks. Dietary intakes from consumed foods were characterized over the feeding period using the Nutrition Data System for Research. The CIR of seven AA (alanine (Ala), glycine (Gly), valine, leucine, isoleucine (Ile), proline, phenylalanine) were measured in fasting serum collected at the end of the two-week feeding period, using gas chromatography-combustion-isotope ratio mass spectrometry. Biomarker models were evaluated using regression $R^2 > 0.36$ as a major biomarker criterion, based on the benchmark R^2 values of well-established recovery biomarkers in NPAAS-FS.

Results: Added sugar intake was associated with CIR-Ala (Spearman's $r = 0.32$; $P < 0.0001$). A model of AS intake based on CIR-Ala, CIR-Gly, CIR-Ile, smoking, leisure physical activity, and body weight met the biomarker criterion ($R^2 = 0.37$). Biomarker-estimated AS intake was not associated with meat or animal protein intake.

Discussion: Results support serum CIR-AA in combination with participant characteristics as a potential biomarker of AS intake in US populations, including those with low AS intake.

Keywords: Added sugar, carbon isotope ratios, biomarker, amino acids, NPAAS-FS

S19. Statistical methods

What do Australian adults eat for snacks? A latent variable mixture modelling approach

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Introduction: Understanding how foods are eaten together at eating occasions (EO) may help identify targeted nutritional strategies to improve eating behaviors. However, the analysis of EO is challenging because there are many possible food combinations and the data distribution of food intake is highly skewed and semi-continuous. Therefore, a novel latent variable mixture modelling (LVMM) approach was used to determine food combinations, or profiles, at snack EO.

Methods: Adult participants (n=7646; ≥19 y) from the 2011-12 Australian National Nutrition and Physical Activity Survey reported their dietary intake at snack EO (n=17,191) during a 24-hour recall. Two-part LVMM was used to determine snack food profiles based on 29 energy-adjusted food and beverage intake groups. Adjusted chi²-tests were used to examine snack profiles by time-of-day. Multilevel regression models were used to estimate differences in sociodemographics, energy intake and adiposity measures (BMI, waist circumference) between profiles.

Results: Four distinct profiles were found among men and women. Two were labelled: “Coffee/tea, milks and sweet cereal products” and “Breads/crispbreads and spreads”. Among men, an “Alcohol” profile and a “Mixed” profile (including fruit and/or unhealthy foods/beverages) were also identified. Two profiles unique to women were characterized by “Fruit” and “Unhealthy foods/beverages”, respectively. Snack profiles varied according to time-of-day, sociodemographic factors and their contribution to energy intake. For example, profiles characterized by unhealthy foods or alcohol were mostly consumed in the afternoon or evening. Men consumers of an “Alcohol” profile were more likely to be smokers whereas women consumers of a “Fruit” profile were more likely to be never smokers (both P<0.001), when compared to the other profiles. Among both sexes, the “Breads/crispbreads and spreads” profile contributed the highest mean energy intake at snacks (P<0.001). No differences in adiposity measures were observed.

Discussion: We identified four snack profiles that varied by time-of-day of consumption, sociodemographics and contribution to energy intake. LVMM is a useful approach for providing novel insights into eating behaviors at snack EO.

Keywords: eating occasions, snacks, latent class analysis, diet quality, eating patterns

Are predictive equations for estimating total energy intake reliable in older adults?

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Introduction: Understanding daily energy requirements and expenditure for older people is critical to ensure adequate nutrition for this age group in an attempt to contribute to population healthy aging. The present study aimed to assess the accuracy of previous predictive equations for estimating energy requirements in older adults using the doubly labeled water (DLW) as reference method.

Methods: A total of 38 free-living older adults aged 60-84 years old, who were enrolled in the 2015 Health Survey of São Paulo, Brazil were included. Total energy expenditure (TEE) was determined by the DLW technique (2g of O¹⁸/kg of TBW in atom. excess 10% and 0.15 g of D²⁰/kg of TBW in atom. excess 99.8%). We measured weight and height to calculate TEE according to the Dietary Reference Intake (DRI) and Vinken et al. equations. Mean difference between measured and predicted TEE was compared by paired t-test. Intra-class correlation (ICC) coefficients were used to evaluate the reproducibility between TEE predicted by each equation and measured by DLW. Predicted TEE was considered accurate if the energy estimated was within $\pm 10\%$ of measured TEE.

Results: Participants were mostly male (57.9%), white (65.8%), normal weight (36.8%) or obese (44.7%). TEEDLW was higher in men (mean:2657kcal/day, standard deviation (SD):406kcal/day) than in women (mean:2169 kcal/day, SD:374kcal/day) ($p < 0.01$). No significant differences were observed between TEEDLW (mean:2451.30kcal/day, SD:457.79kcal/day) and the two previous predictive equations (DRI - mean:2477kcal/day, SD:353kcal/day; Vinken et al. - mean:2450kcal/day, SD:467kcal/day). Both equations had the same proportion of accurate TEE (60.5%). However, Vinken et al. presented the lowest proportion of overestimation of energy requirements than DRI (18.4% vs. 26.3%). The ICC for DRI equation (0.69, $p < 0.001$) and Vinken et al. equation (0.67, $p < 0.001$) suggested a moderate degree of reproducibility compared to TEEDLW.

Discussion: The DRI and Vinken et al. equations presented moderate agreement with energy expenditure measured by DLW in older adults. It is relevant to consider the modification in active metabolic tissue with age, which leads to a reduction in older people's energy requirements. Thus, developing more accurate equations, considering the specificity of race and body composition of this age group appears to be of clinical relevance.

Keywords: Energy Expenditure, Doubly Labeled Water

Comparison of several energy intake misreport identification methods on the accuracy of nutrient intake estimations using urinary biomarkers

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Introduction: Different studies apply different methods to identify energy intake (EI) misreports, which makes interpretations difficult. This study aimed to evaluate how different methods influence EI misreport prevalence as well as the accuracy of nutrient intake estimates.

Methods: Adults participants in the Portuguese National Food, Nutrition and Physical Activity Survey, IAN-AF, 2015-2016 were included (n=3639). Dietary intake was measured by two 24-Hour dietary recall. Physical activity was measured by International Physical Activity Questionnaire. Under, plausible and over-reporters were identified according to univariate (Willett, Interquartile Range) and multivariate methods (Goldberg and predicted Total Energy Expenditure (pTEE), testing for different standard deviations (SD)). Since EI misreport is reflected on nutrient misreport, dietary biomarkers including nitrogen, potassium and sodium were measured in a sub-sample that collected a 24-Hour urine (n=80). The comparison between nutrient intake and their respective estimation by urinary excretion in the 24-Hours urine was assessed by linear regression coefficients (β).

Results: EI misreport prevalence according to different methods varied widely ranging from 0.2% (Willett method) to 63.9%, reaching a maximum of 60.5% of under-report and 3.4% of over-report (pTEE 1 SD method). Differences in estimates are higher when the number of individuals excluded is also higher (from -5Kcal using Interquartile Range to +466Kcal using pTEE 1 SD method). When studying the sub-sample who collected 24-Hours urine, the associations between nutrient self-reported intake and estimated intake using urinary biomarkers were: $\beta_{\text{protein}}=0.216$; CI95%=-0.034-0.380; $\beta_{\text{potassium}}0.645$; CI95%=0.408-0.836 and $\beta_{\text{sodium}}0.228$; CI95%=-0.003-0.452. After excluding misreporters according to each method, stronger associations were found, using pTEE 1SD method ($\beta_{\text{protein}}=0.459$; CI95%=0.259-0.764; $\beta_{\text{potassium}}=0.940$; CI95%=0.669-1.192) and Goldberg 2SD ($\beta_{\text{protein}}=0.337$; CI95%=0.144-0.536; $\beta_{\text{potassium}}=0.781$; CI95%=0.465-1.011). No significant differences were observed for sodium.

Discussion: EI misreport prevalence varies substantially according to the used method, being higher using multivariate methods in which it has greater impact on nutrient estimation. The association between estimated intake by self-report and by urinary biomarkers among plausible reporters identified in each method was greater using the pTEE 1SD method. The Goldberg 2SD method has also showed to be a reasonable alternative.

Keywords: Misreport, dietary assessment, national dietary survey, energy intake, Portugal

Predicting mortality in the National Health and Nutrition Examination Survey using a lasso-weighted and 6-component Healthy Eating Index-2015

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Introduction: High diet quality measured with the Healthy Eating Index (HEI) or similar indexes is consistently associated with an 11-26% mortality risk reduction. Despite compositional differences across indexes, consistent mortality associations suggests shared components (i.e. whole grains, fruit, vegetables, and plant-based proteins) may drive these associations. Therefore, this analysis examined whether reweighting individual HEI-2015 components modified mortality associations.

Methods: Longitudinal data from adult (≥ 20 years) participants in the nationally-representative National Health and Nutrition Examination and Survey III (1988-94; $n=13,980$) were analyzed. Participants were excluded if they had missing/unreliable mortality or dietary data, were pregnant, lactating, diagnosed cardiovascular disease, or had implausible energy intake ($>4,000$ or <700 kcals). Linked National Death Index files determined mortality status. Three HEI-2015 scores (out of 100 points) were calculated from one 24-hr recall: 1. standard HEI-2015, 2. HEI-2015 with 6 equally-weighted components representing 4 food groups (whole grains, fruit, vegetables, and plant-based proteins), 3. HEI-2015 with component weights determined using lasso regression, a statistical shrinkage/regularization method. Sex-stratified, survey-weighted Cox models adjusted for sociodemographic and health-related covariates compared mortality risk between the highest and lowest HEI-2015 quintiles (Q).

Results: Over a median follow-up of 22.7 years, 4,840 total deaths occurred. Participants were on average 46.5 years old, 52.8% female, 40.7% non-Hispanic White, 13.1% college graduates, and 60.0% had a BMI ≥ 25.0 . Using the standard HEI-2015, mortality risk was 16% lower in Q5 vs. Q1 for men (HR: 0.84 [0.72, 0.98]) and women (HR: 0.84 [0.71, 0.99]). For women, the 6-component score had stronger mortality risk reductions (HR: 0.76 [0.62, 0.92]) whereas mortality risk was attenuated and nonsignificant for the men's 6-component score and the men and women's lasso-weighted scores.

Discussion: Among 3 HEI-2015 scores, mortality risk was most reduced within the standard HEI-2015 for men and the 6-component HEI-2015 for women. The less consistent non-traditional HEI-2015 score results could be driven by factors such as use of a single 24-hr recall or limited variation in intake ranges. Therefore, this study provides some initial support for further exploration into the influence of differential component weighting in mortality prediction within other cohorts using more detailed assessment methods.

Keywords: *NHANES, diet quality, Healthy Eating Index, Lasso regression*

Substitution analyses of diet-related greenhouse gas emissions: How to reduce emissions by switching to plant-based meals for lunch

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Introduction

Climate change is an urgent global issue and the food sector is estimated to contribute to 25% of the total greenhouse gas emissions (GHGE). A majority of the Swedish work force eat hot meals for lunch at work. We hypothesized that switching from a traditional animal-based lunch to a plant-based lunch would be a feasible behavior change to reduce diet-related emissions.

Methods

We use data from a national dietary survey and each participant (n=1,094) filled out web-based food records for 4 days, generating a total of 3,959 lunches. The dietary intake was linked to published Life Cycle Assessment data on GHGE and nutrient content for each food item. Meat and fish dishes were grouped into 10 main categories, and plant-based dishes into 6 main categories. We designed substitution scenarios by replacing animal-based dishes with plant-based. We computed the average difference in carbon dioxide equivalents (CO₂e) pre- and post-substitution per person per lunch. We assessed nutrient quality pre- and post-substitutions by computing the proportion of subjects adhering to the Nordic Nutrition Recommendations (NNR) for iron, vitamin C, vitamin B12, protein, fat, fibre.

Results

The proportion of meat and fish in the 10 main lunch categories contributed with 23% of the total food intake in terms of grams during lunch, but made up 62% of the total CO₂e. The GHGE for animal-based dishes ranged between 39 and 5066 g CO₂e/100 g food and corresponding GHGE for plant-based dishes between 20 and 453 g CO₂e/100 g food. When all the “Mixed meat dishes” were substituted for a plant-based lunch dish, we observed an average decrease of 303 g CO₂e per lunch per person for the whole group, corresponding to a 18% reduction of total emissions from lunches. At the same time, we observed increased adherence to the NNR regarding intake of fiber and protein.

Discussion

Substituting animal-based lunch dishes with plant-based alternatives is a potential efficient behavior change to reduce emissions if done by a large part of the population. Increased awareness about the impact of small dietary changes could be one strategy to combat climate change and improve nutrient intake globally.

Keywords: Webbased food records, CO₂e, substitution

S20. Development of methods

Nutritools: an interactive guided website including validated dietary assessment tools and a food questionnaire creator

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Introduction: health researchers often struggle to choose suitable validated dietary assessment tools (DATs) for their target population. The aim of this project was to identify and collate information on validated DATs and validation studies included in the Nutritools website to support choice of appropriate DATs.

Method: a systematic review of reviews of DATs was undertaken. A searchable website was designed to display this data. Mean differences and Bland-Altman limits of agreement between test and comparison methods were extracted or calculated; and compared for energy, macronutrients and micronutrients. Best practice guidelines in assessing dietary intakes were developed from an expert-led Delphi technique. Food questions were mapped to food databases to allow users to create bespoke online food questionnaires.

Results: the www.nutritools.org website contains detailed information on 126 validated DATs from all over the world. Over 900 validation results covering 5 life-stages, 18 nutrients, 6 dietary assessment methods and 9 validation method types were extracted.

For the UK, 63 validated DATs were identified from 68 reviews with 17 validation studies on <18y using 14 DATs. The most commonly validated nutrients were macronutrients, calcium, iron, folate and vitamin C. In children, there were no validated DATs reporting assessment of zinc, iodine or selenium intake; and sugar, fibre and sodium were limited. The most common reference method was the weighed food diary. Summary

plots were created to facilitate comparison between tools. On average, the test tools reported higher mean intakes than the reference methods with some studies consistently reporting wide LOA.

The best practice guidelines provide a valuable interactive guide for health researchers to choose the most appropriate dietary assessment method for their studies. Existing validated questionnaires can be transformed from paper to web-based tools using Nutritools. Food questions can be mapped to the latest food databases for easier data collection and nutrient analysis.

Discussion: The interactive www.nutritools.org website holds extensive validation data, best practice guidelines and a standardised questionnaire creator, which allows researchers with no nutrition expertise to critically compare, choose or develop a suitable DAT for their research question, leading to improvement in standards for dietary assessment in nutritional epidemiology research.

Keywords: dietary assessment tools, validation, online, best practice guidelines, questionnaire creator

Development of the Dutch food consumption application DitEetIk!

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INTRODUCTION: National food consumption surveys collect elaborate food consumption data often via 24-hour dietary recalls by dietitians. This can be time consuming and non-flexible. Mobile phone applications offer an opportunity of collecting dietary information while making it easier and more time flexible for participants and eventually making it less costly for researchers. Here we describe how feedback from participants was collected and used to aid the ongoing development of the Dutch DitEetIk! food consumption application.

METHODS: Before the app-building several commercially available apps were tested and evaluated. The app is being developed in sequential sprints, in which a set of work is completed in a set period of time. Information or prototypes of the app were presented to participants in two usability tests (n=12) and five focus groups (n=62). The usability tests focused on the flow and handling using the 'think aloud' method, the focus group discussions mainly focused on the data and specific functionalities. System-usability-scales (SUS) were applied four times to measure user-friendliness. After each session the prototype was improved according to the feedback.

RESULTS: During both the usability tests and the focus groups several problems were mentioned. Some problems were pointed out by most participants and easily fixable. For instance, participants disliked for a text search to begin automatically or if food names were not completely displayed. Other problems were harder to fix. When searching products via text, a long list appeared. The sequence of the products displayed was not always in order of relevance. All participants were enthusiastic about the ability to scan foods. On average 50% of the products were scanned by participants. The SUS scores were below average three out of four times and can therefore not be considered user friendly yet.

DISCUSSION: Integrating feedback of users in the design and development of the app has positively contributed to the overall quality of the app. However, smaller user feedback studies do not replace validity studies; these are still needed to assess the overall reliability.

Keywords: food consumption, application, DNFCs, focus group, usability

Environmental sustainability of diet – feasibility of linkage to automated online dietary assessment tools

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Introduction

The environmental impact of diet has been addressed on a societal level by the EAT Lancet Commission. It describes the need for a ‘Great Food Transformation’ to ensure food production systems deliver diets that promote human and planetary health. Dietary assessment currently focuses on the nutrient composition of foods, without addressing their environmental impact. We aim to identify and link greenhouse gas emission (GHGE) values for key generic food items on the myfood24 automated dietary assessment tool. We also aim to identify the additional information required to generate accurate GHGEs and other environmental indicators for individual-level diets.

Methods

A scoping review of the literature was undertaken to identify where GHGEs exist for commonly consumed foods and where knowledge gaps exist. From this, GHGE values were added to the 3287 generic items in the UK Composition tables held in the online dietary assessment tool, myfood24. Missing values were populated where possible using proxy values based on the literature. GHGE values were harmonised to cover food life cycle stages up to the point of retail.

Results

GHGEs were assigned to >98% (n=3232) generic food items. GHGE values for 1981 foods were taken from Poore et al. and the remaining 1248, mainly composite and processed foods, from Green et al. Three items (breastmilk) were assumed zero impact. The 55 foods without GHGE values were primarily sauces and condiments. Very few items specified farming or production method, seasonality or country of origin. We also apply GHGEs to a pilot sample (n=212 on at least one occasion) to enable the generation of individualised dietary GHGE values.

Discussion

We have successfully assigned GHGEs to the majority of generic food items held in the online dietary assessment tool, myfood24. There are limitations and gaps in the data. GHGEs for sauces were lacking and more detail is required on production method, provenance, seasonality and agricultural standards like organic, which influence GHGEs. Future research will use brand-level dietary information and web-scraping to fill these knowledge gaps, and use multiple environmental indicators to create a fuller picture of environmental impact and provide optimised diets for people and planet.

Keywords: greenhouse gas emissions, individual diets, climate change, automated dietary assessment.

Comparison of large-scale grocery purchases and individual-level food consumption: results from the LoCard-study

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Introduction: Studies suggest that grocery purchases can be used to assess food consumption, but to date, most studies have required active participation from the customers (i.e., collecting receipts). This study investigated whether grocery purchase data collected via loyalty cards can be used to assess food consumption.

Methods: The data on participants' grocery purchases were issued by a major retail chain. The participants reported the consumption frequencies of 52 food items during one month using an electronic food frequency questionnaire (FFQ). We compared FFQ data on the consumption of fresh vegetables; cooked vegetables; legumes; fruits; berries; skimmed milk; vegetable oils; butter and butter-fat blends; margarines; fish; red meat; white meat; processed meats; rye bread; white bread; sugar-sweetened beverages; chocolates; and sweets with purchase data (volume and frequency over the past 1- and 12-month periods). We used the gamma statistic to examine the association between thirds or quarters of FFQ and purchase data. In terms of rank agreement, we calculated the percentages of participants classified into the same; same or adjacent; and opposite category using the FFQ and purchase data (12 months, volume).

Results: Altogether 11,983 participants (mean age 48.5 years) were included. The associations between FFQ and purchase data were statistically significant but modest (range 0.12–0.75). The associations were strongest for skimmed milk (0.63–0.74) and margarines (0.63–0.75) and weakest for cooked vegetables (0.12–0.15). The results were fairly similar regardless of the type of the purchase data used (1- vs. 12-month, volume vs. frequency). Regarding sweets, red meat, margarines and skimmed milk, the two methods classified the participants relatively similarly (46–49% in the same category, 4.1–11% in the opposite category), whereas discrepancies were observed in categorizing fresh vegetables, cooked vegetables, berries and vegetable oils (31–42% in the same category, 12–21% in the opposite category).

Discussion: Loyalty-card data on grocery purchases can be used to assess food consumption in adult population. However, concerning some food groups, caution must be exercised while interpreting the results. Future studies should consider grocery purchase data as resource-saving, relatively valid and objective measure of food consumption in large samples.

Keywords: loyalty card, big data, relative validity, dietary assessment, supermarkets

The Development of a Total Nutrient Index Using Nationally Representative Data from Adults in the United States

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Introduction: Many diet quality indices exist; however, few nutrient-based indices are available; and to our knowledge, none assess total nutrient exposures inclusive of dietary supplements (DS). To fill this gap, we developed a comprehensive total nutrient index (TNI), that is, a nutrient-based scoring system to assess intakes from foods, beverages, and DS.

Methods: Usual nutrient intakes from foods, beverages, and DS by U.S. adults (≥ 19 y) were estimated using an adaptation of the NCI method and data from 24-hour recalls and a questionnaire on DS use and an in-home DS inventory collected in the 2011-2014 National Health and Nutrition Examination Survey ($n=9,954$). The TNI includes the eight shortfall nutrients as identified in the 2015-2020 Dietary Guidelines for Americans: calcium, magnesium, potassium, choline, and vitamins A, C, D, and E. Total nutrient intakes were expressed as a percentage of the appropriate Recommended Dietary Allowance or Adequate Intake and truncated at 100% to compute TNI-component scores for each nutrient. The average of the eight TNI-component scores yielded the TNI score. Relative validity was determined by correlating TNI scores with Healthy Eating Index (HEI-2015) total scores and construct validity by examining TNI scores stratified by population subgroups with known differences in diet quality.

Results: Preliminary results indicate an estimated mean TNI score of 75.4; whereas the same index based on dietary sources only was 69.0. The TNI scores were significantly different ($p<0.001$) for DS-users (83.5 vs. non-users: 67.1), non-smokers (76.8 vs. smokers: 70.3), and by food security status (food-secure: 76.6 vs. food-insecure: 69.1). The Pearson correlation coefficient of the TNI and the HEI-2015 total score was 0.48. This suggests that the TNI captures dimensions of nutrient intake that are distinct from those captured with the HEI-2015.

Discussion: The TNI assesses total usual intake of shortfall nutrients and extends existing measures of diet quality by representing nutrients obtained from DS in addition to those from foods and beverages. The preliminary results of validity tests suggest that the TNI may have the potential to be an effective tool in assessing total nutrient exposures of shortfall nutrients in the U.S. adult population.

Keywords: Diet quality, Dietary assessment, Dietary supplements, Methodology, NHANES

The relationship between adults' dietary intakes and food insecurity status in Canada: implications for future population assessment

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Introduction: Household food insecurity is a serious problem in high-income countries. Its adverse effects on health rise with the severity of food insecurity, but dietary assessments have typically treated food insecurity as a binary variable. Challenges in assessing this population include: small cell sizes limiting stratification possibilities, presumed differences in within-person variation with food insecurity, and more apparent under-reporting of intakes. Our objectives were to examine the relationship between household food insecurity status and adults' dietary intakes in Canada and identify implications for population assessment.

Methods: Dietary intake was assessed in the 2015 Canadian Community Health Survey-Nutrition (n=20,487) using 24-hour recalls, with food insecurity measured using the 18-item Household Food Security Survey Module (HFSSM). We estimated adults' usual intake distributions for calcium, folate, vitamins A, C, D, B6, B12, riboflavin, and ultra-processed food intake (NOVA classification) using the National Cancer Institute method. All models were stratified and compared by household food insecurity status, defined using a 4-level categorical variable and the conventional binary variable. We determined apparent energy misreporting by applying Garriguet's (2018) thresholds to the ratio of energy intake to estimated requirements and then compared the probability of under-reporting to individuals' responses on the HFSSM.

Results: 4.1% were marginally food-insecure, 6.2% were moderately food-insecure, and 2.8% were severely food-insecure. Within-person variance estimates differed markedly between groups. The prevalence of under-reporting ranged from 32% among the food-secure to 57% among the severely food-insecure, but under-reporting among food-insecure adults correlated with self-reported food deprivation. Mean usual nutrient intakes decreased overall by severity of food security status. No consistent pattern was observed for intakes of %kcal from ultra-processed foods by severity. The extreme deprivation of severe food insecurity was invisible when food insecurity was assessed as a binary variable.

Discussion: The nutritional disparity of food-insecure adults in Canada lies in their altered nutrient intakes, not the over-consumption of 'foods to limit'. Our findings highlight the importance of oversampling at-risk groups, assessing severity of food insecurity, and evaluating all aspects of the diet in future population surveys.

Keywords: food insecurity, Canada, NCI method, nutrient adequacy, misreporting

S23. Contextual factors

Development of a Dutch Diet History Questionnaire to assess the dietary intake of low SES pregnant women

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Background: Pregnant women often fail to meet dietary requirements, especially in low socioeconomic status (SES) populations. To gain insight into the usual dietary intake of low SES pregnant women in the Netherlands, we developed a Dutch Diet History Questionnaire (DDHQ). The DDHQ was generated to combine the open character of a Diet History interview with the standardization of a food frequency questionnaire (FFQ).

Methods: The format of the questions was based on that of an existing FFQ. A meal-based structure was created and open questions on missing foods and context were added. Food items and portion sizes were adjusted to the target population by analysing dietary data of both pregnant women and women of reproductive age, to theoretically cover at least 95% of the intake. The Dutch FFQ tool was used to generate the computer-based DDHQ, automatically calculating energy and nutrient intakes using the Dutch Food Composition Database. A small-scale pilot study (n=7) was conducted to test the face validity and acceptability of the DDHQ in the target group.

Results: The result is a 185-item meal-based questionnaire with a one month reference period, administered by trained dietitians in interviews conducted at the participant's home (if possible). The pilot study showed that the method was comprehensible and feasible, although the length of the questionnaire was considered a drawback by some participants. The DDHQ interviews have been found to take 1.5 up to 3 hours, which is similar to the time needed for a diet history interview.

Discussion: We have developed a method that is less costly and time consuming than a full Diet History method and more comprehensive than an FFQ. Although the FFQ that served as a basis was validated, the current method has not been validated yet in the target population. We do expect that by adjusting the food list to the target group, adding open questions and administration by trained dietitians, we cover the complete (contextual) dietary intake of low SES pregnant women.

Keywords: dietary assessment; pregnancy; interviewer-administration

Ranking barriers to healthy eating in young adults: application of a discrete choice experiment

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Introduction

Understanding barriers to healthy eating decisions is limited by methodologies that do not consider the complexity of food choice behaviours. Discrete choice experiments (DCE) are a quantitative methodology to rank choices in a decision-making context. Application of a DCE will advance knowledge of trade-offs made between meal attributes, thus identifying targets for tailored dietary interventions. This DCE aimed to rank barriers to healthy meal choices in young adults and to examine differences by sub-groups.

Methods

Young Australian adults (18-30 years) were recruited via social media to complete an online DCE and survey. Participants were presented with 12 choice tasks about a typical weekday meal and were asked to choose between three meal options. Each meal consisted of five meal attributes (taste, preparation time, nutrition content, cost and meal quality) and three attribute levels. Standard descriptions of each attribute were provided. Dietary intake was assessed by 17 brief dietary questions. A diet quality score (Dietary Guideline index) was calculated. Conditional logit models were used to rank meal attributes. Moderation analyses investigated variations in meal preferences by sex, diet quality and education. Feasibility of the DCE was assessed in the online survey.

Results

In total, 577 adults (46% female, 23.8 (SD 3.8) years) completed the DCE and survey. Nutrition content was the most important influence on meal choice, followed by cost, quality, taste and preparation time. Compared to males, females had higher preference for better taste ($B=0.31$; CI: 0.11, 0.51), nutrition content ($B=1.07$; 0.73, 1.42) and lower preference for increased preparation time ($B=-0.31$; -0.52, -0.09) and cost ($B=-0.27$; -0.52, -0.03). Participants with higher diet quality had higher preference for nutrition content ($B=1.26$; 0.93, 1.59) and lower preference for increased preparation time ($B=-0.22$; -0.43, -0.01). Higher educated participants had higher preference for higher nutrition content ($B=0.64$; 0.31, 0.98). Difficulties answering the DCE were reported by 5% of participants.

Discussion

The present study identified that nutrition content was the most important influence on young adults' meal preferences, which varied according to demographics and diet quality. DCEs may offer an acceptable methodology for understanding the complexity of food choice behaviours in young adults.

Keywords: discrete choice experiment, diet quality, barriers, healthy eating, young adults

The impact of sugar-sweetened beverages consumption on healthy food markers: National Dietary Survey 2008-2009

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Introduction: Sugar-sweetened beverage (SSB) consumption has been associated with low quality diet and it represents more than half of ultra-processed food intake in Brazil. In addition, SSB has been associated with overweight and chronic diseases.

Methods: The Brazilian National Dietary Survey was conducted in 2008–2009 covering 32,900 individuals with 10 years old or older. Dietary data were obtained from two food records of non-consecutive days. The percentage of energy intake (% of energy) from healthy (HFM) and unhealthy food markers (UFM) were categorized in usual daily portions: HFM [Vegetables (50 kcal); Fruits (60 kcal); and Dietary fiber density (25g)]; and UFM [Sweets, cakes, crackers, snacks and fast food (150 kcal); and Energy intake from added sugar (10% of energy intake)]. The SSB group was defined as the independent variable and it consisted of fruit drinks, juices, soft drinks and milk sugary drinks. The SSB intake was categorized into glasses (250 ml), considering approximately 140 kcal each (non-consumers, one glass, two glasses and three or more glasses). Consumption of SSB, HFM and UFM were described according to sociodemographic characteristics. Multiple linear regressions were applied to analyze the association between the consumption of SSB (glasses) on portions of HFM and UFM.

Results: SSB contributed with 8% of the total energy intake, being significantly higher between urban (8.3%) than rural areas (5.3%). It was observed an inversely association of SSB and HFM ($\beta = -43$; 95%CI = -48; -39), and a directly association between the consumption of SSB and energy intake ($\beta = 237$; 95%CI = 221; 253). For each additional glass of SSB, the main impact would be the increase of 10% of total energy intake among Brazilian population. However, not consuming SSB would imply an increasing of 15% increase in dietary fiber and a reduced intake in 3% of added sugar. All of the analyses were statistically significant ($p < 0.01$).

Conclusion: SSB consumption contributed with almost all WHO recommendation for energy intake from added sugar and this information may contribute to the subsidization of public protection policies that regulate the supply of SSB.

Keywords: Beverages, Food markers, Added Sugar, Energy Intake, Diet Survey.

Examining the effect of voluntary fortification on usual nutrient intakes in the Canadian population

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Introduction: In countries like Canada where fortification for public health purposes is tightly regulated, voluntary food fortification (VFF) refers to the addition of micronutrients by manufacturers for marketing purposes. As this practice expands in Canada, our objective was to examine its effects on usual nutrient intakes.

Methods: In the 2015 Canadian Community Health Survey, a population-representative sample of 20,487 individuals completed one 24-hr dietary intake recall, with second recalls on 7608. The intake data included 15 food codes denoting VFF, but 97.6% of participants reported zero VFF intake on day 1. We limited our analyses to 14-50 years old (n=8442, including 75% of survey participants reporting VFF intake). We estimated usual intake distributions for the main fortificants (riboflavin, niacin, zinc, vitamins A, B6, B12, C) for VFF consumers and non-consumers separately using the National Cancer Institute method, applying the 'shrink and add' method to estimate intakes among supplement users and assessing apparent benefit and risk by comparing usual intake distributions to EARs and ULs.

Results: Among participants with two 24-hr recalls, 25.1% reporting VFF consumption on day 1 also reported VFF on day 2, versus 1.7% of participants with no VFF on day 1. On average, VFF contributed 8.5% to total energy, but as much as 38.0% of vitamin B6 intake. The distributions of usual intake for all B vitamins were significantly higher for VFF consumers than non-consumers, but both groups had negligible prevalence of inadequacy. VFF consumers had higher usual intakes and less risk of inadequacy than non-consumers for vitamins A, C and zinc, but 95% confidence intervals around these estimates overlapped. The probability of supplement use did not differ significantly by VFF consumption. Among supplement users, the 95th percentile of usual zinc and vitamin A intakes exceeded the ULs, irrespective of VFF consumption.

Discussion: VFF consumption was associated with higher usual intakes, but no apparent benefit or harm. Our analysis is biased by the use of one 24-hr recall to identify VFF consumers. Given the concentration of VFF consumption among a discrete population subgroup, food frequency data are required for population-level assessment of its impact on nutrient exposures.

Keywords: *voluntary fortification, usual intakes, NCI method, supplement use, Canada*

Restricting promotions of unhealthy foods and beverages by price and location: applying UK Nutrient Profiling Models to a retail product dataset.

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Introduction

The UK government plans to restrict price and location promotions of products high in saturated fat, salt and free sugars (HFSS); a bid to reduce population obesity. The 2004/5 UK nutrient profiling model (NPM) which scores products to generate a pass/fail, is the proposed basis for restrictions. Yet, the current model may imminently be superseded by the draft 2018 NPM.

Additional to public health benefits, the legislation may impact retailers' revenue, supplier contracts and store layouts. Further, it is unclear how retailers will implement the legislation within the current data landscape. This paper aims to address these challenges.

Methods

Algorithms were developed to apply the current and draft UK NPMs to products in the myfood24 food composition database, representing a retail portfolio of ~45,000 products.

Scoring criteria were established for the draft 2018 NPM allowing comparison with the current 2004/5 NPM. Implementation challenges were assessed and recommendations developed, aligned to questions from the legislation's public consultation. NPM pass-rates and micronutrient compositions were compared using chi-squared and paired t-tests respectively.

Results

75.7% (n = 30,522) of myfood24 products were considered HFSS. Overall pass-rates were similar; 42.3% and 42.0% for the 2004/5 and 2018 NPM respectively, with 95% agreement. Yet the 2018 NPM was more restrictive for beverages.

Micronutrient levels were significantly higher among products which passed vs those which failed the NPMs, except for folate, for which the mean for passed and failed products under the 2004/5 NPM was not significantly different. Mean vitamin E was 8% lower (95% CI: 1%, 15%, p=0.04) and mean folate was 13% lower (95% CI: 5%, 23%, p<0.01) for products passing the 2018 NPM compared with those passing the 2004/5 NPM.

Discussion

Missing ingredient information and differences in product categorisation approaches between legislative documents and product databases made both NPMs challenging to implement. Calculation of free sugars further complicated the application of the 2018 NPM. Given little difference in pass rates or nutritional quality between models, the 2004/5 NPM is considered a pragmatic basis for promotional restrictions. Collaboration between manufacturers and retailers is needed to address data challenges and ensure legislative compliance.

Keywords: Nutrient Profile Modelling, legislation, retail

Investigating eating architecture: how precise does time of eating have to be?

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Introduction: Eating architecture refers to the size, timing and frequency of eating. Measurement varies in the precision used to capture the time of consumption from exact time to broader meal slots. Exact time is more precise but laborious to capture and code. We explored if the precision of time makes a difference when investigating eating architecture.

Methods: Data came from 3-day diet diaries for $n=7285$ children aged 7y in the Avon Longitudinal Study of Parents and Children. Eating occasions were originally coded using 7 meal-slots ranging from 2 to 7-hour periods. Exact time of eating, which was recorded in diaries but not coded, was entered for a subsample of diaries ($n=2814$). We computed eating size, timing and frequency variables using exact times (precise) or the mid-point time of meal slots (broad). Bland-Altman analysis estimated the mean difference and limits of agreement (LOA) between methods. Correlations with 95% confidence intervals (CI) using bootstrapping were used to compare associations of eating architecture with total energy intake (TEI), waist circumference (WC) and body mass index (BMI).

Results: Broad vs. precise underestimated the frequency (2.2 LOA -0.7, 5.1 times/day) and overestimated the size (83 LOA -27, 192 grams), last time (52 LOA -51, 156 min), inter-meal intervals (48 LOA 8, 88) and total period (53 LOA -78, 183 min) of eating. Overestimation of size was non-differential. Differences in timing and frequency were greater for eating more frequently, starting later, stopping earlier, having longer intervals and shorter periods. While generally directionally consistent, correlations were stronger for precise size-frequency ($r=-0.58$ (95% CI -0.55, -0.60) vs. $r=-0.29$ (-0.25, -0.32)) and weaker for precise frequency-timing ($r=0.48$ (0.45, 0.51) vs. $r=0.64$ (0.62, 0.66)) and precise size-TEI ($r=0.22$ (0.17, 0.28) vs. $r=0.46$ (0.43, 0.48)) associations.

Discussion: Precise times are important for accurately describing the true size, timing and frequency of eating with broader meal slots leading to an underestimation of eating frequency and an overestimation of size and duration of eating. However, the magnitude and direction of associations with eating architecture were generally consistent across methods suggesting that capturing broad times could be an efficient method for investigations.

Keywords: Eating architecture, definition, eating occasions, timing of intake, precision

S24. Databases

Stage 1- Rationalisation of the UK Nutrient Databank to enable the UK National Diet and Nutrition Survey to move to a web-based 24hr recall (Intake24)

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Introduction: The National Diet and Nutrition Survey rolling programme (NDNS RP, 2008-) uses the UK Public Health England Nutrient Databank (NDB) to derive dietary intake data. We are leading work to replace the traditional paper-based 4-day estimated diet diary method for capturing dietary intake in NDNS RP with a web-based 24hr recall open-source system, Intake24. This paper describes the standardised rationalisation approach to update and streamline the NDB for development of the UK foods database (phase 1) and associated nutrient composition information (phase 2) for Intake24

(<https://ndns.intake24.org/>). Methods: The first 10 years (2008/09 to 2017/18) of NDNS RP dietary intake data were examined to identify consumption rates of foods included in the NDB. Each food was assessed according to factors including frequency of use and amount of consumption, similarities between nutrient composition of foods, public health priorities, usability for participants, availability of products in the market, and variations between different brands and food preparations. All foods were allocated to one of the following categories: RETAIN (required), EXCLUDE (not required), REPRESENT (could be represented by another food) and INGREDIENT (required for respondents to self-report a recipe). Results: All foods that were available in NDB for coding in years 1-10 (n=5554) were reviewed. Of these, 21% (n=1167) had not been used. Subject to final confirmation, numbers of foods assigned to each category were:

1. RETAIN = 1959 (36%)
2. EXCLUDE = 1292 (23%)
3. REPRESENT = 1954 (35%)
4. INGREDIENT = 349 (6%)

Discussion: This standardised approach to rationalisation of NDB effectively facilitated decision making necessary to balance the need for preserving adequate heterogeneity of foods in UK with sufficient simplicity and usability of foods to be included in the NDB to ensure the tool was accessible for participants. This work has significantly rationalised the food database which had grown unsystematically over many years. Following the update of associated nutrient composition information, next steps include evaluation of the change. Our work results in a fully updated and available Intake24 and UK NDB which should make the on-going management more efficient.

Keywords: NDNS, Survey, Rationalisation, Food composition, Databank

Enhancing qualitative assessment of complex food behaviors through free-listing informed mind-mapping: development and feasibility analysis

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Introduction: Capturing the pervasive and interconnected role of food in everyday behaviors has presented a major challenge in nutrition research. There is a critical need for innovative qualitative approaches that can capture, more comprehensively, nuanced food behavior data. The COVID-19 pandemic research restrictions have fueled the development of innovative virtual qualitative methods. We describe the development and evaluation of virtual, free-listing informed mind-mapping as a method to enhance qualitative data collection and the analysis of food behavior data.

Methods: A qualitative study, conducted in Oct-Nov 2020, assessed key factors involved in typical foods eaten by 2nd Generation South Asian Americans. Participants received a one-on-one interactive ZOOM-based interview comprised of 1) free-listing and ranking exercise (identifying the key drivers of the foods they typically ate), 2) mind-mapping exercise (mapping factors and connections between them), and 3) discussion of the individual's mind-map. Participants were asked to provide feedback on the study methodology, and researcher reflections on the methodology were recorded and analyzed.

Results: All participants (N=31, 53.1% female, 22.4y mean age) found the virtual free-listing informed mind-mapping to be beneficial, although specific reasons differed. Key themes included elucidating new ideas and connections, visual learners were better engaged in the interview, and non-repetition of ideas/talking points. Areas of improvement centered around the difficulty in thinking of new ideas after connections and sub-factors had been described. Researcher observations included (1) ease in identifying helpful probing questions through the mind-maps, (2) the use of color and other stylistic elements to contextualize the mind-map themes, and (3) enhancing the comprehensiveness of the discussion while minimizing the repetition of conversation points.

Discussion: Virtual free-listing informed mind-mapping was a useful strategy to identify complex food behaviors. Data collection can benefit from increased participant engagement. Future efforts may consider different types of virtual software or focus only on the most salient free-listing factors identified during mind-mapping. Data analysis benefits from the variety of outputs that can collectively be used to enhance identification of key themes in the interview transcripts or assist in the development of meta mind-maps and visual data presentations.

Keywords: *food behavior, qualitative methods, socio-ecological, virtual, mind-mapping*

NOVA food classification: How specific does survey data need to be collected?

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Introduction: The NOVA classification was created, based on the extent and purpose of food processing, as such: unprocessed and minimally processed foods; processed culinary ingredients; processed foods and; ultra-processed foods. However, when using this classification, some difficulties have been observed for the correct categorization of food items. For this reason, the objective of this work was to identify what methods and information are necessary for a correct classification of foods and culinary preparations according to NOVA. Methods: Dietary data previously collected in three Brazilian food surveys were obtained. These surveys used different methodologies: 1) National survey with manual dietary record; 2) Local survey with a 24-hour computerized recall (R24h) and 3) Local survey with structured manual R24h, with subsequent software data entry. The foods were grouped according to the NOVA classification with the addition of a fifth group, defined as uncertain, to classify those foods from which details were insufficient to determine the type of food processing. The daily energy intake and contribution of each group was calculated. Three scenarios were created according to the degree of uncertainty regarding food processing: 1) Uncertain 2) Less conservative (uncertain classified foods were assumed to be unprocessed or minimally processed) and 3) More conservative (uncertain classified foods were assumed to be ultraprocessed). These scenarios were used to compare each methodology. Results: Unprocessed and minimally processed foods provide most of the energy consumed, followed by ultra-processed foods, in the three studies. The processed culinary ingredients contributed similarly in the studies using R24H while the dietary record in the national survey had a lower contribution. Regarding the uncertain scenario, the three studies showed a contribution of 31.9%, 17.3% and 14.4% for the unclassified foods, respectively. While the energy contribution of unprocessed foods became larger in the less conservative scenario, the contribution of ultra-processed foods increased in the more conservative scenario, except at the third study. Discussion: Our findings suggest that the computerized R24h could better capture detailed information, especially regarding the degree of food processing. In addition, the structured R24h can help to identify ultra-processed foods, regardless of being computerized, reducing uncertainty in the classification.

Keywords: NOVA classification, ultra-processed foods, food surveys, food consumption

FAO/WHO Global Individual Food consumption data Tool (FAO/WHO GIFT): increasing the availability, harmonization and use of individual quantitative food consumption data worldwide

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Introduction: Understanding the various eating habits of different population groups, according to the geographical area, is critical to develop evidence-based policies for nutrition and food safety. The FAO/WHO Global Individual Food consumption data Tool (FAO/WHO GIFT) is a novel open-access online platform, hosted by FAO and supported by WHO, providing access to harmonized individual quantitative food consumption (IQFC) data, especially in low- and middle-income countries (LMICs).

Methods: FAO/WHO GIFT disseminates IQFC data as ready-to-use food-based indicators in the form of infographics, and as microdata. The infographics intend to facilitate the use of these data by policy makers, providing an overview of key data according to population segments and food groups. The microdata is publicly available for download, and is intended for users that would like to do further analysis of the data. All datasets are harmonized with the European Food Safety Authority's food classification and description system FoodEx2.

Results: FAO/WHO GIFT is a growing repository. By October 2020, 22 datasets were available for dissemination and download, and an additional 36 datasets will be made available by 2022. As a result of the FAO/WHO/EFSA collaboration, FoodEx2 has been updated for global use. FAO/WHO GIFT also provides an inventory of existing IQFC data worldwide, which currently contains detailed information on 282 surveys conducted in 109 countries.

Discussion/Conclusion: FAO/WHO GIFT collates, harmonizes and disseminates IQFC data collected in different countries. This harmonization is aimed at enhancing the consistency and reliability of nutrient intake and dietary exposure assessments globally. FAO/WHO GIFT is developed in synergy with other global initiatives aimed at increasing the quality, availability and use of IQFC data in LMICs to enable evidence-based policy-making for better nutrition and food safety.

Keywords: dietary data; data harmonization; data sharing; nutrition; food safety;

EU Menu project harmonised food consumption data collection and challenges to face

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Introduction

Food consumption data are essential for assessing how consumers are exposed to potential risks in the food chain. For this reason, EFSA has been collecting these data over the last years at an increasing level of detail. The EFSA Comprehensive European Food Consumption Database is a compilation of existing national dietary information and currently includes individual food consumption data for different population groups from most of the EU Member States.

Methods

In view of updating this database with more recent and standardised information on what people eat in all countries and regions across the EU, EFSA launched the EU Menu project. Data collection following this harmonised methodology allow EU-wide analyses, more accurate exposure assessments and support risk managers in their decision-making on food safety.

Results

32 surveys for different age groups across Europe were funded under the EU Menu project. The first round of harmonised food consumption data from seven dietary surveys were made available in spring 2018 through the Data Warehouse of EFSA, while data from all surveys are expected to become available by 2023.

Discussion

Running such national surveys based on an harmonised methodology is a complex task and entails many different challenges. Several issues faced during the organisation and execution of the studies have been reported. These were related to: i) financial aspects, as the support provided by EFSA under the procurement procedure covered only part of the cost of a national dietary survey ii) the low response rate, due to people's low interest to participate iii) the ability to reach the minimum number of subjects required per age group and gender, iv) changing in the composition of the project team due to drop outs or reshuffling of tasks in their organisation, v) under-reporting as participants appeared to either not providing their actual consumption or not reporting special conditions, such as illnesses or special diets, iv) update of the methodological criteria that took place in the course of the years since the first projects initiated and vii) capturing the food supplements consumption. Measures to prevent and/or decrease the severity of such issues are discussed.

Keywords: EFSA, EU Menu, consumption, data

Methodology for estimating the intake of free sugars: a food disaggregation approach in the context of the Finnish food composition database

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Introduction: The lack of free sugar (FS) values in food composition databases (FCDBs) prohibits monitoring FS intake in the general population, and epidemiological research. Although systematic methodologies have been suggested in literature, the data structure of the FCDB may hamper their straightforward adoption. We aimed to create a food disaggregation-based method to estimate FS intake in Finland.

Methods: We used the data of the FinDiet 2017 Study comprising a nationally representative sample of Finnish adults (n=1655, age range 18-74 years, 53% participation rate). Two non-consecutive 24-hour dietary recalls served as the dietary assessment method. In-house calculation software and national FCDB Fineli® were used to calculate food consumption on ingredient level (including the decomposition of standard recipes), intakes of total sugars, and individual sugars (glucose, fructose, galactose, sucrose, lactose, maltose). The software allows the calculation of ingredient level food sources of the individual sugars. Usual intake distributions for FS intake were estimated using the SPADE 3.2 program.

Results: The algorithm included two steps: 1) the calculation of intrinsic sugars (g/day/person), 2) the subtraction of intrinsic sugars from total sugars. In the first step, we assumed: a) all sugars from fruits, berries, vegetables, and legumes are intrinsic, b) 50% of the sugars in canned fruits, canned vegetables, and jam are intrinsic, c) the main sweetener of milk products is sucrose, hence glucose in milk products is intrinsic (i.e. derived from the breakdown of lactose during milk processing). In the second step, we assumed that lactose and galactose regardless of the food source are intrinsic. Average FS intake was 9,2 E% in men, and 9,3 E% in women. Of the adults, 37% did not reach the WHO recommendation (FS intake <10 E%), which is a larger share compared with the approach where sucrose intake is used as a proxy measure for FS intake (22% in men, and 32% in women).

Discussion: The proposed methodology, utilising flexible calculation procedures and Finnish FCDB, is relatively easy to adopt in nutritional monitoring, and epidemiological research. However, it emphasizes the information quality of the FCDB, and flexible software – key challenges of nutrition research.

Keywords: free sugars, food composition database, adults, public health, epidemiology

POSTERS

1. Methods development and feasibility and validation research

A systematic review of validation and comparison studies of portion size estimation tools

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Introduction: Portion size estimation remains a well-known challenge in dietary assessment. There is a lack of knowledge on the efficiency of different portion size estimation elements (PSEEs) and a lack of well-developed studies testing the validity of PSEEs. The main objective of this study was to review the accuracy of PSEEs tested through validation (comparing PSEE to actual food amounts) and comparison studies (comparing PSEEs against other PSEEs). The secondary objective was to develop a tool for standardized assessment of the quality of validation studies and their limitations.

Methods: A systematic review of literature published between 1910 and 2018 identified 21 validation studies and 13 comparison studies testing PSEEs. Accuracy was examined according to reported “accuracy parameters (e.g. estimation error)”. Quality of the validation studies was assessed using a novel quality scoring tool developed for this review. The resulting quality score was based on a total of 8 differentially scored criteria, including study design, validity, reliability, agreement and future application, with a threshold of 75% in total indicating high study quality.

Results: Estimation error was the most commonly reported accuracy parameter. Across validation studies estimation errors ranged from -10.7% to 39% for food photographs (n=4) and from 33.2% to 58% for food models (n=2) and household utensils (n=1). The estimation error across comparison studies ranged from 53.1% to 87.7% for household utensils (n=3) and from 32% to 44.8% for food models (n=4). Quality assessment of validation studies showed that only very few studies (n=6/21) were of high quality. The factors that adversely influenced the quality of validation studies were insufficient description and sample size of study population and lack of pilot and reliability testing.

Discussion: The evidence suggests that food photos were more accurate than food models and household utensils, considering that the estimation error reported for food photos were lower than food models and household utensils. Our novel “quality scoring tool” could be a useful tool when designing future studies validating PSEEs or using validated PSEEs as it enables a standardized assessment of study quality.

Keywords: Portion size tools, portion size estimation, dietary assessment, validation, comparison

Temporal Physical Activity Patterns and Association with Health Status Indicators and Chronic Disease

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Introduction: Few attempts have been made to incorporate multiple aspects of physical activity (PA) to classify patterns that link to health. Temporal PA patterns integrating time and activity counts were created to determine their association with health status.

Methods: PA accelerometry data obtained from the cross-sectional National Health and Nutrition Examination Survey 2003-2006 was used to pattern PA counts and time of activity from 1,999 adults with one random valid weekday of activity. Dynamic time warping and kernel k-means clustering partitioned 4 participant clusters representing temporal PA patterns. Multivariate regression models determined associations between clusters and health status indicators and conditions obesity, type 2 diabetes, and metabolic syndrome.

Results: Participants in Cluster 3, represented by a temporal PA pattern with activity counts reaching $9.6e4-1.2e5$ cph between 16:00 to 21:00, were associated with lower mean body mass index (BMI) ($p<0.001$) and waist circumference (WC) ($p<0.01$), and 60% lower odds of obesity relative to normal weight status compared to Cluster 1 with the lowest activity counts reaching $4.8e4$ cph from 6:00-23:00 (OR: 0.4; 95% CI: 0.2, 0.8). Cluster 4 participants, characterized by activity counts reaching $9.6e4$ cph between 8:00 to 11:00, were associated with lower BMI and WC compared to Cluster 1 (both $p<0.05$).

Discussion: U.S. adults with temporal PA patterns of higher activity counts performed early (8:00 to 11:00) or late (16:00 to 21:00) throughout the day had significantly lower mean BMI and WC compared with adults with a pattern of the lowest PA counts. Temporal PA patterns appear to meaningfully link to health status.

Keywords: temporal, physical activity patterns, body mass index, waist circumference, obesity

Comparison of 2 different approaches to calculate dietary intakes in the Oxford WebQ questionnaire used in UK Biobank

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Introduction: The Oxford WebQ is a web-based 24-hour dietary assessment tool used in UK Biobank and other large-scale prospective studies to assess dietary intake. The food composition table (FCT) used to calculate nutrient intakes, the McCance and Widdowson's FCT 6th edition (2002), has recently been replaced with the UK Nutrient Databank (2013), as this FCT is, on average, closer in time to when participants completed the questionnaire. Moreover, portion sizes, personalisation of fats used in cooking, food group disaggregation and the underlying code for nutrient calculation were revised and updated. In this study we aim to compare the two versions of obtained nutrient intakes in UK Biobank participants.

Methods: A subsample of UK Biobank participants recruited towards the end of the recruitment period and/or those who provided email addresses, completed the Oxford WebQ questionnaire up to 5 times (2009/2012). After excluding participants with extreme energy intakes (men: >20,000 kJ/d, women: 18,000 kJ/d), a total of 210,109 participants, who completed the Oxford WebQ questionnaire at least once, were included. Means and standard deviations of macronutrient and fibre intakes were averaged for all completed WebQ questionnaires for each participant and Spearman correlations and paired t-tests were used to compare the mean nutrient intakes between the two versions.

Results: All nutrient intake differences were significantly different from zero after the WebQ update ($P < 0.001$). Compared to the previous version, mean nutrient intakes in this updated version were slightly lower for energy (-144kJ/d), protein (-1.2g/d), total fat (-4.5g/d), saturated fat (-2.7g/d) and trans-fat (-0.3g/day), but slightly higher for carbohydrates (+1.8g/d), total sugars (+5.3g/d) and fibre (+1.4g/d). Except for trans-fat ($r = 0.60$), high correlations were found between nutrients calculated using the two versions: energy ($r = 0.96$), protein ($r = 0.97$), total fat ($r = 0.95$), carbohydrates ($r = 0.95$), saturated fat ($r = 0.91$), total sugars ($r = 0.96$), and fibre ($r = 0.94$).

Discussion: Absolute differences in nutrient intakes between the two versions were observed, although the ranking of individuals was minimally affected for most nutrients. Future work will assess the heterogeneous differences among individuals caused by the changes made to the WebQ, and this updated version will be available to all studies using the Oxford-WebQ.

Keywords: Oxford WebQ, UK Biobank, comparative study, food composition table

Sustainability analysis of Finnish pre-schoolers' diet based on the EAT-Lancet reference diet's targets using food ingredient data derived from food records

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Introduction: The EAT-Lancet reference diet is a healthy plant-based dietary pattern from environmentally sustainable food production systems. To identify the most pivotal action areas for the food system transformation, evidence on the gaps between current diets and the reference diet is needed. We compared Finnish pre-schoolers' food consumption to the reference diet's food group level mass-based targets.

Methods: Our data for 3-6-year-old children were collected in the cross-sectional DAGIS survey in 2015–2016. Food records, covering from one up to five complete days, were kept by parents and pre-school personnel. Detailed information of foods, such as ingredients of composite dishes and product names for packed foods were recorded. Food record data were decomposed into ingredients by AivoDiet dietary software. We manually decomposed industrial products such as sausages and biscuits into ingredients by estimating the shares of ingredients using product information available on a retailer's online database and food manufacturers' webpages. We developed formulas to calculate the consumption of added sugars. We converted the consumption of dairy products into milk equivalents using factors from the literature. Finally, we manually classified the ingredients into the reference diet's food groups and calculated daily average consumptions. We set the target amounts (separately for two age groups) in grams by proportioning the published target amounts (that assume a 2500 kcal diet) to the children's average reported energy intake.

Results: Compared to the targets, on average, the daily food consumption for 3- to 4-year-olds (n 460) and 5- to 6-year-olds (n 402), differed for vegetables (60% of the target in both age groups); legumes (about a tenth of the target); nuts (about 5% of the target); whole grains (a third of the target); red meat (about 5 and 5.5 times the target accordingly); dairy foods (nearly 5 times the target); and added sugar (close to double of the target).

Discussion: To enable comparison with the EAT-Lancet reference diet's targets, we developed an approach for disaggregating children's food record data. To comply with the targets, Finnish pre-schoolers would need to consume more vegetables, whole grains and legumes, and less red meat and dairy products.

Keywords: Food records, Children, Food consumption, EAT-Lancet, Sustainable diets

Adjusting for the plausibility of reported energy intake improves the estimators of the association between dietary inflammatory index and adiposity indicators in adolescents

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Diet may play a role in low-grade inflammation associated with obesity. Misreport of food consumption might introduce bias in the association between dietary factors and overweight.

This study aimed to estimate the association between the Dietary Inflammatory Index (DII) and indicators of adiposity and to evaluate the effect of adjusting by the plausibility of the food consumption report in logistic regression models analyzing the association between DII and adiposity outcomes.

Data came from the Study of Cardiovascular Risks in Adolescents (ERICA 2013-14), a nationwide cross-sectional school-based study that examined 12-17 year-old students. Food consumption was estimated by a 24-hour dietary recall. The plausibility of reported energy intake was assessed by comparing estimated energy requirements with reported energy intake and categorized into plausible, under- and over-reporting. The DII was estimated from 39 food parameters and categorized into quartiles. The association of DII with body mass index ($BMI = \text{weight}/\text{height}^2$), waist circumference (WC), and waist-to-height ratio (WHtR) was assessed according to sex.

This analysis included 71,740 students (50.2% male; 49.8% from 12-14 years old). The IID ranged from -5.44 to 4.27 (mean for boys: 0.04; girls: 0.77). In the final models, the increase in DII was associated with an increase in the chance (Odds Ratio - OR) of being overweight between 1.46 and 1.76, having high WC between 1.26 and 1.73, and high WHtR between 1.24 and 1.91. In boys, the additional adjustment for the quality of diet recall provided an increase in OR for the second quartile compared to the first quartile for WHtR, and an increase for the third quartile for excess weight and WC.

In girls, this adjustment provided significant OR estimates for the second quartile compared to the first quartile for WC and WHtR, and an increase in the quartile 4 estimates for the three evaluated indicators. The increase in the DII was associated with an increased chance of excess weight, elevated WC and WHtR, diet influence low-grade inflammation. Adjusting therefore, the results are consistent with the hypothesis that for the quality of food consumption report can reduce bias in the analysis of the association between dietary intake and outcomes associated with nutritional status.

Keywords: Adolescent, Dietary Inflammatory Index, Food Consumption, Inflammation, Obesity.

A Food Literacy Screener, ready to use in food literacy interventions?

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Introduction: In the field of nutrition, the concept of food literacy is emerging. Food literacy is the interrelated combination of knowledge, skills and self-efficacy on food planning, selecting foods, food preparation, eating and evaluating information about food with the ultimate goal of developing a lifelong healthy, sustainable and gastronomic relationship with food. The present study describes the development and validation of a food literacy screener (FLS) aimed to assess food literacy and to prioritize goals on food literacy in an intervention study in couples trying to conceive.

Methods: First, a conceptual framework of food literacy was defined, food literacy goals were prioritized and items of the FLS were generated based on expert insights and literature review following an iterative process. After expert review of the FLS, readability was assessed by calculating the Flesch reading ease score and semi structured interviews were conducted with 15 people of reproductive age to determine content validity. Subsequently, an online survey was conducted among 114 people in order to determine validity and reliability of the FLS. Construct validity was assessed against dietary variables including diet quality and healthy eating self-efficacy (HESE) that were expected to correlate with food literacy. Reliability was assessed with a two-week test-retest. Pearson correlation tests were conducted.

Results: Conceptualization led to 24 goals regarding food literacy, which were translated, into a 17-item FLS. Every question of this FLS received a weighing factor to prioritize the food literacy goals. Flesch reading ease score of the FLS was 75.6 and content validity revealed that the FLS was relevant and well understood by the target population. Food literacy was positively correlated with diet quality ($r=0.536$, $p<0.001$) and with HESE ($r=0.685$, $p<0.001$). Test-retest showed a good reliability of the FLS ($r=0.721$, $p<0.001$).

Discussion: The newly developed FLS is an expert-based tool to assess food literacy and to prioritize individuals' food literacy goals. The FLS has a good construct validity and reliability and can be used to tailor food literacy interventions to the individual needs of couples trying to conceive. Further research is needed to validate and test the FLS in different food literacy interventions in different populations.

Keywords: Food literacy, Screener, Tailoring, Development, Validation

Development and external validation of the “Flower-FFQ”: a food frequency questionnaire designed for the Lifelines Cohort Study

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Objective: Food frequency questionnaires (FFQs) assess habitual dietary intake and are relatively inexpensive to process. Comprehensive FFQs are long questionnaires that may take up to 60 minutes to complete. The Flower-FFQ consists of four short FFQs measuring either the intake of energy and macronutrients or specific (micro)nutrients/foods. The FFQs can be merged using predefined algorithms into one complete daily assessment. This article describes the validation of the Flower-FFQ.

Design: Dutch adults (54±11 years old) completed the Flower-FFQ and validated 213-item FFQ (n=401); urinary nitrogen (n=242) and potassium excretion (n=361) were measured. We evaluated: 1) group-level bias, 2) correlations, and 3) cross-classification.

Results: Flower-FFQ1, Flower-FFQ2, Flower-FFQ3, and Flower-FFQ4 were completed in ±24, 9, 8 and 9 minutes (±50 minutes total), respectively. The 213-item FFQ was completed in ±43 minutes. Both FFQs showed comparatively similar mean energy (flower vs. regular: 1897 vs. 2080 kcal/day) and macronutrient intakes (carbohydrates: 204 vs. 222 g/day; protein: 75 vs. 76 g/day; fat: 74 vs. 83 g/day). Spearman correlations ranged from 0.60-0.80 for all macronutrients (g/day) and from 0.40-0.80 for vitamins and food groups. Moreover, ≥80% of the participants were classified in the same or adjacent quartile for most nutrients and foods, except retinol (78%) and vegetables (79%). Urinary nitrogen and potassium excretion were underestimated by 24% and 18%, but 75% and 73% of the participants were ranked in the same or adjacent quartile.

Conclusion: The Flower-FFQ showed a moderate to good ranking ability for most nutrients and foods and performs sufficiently to study diet-disease associations. The total time to complete the four questionnaires was only slightly higher than the total time needed to complete the general FFQ.

Keywords: Dietary assessment, FFQ, validation

Evaluating the association between healthfulness and cost of diets in Mexico with a new modeling approach.

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Introduction: Previous evidence, mainly from developed countries, suggest that healthy foods and diets are more expensive than unhealthy ones, but findings could be contradictory depending on the methodological approach. Healthy food is expensive per energy unit, but cheap per weight unit, and if comparing total diets as consumed by the population results could be influenced by other factors (e.g., in the Mexican population more expensive diets are higher in fruits, vegetables, but also on sugary beverages and discretionary foods). Thus, we used a new approach proposed by the INFORMAS framework to compare the cost of modeled diets.

Methods: We created 2-week menus for a reference household of four persons using the DIETCOST programme. We selected 110 common foods based on the Mexican National Nutrition Survey 2012 (ENSANUT). Food prices were obtained from the Consumer Price Index from 2011 to 2018. We created menus using the common foods and defining nutrient and food group targets for each diet. For the healthy diets we followed 1) the Mexican guidelines and 2) the EAT-lancet recommendations, and for the current diet we followed the mean nutrient and food group intake reported in ENSANUT. We estimated and compared the total cost of the menus obtained from the DIETCOST programme (110 to 548 menus per person and diet).

Results/findings: In 2018, on average, the total cost (MXN/per household) for a 2-week menu was \$3,702 for the EAT-Lancet diet, \$3,719 for the Mexican healthy diet, \$4,629 for the current Mexican diet, and \$4,224 for a current Mexican diet but with the same energy content as the healthy diets (current isocaloric). Healthy menus were less expensive because they had less meat (which is expensive) and because the higher cost associated with the increase in fruit, vegetables, grains, and legumes was offset by the savings of decreasing sugary beverages and discretionary foods.

Discussion: Our findings suggest that cost might not be an important barrier to adopting a healthy diet in Mexico, as opposed to previous findings from developed countries. The DIETCOST programme proved to be a useful tool to evaluate the association between cost and healthfulness of diets.

Keywords: cost, diet quality, DIETCOST program, menus, Mexico

Adjustment for within-person nutrient intake variance in the estimation of usual nutrient density adequacy of complementary feeding among 6- to 9-month-old Malawian children

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Introduction: To reduce bias in estimated prevalence of nutrient intake inadequacy, usual intake distributions should be modelled with adjustment for day-to-day variance. Among infants and young children transitioning from breastmilk to complementary foods, nutrient adequacy of the complementary diet is determined based on nutrient density, expressed as nutrient intake per 100 kcal. Nutrient density is inadequate when nutrient requirements are not fulfilled by the complementary diet, assuming average intakes of breast milk and energy. The National Cancer Institute (NCI) method of modeling usual nutrient intakes has been used to describe ratios of dietary components and can be applied to modeling the nutrient density adequacy of complementary diets.

Methods: We used the NCI method to estimate usual nutrient density of 10 micronutrients and estimate prevalence of inadequacy among 6- to 9-month-old rural Malawian children participating in a randomized controlled trial evaluating the impact of eggs on child growth (n=660). Data on complementary diets were collected by 24-hour recall interview of primary caregivers. A single recall was completed for all children at baseline. An additional 1-2 recalls were completed in a subsample before beginning the intervention (n=100). Using SAS macros published by NCI, we estimated usual nutrient density adequacy distributions for calcium, iron, zinc, selenium, thiamin, riboflavin, niacin, vitamin B5, folate and vitamin C. We compared estimated prevalence of inadequacy obtained using the NCI approach with estimates obtained using unadjusted, observed intakes from the single baseline 24-hour recall.

Results: Median nutrient densities below inadequacy cutoffs for all micronutrients except selenium. Prevalence of nutrient density inadequacy was over 90% for calcium, iron, zinc, riboflavin, vitamin B5, and vitamin C. Estimates of inadequate nutrient density for vitamin A, thiamin, niacin and folate were also high, above 60%. Prevalence of inadequacy was lowest for selenium (25%). Estimates of prevalence of inadequacy based on usual or observed nutrient density were generally similar.

Discussion: Among this sample of rural Malawian children, the NCI model adjustment for day-to-day variability had little impact on estimated prevalence of nutrient density inadequacy for several micronutrients because the range of intakes fell nearly entirely below the requirements, making inadequacy near universal.

Keywords: *24-hour recall, usual nutrient intakes, nutrient density, complementary feeding*

Exploration of usual intake estimation methods applied to the UK National Diet and Nutrition Survey (NDNS) Rolling Programme

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Introduction: Usual intake estimation aims to quantify the long-term, habitual intake of foods and nutrients in the population. Many methods have been developed to estimate usual intake with mostly subtle variants in assumptions and procedures. Some use Food Frequency Questionnaire (FFQ) information to augment short term dietary records. The National Diet and Nutrition Survey (NDNS) Rolling Programme (RP) is a cross-sectional survey of diet and nutrition in the UK and provides the only authoritative source of representative data on dietary habits for the UK population. NDNS made the decision to change the dietary assessment method from a paper diary completed on 4 consecutive days to an online 24-hour recall completed on 4 non-consecutive days. In parallel with this we considered opportunities for continual improvement of statistical methods by exploring usual intake estimation.

Methods: Statistical methods of estimating usual intake including Iowa State University (ISU), National Cancer Institute (NCI), Multiple Source Method (MSM) and Statistical Program to Assess Dietary Exposure (SPADE) were investigated. Comparison studies by other authors were reviewed and MSM (which uses a web-based application to estimate usual intakes - with statistical calculations performed using R) was deemed the most appropriate method for NDNS. Population estimates of usual intake were compared to published NDNS RP 'Years 7&8' (2014-2016) results (using the traditional 'day average' method) to assess the impact on key food and nutrient intakes. Both methods incorporated complex survey design information (stratification, clustering, weighting) to ensure results were generalisable to the UK population.

Results: Effects were consistent across all variables. Estimated mean energy intake for boys 4-10yrs remained consistent between the 'day average' and 'usual intake' methods (1496kcal/day and 1494kcal/day respectively) whereas the estimated standard deviation reduced (329kcal/day and 288kcal/day). This reduction in dispersion was also reflected in the 2.5th and 97.5th percentiles ((893, 2152)kcal/day and (970, 2067)kcal/day).

Discussion: This method change results in a 'shrinkage to the mean' and provides unbiased population mean estimates and a more accurate reflection of population habitual intake distribution. This has implications for interpretation and communication of NDNS results and considered alongside how other national dietary surveys collect and report their data.

Keywords: Dietary assessment, usual intake, 24-hour recall, statistical analysis, NDNS

Assessing usual nutrient intake through a direct approach with GAMLSS

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Introduction: Assessing usual nutrient intake requires dealing with distributions often outside of the exponential family. Currently, the latest methodologies propose transforming data to a normal distribution, estimating between and within-person variance on the transformed scale and then back-transform the distribution percentiles to the original scale through Gaussian Quadrature or Monte Carlo simulation in order to obtain the usual intake distribution. We aim to present a methodology based on Generalized Additive Models for Location, Scale and Shape (GAMLSS), that prevents the transformation to normal distribution. The method presented is still work-in-progress.

Methods: Data from 5811 participants with two non-consecutive 24h-recall converted to daily intake of micronutrients, from the National Food, Nutrition, and Physical Activity Survey of the Portuguese General Population, IAN-AF 2015-2016.

Relevant parametric GAMLSS family distributions are fitted in order to choose the most adequate distribution to each micronutrient. All parameters including between and within-person variance are estimated in one step, with GAMLSS with random effect. Monte Carlo simulation taking the parameters distribution is used to randomly draw several days of intake to each participant in the original scale, and usual intake is obtained through averaging.

Results: Comparison between empirical data distribution based on 1-day intake and 2-day individual mean intake, and the distribution obtained with GAMLSS show that the methodology proposed are capable of fitting adequately macronutrient intake distributions.

Discussion: This proposed methodology might be a dietary assessment tool to estimate usual intake distribution. Because of its ability to estimate all distribution parameters in one step, it avoids a transformation to normal scale and consequently the assumptions regarding back-transforming the distribution to the original scale.

Keywords: *habitual intake, usual intake, gamlss*

Exploring the emotional implications of a food reporting app, DigestInn, on user engagement

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INTRODUCTION

Food reporting tools have immense potential to revolutionise how diet- and fitness-data are collected to reduce overweight and promote active lifestyles. Yet, they have been linked to disengagement and low adherence rates. Emotions can have a substantial influence on modulating user-engagement with food reporting tools e.g., overweight people have recognised feelings of judgement and frustration as strong barriers to engage with tools and discuss their food choices. This work aims to explore the emotional implications of using DigestInn, a commercial food reporting application (app) and its connection with user-engagement in self-reporting.

METHODOLOGY

A user-engagement assessment of DigestInn was deployed. Participants with overweight/obesity ($BMI > 25 \text{ kg/m}^2$) ($N=8$) underwent an intake interview and training on game-use, followed by at least 4-weeks of app-use. During use, participants engaged in daily-reporting of their emotions (Experience Sampling Method) and a weekly user-engagement questionnaire (Daily Reconstruction Method).

RESULTS

The distribution of moods reported was generally skewed towards positive affective states (59%) e.g., calmness, and relaxation. However, negative affective-states (41%) such as tenseness and irritation were reported to undermine user-engagement. User-engagement was hardly experienced in terms of focused-attention ($\mu=1.99$), while participants were neutrally inclined towards perceived-usability ($\mu=3$), aesthetic-appeal ($\mu=2.95$), and rewards ($\mu=2.86$). The negative affective states were often linked to: feelings of incompetence and a sense of losing control, feeling punished for not eating well, misappropriation of game-points, the inaccurate interpretation of sensor-data (e.g., step-counts), the initial learning curve, and technical instability (e.g., frequent restarts).

DISCUSSION

Self-reporting supports the transition from mindlessness to mindfulness. Therefore, studying user-engagement of the self-reporting activity itself deserves attention. This work highlights the negative emotional impact on user-engagement of complex reward mechanisms. When rewards are focused on interpretations of single outcomes of self-reporting and other sensing activities (e.g. the healthiness of the reported food, the portion size, the number of steps, etc.) the higher the likelihood of misinterpretations resulting in perceived misjudgement, unfairness, and lack of control. A reward system that emphasises on the quality of the reporting itself (e.g. frequency, relevance, timing, etc.) instead of its outcome, is expected to positively impact the users' daily emotional experience and therefore support sustained engagement.

Keywords: self-reporting, obesity-treatment, user-engagement, emotions, serious-games

Nutrition analytics using supermarket transaction data: identification of changes in UK meat consumption patterns

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Introduction

Vegetarian and vegan diets are increasing in popularity in the UK. Main motivations behind these dietary choices include health benefits along with concerns for animal welfare and the environment. Little is known however, on how people's overall dietary patterns change when they reduce their meat consumption. Traditional food surveys can provide some information about global trends, but lack insight of changes in behaviour at an individual level over time. In the current work, we are using loyalty-card data from one of the major UK retailers, with the aim to investigate changes in purchasing behaviour of a cohort of households over time.

Methods

Machine learning techniques will be applied to supermarket transaction data in order to identify households that are reducing their meat consumption. The source data for the study are food and drink purchases obtained from UK retailer for regular customers (shopping at the retailer on at least 10 occasions per year and buying products from at least 7 of 11 food categories of Living Cost and Food Survey), living in Yorkshire and the Humber region between January 2016 and December 2018. Yearly consumption of different meat types (red meat, poultry, processed meat) are going to be fed to longitudinal k-means algorithm, to find groups changing their meat purchasing behaviour over time.

Results and Discussion

Preparation of 'big data' collected for business purposes, not dietary assessment, present significant data cleaning and computational challenges. Categorising purchases in a nutritionally meaningful way draws upon existing survey methodology, combined with nutrition expertise. In order to run complex algorithms, optimised code syntax is essential, alongside the use of multiple cores in a high performing computing infrastructure. Access to commercial data sources requires significant time investment in legal, ethical and governance frameworks.

Exploratory analysis of 2016 transactional data suggests there is a seasonal variation in meat consumption. Analysis of 2017-2018 data (work in progress and will not be presented) will allow us to control for this variation and focus on consumers reducing their meat purchases. This can inform future interventions encouraging meat reduction and help investigate subsequent health and environmental impacts.

Keywords: transaction, meat, big data, methods

Accelerometer data reduction methods to examine correlates of waking activity patterns in the absence of logs among a low-income, majority Hispanic cohort of preschoolers with overweight

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INTRODUCTION: Guidelines for 24-hour movement patterns have been recommended for young children (<5 years). Although 24-hour monitoring with waist-worn accelerometers in young children is feasible, sleep/non-wear algorithms have not been developed for this age group. Further, datasets that lack logs (sleep/on/off) have additional considerations when establishing wear time, as do studies conducted in low-income, racially diverse populations due to disparities in sleep sufficiency. This study describes an accelerometer data reduction method to estimate wear time in the absence of logs in a low-income, majority Hispanic cohort of preschool-aged youth (ages 2-5 years) with overweight.

METHODS: Participants (N = 141) wore an ActiGraph wGT3X-BT monitor on the hip for 24 hours on 7 days. Accelerometer logs were not available. Each file was visually examined for sleep/waking periods. A large percentage of participants had activity counts throughout “normally” occurring sleep hours, i.e. sleep disruption. Therefore, we decided to utilize an hourly technique to define waking hours by major activity shifts. Bedtime: parent-reported usual bedtime was between 19:00-01:00 hours. Accelerometer-determined hourly intensity estimates (sedentary, light intensity physical activity (LPA), moderate-to-vigorous physical activity (MVPA)) between 19:00-01:00 were examined. Wake time: Hourly intensity estimates between 04:00-10:00 were examined. Visual illustrations of hourly patterns stratified by sociodemographic factors were developed.

RESULTS: Largest percent change in sedentary time (+15.5%), LPA (-10.7%), and MVPA (-3.8%) was between 22:00-23:00 hours, therefore bedtime was set at 22:59 hours. At 23:00 hours, 94.6% (IQR: 85.0, 97.6) of the hour was spent sedentary. Largest percent change in sedentary time (-11.7%), LPA (+11.2%), and MVPA (+1.6%) was between 06:00-07:00 hours, therefore wake time was set at 06:00. Defining valid wear time as ≥ 10 hours (between 06:00-22:59) on ≥ 3 days (≥ 1 weekend) resulted in 10 participants with non-compliance (no significant demographic differences). Waking activity patterns differed by sociodemographic factors ($p < 0.05$).

DISCUSSION: Accelerometer data processing when sleep disturbance is present is challenging. As accelerometer log compliance may be low/nonexistent, this method provides a way to identify waking periods within a large sample. However, the validity of this method is unknown. Ultimately, sleep/non-wear algorithms need to be refined for early childhood.

Keywords: Physical activity, Accelerometry, Early childhood, Pediatric obesity, TX CORD

Creation of an Ingredient Database for NCI's Automated Self-Administered 24-hour Dietary Assessment Tool (ASA24) Recipe Feature

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Background

Dietary recalls and records are used to collect information on foods and beverages consumed and on habits and trends. Although food and nutrient databases offer a variety of foods, having the additional ability to create unique recipes can allow for more specificity of foods and beverages recorded.

Objective

To create an ingredient database and add a recipe feature to NCI's Automated Self-Administered 24-hour Dietary Assessment Tool (ASA24).

Description

NCI obtained permission to use USDA's SuperTracker ingredient database as a basis for ASA24 ingredient data. Westat updated foodcodes to include only those in USDA's Food and Nutrient Database for Dietary Studies (FNDDS) 2013-2014 and National Nutrient Database for Standard Reference 28. We ensured that ASA24 included all appropriate forms of ingredients, such as raw, cooked, chopped, and sliced. We used yield data from FNDDS or Agriculture Handbook 102, USDA's cooking yield database, to adjust weights and nutrients from the raw to the cooked ingredient to allow respondents to report the amount of a raw ingredient in a recipe that they consumed in cooked form. Additionally, given that respondents are likely to report salt added as an ingredient in recipes, we removed salt in FNDDS cooked foods by adjusting the sodium value in the nutrient profile of ingredients to avoid artificially high levels of sodium. The recipe feature allows the respondent to name the recipe, assemble ingredients, specify the recipe yield in servings, and enter the number of servings consumed into the record or recall. The newly created recipe is available to the respondent for other meals within the intake day and for subsequent intake days.

Conclusion

ASA24-2018, released in November 2018, includes a new recipe feature with over 2000 ingredients available to respondents. The ASA24 recipe feature provides an avenue for respondents to provide more discrete details about foods consumed.

Keywords: dietary assessment, recipe, database, dietary recall, ingredient

What we eat in Saudi: method used to develop Saudi food composition data

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Background: One of the long-term goals of food safety authorities around the world is to have updated, detailed and high-quality food consumption data. Such data are vital for the risk analysis paradigm through evaluating hazards and providing data for estimating exposure to contaminants, additives and other chemicals in food. Developing a local food composition database (FCDB) is a very important phase in order to have reliable data reflecting foods that are consumed by the population. There is no authoritative FCDB for Saudi, only some food dishes and limited food items have been analyzed.

Aim: To illustrate the approach that was used to develop the Saudi FCDB based on the available resources.

Methodology: Most FCDBs are prepared using a combination of direct and indirect techniques. Although direct chemical analysis is the most accurate measure of food nutrient data, it is a complicated and time-consuming process. Therefore, an indirect method was used in developing a Saudi FCDB. Food items were classified using the European Food Safety Authority general description system for Raw Commodities (RC), Simple Commodities (SC), Recipe Homemade Dishes (RHD), and Purchased Commodities (PC). Four focus group discussions were conducted to develop a list of the most commonly consumed foods. Four business meetings with the top food companies (66 companies) and 60 field visits to small food companies were arranged to collect information about food recipes and nutritional information (using data from certified laboratories, or Back-of-Pack (BOP) nutrition data). For HMDs, three comparable recipes were attained from different sources (cookery-books and non-sponsored websites) and used to guide decisions regarding standardized recipes. Nutrient content of HMDs was calculated using specific software.

Result and discussion: the Saudi FCDB contained almost 1060 different types of foods, and 200 HMDs covering a variety of commonly consumed foods among Saudi population. One of the most significant issues faced was collecting information regarding PC dishes' ingredients or recipes, as food companies refused to share such data.

Conclusion: Development of a local FCDB can help with the undertaking of scientific studies and research to establish and develop specialized scientific databases related to food safety and risk assessment.

Keywords: Food composition data, homemade dishes, Food commodities, Saudi Arabia

What we eat in Saudi

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Background: One of the strategies to achieve Saudi vision 2030 objectives is improving individuals' health and lifestyles. A monitoring food consumption survey (FCS) forms the main and most important basis of nutrition and food policy. FCSs provide information that is needed for scientific research on the association between nutrition and health, and to estimate population dietary exposure. The first national dietary survey conducted in Saudi was in 1996. Up-to-date and valid assessment of what people eat and drink is essential to generate evidence to formulate effective policies.

Aim: To conduct a cross-sectional survey designed to collect nationally representative and high-quality data on types and quantities of foods and beverages that are consumed by the Saudi population aged 12 years and over in Riyadh city. This study covers three age groups (adolescents, adults, and the elderly) comprising both genders.

Methodology: A complex, multistage, probability sampling design is used to select participants representative of the Saudi citizenry. For each participant, at least two non-consecutive days of a 24-hour dietary recall method (multiple-pass technique) are used to collect detailed dietary intake data. Data on socio-demographic characteristics, eating habits, food propensity questionnaire, food supplements, and International Physical Activity Questionnaire (IPAQ) are collected, with a face-to-face questionnaire using a computer-assisted personal interviewing technique (CAPI). Trained dietitians measure the height and weight of all respondents, apart from pregnant women. Data collection runs over different seasons and days of the week, in order to incorporate seasonal effects and day-to-day variation in food dietary intake. At this stage, limitations to time and budget have prevented this study from including children or collecting blood or urine samples. To have a positive effect on responses rate, \$50 vouchers are given to each participant on the completion of the study requirements.

Conclusion: It is very important to provide detailed and harmonized high-quality food consumption data to improve the quality of exposure assessments and allow for comparison between countries. These findings will play a main role in applying dietary risk assessment of potential chemical and microbial hazards, and will help to support the decision-making process (i.e. standard setting) based on scientific opinions.

Keywords: Food consumption, 24hour dietary recall, adults, adolescents, Saudi Arabia

Interpreting Dietary Intake and Quality of Adults Prior to Conception: A New, Easy-to-Use Questionnaire and Assessment Method

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Background: Longitudinal intervention studies, such as Healthy Life Trajectories Initiative – Canada, often require short tools to collect and assess participant dietary intake and methods to interpret dietary data without specific nutrition training. A short dietary questionnaire (DQ) that was adapted to align with 2019 Canada’s Food Guide shows promise.

Objectives: 1) Develop a dietary quality scoring system for the DQ; 2) examine diet intake and quality scores in a cross-sectional sample of preconception women and men to guide further psychometric validation.

Methods: The DQ food/drink choices were grouped into 1 of 3 quality categories: high (HQ; 13 foods/drink, scores: 0-52), moderate (MQ; 3 foods/drink, scores: -6-6), low (LQ; 8 foods/drinks, scores: -32-0). Scores were summed into a Total Score (TS; -38-58). Intake frequencies ranged from <1/week; 1x/week; 2-4x/week; nearly or 7x/week; =>2x/d. Pre-conception Canadian adults completed the DQ. Descriptive statistics of HQ, MQ, LQ and TS were examined; subgroups analyses (planning pregnancy, y/n; met activity guidelines, y/n) were conducted using multivariate regression adjusting for relevant covariates.

Results: A total of 1,227 participants completed the DQ (93% response rate). Participants were primarily female (83%), college/university educated (93%), born in Canada (83%), and had an annual household income =>\$75K (71%). Mean age was 34 (SD=4.9). Mean DQ scores (range) were: HQ:4 (5 to 49); MQ:2 (-6 to 6); LQ: -7 (-24 to 0); TS:19 (-15 to 48). Quality scores for participants planning vs. not planning a pregnancy were similar. However, a greater proportion of those planning pregnancy (69%) vs. not (53%) reported consuming alcohol “<1x/week”. Individuals who met physical activity guidelines vs. not had lower MQ scores (Beta=-0.31, 95% CI: -0.559 to -0.069), but higher LQ (Beta=0.72, 95% CI: 0.300 to 1.143), HQ (Beta=2.73, 95% CI: 2.040 to 3.420), and overall TS scores (Beta=3.14, 95% CI: 2.296 to 4.035).

Discussion: The adapted DQ and a scoring system that uses HQ, MQ, LQ, and TS scores allows for practical assessment of diet quality by people without extensive nutrition knowledge. Additional studies will validate this method against 24-hour dietary recalls and examine changes over time across different periods of the life-course.

Keywords: dietary quality, dietary intake, food frequency questionnaire, preconception, adults

Development and evaluation of the Vietnamese Healthy Eating Index

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Introduction: This study aims to develop and evaluate the Vietnamese Healthy Eating Index (VHEI). The VHEI is a measure of dietary quality and measures the adherence to the 2016-2020 Vietnamese food based dietary guidelines (FBDGs) developed for healthy Vietnamese adults.

Methods: The VHEI included eight components reflecting the recommendations for the eight food groups of the 2016-2020 Vietnamese FBDGs. Each component was scored from 0 to 10, resulted in a total score between 0 (lowest adherence) and 80 (highest adherence). Food consumption data of 8,241 households from the Vietnamese general nutrition survey 2009-2010 was translated into individual dietary intake data using the adult female equivalent approach.

Results: Mean (SD) score of the VHEI was 43.7 (8.2). Of the individual sugars and sweets (9.8 ± 1.2) scored the highest dairy (0.6 ± 1.8) scored the lowest. Each score for a component increased across tertiles of the VHEI. The intakes of micronutrients calcium, potassium, magnesium, iron, zinc, folate, riboflavin, vitamin A retinol, vitamin C, vitamin B6 and vitamin B12 was positively associated with the VHEI, both before and after total energy intake adjustments. For thiamin and vitamin E, there were no associations across tertiles of the VHEI. However, positive associations were observed when these intakes were adjusted for total energy intake.

Conclusion: Our findings show that the VHEI is able to classify healthy Vietnamese adults according to their adherence to the 2016-2020 Vietnamese FBDGs. Participants with a higher score have a better dietary quality with higher micronutrient intakes and a more diversity in food group consumptions.

Keywords: healthy eating index, diet quality

Contribution of food groups to breakfast energy intake according to Brazilian Breakfast Quality Index in residents of São Paulo, Brazil

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Introduction: Breakfast may present various compositions, and consequently, different nutritional qualities. Investigating the main foods that contribute to this meal may help to understand dietary habits of the population and support disease prevention programs. **Objective:** To describe the frequency of consumption and energy contribution of food groups to breakfast energy intake in adults from São Paulo, Brazil.

Materials and Methods: Data were drawn from the 2015 Health Survey of São Paulo, a cross-sectional population-based study, with 606 adults and 537 older adults living in São Paulo city. Dietary data were obtained from 24h dietary recalls. Individuals were classified according to their Brazilian Breakfast Quality Index (BQI) score as Low (0-3 scores), Medium (4-7 scores) or High (8-10 scores). Reported foods were classified into 25 groups and the prevalence of consumers, and percentage of energy contribution in each food group were calculated. **Results:** The most consumed food groups at breakfast were: coffee (74.1%), white breads/crackers (71.2%), milk (56.4%), sugar/honey/jams (53.7%), and butter/margarine (43.4%). For individuals with Low BQI (17%), milk and butter/margarine were not among the most consumed food groups, and for those in High BQI category (16%) there was an addition of fruits, dairy and exclusion of butter/margarine and sugar/honey/jams among the most consumed food groups. The five main energy contributors of breakfast were white breads/crackers (35.0%), butter/margarine (15.7%), milk (14.9%), sugar/honey/jams (6.7%) and dairy products (5.8%). When considering only participants classified as Low BQI sugar/honey/jams and sweets/candies contributed more than milk; for participants with Medium BQI there was a more expressive presence of milk and dairy products; for High BQI the major contributors were white breads/crackers followed by milk, fruits, dairy products, and butter/margarine. **Conclusion:** Brazilian traditional foods for breakfast are the main contributors to its energy intake, however only five food groups were consumed by more than 30% of the population, showing low diversity of food intake at this meal. Energy contributors differed among BQI categories, in which an expressive presence of fruits, milk and dairy was observed at High category, highlighting the BQI as a useful method for characterizing a healthy breakfast.

Keywords: Breakfast, Quality Index, Food Intake

Mobile app to assess Brazilian schoolchildren's diet

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Background: The use of technology to evaluate children's diet has become increasingly popular and attractive, reduction errors and standardizing data collection. Few technologies were developed in Brazil, specially for children.

Methodology: This is an ongoing study to develop a mobile application to assess Brazilian schoolchildren's diet between 6 and 10 years old. This tool will combine both children, their parents', and teachers reports about children's diet different environments: in and out of home including school environment. Interfaces will be created to evaluate simple and complex food, and recipes including questions about special diets. The food and household measure lists will contemplate cultural food diversity of Brazilian children allowing the estimate of food and nutrients intake. The app database was based on national food survey and regional studies conducted with schoolchildren from all Brazilian regions.

Results: Data included in the app database were based on 2017-2018 Brazilian National Dietary Survey. Data from regional studies were mostly based on studies that assessed diet using food frequency questionnaires with fixed food lists or tools that investigate only food groups' intake. We observed a scarcity of regional studies investigating schoolchildren diet in the North and Midwest regions of the country. Most of studies were conducted in South and Southeast regions.

Keywords: *dietary assessment, children, schoolers, mobile devices, technology-based dietary assessment*

Evaluation of a diet quality scoring tool to determine data-driven dietary patterns in adults with multiple sclerosis

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Introduction

Multiple sclerosis (MS) is one of the world's most common neurodegenerative diseases in young adults, affecting 2.5 million people globally. Evidence suggests that diet may play an important role in MS pathogenesis and progression but validated dietary assessment tools are required to understand the dietary characteristics of persons with MS. The aim of this study was to evaluate the psychometric properties of the Dietary Habits Questionnaire (DHQ). Given the limited evidence-based dietary guidance for persons with MS, data-driven dietary patterns were also derived to explore the dietary patterns of the sample.

Methods

The DHQ was evaluated against repeated 24-hour recall dietary assessments of the HOLISM cohort from Australia, New Zealand, the United States of America, and the United Kingdom. The Automated Self-administered Assessment-24 (ASA-24) tool was used to collect dietary intake data, to which regression models were applied to form usual dietary intakes. The DHQ sub-scores of key nutrients and food groups were calculated and statistically compared to the usual intake data. Dietary patterns were generated by using principal component analysis (PCA) from 21 food groups based on the AUSNUT2011-13 food groups.

Results

A total of 96 participants with relapsing-remitting MS completed the DHQ, with 30 participants completing two or more ASA-24 recalls. The median total DHQ score was 84.50 (IQR: 77.04-91.83). The highest absolute correlations were between the DHQ scores and ASA-24 intake for cereal ($r=0.395$, $P<0.001$), fruit and vegetables ($r=0.436$, $P<0.001$), and total dietary fibre ($r=0.482$, $P<0.001$) sub-scores. Small differences in the fruit and vegetables DHQ sub-scores were found across age groups (older and younger adults, $P=0.029$). Five dietary patterns were identified by PCA - grains, vegetables, fish & seafood, meats, and fats & oils - explaining 42.1% of the total variance.

Conclusions

The DHQ may be most appropriate for assessing intakes of fruit and vegetables. The web-based ASA-24 dietary assessment tool may be a feasible tool to collect more detailed dietary intake data over multiple days in people with relapsing-remitting MS.

Keywords: dietary assessment validation, multiple sclerosis, diet score, dietary pattern

Eating out of home according to different classification approaches and sociodemographic and lifestyle factors among adolescents

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Introduction:

The definition and classification of eating away from home is not well established. Its definition can facilitate the comparison between studies and favor the development of intervention strategies focusing on food choices, preparation and supply of food by commercial establishments and regulation of food offered to adolescents. The aim of this study is to describe the socioeconomic and lifestyle characteristics of adolescents who consume foods outside the home in Brazil, considering different approaches to defining food outside the home.

Methodology: Data from the Cardiovascular Risk Study in Adolescents were used with 71,740 adolescents who answered a 24-hour food recall. Adolescents were classified using 3 approaches: consumption of at least one item away from home, not including school (OTHER PLACES); consumption of at least one item away from home, including school (OTHER PLACES and SCHOOL); consuming at least 25% of total calories away from home (25% OTHER PLACES).

Results: 52.1% of adolescents consumed food outside home (OTHER PLACES and SCHOOL), 22% only at other places and 11% when considering 25% of calories away from home. The practice of having meals outside the home (OTHER PLACES and 25% OTHER PLACES) was more prevalent among older adolescents, who studied in private schools, and who rarely had lunch with their parents or guardians. Results differed when considering school in away-from-home consumption. Central-west region presented the highest percentage of eating out independent of the approach used to classify. **Conclusion:** The analysis of out-of-home food denoted that the school environment represents an important place for out-of-home eating by adolescents.

Keywords: Adolescent, Feeding Behavior, Lifestyle, Cross-Sectional Studies

Methodological challenges of assessing change in dietary pattern scores among breast cancer survivors in the Pathways Study.

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Background: Dietary pattern scores are a popular approach to describe overall diet quality; however, how best to model dietary change in observational studies is unclear. This uncertainty stems from narrow ranges of exposure, unevenly spaced or incomplete dietary assessments and limited options for categorizing dietary change scores. To examine these challenges, we used data from the Pathways Study to compare change in overall diet quality using two different approaches.

Methods: We included 3,661 women diagnosed with invasive breast cancer from 2006 through 2013 at Kaiser Permanente Northern California and categorized post-diagnostic change in the 2015 Healthy Eating Index (HEI) score from baseline to 24-month follow-up. The first approach categorized dietary change into three levels: “increasers” for those who increased their score by ≥ 10 points, “decreasers” for those who decreased their score by ≥ 10 points and “non-changers” for those who changed by <10 points in either direction. The second approach categorized dietary change into four levels: “stable-low” for those remaining below the baseline median, “stable-high” for those remaining above the baseline median, “low-high” for those moving above the baseline median and “high-low” for those moving below the baseline median, at follow up. For both approaches, we calculated adjusted associations with all-cause mortality using Cox proportional hazards models.

Results: Using the first approach, we found that 8.9% of women were increasers and 7.6% were decreasers between baseline and 24 months. Also, 32.4% of women were stable-low, 42.3% were stable-high, 14.2% were low-high and 11.1% were high-low. Over 12.4 years of follow up, there were 651 deaths due to any cause. We found that increasers had a lower risk of death (HR=0.958, 95% CI: 0.64-1.45) as did decreasers (HR=0.94, 95% CI: 0.77-1.53), when compared to non-changers. Those who were stable-high also had a lower risk of death (HR=0.79, 95% CI: 0.59-1.05), as did low-high (HR=0.90, 95% CI: 0.62-1.31) and high-low (HR=0.95, 95% CI: 0.64-1.41), when compared to stable-low.

Conclusions: Both approaches underline the importance of examining overall dietary change, however the second approach may be more desirable when needing to emphasize dietary quality at baseline.

Keywords: diet, change, patterns, breast, cancer

Does the use of default values for vitamin and mineral supplements yield the same outputs at the national population level compared to exact nutrient profiles?

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Introduction: Supplements are widely consumed in Canada. The 2015 Canadian Community Health Survey (CCHS) - Nutrition showed that 45.6% of Canadians aged one year and older reported using at least one nutritional supplement. The Licensed Natural Health Products Database (LNHPD) was used to code reported vitamin and mineral supplements which required extensive manual intervention and verification. The objective of this study is to compare intakes from these supplements at the national population level when using default values instead of exact nutrient profiles from Natural Product Numbers (NPN).

Methods: The study was conducted using 1 day data intake from the 2015 CCHS-Nutrition for females aged 31 to 70 years. All reported supplements were matched to generic supplement categories based on the Diet History Questionnaire III (DHQ). New categories were created when supplements did not fit within the existing classification. The nutrient profile for each DHQ category was reviewed and adapted to better match data reported in 2015 CCHS-Nutrition. The CCHS-Nutrition vitamin and mineral data was analysed using the default nutrient values and compared to original values. **Results:** Preliminary results were obtained for the most consumed supplement types among females aged 31 to 70 years (Vitamin D, Vitamin C, Iron, Vitamin B12 and Calcium with Vitamin D), excluding multivitamins. The distributions of nutrient intakes were not significantly different between the two methodologies for all analysed supplements.

Discussion: These preliminary findings suggest that using default values instead of collecting NPN's provide accurate results for single-nutrient supplements. Next is to analyze the remaining supplement categories, including multi-nutrient supplements. If these results are conclusive, the same process will be applied to the whole survey population to evaluate the reliability of the methodology to calculate intakes of a nationally representative population.

Keywords: Supplements, Database, Canada, Surveillance, CCHS-Nutrition

Comparability between the probability method and estimated average requirement (EAR)-cut point method in assessing nutrient adequacy using real-life examples

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Introduction

Dietary reference intakes (DRIs) are used assessing population's nutrient adequacy with food consumption survey data. The EAR-cut point method is applied as short cut of the probability method, and seems to predict the proportion of the population at risk of inadequate intakes well under specific conditions: a) intake and requirement are independent, b) requirement distribution is symmetrical around the EAR, c) variance of requirement < variance of habitual intake. The aim of our study is to evaluate how well the proportions with inadequate intakes estimated with the EAR-cut point method correspond with the probability method using real-life examples of the Dutch food consumption survey to estimate the intake.

Methods

Data of the Dutch Food Consumption Survey 2012-2016 (N=4313; 1-79 yrs.; 2x 24 hr. recall) and the EARs of the Dutch Health Council and European Food Safety Authority were used to estimate the proportion at risk of inadequate intake using both the EAR-cut point and Beaton's full probability method. Habitual intake was estimated, separately for age-groups, using Statistical Program to Assess Dietary Exposure (version 3.2). Folate, vitamins A and C, and iron were used as an example.

Results

The estimated proportion inadequate intake was similar between EAR-cut point and probability method for vitamins A and C. There was a statistical significant difference in this estimate for folate (girls 15-17 yrs.): 87% and 92% respectively and also for iron for girls 7-11 yrs.: 64% versus 70%, women 18-50 yrs. 23% versus 15%, women 51-70 yrs. 5% versus 2%, and male (18-70 yrs.): 1% versus 0%.

Discussion

For women of childbearing age with a skewed iron requirement distribution, the difference between methods was largest. For iron the variation coefficient (%CV) of requirement and intake were similar, and several age-groups had statistical significant difference between both methods. Although for folate the %CV for intake was 10%-point higher than the %CV for requirement, one age-group had a statistical significant difference between methods. Part of the estimated proportions inadequate intake were very high or very low, it is known the EAR cut point method does not perform well at extremes.

Keywords: EAR-cut point, probability approach, nutrient adequacy, real life data

“The newly developed Diet Quality Index for Estonia is a valid and reliable tool to assess overall dietary quality of the Estonian population”

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Introduction. A diet quality index is a simple, yet comprehensive tool to measure dietary quality by estimating the population’s alignment with national nutritional recommendations, and a good indicator for tracking the risk of obesity and non-communicable diseases. Estonia is lacking such a tool. The purpose of this study was to develop a Diet Quality Index for Estonia (DQI-E) based on the Estonian Nutrition and Physical Activity Recommendations 2015 (ENPAR2015) and to evaluate its validity and reliability by applying it to the Estonian National Dietary Survey 2014 (ENDS2014).

Methods. DQI-E components were selected from ENPAR2015, based on expert knowledge, the availability of candidate components in ENDS2014, and their association with health outcomes. The DQI-E comprised 11 components (six adequacy, three moderation and two overall balance components) with a scoring scheme that reflected ENPAR2015 recommendations for individual dietary elements. Each component was proportionately scored from 0 to 10 based on how closely an individual’s intake matched the appropriate recommendations for their energy requirements; the total DQI-E score ranged from 0 to 110 and was converted to a percentage score. Validity and reliability of the DQI-E were examined by eight questions: five for construct validity and three for reliability, following methods used for the Healthy Eating Index. All secondary analyses were on dietary data (average of two 24-hour diaries/recalls) from 4293 participants aged ≥ 2 years from the population-wide cross-sectional ENDS 2014.

Results. For construct validity, DQI-E yielded high scores for exemplary menus; differentiated between groups with known dietary differences; assessed diet quality independent of diet quantity; and demonstrated multidimensionality. For reliability, DQI-E showed low intercorrelation of components; and Cronbach’s alpha of 0.45. The mean DQI-E total percentage score was 51.7 (SD 14.1) with only 72 individuals (1.7%) receiving a score $>80\%$.

Discussion. DQI-E is a valid and reliable indicator of diet quality relative to ENPAR2015. This has implications for population monitoring, intervention evaluation and targeted health promotion. Results showed, a large proportion of the Estonian population does not adhere to ENPAR2015 recommendations known to be beneficial to health. Further studies are required to identify subpopulations in need of targeted nutritional interventions.

Keywords: diet quality index, dietary quality, validity, reliability, Estonia.

”Dietary quality of Estonians differs by age, sex and education level, but not by ethnicity and net income”

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Introduction. The rates of obesity and non-communicable diseases in Estonia have increased to the levels seen in other Western European countries. No research has been conducted to measure overall dietary quality, as a common risk indicator, of the Estonian population. The newly developed Diet Quality Index for Estonia (DQI-E) is a validated assessment tool that measures dietary quality in terms of adherence to nutritional recommendations. The purpose of this study was to estimate the dietary quality of Estonians by varying sociodemographic factors to provide insights about risk groups.

Methods. Secondary analysis of dietary data was conducted on 24-hour recalls/diaries of 4293 participants ≥ 2 years in the population-wide cross-sectional Estonian National Dietary Survey 2014 (ENDS2014). DQI-E was applied to ENDS2014 dataset to calculate total percentage DQI scores. Analyses of the relationship between total percentage scores (i.e. dietary quality) and sociodemographic factors (age, sex, education level, ethnicity, net income) utilised general linear model analysis in SPSS with only significant factors ($p \leq 0.05$) in univariate analysis taken forward to a multivariable model.

Results. Mean total DQI-E percentage score was 51.7 (95% CI 51.3, 52.1). In univariate analysis, total DQI-E percentage score was significantly related to sex ($p < 0.001$), age ($p < 0.001$) and education levels ($p = 0.026$), but not to ethnicity ($p = 0.995$) or net income ($p = 0.436$). In the multivariable model 2-5-year-olds had the highest and 14-17-year-olds the lowest mean total percentage score of 55.5 (95% CI 53.9, 57.3) and 47.3 (95% CI 44.0, 50.6), respectively ($p < 0.001$); females had higher scores (51.8, 95% CI 50.8, 52.7) than males (51.0, 95% CI 49.7, 52.2) ($p < 0.001$); and diet quality improved with higher education level with individuals with master’s and doctoral degrees having the highest dietary quality (52.1, 95% CI 50.7, 53.4) ($p = 0.005$).

Discussion. The DQI-E is a useful tool to monitor the dietary quality of the Estonian population. The diets of Estonians, regardless of sociodemographic factors, are far from optimal. Although differences between sociodemographic groups were small, these findings have implications for population monitoring and targeted health promotion because improvements in the nutritional health of the Estonian public are urgently needed.

Keywords: diet quality index, dietary quality, sociodemographic factors, Estonians.

Study protocol for a randomized controlled multi-center study of the New Nordic Diet in gestational diabetes mellitus: iNDIGO

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Introduction

Gestational diabetes mellitus (GDM) is associated with severe adverse outcomes for mother and newborn and its prevalence is increasing. Diet represents the first line treatment of GDM but even so, evidence-based guidelines for the optimal diet during GDM is lacking. The health benefits of the Mediterranean diet have received much attention but there is growing interest whether the same benefits can be replicated with a diet representative of the Nordic countries. The New Nordic Diet (NND) is an initiative with the purpose to develop a diet under the principles: (i) health; (ii) gastronomic potential and Nordic identity, and (iii) sustainability. Main aim of the iNDIGO study is to investigate if a diet according to NND, compared to routine care, will reduce complications for woman and newborn.

Methods/Design

The iNDIGO study is a randomized controlled single-blinded multi-center study. In total, 360 pregnant women diagnosed with GDM will be recruited at antenatal clinics in Southern and Northern Sweden. The GDM diagnosis is based on oral glucose tolerance test or random blood glucose test in gestational week 24-28. As soon as possible after diagnosis and informed consent, subjects undergo baseline evaluation including blood tests, dietary assessment, physical activity measurement, and questionnaires on health and health-related quality of life. Baseline measurements are repeated at the follow-up visit at gestational week 37. Women randomized to the intervention group meet for a face-to-face visit with a study dietitian for structured individual diet modification treatment according to NND and a cognitive behavioral approach. The NND includes rapeseed oil, whole grain bread, wild fish, seafood and game, potatoes, root vegetables, cabbages, Nordic fruits and berries. Women in the intervention group are followed frequently during the study duration, midway by telephone and bi-weekly by text messages. Pregnant women randomized to the control group receive routine care and will meet their regular midwife or dietician for standard diet advice. Main outcome is glycosylated haemoglobin A at gestational week 37. Secondary outcomes include gestational weight gain, nutritional status, health-related quality of life, small-for-gestational age, large-for-gestational age, and risk of developing type 2 diabetes mellitus up to 15 years after delivery.

Trial registration: NCT04169243

Keywords: gestational diabetes mellitus, Nordic diet, pregnancy, randomized controlled trial, protocol

Development of a tablet-based 24 hour dietary recall tool to assess children dietary intake in a national household survey in Brazil

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Introduction: The use of 24-hour dietary recalls (R24h) in paper impose excessive demands on time, resources, and data entry in studies, even more in household surveys. To this end, we described the development of a mobile device tool to collect R24h data in a Brazilian survey. Methods: A R24h-application (R24h-app) was designed for dietary data entry on Android-based mobile devices. It is being used to collect dietary intake of a probability sample of 15,000 children < 5 years old in the ongoing National Children's Food and Nutrition Survey (ENANI, Portuguese acronym). The R24h-app contains several dietary databases: (1) national consumed foods (in-natura and industrialized); (2) cooking method; (3) ingredients added; (4) place where meal was eaten; (5) portion sizes. After data collection, dietary recall data will be linked to food composition tables. Results: In the main screen of the app, the interviewer fills the child's name, the relationship between the child and the respondent and whether the dietary intake refers to a usual day. The following screens represent the five steps derived from the "Multiple Step Method": (1) Quick-list of recalled foods; (2) Probing for forgotten food items; (3) Recording time and meal names; (4) Detailing of preparation types, addition of ingredients, place where meal was eaten, and quantity/unit/thickness based on foods reported in household measures using a food photography book of children's portion sizes created specifically for the study; (5) Review of foods consumed in chronological order. All interviewers undertook a specific training course before using the app and rated it as user-friendly. A quality control of the data is being done weekly. After identifying the most common errors, the interviewers receive mobile text messages reinforcing the training provided. Discussion: The app is an important innovation for child nutrition research in Brazil, as it allows a practical, efficient and standardized data collection for remote settings, and provides easy access to the data. The R24h-app will soon be available for other research groups.

Funding: Ministry of Health (MoH)/ Department of Science and Technology (DECIT)/National Council for Scientific and Technological Development (CNPq).

Keywords: children, 24 hour dietary recall, mobile applications

Method for the development of the WISH, a globally applicable index for healthy diets from sustainable food systems

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Worldwide, diets of poor quality are the main contributors to all forms of malnutrition. However, emphasis should not only be put on promoting a healthy diet but also the environmental sustainability aspects of production and consumption of foods should be taken into account. To be able to evaluate diets for healthiness and sustainability we developed the WISH (World Index for Sustainability and Health).

The developed index is based on the EAT Lancet commission set of recommendations for a healthy and sustainable diet in the general population with global applicability across multiple settings. The 13 food groups (including whole grains, vegetables, fruits, dairy foods, red meat, fish, eggs, chicken and poultry, legumes, nuts, unsaturated oils, saturated oils and added sugars) are scored between 0 and 10, based on their association with disease and impact on selected environmental indicators (greenhouse gas emission, land use, eutrophication, acidification, and scarcity weighted water). The scoring system was applied using a dataset of duplicate 24h dietary recalls from 396 Vietnamese men and women.

Out of a maximum of 130, the mean \pm SD total WISH score was 51.0 \pm 11.3. This Vietnamese population also scored poorly on the healthy (30.7 out of 100) and high environmental impact (14.0 out of 60) sub-scores. Better scores were observed for the less-healthy (20.2 out of 30) and low environmental impact (37 out of 70) sub-scores. Individual mean food group scores were high for vegetables (8.7 \pm 3), saturated oils (10 \pm 0.5) and added sugars (9.9 \pm 0.9), whereas low scores were observed for whole grains (0.0 \pm 0.01), dairy foods (0.2 \pm 1.4), nuts (0.6 \pm 1.8) and unsaturated oils (0.5 \pm 1.5) due to high percentages of non-consumers, and red meat (0.4 \pm 1.8) as the intake of red meat was often above the recommended maximum intake level.

This sustainable diet quality index seeks to measure two complex multidimensional concepts, diet quality and environmental sustainability, in one scoring system. Our initial analysis shows that the WISH is able to differentiate between the healthiness and the environmental sustainability of a Vietnamese diet. Further evaluation of the WISH is planned whereby datasets from other countries containing data on dietary intake and sustainability indicators will be included.

Keywords: Healthy Diet, Sustainability, Index, Global applicability, General population

Adding Value with Dietary Assessment Tool Feedback: User Testing of the Automated Self-Administered 24-hour Dietary Assessment Tool's Respondent Nutrition Report

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Introduction

Efforts to increase value to research participants by providing relevant personalized health information such as lab and genetic results are ongoing. The Automated Self-Administered 24-hour Dietary Assessment Tool (ASA24) allows researchers to collect 24-hour recalls and records. An optional Respondent Nutrition Report (RNR) was added to ASA24 in 2016, allowing researchers to provide individualized nutrition reports to participants. Efforts are currently underway to improve this report.

Methods

The RNR, originally based on USDA's SuperTracker, was redesigned with improved graphics and descriptions of how reported intake aligns with federal dietary guidelines. Trained moderators conducted iterative user testing sessions, including eye tracking, with adults of varying ages, race/ethnicities, and education levels. In round 1, moderators guided volunteers (n=6) through one-on-one sessions with questions to assess understanding of the RNR. Feedback from round 1 was incorporated into an updated RNR design and tested in round 2 with new volunteers (n=6), following the same methodology.

Results

Volunteers in round 1 did not understand the phrase, "percent calories from macronutrients," and struggled with words such as "limits" and "targets." Eye tracking indicated that volunteers viewed but did not understand all graphics, as they requested explanatory text and links for additional information. Word choices for labelling were important; for example, one participant asked if eating "whole fruits" meant eating an entire watermelon. Information provided for food group targets and nutrients to limit were well understood. In round 2, eye tracking and verbal feedback indicated usefulness of other newly added text and web links. However, confusion persisted regarding "percent calories from macronutrients" leading to further changes. New information about supplement intake, Recommended Daily Allowance, and Upper Limits was poorly understood. In both rounds, participants stated that the RNR would help them make positive dietary changes.

Discussion

This testing describes the process of designing an understandable and personalized nutrition report for research participants. Further research is needed to determine if an easily understood RNR can help individuals make dietary improvements, such as in dietary interventions. Given our experience, we recommend those developing feedback reports conduct user testing with the targeted population to maximize understanding and utility.

Keywords: usability testing, personalized feedback, eye-tracking

Prevalence of fermented foods in the Dutch diet and validation of a food frequency questionnaire for estimating their intake in the NQplus cohort

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Fermented foods have a long history of consumption by humans; however, their prevalence in human diets has not been systematically evaluated. There is also a lack of dietary assessment tools that are validated for assessing intakes of fermented foods. We aimed to identify fermented foods consumed in The Netherlands and determine the relative validity of a food frequency questionnaire (FFQ) compared to multiple 24-hour recalls for estimating their intake. The validation population consisted of 809 participants (53.1±11.9 years) from a Dutch observational cohort (NQplus) who completed a FFQ and multiple 24-hour recalls. Fermented foods from the FFQ and recalls were identified and aggregated into conventional food groups. Percent difference in mean intakes, quintile cross-classification, Spearman's correlation, and Bland-Altman analyses were used to evaluate the agreement between the two dietary assessment methods. A range of 16-18% of foods consumed in this population were fermented, and a further 9-14% were dishes containing a fermented ingredient. Fermented foods with the highest consumption included coffee (~453 g/day), yoghurts (~88 g/day), beer (~84 g/day), wholegrain bread (~81 g/day), and wine (~65 g/day). Mean percent difference between the FFQ and recalls was small for fermented beverages (coffee), breads (brown, white, wholegrain, rye), and fermented dairy (cheeses) (0.3-2.8%), but large for buttermilk and quark (≥53%). For all fermented food groups >50% of participants were classified into the same or adjacent quintile of intake [58% (buttermilk) to 89% (fermented beverages)]. Strong Spearman's correlations (crude/energy-adjusted $r_s \geq 0.50$) were obtained for fermented beverages (coffee, beer, wine), fermented cereals/grains (wholegrain bread), and fermented dairy (yoghurts). For 'other bread', quark, and buttermilk, correlations were low ($r_s < 0.20$). Bland-Altman analyses revealed good agreement for fermented beverages (coffee, beer), breads (brown, wholegrain, rye, other), pastries, chocolate, and fermented dairy (cheese) (mean difference: 0.1-9.3). As expected, fermented food groups with acceptable or good validity across all measures included commonly consumed foods in The Netherlands, including fermented beverages (coffee), wholegrain and rye bread, and fermented dairy (cheeses). However, for less frequently consumed foods, such as quark and buttermilk, the levels of agreement were poor and estimates of intake should be interpreted with caution.

Keywords: Fermented foods, dietary assessment, validation.

Development of accelerometer data validation and correction tools for objective free-living measurement of physical behaviours

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Body-worn accelerometers have been widely used to provide an objective free-living measure of the time spent in different physical activities. To obtain a valid measure of free-living physical behaviour robust methods are required to demonstrate the sensor has been worn and worn correctly.

With a defined sensor placement (wrist, ankle, waist, thigh) there is a-priori knowledge of the signal characteristics expected from the worn sensor. We used a tri-axial acceleration sensor worn on the ventral aspect of the thigh where stepping will occur in a vertical orientation and sitting will be in a pure pitch relation to the stepping vertical alignment. This allows rules to be defined which validate wear location. In previous work we projected the spherical coordinates from the accelerometer on to the six surfaces of a cube to provide a simple validation of wear alignment. For greater resolution the orientations of the acceleration data were plotted on the surface of a sphere. In practice the data forms an ellipsoid and so we took stationary points (non-movement) from the free-living data and used a standard ellipsoid fitting technique to resolve the ellipsoid to a true sphere. We used a 15 second average of the dynamic acceleration periods to position the dynamic acceleration magnitude on the sphere.

The outputs from the calibration were visualised on an interactive 3D plot. This visualisation disclosed a temperature-acceleration relationship where non-wear periods had a different radius from the worn-sensor data and hence the calibration should use known-wear data only. The upright orientation vector is identified by the presence of stepping and the unit vector for sitting is then calculated by finding the average unit vector immediately following a sit-stand or stand-sit transition. The cross product of the upright and sitting vectors are used to calculate a set of orthogonal vectors which define the thigh alignment basis. The thigh alignment should be recalculated every time the sensor is taken off and replaced.

We have demonstrated that data from a sensor secured in any orientation on the thigh can be processed to identify the activities in upright and sedentary postures.

Keywords: Accelerometer, inclinometer, validation, physical behaviour, thigh

Assessment of availability and variability of food products in the UK supermarkets through automated data extraction techniques

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Introduction

Available food products are changing with an unprecedented speed and food databases are not regularly updated to include new products. The purpose of this study is to explore the availability of ready meals, vegan and free-from food products in the supermarkets of the UK via automated data extraction techniques over the period of one week.

Methods

Automated data extraction techniques (i.e. web scraping) were used to access food label information based on the HTML structure of the retailers' websites. Four of the top grocery retailers in the UK were chosen. Data collection was conducted daily for a week from the 29th July until the 2nd August 2019. Food items were scraped for three different entries in the retailers' website search box: "ready meals", "vegan" and "free from". Foods were then grouped based on cuisine and the FoodEx2 classification system for further analysis. The web scraping code was written in Python.

Results

The number of products that were scraped each day varied. Over a one-week period 1090 to 1218 ready meals, 2532 to 3358 free from products and 1110 to 1190 vegan foods were identified in total each day from the 4 stores. The maximum increase was between Monday and Tuesday: 10% in the ready meals, 8% in the free from and 32% in the vegan foods. Ready meals had similar energy content across different cuisine types (mean/100g~ 150kcal, SD 11). The free from items were grouped into 17 categories to allow comparison, for example, 261 free from bakery and 218 free from snacks were identified with nutrient information. Finally, not all the products that were scraped belonged in a food category, e.g. soaps considered as vegan.

Discussion

This study has demonstrated a valid approach to collecting food and nutrient information on branded products. The web scraping code depending on the retailers' website is the most important limitation. This methodology has great potential in contributing to the understanding of the availability of ready meals, free from and vegan products across retailers and to their variation over time.

Keywords: automated, data, extraction, food, availability

Photographs of foods – Experiences from adapting a British web-based dietary assessment tool (myfood24) for Norway

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Introduction: Self-administered 24-hour-recalls demonstrate similar accuracy as traditional 24-hour-recalls, but the former is usually preferred by users and reduce the burden of data handling for researchers. Norway lacks a self-administered web-based 24-hour-recall-system for adults. We have recently adapted the British myfood24 for Norway, including the photo-series for portion size estimations. The foods illustrated in the photo-series should look familiar for the users, not to compromise the user-friendliness of the tool.

We aimed to identify suitable photo-series for portion size estimation for the Norwegian myfood24 in this study.

Methods: All 59 photo-series from the British version of myfood24 was tested in a nutrition expert group (n=16). Subsequently, the photos were tested in a group of young adults between 18-45 years (n=41). Participants in both groups evaluated whether the photos were suitable for assessing dietary intake in Norway.

The expert group assessed all 59 photo-series, whereas the group of young adults assessed the 37 photo-series regarded as unsuitable for a Norwegian version of myfood24 by at least one expert. The suitability of each of the British photo-series was defined by the frequency and proportion of participants who regarded the photo-series as such.

Results: Twenty-two out of 59 British photo-series were identified as suitable by all in the expert group. The remaining 37 photo-series were identified as unsuitable by 6-100% of the experts (17/37 by more than 40%).

Eight out of these 37 photo-series were identified as unsuitable by more than 40% of the young adults. The sponge pudding photo-series was rated as unsuitable by the most (76%). The photo-series of raw carrots was on the other hand rated unsuitable by 2% of the young adult group, which was the lowest out of all 37 photo-series.

Discussion: Few photo-series were identified as unsuitable by the young adults, which may reflect international food habits in this age-group. The results should not be generalized to older individuals, indicated by the results from the expert group with no upper age limit.

Most of the photos-series of portion sizes in the original myfood24 seem suitable for a Norwegian version of myfood24 by a group of young adults.

Keywords: dietary assessment, portion size, photography

Associations between diet quality and cognitive function in mid-life: a comparison of 3 diet scores using UK Biobank

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Introduction

Recent evidence suggests a long prodromal stage of dementia, with changes occurring 20 years before a diagnosis. As there is currently no cure, preventative strategies targeting lifestyle behaviours in mid age to delay development of dementia are critical. An association between better diet quality and reduced dementia risk in adults >65 years has been observed, associations in mid-life are unknown. This study investigates associations between diet quality and cognitive function in mid-aged adults.

Methods

The UK Biobank is a prospective study that recruited 502,536 men and women volunteers between 2006 and 2010. A subset of the participants aged between 40 and 65 years who completed the dietary intake and cognitive function assessments were included in the analysis. Dietary intake was assessed using the Oxford WebQ. Three measures of diet quality were used: adherence to a Mediterranean diet (Mediterranean Diet Score, MDS), British healthy eating guidelines (Healthy Diet Indicator, HDI) and dietary variety (Recommended Food Score, RFS). Episodic memory, reasoning and problem solving, and processing speed were assessed using the pairs matching, fluid intelligence and reaction time tests respectively. Separate linear regression models examined associations between each diet quality score and each cognitive function outcome, adjusting for potential confounders (e.g. age, income, education).

Results

A total of 65,076 participants (mean age = 54.3 years, SD 7.4, 53.2% women) were included in the analysis. A higher RFS was associated with better fluid intelligence $\beta=0.017$ (95% CI: 0.016, 0.019), pairs matching $\beta=-0.05$ (-0.007, -0.003) and reaction time $\beta=-0.003$ (-0.005, -0.001). A higher score on the MDS was also associated with better fluid intelligence performance $\beta=0.020$ (0.013, 0.026). Higher scores on the HDI was associated with better performance on fluid intelligence $\beta=0.011$ (0.006, 0.016) but poorer scores on pairs matching $\beta=0.006$ (0.001, 0.011).

Discussion

Cross-sectionally, across all measures, a higher quality diet was associated with better fluid intelligence. Men and women with greater dietary variety (RFS) reported better cognitive function across several domains, whilst associations between healthy eating guidelines (HDI) and cognitive function were mixed. Future studies should investigate associations over time to determine if these relationships can predict future dementia risk.

Keywords: diet quality, cognitive function, dementia, UK Biobank

Development of a web-based Food Inventory Technology System (FITS): Integration of qualitative methods to generate a novel food list for South Asians living in America

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Introduction: South Asians (SA) are the fastest growing major ethnic population in the United States (U.S.). Despite their growing presence, there is no culturally tailored food assessment method to quantify their diet, which uniquely combines western and traditional SA foods. The present study sought to create a food list using an interviewer-guided questionnaire combined with a novel method of home food inventory (HFI) that records food in a person's kitchen pantry and refrigerator. The study will be instrumental in producing a list of foods to be included in a web-based validated Food Inventory Technology System (FITS).

Methods: Adults aged ≥18 who self-identified as SA were recruited via e-mail and social media platforms. Demographic information, physical activity, alcohol consumption, and food security survey information was collected via Qualtrics survey, and participants were interviewed on zoom. Two qualitative diet assessment modalities, 1) interviewer-guided 24-hour dietary recall and 2) HFI, were conducted using a zoom video feature to record food pantry, refrigerator, and kitchen contents.

Results: Sixty participants were recruited. Respondents, aged 20 to 65 years, hailed from the U.S., Bangladesh, India, Nepal, and Pakistan. Participants reported that intake was influenced by both traditional dietary practices and western food items. The HFI enabled participants to refer to food items in their kitchen, particularly staples, herb and spice use, and preference for shelf-stable convenience foods. The integrated methods have resulted in a comprehensive list of foods that will be utilized to build a SA FITS. We successfully built a food list that encompassed beverages, dairy, vegetables, fruits, beans and lentils, meats, grains, mixed dishes, and desserts categories that were culturally specific.

Discussion: This project provides the foundation for a culturally relevant FITS, a novel diet assessment tool tailored to SA living in the U.S. Virtual dietary recall and HFI provide a unique opportunity for assessing the diet patterns of a heterogeneous population subgroup that is quickly growing across the U.S. The online recruitment and qualitative method to query foods are complemented by HFI. This tool will have a significant impact on surveillance and understanding diet-disease relationships in this population.

Keywords: *South Asian, Home Food Inventory, Food Inventory Technology System*

Methodology to estimate total red meat and total poultry intakes from the US National Health and Nutrition Examination Survey

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Background: Total red meat and processed meat/poultry are often associated with increased chronic disease risk. Yet, there is no systematic method to estimate red meat, processed meat, and processed poultry intakes for the U.S. population.

Methods: Using USDA's Food Patterns Equivalents Database (FPED) of the 2013-2016 National Health and Nutrition Examination Survey (NHANES), two researchers independently manually disaggregated the 'cured meat' (i.e. processed red meat and poultry) FPED variable into cured red meat (CRM) or cured poultry (CP) based on food code descriptions, ingredients, and categories. 'Cured meat' was evenly split into CRM and CP if text like 'meat and poultry' was specified; CRM was defaulted if text was ambiguous. We added CRM to unprocessed red meat to calculate total red meat (TRM) and CP to unprocessed poultry to calculate total poultry (TP). We developed a SAS program to mimic our manual coding for application to other NHANES cycles. We calculated concordance between our manual code and SAS program. We estimated consumption prevalence and mean intake (\pm SE) of TRM, CRM, TP, and CP using 1-day dietary recalls for individuals 19+ years ($n= 10,064$) with SAS survey commands.

Results: Of the 689 foods containing 'cured meat', manual coding identified 567 as CRM (22 by default), 37 as CP, and 85 as containing both CRM and CP. There was $\geq 96\%$ agreement between the manual code and SAS program for all variables. Prevalence was $70 \pm 0.8\%$ (TRM), $42 \pm 1.0\%$ (CRM), $68 \pm 0.7\%$ (TP), and $12 \pm 0.6\%$ (CP). Mean intakes were: 1.1 ± 0.02 (TRM), 0.4 ± 0.01 (CRM), 1.1 ± 0.03 (TP), and 0.1 ± 0.01 (CP) oz.-eq/1000kcal.

Conclusions: Our new meat and poultry variables can help identify population subgroups that would benefit from targeted dietary recommendations and assess associations with chronic disease risk in a nationally representative U.S. sample.

Keywords: red and processed meat, nutrition surveillance, chronic disease risk

The Development and Evaluation of the Healthy Beverage Index for U.S. Children and Adolescents

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Introduction: Improving beverage consumption patterns through promoting healthy beverages and reducing sugar-sweetened beverage (SSB) intake are recommendations to combat obesity in childhood and adolescence (2-19 years). Therefore, it is important to assess beverage intake quality in this population. For adults, the Healthy Beverage Index (HBI) was created based on concepts from the Healthy Eating Index to assess beverage intake quality. Because many beverage recommendations for children and adolescents differ from adults, the objective was to develop and validate a HBI for U.S. children and adolescents (HBI-CA). Methods: Modeled after the adult HBI, age-specific, evidence-based recommendations for each type of beverage, fluid requirements, caffeine intake, and beverage energy were determined. A total of ten components were included to assess beverage pattern quality. The HBI-CA provides scores of 0-100, with higher scores indicating better adherence to recommendations. 24-hour dietary recall data from the 2015-2016 National Health and Nutrition Examination Survey was used to estimate HBI-CA scores among a weighted sample of U.S. children and adolescents. To assess construct validity, adult HBI scores were compared to HBI-CA scores, the distribution of HBI-CA scores across quartiles were determined, and principal component analysis (PCA) was used to determine the multidimensionality of the HBI-CA. Pearson's correlations were used to assess reliability. Results: The HBI-CA resulted in a mean±SE total score of 69.2±0.8 (n=2,874), which is similar to the adult HBI mean total score (63). Mean total HBI-CA score quartiles were significantly different ($p \leq 0.01$), allowing for detection of meaningful differences in HBI-CA scores (47.7±0.3, 63.9±0.1, 75.2±0.1, 89.9±0.3; quartiles 1-4, respectively). PCA identified 6 factors, indicating the multidimensionality of the HBI-CA, with more than 1 combination of components contributing to variation in total scores. Most HBI-CA components were significantly correlated to the total score, with water, SSB, beverage energy, and fluid requirements demonstrating the strongest correlations ($r=0.335-0.735$; $p \leq 0.01$). Low-fat milk and unsweetened coffee/tea were not significantly correlated to the total score. Conclusion: Overall, the HBI-CA is a promising method that can quantify and assess beverage intake quality in children and adolescents. Future studies should be conducted to assess the predictive validity and sensitivity of the HBI-CA.

Keywords: Beverage patterns, children, adolescents, obesity

Meal and food differences by 24-hr recall methods relative to a measure of true intake

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The objective was to compare the accuracy of the Interviewer-administered Automated Multiple-Pass 24HR (AMPM) with the Automated Self-Administered 24HR (ASA24), to assess whether image-assisted methods improved accuracy, and to detect the most common sources of error by meal and food types. Using a controlled feeding study design, all food and beverages consumed were surreptitiously weighed. Participants (n=56) were randomised to either AMPM, AMPM+images, ASA24 or ASA24+images. Before and after eating images of all meals were taken using a mobile food record app. They consumed three meals over 24 hours and returned the following day to complete a 24HR. The image-assisted groups viewed their meal images to assist with the recall process. Differences between true and reported energy intake by all three meals and individual foods were calculated and data analysed using ANOVA. Differences were found between true and reported intakes in Breakfast (BF) (3728 ±2124kJ, 2667 ±1240kJ), Dinner (DIN) (4239 ±1661kJ, 3451 ±1669kJ) and 24-hr (10659 ±4158kJ, 8870 ±3352kJ) (p<0.001), but not in Lunch (LUN) (2568 ±1554kJ, 2701 ±1089kJ). There were no differences across recall methods for mean difference energy intake by meal or day. Comparing all 4 methods, Breakfast and Dinner were overestimated and different (p<0.05) to Lunch (underestimated). For AMPM (BF, 940 ±1210kJ; LUN, -125 ±1163kJ; DIN, 562 ±951kJ), AMPM+images (BF, 1705 ±1376kJ; LUN, -169 ±1524kJ; DIN, 253 ±2060kJ), ASA24 (BF, 957 ±1138kJ; LUN, -299 ±1124kJ; DIN, 1214 ±1398kJ), ASA24+images (BF, 759 ±1635kJ; LUN, -49 ±1175kJ; DIN, 847 ±954kJ). There were no differences between Dinner and Breakfast. Seven food types had a higher mean difference in energy (Curry, Pastry, Bread, Lasagne, Rice, Stir-fry, and Cereal) (p<0.05). AMPM and ASA24 presented five of those food types, AMPM+images presented four, and ASA24+images only three. Two of those food types were found higher in all four methods; Curry (617 ±156.93kJ; 485 ±140kJ; 817 ±164kJ; 296.96 ±142kJ; respectively), and Pastry (648 ±105kJ; 324 ±89kJ; 196 ±98kJ; 515 ±100kJ; respectively). Analysis using only the total energy difference across methods obscured the errors reported by the food and meal based analysis.

Keywords: Image-based dietary assessment, mobile food record, technological advances, misreporting

Misreporting of foods and nutrients among children and role of socioeconomic status

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Objective: Few studies have examined misreporting of energy intake among children and the contributing role of socioeconomic status. The aim of this study was to examine the food and nutrient intakes of children classified as low energy reporters versus plausible reporters, and to investigate the effect of socioeconomic status on this association.

Methods: Children aged 2-18 years (n=2318) participating in the Australian National Nutrition and Physical Activity Survey 2011-12 were classified as low energy reporters or plausible reporters, based on their ratio of reported energy intake to basal metabolic rate, using the first of two 24-hour dietary recalls undertaken. Differences in intakes of nutrients and food types (five food groups and discretionary foods) were assessed between the two groups, and the interaction between misreporting status and socioeconomic status quintile was investigated using generalised linear modelling. All analyses were adjusted for age and sex.

Results: Children classified as low energy reporters (11.3%) had significantly higher intakes of protein (17.8% versus 16.2% energy) and added sugars (14.8% vs 13.6%E) but lower intakes of total fat (27.3% vs 31.5%E) and saturated fat (11.0% vs 13.3%E); all $P < 0.01$. Intakes of all five food groups (g) and discretionary foods (%E) were significantly smaller in low energy reporters compared with plausible reporters; all $P < 0.001$ (for discretionary foods, 31.4% E and 36.8%E, respectively). Children in the lower socioeconomic quintiles were more likely to be low energy reporters ($P_{\text{trend}} = 0.002$) and consumed a higher %E from discretionary foods ($P_{\text{trend}} = 0.004$) than those in higher quintiles. However, across the socioeconomic quintiles, those classified as low energy reporters described a similar energy contribution from discretionary foods ($P_{\text{trend}} = 0.226$).

Conclusion: Low energy reporting was more common in children of lower socioeconomic status but when comparing low energy reporters to plausible reporters, discretionary foods were not differentially under-reported across the socioeconomic gradient. These findings provide a better understanding of sociodemographic factors associated with Australian national dietary data enhancing the interpretation of the survey results.

Keywords: misreporting, food intake, children, socioeconomic

Automated Web-based Assessment system using Recipe-Data for Japanese (AWARDJP) – a pilot study for the middle and old age population-base cohort studies in Japan.

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Background: A large scale multi-country cohort consortium may improve statistical power in nutritional epidemiological study, but also may require comparability of mean intakes between different dietary patterns. Minimal biased-dietary assessment is desirable as a part of the large-scale epidemiological study to overcome the dilemma of using FFQs. A computerized 24-hour dietary recall system is one of the tools which was demonstrated to provide high-quality dietary intake data with minimal bias. We conducted a pilot study of the web-based computerized 24h-DR system (AWARDJP) in some large-scale cohort studies in Japan.

Method: This system is PC based, and follows USDA Automated Multiple-Path Method, and has a built-in representative recipe (a component of ingredients and their weight in the mixed-dishes as a unit) database based on the observational weighed food record and photographs of those recipes. We recruited 5013 among 21,537 subjects in 4 area of four cohort studies for middle and old age Japanese by mail. Subjects were assigned for 4 seasonal group, and they were asked to login to the Web-system on the Day randomly assigned within 3wk of the season. If the participant was not familiar with the internet system, they were able to respond by telephone using a dish scale enclosed.

Results: 975 men (n=471) and women (n=504) aged 60.8 (response rate 20%) participated, and it was 4.5% of all cohort subjects. Of those, proportions of respondents to the self-administrated Web-system (47%) were lower than those by interviewer-administrated telephone survey (53%). The proportion of the day's responses was equal on each day: 73% for weekday, and 27% for weekends. Although 74.5% of middle age (<60y) participants selected the self-administrated Web-system, 76.2% of the old age (≥60y) participants selected interviewer-administrated telephone. Easiness of the operation of Web-system in choice of dishes eaten were a problem in the attached questionnaire.

Conclusion: This PC-based system leaves much to be desired for use as a platform for the calibrated large-scale middle and old age cohort consortium with any other Asian cohort studies.

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Keywords: automated 24hour recall, recipe database, middle and old age cohort

Development of the FiberScreen: a short questionnaire to estimate fiber intake in healthy adults

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Introduction: health effects of dietary fibers continue to be the topic of many human intervention studies. Eligibility criteria for these studies often include a low fiber intake, which requires a screening step in the selection process. However, current dietary assessment methods are unnecessary extensive and burdensome for both researcher and participant. Therefore, we developed a short fiber questionnaire (FiberScreen) to identify participants with a relative low or high fiber intake.

Methods: The FiberScreen was validated as part of a high-fiber personalized dietary advice study, consisting of a 6-week intervention and a 3-month follow-up. Participants were healthy adults which completed the FiberScreen (version 1) and a 247-item meal-based food frequency questionnaire (FFQ) during study screening (n=131). Furthermore, an optimized FiberScreen (version 2) was tested at 3-month follow-up (n=87). In this study, a low fiber intake was defined as <26 grams for women and <33 grams for men (based on the FFQ), which is $\geq 15\%$ below the recommendation.

Results: FiberScreen Version1 included 5 items assessing intake of high-fiber product categories, namely fruit, vegetables, whole grain products, pasta/rice/potatoes and legumes. Total fiber intake was moderately correlated with fiber intake from the FFQ ($r=0.356$), but the separate product categories had a weak correlation with similar categories from the FFQ. FiberScreen Version2 included 9 items. Total fiber was strongly correlated with the FFQ ($r=0.707$) and product categories were strongly or moderately correlated ($r_{\text{fruit}}=0.707$, $r_{\text{vegetables}}=0.457$, $r_{\text{whole grain products}}=0.603$, $r_{\text{pasta, rice, potatoes}}=0.505$, $r_{\text{legumes}}=0.731$, $r_{\text{nuts}}=0.469$). FiberScreen Version2 had a sensitivity of 0.66, specificity of 0.89, a positive predictive value of 0.48 and a negative predictive value of 0.92. Moreover, it correctly classified 82% of the participants as having a “truly” high or low fiber intake. Estimated FiberScreen completion time is <10 minutes, whereas completion time of the FFQ is 30-60 minutes.

Discussion: FiberScreen Version2 has an adequate comparability with the FFQ and is able to rank and identify participants with a low or high fiber intake. Therefore, the FiberScreen is a suitable screening tool to identify participants with a relative low or high fiber intake.

Keywords: Dietary fiber, screening, questionnaire, food frequency questionnaire, comparability

The Dietary Quality Score: an updated validation including association with risk factors for cardiovascular disease and type 2 diabetes

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In the mid-2000s, the Dietary Quality Score (DQS) was developed as a tool to evaluate the general dietary quality of the Danish population. The DQS was based on a 48-item food frequency questionnaire (FFQ), which has since been updated and the validity of the DQS could potentially be affected by this revision. Therefore, the objective of the current study was to assess the validity of the DQS and to examine whether the DQS was still associated with risk factors for cardiovascular disease (CVD) and type 2 diabetes (T2D). A random sample of 598 men and women aged 18-73 years from the cohort Diet, Cancer and Health – Next Generations (DCH-NG) were invited to complete the short revised 23-item FFQ. In the analysis, 450 participants were included. The DQS was based on the short 23-item FFQ and validated against a long 376-item FFQ from the DCH-NG cohort. The associations between the DQS and risk factors for CVD and T2D were examined using linear regression models. Results showed that a high DQS, i.e. having healthy dietary habits, was significantly associated with a higher intake of fruits, vegetables, fish, fibre, several vitamins and minerals and a lower intake of saturated fat. Additionally, a high DQS was significantly negatively associated with LDL cholesterol ($P=0.017$), WC ($P=0.0161$), visceral fat ($P=0.0003$), fat mass ($P=0.0106$), fat percentage ($P=0.0030$) and Hs-CRP ($P=0.0449$) and significantly positively associated with HDL cholesterol ($P=0.0379$), when adjusting for education, smoking habits and physical activity. There were no significant association with total cholesterol, triglycerides, HbA1c, BP and BMI. In conclusion, the DQS, based on the revised 23-item FFQ, remains a good tool for ranking overall dietary quality in the Danish population and is significantly associated with risk factors for CVD and T2D.

Keywords: Dietary quality score, validation, FFQ, cardiometabolic risk factors

Children's Obesity Risk Assessment (CORA): the development and internal validation of an obesity risk prediction model for older primary school children

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INTRODUCTION: Childhood and adolescent obesity is a public health priority that warrants prevention measures, but limited resources may dictate targeted interventions. We developed and evaluated an obesity risk algorithm for children aged 10 years old without obesity, intended to identify communities at higher risk of obesity in early adolescence.

METHODS: Based on evidence from a systematic review, putative predictors of childhood and adolescent obesity were matched to candidate variables in a dataset from the Avon Longitudinal Study of Parents and Children (ALSPAC). 20 pre-specified predictors had <20% missing, including child's food and drink intakes at 10+ years plus other health behaviours and family measures. The cohort was randomly split, using 75% of eligible children (n=4,114) for algorithm derivation and 25% (n=1,372) for internal validation. Following the protocol, logistic regression with purposeful selection of covariates determined a prediction model for adolescent obesity at 13+ years, defined using UK 1990 growth references. Predictive metrics were calculated.

RESULTS: The final model had 9 predictive variables: Intakes of vegetables, milk, dairy foods and snacks/treats, sugar sweetened beverage frequency, early puberty, mother's overweight, child's body satisfaction and active travel to school. The model kept 3,171 observations with 121 obesity events in the derivation sample and 1,077 observations with 51 obesity events in the validation sample. In the derivation sample the model had good overall predictive ability (Brier score = 0.04), acceptable discrimination (area under the receiver operating characteristic curve, AUROC = 0.76) and showed potential usefulness (sensitivity = 57%, specificity = 79%, positive predictive value, PPV = 10%, negative predictive value, NPV = 98%). In the validation sample the metrics were similar (Brier score = 0.04, AUROC = 0.70, sensitivity = 55%, specificity = 72%, PPV = 9%, NPV = 97%), demonstrating reproducibility.

DISCUSSION: Predictive risk tools are routinely used in clinical settings, but population based algorithms that utilise self-reported risk factors are novel. Few include food intakes as predictors. The CORA model requires external validation to gauge its transportability to a different population setting. Discriminating and well calibrated predictive models could help public health professionals target obesity prevention more effectively.

Keywords: Child, Diet, Adolescent, Obesity, ALSPAC

An evaluation study of food portions size photographs for use in a web-based 24-hour dietary recall system (myfood24) for Norway

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Objective

To develop and validate new cultural specific image-series for portion size estimation to be used in a Norwegian version of a British web-based dietary assessment tool (myfood24).

Design

Twenty-three image-series of different foods, each containing seven portion size images, were developed and validated in a group of adults (n 41, 58% female) aged 19-44 (median 23) conveniently sampled, out of which 63% had higher (tertiary) education. In a large university kitchen, at the University of Agder in southern Norway, November, 2019, the participants compared 46 portions of pre-weighed foods to the portion size images (1886 comparisons in total). Portion size estimations were subsequently classified as correct, adjacent or misclassified, and the degree of misestimation (weight discrepancy in % between chosen and correct portion size image) was calculated. Mann-Whitney U-tests were used to explore the impact of sample characteristics and type of food presentation on levels of portion size estimations.

Results

For 38 of the 46 presented food items, 90-100% of the participants selected the correct or adjacent portion size image. The remaining eight food items were on average misclassified by 27% of the participants. The mean weight discrepancy was +2.5% between the reported and the correct portion size images. Women estimated portion sizes more accurately than men ($p=0.019$).

Conclusion

The new image-series performed satisfactorily, except for some food items (bread, caviar spread and marzipan cake), adding to the importance of validating portion size estimation tools. Women estimated the correct portion size more often than men.

Keywords: dietary assessment, validation, methodology, portion size estimation, perception

Inventory of prerequisites for nutrition apps to engage consumers for long term usage

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Healthy eating and physical activity are both important elements of a healthy lifestyle. Increased smartphone usage has allowed the popularity of health applications, that provide behavioural interventions to stimulate a healthier diet and/or active lifestyle. Many people adopt the usage of health apps to engage themselves in healthier behaviours. Despite this, the number of people that meet dietary recommendations does not seem to increase. Therefore, the main objective of this study is to identify the prerequisites that a nutrition app needs to meet to successfully monitor, support and/or maintain healthy eating behaviour.

For a consumer home-use test, six nutrition apps were selected based on criteria, including behaviour change techniques (BCTs), found in literature. Six groups of eight consumers were recruited. Each group tested one app for a period of 3-4 weeks. At the start consumers filled out a questionnaire including socio-demographics and a range of psychological determinants. After four weeks, each group discussed their findings in a focus group discussion (FGD) at our research facility. At the start of each FGD participants filled out a usability questionnaire of the app that they tested.

The FGDs revealed 10 clusters of user-centric aspects of the apps: purpose, introduction, personalisation, user-friendly interface, database, education & information, progress and monitoring, feedback & support, social media & communication, and motivation & continuous usage. Within these clusters, key properties for long-term usage were identified. The clusters match the identified BCTs and app features found in literature. However, it seems impossible to include all key aspects as features in an app, as this will have an impact on the usability.

At this moment it is not clear which aspects, BCTs and app features and/or their combinations are most successful in supporting healthy eating behaviour. In addition, personality traits, knowledge, and (intrinsic) motivation of the user also affect the evaluation of the app and their engagement in using such an app, and this might affect the effectiveness. Further research on how to best apply apps to change eating behaviour (for various target groups and goals) is needed.

Keywords: nutrition apps, engagement, prerequisites, focus group discussion, consumer perception

Validity and inter-rater agreement of the Home-Cooking Environment and Resource Inventory (Home-CookERI™) Observation Form

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INTRODUCTION: Capacity to quantify home cooking environments has applications in nutrition epidemiology, health promotion and nutrition interventions. This study aimed to develop a usable and comprehensive tool to validly and reliably quantify household cooking environments.

METHODS: An 80-item Home-Cooking Environment and Resource Inventory Observation Form (Home-CookERI™ OF) was developed as an online Qualtrics™ survey in 2019. Items included domestic spaces/resources for the storage, disposal, preparation and cooking of food or non-alcoholic beverages. Home-CookERI™ OF was piloted to assess face and content validity, and usability, with 13 Australian-based experts (i.e. dietitians, nutrition researchers, qualified chefs, a food technology teacher and kitchen designer) and 14 lay people. Participants also provided feedback in a 10 minute telephone interview. Accordingly Home-CookERI™ OF content and formatting was modified. In Newcastle, Australia, inter-rater agreement (IRA) for each Home-CookERI™ OF item was examined between two raters (from a team of four dietitian researchers) in 33 unique homes. Raters were required to observe each item before entering a response in Qualtrics™. Home occupants were instructed to only assist with locating items if asked. Raters were blinded to each other's responses. IRA was calculated as percent agreement [%] and Cohen's Kappa [κ] using Stata statistical software.

RESULTS: Piloting identified that 95% of items were clear and 99% were relevant. IRA was $\geq 80\%$ for 93% of items ($n=74/80$) and $\geq 69\%$ for all items. κ was: perfect [$\kappa=1.0$] for 23 items (28.75%), near perfect [$\kappa=0.81-0.99$] for 14 items (17.5%), substantial [$\kappa=0.61-0.8$] for 18 items (22.5%), moderate [$\kappa=0.41-0.6$] for 8 items (10%), fair [$\kappa=0.21-0.4$] for 6 items (7.5%), slight [$\kappa=0.1-0.2$] for 3 items (3.75%), and chance or worse [$\kappa \leq 0$] for 8 items (10%). For items with $\kappa \leq 0.2$, many were either highly common or uncommon items. Hence, item disagreement in one or a few households substantially impacted κ .

DISCUSSION: Overall, Home-CookERI™ OF is a comprehensive, valid and reliable tool, with established feasibility, for conducting physical observations to quantify Australian household cooking environments. To expand Home-CookERI™ applications, a home occupant self-completion version is planned for validation.

Keywords: Cooking, environment, validity, reliability, online survey

Evaluation of the Eetscore, a screener to assess diet quality

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The “Eetscore” is a self-administered web-based screener for assessing diet quality. The Eetscore consists of a short Food Frequency Questionnaire (FFQ), and is scored with the Dutch Health Diet 2015-index (DHD15) to evaluate to what extent habitual intake adheres to the Dutch food-based dietary guidelines of 2015. The present tool is an update of an earlier version. This study evaluated diet quality assessed by the Eetscore and compare it to that assessed by a full length FFQ, evaluated the reproducibility of the Eetscore and investigated associations between diet quality assessed by the Eetscore and participant’s characteristics.

Data of 751 adult Dutch men and women from the EetMeetWeet study were used. Participants completed the Eetscore once or twice, and a full length FFQ once, with at least one month between the FFQs. The intake by both FFQs were scored with the DHD15. Correlation and Bland-Altman analyses were performed to compare the methods. Linear regression analysis and chi-square tests were performed to examine associations between index score quintiles and participant’s characteristics and macro- and micronutrient intake.

The correlation between the total index-scores assessed by both FFQs was 0.69 (95%CI: 0.62–0.74) The Bland-Altman analysis showed systematically higher total index scores derived from the Eetscore than from the full length FFQ, and wide 95% limits of agreement (-6.6 and 42.2). For the reproducibility of the Eetscore, the correlation was 0.83 (95%CI: 0.80–0.86) for the total index score. Individuals with a higher score were more likely to be women, highly educated, never smokers and to have a lower body mass index. Across quintiles, significantly positive linear trends were observed for total and plant protein, dietary fibre, calcium, folic acid, vitamin E, and significantly negative trends for saturated and trans-unsaturated fat and alcohol.

In conclusion, the DHD15 derived from the Eetscore was acceptable in ranking of participants according to their diet quality. The associations found with several participants’ characteristics, and macro- and micronutrient intakes support that the Eetscore indeed assesses diet quality.

Keywords: diet quality, Eetscore, screener, DHD15index

Implementation of Eetscore in eHealth: an online tool for personalized dietary advice at home or in an outpatient setting

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Introduction. Healthcare professionals increasingly advise a healthy diet for people with chronic diseases. However, in the hospital and chain care, general nutritional assessment and advice is often not part of treatment or self-management. User-friendly online dietary assessment tools may help healthcare professionals and patients to assess and monitor the diet, and provide or get personalized dietary advice. This study evaluated whether the use of Eetscore in eHealth is useful to support patients and healthcare professionals in nutrition communication.

Methods. The Eetscore is a validated self-administered web-based screener for assessing diet quality. The Eetscore consists of a short Food Frequency Questionnaire (FFQ), and is scored with the Dutch Healthy Diet 2015-Index to evaluate the adherence to the Dutch Food Based Dietary Guidelines. It also provides personalized dietary advice based on the assessment. The Eetscore was implemented in outpatient settings via eHealth, and diet quality of 95 hypertension patients and 36 cardiac rehabilitation patients was assessed. The Eetscore was also evaluated in 75 patients and 40 multidisciplinary healthcare professionals by questionnaires, interviews, and focus groups. The dietary advice of Eetscore was evaluated on usability, practicality and feasibility.

Results. Hypertension patients had an average diet quality score of 96.7 ± 19.3 out of 160, and cardiac rehabilitation patients of 100.0 ± 22.1 . Seventy-two percent of patients indicated that the Eetscore provides insight into their dietary habits and 61% was motivated to eat healthier. Patients suggested to better tailor the advice to someone's personal situation and provide more practical tips, for example by recipes. Healthcare professionals reported that the Eetscore is a quick and useful tool to get insight into diet quality of their patients. Also, they thought the dietary advices of Eetscore are helpful as guidance in healthcare practice and for self-management. Finally, they believe using the Eetscore may improve nutrition communication between healthcare professionals.

Conclusion. Healthcare professionals and patients judged the Eetscore as a useful tool for use both at home as well as in outpatient clinics. Future perspectives include further implementation of Eetscore for other healthcare organisations or specific patient populations. Besides, dietary advice will be more tailored to the personal situation of an individual.

Keywords: diet quality, implementation, evaluation, health care, eHealth

Comparison of an epoch-based activity-intensity approach with a posture-change event-based approach to objectively quantifying time in Sedentary Behaviour

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Body-worn accelerometers are popular tools for quantifying sedentary behaviour (SB). Traditionally an accelerometer worn on the hip, but often now on the wrist or thigh, is used to record acceleration during free-living activities and this acceleration data is accumulated in epochs. These accelerations reflect activity intensity and a threshold can be used to class the epoch as SB. Additionally, inclination information from the sensor can provide further activity context. Thigh inclination can identify posture change events (sedentary to upright and upright to sedentary). Within the upright periods stepping events can be identified using the peak acceleration generated by the heel-strike of the step. The purpose of this study was to investigate how the inclination based approach effects the estimation of time in SB. For clarity in this analysis we have not attempted to remove sleep time from the SB.

A convenience sample of 12 older adults wore an accelerometer on their anterior thigh 24 hours/day for a minimum of 3 days. The data was processed to identify posture change events and stepping events giving three event classes, SB, quiet standing (QS), and stepping (SP). We calculated the cumulative vector magnitude in 15 second epochs. We used the event data to categorise each epoch as either SB, QS or SP. Epochs containing more than one event class were excluded from this analysis. For each subject we found the lowest cVM value that included 95% of the SB epochs. We then calculated the number of the QS epochs that were below the 95% threshold.

Across the twelve subjects they had a daily average (range) of 19.1 hours (16.5 – 21.7) in SB classed epochs. An average (range) of 1.7 hours (0.4 – 4.6) of QS fell under the 95% threshold out of a total (range) of 2.7 hours (0.9 – 5.8) of QS per day.

This is a sedentary group spending only around four hours upright per day. More than half their standing epochs had a similar acceleration intensity to the sedentary epochs. These results suggest that the addition of inclination can improve the estimation of time in Sedentary Behaviour in this population.

Keywords: accelerometer, inclinometer, epoch, posture, Sedentary Behaviour

The development of a food frequency and mealtime behaviours questionnaire to evaluate diet in school-aged children 9-11 years in Ho Chi Minh City, Vietnam

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Introduction

The semi-quantitative Food frequency questionnaire (sqFFQ) is used in nutritional surveys to capture usual food intake over a pre-determined, retrospective timeframe. This tool is specifically designed for the population for which it will be used. In addition to food intake, certain mealtime patterns and behaviours have become an important component of diet quality. To date, there is no validated sqFFQ to measure food intake of Vietnamese children and little is known about the mealtimes of these children. Thus, a food frequency and mealtime behaviours questionnaire (FFMBQ), targeting children 9-11 years old, was developed.

Methods

24-hour recalls from a recent study were used to develop the sqFFQ. Children were aged 9-11 years from Ho Chi Minh city (n=262). Block's equation method was used to select food items that contributed 90% of energy, macronutrients (protein, lipid, carbohydrates), and micronutrients (vitamin A, vitamin C, vitamin D, iodine, zinc, iron, calcium, sodium). To assist children in answering food frequency questions, the questionnaire was designed as a three-step process. First, children indicated which foods were not eaten in the last week, followed by selecting one of 8 frequency options and one of three portion sizes options for the remaining foods. A booklet with photos of food items representing the middle portion size accompanied the questionnaire.

Questions about mealtime patterns and behaviours were developed from the literature. The developed FFMBQ was reviewed by five experts, before cognitive interviewing with three child-parent dyads from 5th grade (aged 9-11 years old).

Results and Discussion

For the sqFFQ, 115 food items were selected and categorised into eight Vietnamese concept groups (cereals and common dishes; main dishes with rice; vegetables and nuts; fruits; beverages; dairy; other snack foods and nutritional supplements).

For meals, 17 questions addressing six mealtime patterns and behaviours were included (number and origin of meals, meal skipping, who the meal is consumed with, where the meal was consumed and activities whilst eating

The FFMBQ will be piloted in a rural district and include further cognitive interviewing and refining, before being validated in a representative sample of children aged 9-11 years in Ho Chi Minh City, Vietnam.

Keywords: development, food frequency, mealtime behaviour, children, Vietnam

The development of short dietary questionnaire to evaluate diet in school-aged children 9-11 years in Ho Chi Minh City, Vietnam

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Introduction

Regular and timely assessment of childrens' diet is crucial in the context of increased childhood overweight and obesity in countries undergoing nutrition transition. The National Nutrition Survey in Vietnam is conducted every ten years, and to date, there is no quick, simple, validated dietary assessment tool to evaluate children's diet between national surveys. Thus, a self-reported short dietary questionnaire (SDQ) was developed for rapid assessment of the dietary characteristics of Vietnamese children aged 9-11 years old.

Methods

The SDQ was designed based on the Vietnamese food-based dietary guidelines, the Food Pyramid for children aged 6-11 years old in Vietnam, and reviewing available short dietary questions for children aged 9-11 years old, internationally. The SDQ consisted of 29 open- and closed-ended questions on the frequency and amount of food intake, as well as mealtime behaviours over the last week. The SDQ was reviewed by five experts and underwent cognitive interviewing with three children aged 9-11 years old in Ho Chi Minh City.

Results and Discussion

Cognitive interviewing revealed that children were able to complete all closed-ended questions but experienced difficulty in answering open-ended questions on serves of fruit and vegetables consumed. The panel of experts also suggested condensing the food list by focusing on presenting a list of food groups and minimizing the number of individual items.

Based on this finding, the SDQ was modified to include 25 closed-ended questions. The food list consisted of 21 items: core foods (grains, vegetables, fruits, meat and alternatives, dairy) and non-core foods (sweetened beverages, sweet and savoury snacks, processed meat, instant noodles) and water. Next to each food item was an option to indicate "not eaten" or one of 7 frequencies (< once/week, once/week, 2-4 times/week, 5-6 times/week, one/ day, 2-3 times/day, > 3 times/day). The next section covered mealtime behaviours: eating a meal with the family, eating while watching TV, eating out of home/school, meal skipping.

This SDQ will be piloted among children in a rural district and validated against three 24 hour recalls in Ho Chi Minh City, Vietnam, with the view of shortening the length of the questionnaire.

Keywords: development, short dietary questionnaire, children, Vietnam

Development of an adaptive algorithm to quantify fiber intake

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High quality dietary data is a crucial ingredient for the content of personalized nutrition (PN) advice. It is well-known that all self-report methods, e.g. food frequency questionnaires, dietary recalls or records, are subject to measurement errors and are expensive to process. For PN solutions, improved user-friendly and validated dietary food intake tools will be needed to capture and provide good quality individual intake data.

Dietary fibers are linked to improved health and prevention of diseases such as obesity, stroke, hypertension, diabetes and colorectal cancer. Moreover, fibers play a crucial role in improving and maintaining gut health, by increasing stool weight, stool frequency and improvement of stool consistency. Currently, very few adults meet the recommendation of 30 (females) or 40 (males) grams per day. Therefore it would be very informative to have a method to easily assess fiber intake.

We need tools that can collect quantitative data in a more intuitive, fun, economical, and less time-consuming way, while maintaining accuracy. Ideally, only a few questions are needed to assess a certain quantitative value. This practice has been optimized in the field of examination for decades. Computerized adaptive testing successively selects questions from a database to maximize the precision of the exam based on the knowledge of the examinee from previous provided answers. Using methods from this field we select the optimum follow-up question based on information that is given in preceding questions. We repeat this until we can quantify an outcome measure with a satisfactory degree of certainty.

The system iteratively estimates fiber intake with a varying number of questions, depending on the answers given. All have the same starting point, take a different set and number of follow up questions out of the database with possible questions. Sufficient certainty is reached when the probability of observing the given answers independently of estimated income is lower than 0.05.

Keywords: machine learning; adaptive testing; intake data; data collection

Bioavailability of Phosphorus: Improving estimates of phosphorus exposure for use in relation to health outcomes

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Phosphorus (P) exposure is important for kidney disease and other health outcomes. Nutrient databases provide total P, but bioavailability of this mineral varies greatly by source, limiting the study of phosphorus intake and outcomes. Therefore, we aimed to assess natural, added and bioavailable P intake, by creating weights based on bioavailability, and food source (natural or added phosphorus compounds), and to relate these to estimated glomerular filtration rate (eGFR) in the Jackson Heart Study (JHS), as a preliminary test of validity. Design: A total of 4004 African American men and women, aged 21-84 y without self-reported kidney disease, 24-hour albuminuria <30 mg, and eGFR ≥60 ml/min/1.73m² at baseline were included in this analysis. Diet was assessed by food frequency questionnaire. We developed an algorithm to estimate phosphate bioavailability and weight the proportions of P in foods as natural vs. added, and by P bioavailability for different food groups, based on published literature. Relationships between P variables and eGFR were assessed using multivariable regression. Mean ± SE intakes were 1212 ± 7.28 and 1200 ± 5.50 mg for total P; 808 ± 5.49 and 802 ± 4.14 mg for bioavailable P; and 332 ± 3.06 and 325 ± 2.31 mg, for added P, in participants with eGFR 60-89 or ≥90 ml/min/1.73m², respectively. Major sources of total P included fish, milk, beef, eggs, cheese, poultry, corn bread, hot cereal, soft drinks, rice, and beans; and of added P, fish, beef, poultry, soft drinks, citrus juice, processed meat, pizza, and pork. After adjustment for confounders, total and bioavailable P intake (/100 mg) were significantly associated with lower eGFR: β=-0.31, p=0.02, and β=-0.43, p=0.02, respectively. When adjusted for each other, natural P was not associated with eGFR (p>0.10), but added P was strongly associated (β=-0.76, p=0.004). Added, but not natural, P was negatively associated with kidney function, raising concern about P additives in the food supply. Further studies should be conducted to improve estimation of P exposure from diet and to clarify the role of added P as a risk factor for kidney disease and other health outcomes.

Keywords: Phosphorus, bioavailability, database, processed foods

Choice of substitute products significantly affects energy and nutrient intake estimates in a digital dietary intake tool

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Because not all food products are available in databases of dietary intake assessment apps, people are forced to choose a suitable (i.e. similar) substitute when registering their food intake. This may result in significant over- or underestimation of their energy and nutrient intake which in turn may result in erroneous interpretations of their adherence to dietary treatment. In this study we examined the impact of selecting substitutes on the accuracy of energy and nutrient intake estimates.

Students of “The Hague University of Applied Sciences” were asked to record a complete day’s dummy diet of a virtual person in the dietary intake tool “Mijn Eetmeter”. The foods and drinks of the dummy diet (10 products containing 2613 kcal in total) are commonly available in the Netherlands, but not registered in the database of this tool. All information available on the product’s label was shown after which volunteers were asked to choose both the product and portion size in the tool. The impact (i.e. difference) of substitute choices – corrected for portion size – on daily estimates of energy and nutrient intake (fat, protein, carbohydrates, sodium and dietary fibre) was calculated. Differences were analysed using a one-sample T-test in SPSS ($p < 0.05$).

Complete data of 142 students were analysed. The choices of the substitutes led to significant differences ($p < 0.001$) in estimates of -5% for energy, -10% for fat, +15% for protein, -6% for carbohydrates, -30% for sodium and -32% for dietary fibre. The estimates deviated >10% of the accurate values in 29% of volunteers for energy, 72% for fats, 70% for protein, 39% for carbohydrates, 79% for sodium and 100% for dietary fibre.

Incomplete food composition databases in dietary intake apps lead to choices of substitute products which result in inaccuracies in energy and nutrient intake estimates. Both the magnitude of these inaccuracies and the frequency of relatively large inaccuracies warrant caution when interpreting the results of dietary intake data self-registered with an app. Informing and training clients before use and especially recall of the registered products afterwards is essential in order to improve the quality of data collection.

Keywords: smartphone application, dietary assessment, diet apps, nutrition apps, mobile applications

More actual national food consumption data by applying lean-thinking

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Background: A challenge in food monitoring studies is the labour intensive data handling necessary after data collection. In many countries this process takes about 18 months, compromising actuality of the results as requested by the client (government). It is worthwhile to do research on less labour intensive improvements for collecting and handling food consumption data while maintaining the quality.

Objective: To apply lean-thinking in the process of data handling of food consumption data in order to improve the actuality of the data.

Method: The team of the Food consumption survey applied the method LEAN-Six-Sigma to improve the processes of matching the data to food composition data. This method included 5 phases: Define, Measure, Analyze, Improve and Control (DMAIC). By mapping a value stream we identified waste and bottlenecks in the processes. We collected quantitative data on these points and subsequently tried to analyse the main causes which should be eliminated. Furthermore, we tried to solve the problems. If necessary we performed scenario analyses and checked whether the improvements worked. To make sure that lean-thinking is continuously embedded in our activities, all team-members followed a course in the principles of LEAN.

Results: Bottlenecks of the process were the time spend on matching of less frequently consumed foods with composition values and the decision on adding new foods to the food composition table.

The problem of less frequently consumed foods is solved by automatic linkage to the most frequently consumed foods and using experts to judge these matches with the focus on the most relevant nutrients.

The decision of adding new foods is improved by clearer instructions and stimulating faster decisions by the experts. Due to this we estimated a decrease in workload by about 600 hours, which can lead to more actual results. Also the cooperation, ownership in improving our own work and the decision-making in the team has been increased.

Conclusions: Thus, with applying lean-thinking by our team the working processes of the food consumption surveys is improved while maintaining sufficient quality. The process of datacleaning and data-analyses are the next processes to improve.

Keywords: Lean Six Sigma, DNFCs, food matching, monitoring data

How to conduct representative surveys in a changing society?

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Background: National food consumption surveys usually collect comprehensive food information using dietary assessment methods like 24-hour dietary recalls (24HRs) or dietary records.

As this data is used for (inter)national food policy, representativeness of the data is very important. Based on experiences in the Dutch monitoring system response rates, we argue that there is a need for more research and solutions on the topic of representativeness of food monitoring data.

Methods: Dutch national food consumption data were collected since 2007 by two 24-hr recalls. Young children and elderly were interviewed at home, the others by phone. Participants were selected from panels of market research organizations, taking sociodemographic factors, season and day of the week into account. During data collection, the response was monitored and processes were adapted if necessary.

Results and discussion: We observed decreasing response rates and increasing drop-outs during the studies. This might be explained by an increasing lack of time, less commitment to this kind of studies or trust with governmental institutes, changes in data collection methods (more online).

The response rate was higher among those visited at home compared to the others. This might be associated with differences in intrinsic motivations or the method itself. Others studies have suggested higher response rates for in-person surveys than for surveys by phone. What will be the response rates with new methods like an app?

During the last survey the market research organization applied several additional actions to improve the response especially in certain groups, like higher incentives among the groups with the lowest responses, more effort in contacting attempts by experienced interviewer or interviewers with the same dialect. Due to these actions the initial low response rates were adjusted, but they might also have had disadvantages. Based on our data it is not possible to fully quantify the impact of the changes.

Conclusions: Dietary assessment methods and the society are changing which might affect the representativeness of national food consumption data. More research should be done on this issue to find possible solutions for this for national surveys.

Keywords: monitoring, representativeness, research, changes

Using multiple tools to improve diet and physical activity assessment - Practicalities, challenges, and strategies for implementing a novel protocol in Alberta's Tomorrow Project, a large prospective cohort study

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The 2018 World Cancer Research Fund Third Expert Report on diet, nutrition, physical activity, and cancer highlighted the need for high quality population-level dietary intake and physical activity data to improve our understanding of disease etiology and prevention. Large prospective cohort studies are well situated to address this need, but, historically, have utilized only single self-report tools (often frequency questionnaires). Due to the various sources of bias that affect self-report data, using a combination of tools is now recommended. In particular, implementing short-term tools such as 24-hour recalls in tandem with frequency questionnaires can generate higher quality data by maximizing the strengths while minimizing the limitations of each tool. Previously, implementing multiple tools was not possible in large cohorts, but with relatively recent availability of well-tested online self-administered tools, this is now feasible. This work-in-progress will describe a protocol, informed by a working group of provincial, national, and international experts, for comprehensive dietary and activity assessment in Alberta's Tomorrow Project, a longitudinal study tracking the health of 55,000 adults aged 35-85y in Alberta, Canada. The approach builds on extensive pilot feasibility testing in this cohort, and will involve multiple administrations of short-term tools with one long-term tool for each of diet and activity implemented over ~1 year either online or over the phone. The tools include the Automated Self-Administered 24-hour Dietary Assessment Tool for Canada and the Physical Activities Completed over Time in 24 Hours, as well as the past-year Canadian Diet History Questionnaire-III and the Past-Year Total Physical Activity Questionnaire. Insights to be presented include methodological and operational considerations, including challenges associated with computer literacy and limited internet access in rural/remote regions, communication strategies to encourage uptake by participants, and estimated resourcing requirements. A process and outcome evaluation plan will also capture learnings and successes during implementation.

While ambitious, the approach will leverage the strengths of different types of tools while maximizing depth and breadth of data collected, allowing for vastly expanded research opportunities in the future. These will include the possibility of modeling time-varying dietary intake and physical activity in relation to cancer, cardiovascular, and other health outcomes.

Keywords: assessment, methods, epidemiology, longitudinal cohort

Can a web-based Food Frequency Questionnaire be useful in a Belgian clinical setting: preliminary results.

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BACKGROUND: To measure dietary quality and habitual intake of foods and nutrients over the past month in Belgian adults, a self-administered food frequency questionnaire (FFQ) was originally developed for use in a clinical and interventional setting.

AIM: To assess content validity, convergent validity and reliability of a newly developed semi-quantitative self-administered web-based food frequency questionnaire for Belgian adults to determine habitual dietary intake of the past month.

METHODS: A sample of 114 Flemish adults was recruited and provided informed consent. Content validity was assessed by a semi-cognitive structured interview in 15 participants by evaluation of participants' interpretation of the questions of the FFQ. Convergent validity was assessed by examining means and mean differences, Spearman's Rho and Bland-Altman analysis for energy and nutrient intake compared to a 3-day food diary registered in a mobile application. Reliability was assessed through evaluation of Pearson or Spearman's correlation, paired T-test and intra-class correlation coefficients for energy, nutrient and food group intake.

RESULTS: The FFQ underestimated intake of energy and most nutrients compared to the 3-day food diary. Spearman's correlations between the FFQ and the food record ranged from 0.09 ($p=0.375$) to 0.53 ($p=0.000$) for energy, nutrient and water intake. Bland-Altman analysis showed good agreement between the FFQ and the food record for energy and nutrients. The test-retest assessment to evaluate reliability showed correlation coefficients ranging from 0.69 ($p=0.000$) to 0.76 ($p=0.000$) for energy and absolute macronutrient intake. Correlation coefficients for food group intake between the two administrations of the FFQ ranged from 0.47 ($p=0.000$) for the food group 'potatoes and cereals' to 0.79 ($p=0.000$) for the food group 'meat'. Intra-class correlation coefficients ranged from 0.68 (95% CI: 0.56-0.78) to 0.75 (95% CI: 0.65-0.83) for energy and absolute macronutrient intake and from 0.46 (95% CI: 0.30-0.60) to 0.82 (95% CI: 0.74-0.88) for food group intake.

CONCLUSION: The food frequency questionnaire showed acceptable validity and reliability. Due to its conciseness and online availability the food frequency questionnaire could be used in a clinical setting to assess patient's dietary behaviour. The FFQ will be validated further by cross validation, consumer only analysis and correction for attenuation.

Keywords: dietary assessment, food frequency questionnaire, validity, reliability, web-based

Augmented Reality in Food Portion Size Estimation: A utility study

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Introduction

Two dimensional serial food photographs are often used to improve portion size estimation in dietary assessment. Augmented reality (AR) technology enables presentation of food dimensions and volume in three-dimensional (3D) format, and therefore has the potential to improve perception and estimation of portion sizes. This study examined the utility of a novel mobile augmented reality application, namely Virtual Atlas of Portion Sizes (VAPS), as a portion size estimation aid.

Methods

The size variation of selected amorphous foods was determined and photographed from various angles in a laboratory setting. Using photogrammetry method, 3D models of these food items were constructed, refined and implemented into AR environment. The minimum viable prototype consisted of two food items and displayed food portions in semi-transparent and vivid modes. A total of 36 participants (22 females, 14 males) aged 24.7 ± 4.3 years evaluated the utility of the prototype based on the given estimation tasks and rated the system's usability on a five-point scale.

Results

The VAPS prototype presented four 3D sizes of a target food upon scanning a marker. The mobile application was perceived to be easy-to-use as a portion size estimation kit, and received mean usability rating of 76 ± 11 out of a maximum score of 100. The use of vivid 3D food models resulted in higher correct estimation (28%) than semi-transparent 3D models (21%). The main suggestions received were related to introducing features to adjust model transparency and to enhance existing user interface.

Conclusion

VAPS harnesses mobile AR technology to aid in portion size estimation. The gathered user feedback will be used to improve the design of the app. The improved version of VAPS will be evaluated for its validity in improving portion size estimation during dietary assessment.

Keywords: Augmented reality, portion size estimation

Evaluation of a food frequency questionnaire (FFQ) to assess nutrient intakes in older adults living in New Zealand

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Introduction: New Zealand's population is ageing. The risk of suboptimal nutrition increases with age. To the best of our knowledge, there is no up-to-date food frequency questionnaire (FFQ) available for older adults within New Zealand. The aim of this study was to evaluate an FFQ adapted to measure habitual nutrient intake in adults 65 to 74 years living in New Zealand.

Methods: Participants (n=294) were recruited as part of the Researching Eating Activity and Cognitive Health (REACH) study. Participants completed a 109-item FFQ assessing dietary intake over the past month (FFQ1). The same FFQ was re-administered four weeks later (to assess reproducibility, FFQ2) and participants completed a four-day food record (4DFR) between FFQ administrations to assess relative validity. Correlation coefficients, cross-classification with weighted kappa statistic and Bland-Altman plots were used to assess the relative validity and reproducibility of nutrients from FFQ1, after adjusting for energy intake.

Results: For 12 of 28 nutrients, intake was higher in FFQ1 compared with the 4DFR (0.9-39.1% difference), and lower in FFQ1 for 16 nutrients and energy (2.6-37.4% difference). Energy adjusted validity correlations ranged from 0.14 (selenium) to 0.61 (alcohol), with a mean of 0.38. Participants correctly classified into the same tertile ranged from 40.5% (potassium) to 68.7% (alcohol). Participants grossly misclassified into opposite tertiles ranged from 2.0% (alcohol) to 17.3% (selenium). Weighted kappa values for validity demonstrated poor agreement ($\kappa < 0.20$) for five nutrients, fair agreement ($\kappa 0.21-0.40$) for 22 nutrients and good agreement ($\kappa > 0.61$) for alcohol intake. Energy adjusted reproducibility correlations ranged from 0.31 (vitamin A) to 0.79 (calcium), with a mean of 0.65. Participants correctly classified into the same tertile ranged from 53.1% (potassium) to 77.9% (alcohol). Participants grossly misclassified into opposite tertiles ranged from 0.3% (alcohol) to 7.8% (protein). Weighted kappa values for reproducibility demonstrated fair agreement ($\kappa 0.21-0.40$) for two nutrients, moderate agreement ($\kappa 0.41-0.60$) for 24 nutrients and good agreement ($\kappa > 0.61$) for two nutrients.

Discussion: The FFQ demonstrated good reproducibility, and fair relative validity. The FFQ could be used to assess relative but not absolute nutrient intakes in older adults living in New Zealand.

Keywords: dietary assessment, elderly, reliability, reproducibility, validity

A Systematic Review of Validation Studies on Dietary Apps

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Mobile phone food dietary apps are widely available and can give a quick assessment of dietary intake. However, self-reporting of dietary intake often results in substantial measurement error. Thus, validation of new dietary apps is needed before they are applied in research. There are no contemporary reviews of the apps that have already been validated. This study aims to compare the validation methodology and relative validity of dietary apps in measuring food consumption and nutrient intakes.

Three electronic databases were searched using keywords to identify validation studies on dietary apps published in English from January 2013 to October 2019. Following PRISMA guidelines, studies were included in the review if the validated apps were food record apps, used a reference method that has a greater degree of demonstrated validity, covering all population groups, and participants were recruited for real-life food recordings. General information, statistical measures, and results of the validation studies were extracted. A meta-analysis of mean differences and standard deviations (SD) between the reference method and the test method (app) was performed for energy and macronutrients across eligible studies. Of the 582 nonduplicate articles identified, 17 articles met the inclusion criteria with varied parameters of study design. Twelve papers used twenty-four-hour recall as their reference method. The sample sizes of the validation studies ranged from 14 to 362 participants, with the majority of studies including less than 50 participants. All studies reported the mean intake of the app and the reference method with SD or confidence intervals (CI) and/or the mean difference between SD or CI. Limits of agreement between the test and reference method was the second most reported test (n=12). Preliminary results of the meta-analysis showed that all studies tended to underestimate energy intake with a range from 8 kcal to 466 kcal compared to reference methods, with a moderate to high heterogeneity ($I^2 = 64.3\%$).

This review showed a varied relative validity of food record apps, with different study designs of the validation studies. A standardized protocol for performing each component of validation studies would help to increase the comparability across studies.

Keywords: dietary apps, validation, review, dietary assessment, food diary

2. Technological advances

Developing an Arabic food composition database for an online dietary assessment tool - myfood24

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Background: Food composition data is needed to assess dietary intake. However, food composition data for Middle Eastern foods are limited, meaning that measurement of diet in these countries is a challenge.

Objective: To develop a database of commonly consumed foods and to generate nutrient information suitable for the Middle East, with a focus on Saudi Arabia and Kuwait. To include the new database in an Arabic version of the online dietary assessment tool, myfood24.

Method: The Arabic Food Composition Database was built using a systematic approach. The following sources provided data: 1) Food composition tables (Kuwait's Composite Food Table, Food Composition for Use in the Middle East, Food Composition Tables for Arab Gulf Countries. 2) Food composition found in published papers. 3) Back-of-Pack (BOP) nutrition information of common food products in Saudi Arabia and Kuwait. 4) Generic food items from the UK food composition database within myfood24. Cleaning and processing the database involved removing duplicated food items, nutrient values conversions and some calculations. Complete nutrition information for each food was generated using the UK myfood24 FCDB Microsoft Access mapping tool. Arabic foods were allocated to similar generic products to fill in missing values of micronutrients. Macronutrient values for all composite and branded foods were taken from the original identified data and BOP food labels. Multiple options for portion size estimations were assigned to each food item. The Arabic Food Composition Database has been translated to Arabic and includes potential alternative names and misspellings to enhance searching within the database.

Results: The Arabic food composition database includes a total of 2016 food items with about 120 nutrients. Generic items from the UK database were the highest in the data (n=1585 food items). 271 food items included from BOP data label for local and regional branded products in Saudi Arabia and Kuwait were and 158 were composite food items from existing FCTs and research articles. 30% of data was assigned portion size images in addition to the other options of household measurements and serving sizes.

Conclusion: A representative Arabic Food Composition Database of commonly consumed food in the Middle East has been created. The database will be integrated into an Arabic version of the online dietary assessment tool, myfood24. This will be essential when assessing dietary intake in these populations.

Keywords: food composition database, myfood24, Arabic

Beyond the concept of 10,000 steps a day: association of physical activity level and variability with 6-month weight change in a real-life study among 26,935 users of connected devices

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Background: Physical Activity (PA) is a modifiable lifestyle factor that can be targeted for increasing energy expenditure and promoting weight loss. However, results regarding the efficient PA amount for weight loss remain heterogeneous. Wearable activity trackers constitute a valuable opportunity to obtain objective measurements regarding PA and study large populations in real-life settings. We aimed to study the associations of 1) objectively-assessed PA characteristics (PA level and variability) and 2) their evolution with six-month weight change.

Methods: We analyzed data from 26,935 Withings connected device users (wearable activity trackers and digital scales). We used the monthly mean of daily step values as a proxy for PA level and derived the monthly coefficient of variation (CV) of daily step values to estimate PA level variability. Associations between PA characteristics and six-month weight change were assessed using multivariable linear regression analyses controlled for age, sex, blood pressures, heart rate, and the predominant season. Restricted cubic spline regression was performed to better characterize the continuous shape of the associations between PA characteristics and weight change. Secondary analyses were performed by analyzing the six-month evolution of PA characteristics in relation with weight change.

Results: Our results revealed that both a greater PA level and a lesser PA level variability were associated with weight loss. Compared with individuals who were initially in the sedentary category (<5,000 steps/day), low active (5,000–7,499), somewhat active (7,500–9,999), and active ($\geq 10,000$) individuals had a 0.21 kg, a 0.52 kg, and a 1.17 kg greater decrease in weight, respectively (95%CI: -0.36,-0.06; 95%CI: -0.70,-0.33; 95%CI: -1.42,-0.93). We also observed that each 1,000 steps/day increase in PA level over the six-month follow-up was associated with a 0.26 kg (95%CI: -0.29,-0.23) decrease in weight. No association was found between the six-month change in PA level variability and weight change.

Conclusions: Our results add to the current body of knowledge that health benefits can be observed below the 10,000 steps/day threshold and suggest that not only increasing mean PA level is important, but also that greater regularity of PA level, irrespectively of PA level, may play an important role for short-term weight loss.

Keywords: digital health; wearables; physical activity; body weight; digital scale;

Measuring individual level dietary intake using digital technology in Bangladesh, India, Pakistan and Sri Lanka: The South Asia Biobank Study

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Introduction: Diet and nutrition are critical to health and longevity but much of the evidence on the link between diet and disease is based on Western populations. The evidence gap in low and middle income countries is due in part to the lack of fit-for-purpose dietary assessment methods. We aim to implement individual level dietary assessment in the South Asia Biobank Study which is set up to understand the determinants of the disproportionate burden of non-communicable diseases in South Asians in Bangladesh, India, Pakistan and Sri Lanka.

Methods: The South Asia Biobank Study is recruiting a representative sample of ~170,000 men and women aged 18+ years living in the study regions. We have adapted and customised an existing online dietary assessment system (Intake24 <https://ndns.intake24.org/>) for use in populations in South Asia. The system is based on the multiple pass 24hr recall method to measure a participant's food and drink intake the previous day. A standardised protocol was developed for the retention or deletion of food items in the existing system, and the collection and integration of new relevant country-or region specific foods and dishes. A series of new portion size photographs were taken to better represent local foods and range of portion sizes. Adaptations were made to ensure the system was relevant for interviewer-led local settings using a tablet interface with offline data capture.

Results and Discussion: The system is currently in the final stages of development. 927 (36%) of the original food and drink items included in Intake24 were retained, while 1627 items not relevant in study regions were deleted. We added 749 new South Asian foods and dishes to the system. Detailed food composition work will follow to ensure the accurate analysis of 24hr recall data. The implementation of this tool will enable the description of dietary patterns and food and nutrient intakes, evaluation of intakes in comparison with available guidelines, and the investigation of the link between diet and health endpoints in South Asians. The system will be open source and available to other researchers wishing to collect dietary data in South Asia.

Keywords: South Asia, automated 24hr recall, digital technology, Intake24

Smart childhood Obesity CARing solution using IoT potential (OCARIoT): defining goals for the decision support system of a gamification-based application for infant obesity prevention

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Introduction

Childhood obesity is a public health problem that is difficult to manage, requiring the creation of innovative strategies for its prevention. This study aims to describe the methods used in proposing personalized lifestyle goals for the development of a mHealth technology, focusing on the prevention and management of childhood obesity.

Methods

This study is part of the OCARIoT project that aims to develop an intelligent and personalized tool that guides children from 9-12 years old to adopt healthy behaviors. For the elaboration of personalized goals, variables and their respective health parameters related to obesity were first defined. The elaboration of the goals was based on each parameter and were defined according to the following requirements: dimension (diet, physical activity and education), objective and target to be achieved, and level of difficulty. The goals comprise the architecture of the Decision Support System (DSS), responsible for managing all the activities of the tool, guiding the sending of individualized intervention plans to the participants.

Results:

Twenty health variables related to eating behavior, physical activity, sleep pattern, anthropometry, psychological factors, sociodemographic characteristics and health conditions were defined. 27 health parameters were also included in the coaching plan supported by the DSS and 71 health goals were developed: 39 related to diet, 15 to education and 17 to physical activity goals. Each goal has a specific expected quantified outcome with quantitative target level to achieve. This set of goals was organized in different levels of difficulty (high - goals closer to the recommendation, moderate - intermediate goals and initial - goals farther from the recommendation).

Discussion

OCARIoT goals are reasoned on behavioral theory approach to engage all participants, even at different stages of changing habits. Personalized lifestyle goals were developed, with a focus on modifiable behaviors, which are fundamental for the improvement and personalization of a system for mobile applications that may be able to innovate in the tracking of child and youth behavior. This strategy provides

to families and health professionals new strategies to improve the lifestyle of children, with a focus on the prevention and management of obesity.

Keywords: Telemedicine, Internet of Things, Health Behavior, Obesity, Child

The use of an internet-of-things (IoT)-based personalized coaching solution to prevent childhood obesity

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Introduction

Advances in technology, including the Internet of Things, electronic health (eHealth) and mobile health (mHealth) are important allies to the health sector to provide personalized care that enables behavioral changes, especially to tackle multifactorial etiology of childhood obesity. The aim of this study is to describe the integration of IoT devices used in the Smart childhood Obesity CARing solution using IoT potential (OCARIoT) study to track children health behaviors.

Methods

OCARIoT is a multicenter study, funded by Horizon 2020 and the Brazilian Ministry of Innovation, Science and Technology, that aims to develop and assess the efficacy of an IoT-based personalised coaching solution guiding children (9-12years) to adopt healthy eating and physical activity behaviour. The OCARIoT delivers a platform that captures and manages data from localization, wearables, IoT sensors and social networking combined with a set of challenge games, with the objective of triggering a long term behavioural change towards healthy habits in the children.

Results:

The components in the study included: 1. a gamified app that will stimulate the adoption of healthy behaviors; 2. an IoT device (smartband) that will track, physical activity, sedentary behavior, and sleep profile; 3. IoT sensors that will measure environmental conditions (smart body weight scale with body composition analyzer) and capture temperature; 4. a Decision Support System (DSS) that will drive the change towards healthy habits in the children proposing them missions within the gamified app and 5. a web and mobile based dashboard that will manage data and investigate specific behaviors related to diet, psychological factors, sociodemographic characteristics and health conditions and that will be used by parents and educators to track children involvement with the app. The gamified app and the dashboard are the tools for interaction with the users, the children, their families and the school educators.

Discussion

All children behaviors will be collected, stored and processed systematically, through the devices, increasing the quality of the value of the data. The IoT device which measures biological variables, like heart rate and temperature, and the DSS will provide new analysis models and results that will identify health profiles to develop individualized intervention plans to the participants.

Keywords: Telemedicine, Internet of Things, Health Behavior, Obesity, Child

Use of accelerometers to objectively measure physical activity of pre-adolescents and their parents in a community-based study in Nairobi, Kenya

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Introduction

Over-reliance on subjective methods of assessing Physical Activity (PA) in Sub-Saharan Africa has led to less accurate data and misclassification. Moreover, these methods take time to administer resulting in participant and researcher fatigue, difficulty in quantifying or estimating PA intensity or duration and consequently low-quality data. In Sub-Saharan Africa, the use of accelerometers is relatively new and their adaptability and acceptance has not been established.

Methods

A cross-sectional study was conducted in Nairobi among pre-adolescents 9-14 years old (n=154) and one of their parents (n=148) to describe their PA volumes and levels. Participants wore an ActiGraph GT3X+ or an ActiSleep+ accelerometer attached to an elastic waist belt, worn over the right mid-axillary line. The monitors were worn 24 h•day⁻¹ for seven consecutive days, removing only for water-based activities. Data was collected at a 30 Hz sampling rate and aggregated to 5 and 60 second epochs for children and adults respectively. Non-wear periods were defined as any sequence of at least 20 consecutive minutes of 0 activity count for preadolescents and 60 minutes of consecutive zeros for the adults. Sleep time was removed with an automated algorithm after which participants providing at least 4 days, including 1 weekend day, of valid data (≥ 10 h•day⁻¹) were included in the analysis. The cut points by Evenson were used for pre-adolescents while Troiano cut-points were used for adults to determine time (minutes•day⁻¹) spent at different intensity categories.

Results

The use of accelerometers was largely positively accepted by the households with some suspicions and resistance from a few participants due to some social-cultural biases. The compliance rate (sufficient wear time) was 71% with a higher rate among preadolescents and low-income area residents compared to parents and middle-income area residents. Use of the stringent accelerometer protocol is expected to result in improved efficiency in data collection, management and quality. Also, use of validated age-specific cut-points minimizes misclassification often witnessed in other methods.

Conclusions

It is feasible, efficient and acceptable to collect and manage PA data using accelerometry in Nairobi with sufficient participant education about the device. We recommend this method in all settings and particularly among populations with low literacy and comprehension levels. There is however need for extensive community sensitization and education prior to data collection.

Keywords: Accelerometer, pre-adolescents, physical activity, parent, Kenya

goFOODTM: an automated nutritional assessment tool of plated and non-plated meals. Pre-validation study in free living-conditions

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Introduction

Conventional dietary assessment methods rely heavily on self-reporting and are prone to errors. Smartphone apps, such as goFOODTM, involve artificial intelligence-based features and use food images, to estimate nutrient content. Typically, the user captures photos or records a video of their meal. Then, the app translates the food image into macronutrient and calorie estimations by using the food items' types, segmentations, 3D reconstruction model and the food composition database. Validation studies in real-life situations are largely lacking.

Objective

This study aims at the pre-validation of goFOODTM against a 24h recall for the case of plated and non-plated meals consumed in free-living conditions.

Methodology

Study participants recorded the foods and beverages consumed during a day with a modified version of goFOODTM, called goFOODTMLite (used only for food capture purposes – no feedback was provided to the users). The participants were asked to take two pictures before and two after each meal or beverage consumption. The next day, a scheduled 24h recall phone interview was conducted by the dietitians. Mean differences in energy and macronutrient intake of plated and non-plated meals were evaluated between the methods using paired t-tests and correlation coefficients. Agreement was evaluated with Bland-Altman plots. Beverages and packaged food were excluded, since their processing at the time of pre-validation study was under-development.

Results

Forty-eight participants completed the pre-validation study (44% women, mean age: 34y, Swiss residents). The values of macronutrient and calorie intake were underestimated by goFOODTM (average values per day: energy: -217kcal, CHO: 27g, PRO: 7g, FAT: 12g in a total of 137 meals). There was a moderately strong correlation of macronutrient and calories between the two methods (Spearman correlation, Kcal: 0.7, CHO: 0.7, PRO: 0.6, FAT: 0.6). Considering the Bland - Altman plots, the agreement of the two methods is moderate and there is no consistent bias between them.

Discussion

goFOODTM system's performance enables us to proceed with a validation study, in which observed mistakes and omissions from the pre-validation will be considered. goFOODTM is a functional app that could support nutritional assessment, not only assisting health care professionals in their everyday practice, but also researchers working in nutrition data acquisition.

Keywords: *mHealth, nutritional assessment, smartphone, apps*

The use of an innovative digital method (ODK, Open Data Kit) for dietary intake data collection among pre-adolescents in Nairobi, Kenya

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Background

Assessment of dietary intake can be particularly challenging among populations with low literacy levels. Most of the conventional dietary data collection methods take time to administer by interviewing, hence resulting in participant and researcher fatigue and consequently less precision and accuracy of data. There is need therefore, for innovative methods to improve the quality and speed of collection of dietary intake. In this study a digital method of data collection, the Open Data Kit (ODK) software was used. This software allows for data collection using Android mobile devices and data submission to an online server at the time of data collection. There is hardly any information on the use of ODK for dietary data collection using a recently developed photographic portion size booklet (Food Atlas) as a reference.

Methods

A cross-sectional study was conducted among 154 randomly selected pre-adolescents 9-14 years old from Nairobi to establish their dietary intake. Data were collected by interviewing, using a semi-quantitative 7-day food frequency questionnaire. A Food Atlas, developed specifically for the study population, enabled portion size data reported by the respondents to be linked to the selected foods, thereby automatically calculating and recording the portion sizes consumed. The survey questions were linked through skip patterns to ensure completeness of data collected. The collected data was stored within ODK cloud server thus reducing chances of data loss.

Results

The use of digital technology resulted in efficiency in data collection and quality of data. The technology ensured real time data was sent to the server through real time checks. Mobile phones are easier to carry than large piles of paper and data collection took a shorter period. Data quality improved because of minimal errors and data completeness and the process of data entry was eliminated. Preliminary food nutrient information can be calculated by linking Food Composition Tables to the Food Atlas.

Conclusions

It is feasible and efficient to collect and manage dietary intake using the ODK software. We recommend this method particularly among populations with low literacy levels for whom self-administered questionnaires would not be the choice of data collection method.

Keywords: Digital data collection, pre-adolescents, dietary intake, Open data Kit

Sensing technologies for monitoring food intake: A systematic review of the literature

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Introduction: There is an urgent need for objective and unobtrusive methods for monitoring food intake, both for research and intervention purposes. Sensing technologies could provide the solution. A large number of sensing technologies have already been tested for their ability to monitor food intake, both in the form of wearables and non-wearables. However, there is no complete overview of these technologies available, which is needed to advance their further development.

Methods: We systematically searched the electronic database Scopus for articles that report on the performance of sensing technologies for monitoring food intake (i.e., when, what and/or how much) in real-life. A search string including search terms related to food intake, sensing technology and validation was used to identify potentially relevant papers. Subsequently it was checked which of these meet our inclusion criteria.

Results: 2234 papers were identified by the search and 157 of them met our inclusion criteria. These papers report on a wide variety of technologies that are used to monitor when, what and/or how much a person is eating. These range from sensing technology that can monitor single events to sensing technology that can monitor a person across the day, from movement sensors to optical sensors, from single sensors to sensor combinations, and from sensing technology tested in a controlled lab setting to sensing technology tested in a real-life setting.

Discussion: This review provides an overview of the sensing technologies for monitoring food intake described in the literature and their technical performance. It provides valuable information for the future development of these sensing technologies.

Keywords: automatic_dietary_monitoring, sensors, wearables, dietary_intake, dietary_assessment

The human factor in automated imaged-based nutrition apps: an example from the goFOODTM application

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Introduction

Technological advancements have enabled nutrient estimation by smartphone apps, such as goFOODTM, an artificial intelligence-based smartphone system, which uses food images captured by the user as an input, to translate them into nutrient estimations. The quality of the data is highly dependent on the pictures the user makes. This can lead to a high data loss and quality issues. Instead of removing this data from the study, in-depth analysis is needed to explore common mistakes in order to use them for further improvement of automated nutrition assessment apps.

Objective

The aim of this study was to analyze common mistakes made by users while using goFOODTM app to improve the given instructions and app functioning.

Methodology

The 48 study participants received a face-to-face instruction of a version of goFOODTM, called goFOODTMLite, that was designed for food-logging without providing results to the users. Participants were asked to record two pictures (one recording) before and two after each food or beverage consumption for one day, using a fiducial marker. All pictures that were discarded for processing due to mistakes, were analyzed to record the main user-mistakes.

Results

Out of the 468 recordings of non-packaged food items captured by the app, 60 recordings had to be discarded due to errors in the capturing procedure. The main issues were: 1) wrong marker or improper marker usage (19 recordings), 2) a combination of various issues (17 recordings), 3) reasons related to testing recordings, obstacles (hand) in front of camera, not matching recording pairs (16 recordings), 4) plate issues like a non-compatible or visible plate (8 recordings).

Discussion

No other studies have focused on main issues derived from the use of automatic nutrition assessment applications. This study showed that instruction of participants in studies is extremely important to get good quality data. Future development solutions could focus on improving the recognition of food on various plates in terms of color or shape and explore alternatives on fiducial marker use. Lastly, understanding participant training needs, enhancing app's user-friendliness and developing automatic image check based on participant feedback are of vital importance for future studies.

Keywords: smartphone, food images, goFOODTM, users

Healthcare professionals' experiences and perspectives relating to online (nutritional) coaching and mHealth apps in pregnant women; an explorative qualitative study

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Background: During the past decade, a broad variety of apps have been released to support pregnant women with their food choices. However, as most apps are of poor quality, they are not recommended by healthcare professionals (HCPs). Midwives and general practitioners can provide crucial information to tackle current limitations as they act as a first point of consultation, which provides them with important insights on the needs and wishes of pregnant women. Therefore, we aimed to explore the experiences and perspectives of HCPs related to (nutritional) online coaching and mHealth apps.

Methods: A qualitative study using semi-structured interviews with 11 HCPs (8 midwives and 3 general practitioners). The interviews were transcribed verbatim, re-read, and summarized by one researcher, and subsequently coded using inductive and deductive coding.

Results: HCPs knew of the existence of mHealth apps for pregnant women, but had limited experience with their use. In order to provide nutritional information, most midwives referred clients to websites and apps; GPs only referred to websites of the Dutch Nutrition Centre and Thuisarts. HCPs generally considered the younger generation of professionals flexible towards the use of innovative technology. However, HCPs were hesitant in the use of apps due to their lack of knowledge on the quality of the apps as well as the extensive number of available apps. HCPs mentioned accessibility, user-friendliness, personalization, as well as scientific basis as key aspects to address during the developmental process. All HCPs showed optimism about the prospect of an app for pregnant women satisfying aforementioned conditions.

Conclusion: Future and current apps should be well communicated through professional networks to inform HCPs. However, there is clear need for guidelines and standard practices on how to refer clients to suitable applications. Overall, HCPs are optimistic about the future of apps and feel that it could enhance the health of mother and child.

Keywords: *Technology, apps, online nutritional coaching, qualitative study, health care professionals*

3. Biomarkers

Evaluation of NutriProfiel®: an online tool for personalized dietary advice considering micronutrient status in a clinical setting

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Introduction. A significant proportion of the Dutch population does not meet the current Dutch dietary guidelines. This may be explained by a lack of knowledge, or perceived barriers when trying to adhere to the recommendations. Also, healthcare professionals lack solid nutrition education, hampering optimal care and prevention in diet-related disorders. This is particularly the case for micronutrient deficiencies, caused by either pathophysiological processes or poor dietary habits, requiring different follow-up of dietary intake. This study evaluated the use of NutriProfiel® in eHealth to support patients and healthcare professionals for improvement of patients' micronutrient status.

Methods. The Eetscore assesses to what extent daily intake adheres to the Dutch Food Based Dietary Guidelines of 2015. It consists of a short Food Frequency Questionnaire and is scored with the Dutch Healthy Diet 2015-Index. Nutriprofiel combines micronutrient blood concentrations of vitamin B6, folate, B12 and/or D with dietary intake assessed by the Eetscore to generate a personalized dietary advice to improve or maintain micronutrient status. Therefore, the clinical laboratory information system is coupled to the Eetscore questionnaire. NutriProfiel is offered to patients under treatment with their family doctor or medical specialist. The use of NutriProfiel was evaluated with seven healthcare professional users and 194 potential users by in-depth interviews and questionnaires, respectively. NutriProfiel was evaluated on understandability, usability and practicality.

Results. Healthcare professionals reported NutriProfiel as a useful tool to gain insight in patients' micronutrient status. They believe NutriProfiel fills the information gap of evidence-based dietary advice which has not yet been implemented in current protocols. Healthcare professionals suggested to expand NutriProfiel with more micronutrients to generate a more complete overview of patients' micronutrient status and an increased use of NutriProfiel. Eighty percent of potential users indicated NutriProfiel as trustworthy, because the tool is evidence-based and developed together with researchers. Furthermore, they reported NutriProfiel to be understandable (84%), professional (68%) and easy (60%).

Conclusion. NutriProfiel received positive evaluation by healthcare professionals and potential users, and is currently available for all incoming blood tests at the clinical chemistry laboratory of Gelderse Vallei Hospital. Future perspectives include expanding the list of nutrient biomarkers for which a personalized dietary advice can be provided.

Keywords: micronutrient status, diet quality, evaluation, health care, implementation

Food intake biomarkers for green leafy vegetables, bulb vegetables and stem vegetables: a review

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Background: Numerous studies acknowledged the importance of an adequate vegetable consumption for human health. However, current methods to estimate vegetable intake are often prone to measurement errors due to self-reporting and/or insufficient detail. More objective intake biomarkers for vegetables, using biological specimens, are preferred. The only concentration biomarkers currently available are blood carotenoids and vitamin C, covering total fruit and vegetable intake. Identification of biomarkers for specific vegetables is needed for a better understanding of their relative importance for human health. Within the FoodBALL Project under the Joint Programming Initiative “A Healthy Diet for a Healthy Life”, an ambitious action was undertaken to identify candidate intake biomarkers for all major food groups consumed in Europe by systematically reviewing the existent literature. This study describes the review on candidate biomarkers of food intake (BFIs) for leafy-, bulb- and stem vegetables, which was conducted within PubMed, Scopus and Web of Science for studies published through March 2019.

Results: In total, 65 full-text articles were assessed for eligibility for leafy vegetables, and 6 full-text articles were screened for bulb and stem vegetables. Putative BFIs were identified for spinach, lettuce, endive, asparagus, artichoke and celery, but not for rocket salad. However, after critical evaluation through a validation scheme developed by the FoodBALL consortium, none of the putative biomarkers appeared to be a promising BFI. The food chemistry data indicate that some candidate BFIs may be revealed by further studies.

Conclusion: Future randomized controlled feeding studies combined with observational studies, applying a non-targeted metabolomics approach, are needed in order to identify valuable BFIs for the intake of leafy-, bulb- and stem- vegetables.

Keywords: Biomarkers, vegetables, dietary assessment, review

myfood24, an online 24h recall is valid for diet measurement in healthy and clinical populations

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Introduction: robust assessment of the association between diet and health in population-based studies requires accurate measurement of diet. Healthcare professionals do not have valid apps or online tools to support dietary measurement in clinical groups. The use of online 24h dietary recalls can provide more accurate intake data than questionnaires, with reduced measurement error. Online tools could reduce administrative costs and free up researcher and healthcare professional time. We have developed an online dietary assessment tool, myfood24, undertaken validation comparing results to independent nutrient biomarkers and tested in clinical populations.

Method: a validation study recruited metabolically stable adults who completed myfood24, an interviewer administered multiple pass dietary recall and provided biomarker samples on 3 occasions. A further clinical study using mixed methods was undertaken exploring the feasibility and usability of myfood24 in women with gestational diabetes (GDM). Women were asked to complete five myfood24 food records, followed by the System Usability Scale (SUS), a measure of usability, and invited to provide interview feedback.

Results: in the validation study biomarkers were obtained from 212 participants. myfood24 gave broadly similar results to the more administratively burdensome interviewer-based tool, for example: protein was measured by myfood24 as 71g, 95%CI 66-75; interviewer 82g, 95%CI 77-86, biomarker 68g 95%CI 64-73. The online tool resulted in attenuation factors of ~0.2–0.3 which will affect estimated risk. The clinical study recruited 199 participants with mean booking body mass index 29.7kg/m², of these 121 women completed myfood24 at least once. The SUS demonstrated ‘good’ usability scoring 71/100. Interviews identified areas for improvement, including optimisation for mobile devices and as a clinical management tool.

Discussion: the less burdensome use of the online tool, with automated nutrient coding and potential for research and clinical staff time saving, makes it well-placed for use in large-scale prospective studies and clinically. myfood24 is being used in a number of large studies including adaptation for other European countries with an Arabic tool in development. Ongoing work is exploring the use of myfood24 in clinical dietetic practice.

Keywords: online, recall, myfood24, validation, epidemiology

Dietary carbohydrates and lipids quality index as predictors of an early heart failure biomarker

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Introduction: B-type natriuretic peptide (BNP) rises in earlier stages of heart failure (HF), a condition that is responsible by high rates of disability, hospitalization, costs, and mortality. There is no consensus in the literature on the role of dietary carbohydrates and lipids in the development and prognosis of HF. This study aimed to evaluate if the dietary profile of carbohydrates (CHO) and lipids would be a predictor of BNP.

Methods: Data are from the DIGITALIS study (2011-2012) carried out in the population assisted by the Family Medical Program in Niteroi, Rio de Janeiro, Brazil. A food frequency questionnaire (81 items) was used to assess food consumption. Serum BNP was measured by the chemiluminescence method. The dietary Carbohydrate Quality Index (CQI) and Lipid Quality Index (LQI) were estimated. CQI is a score ranging from 4 to 20 calculated from dietary fiber intake, glycemic index, the whole grains to total grains ratio, and solid CHO to total CHO ratio. LQI was estimated by dividing the sum of the dietary content of monounsaturated and polyunsaturated fatty acids by the sum of saturated with trans fatty acids. BNP, CQI and LQI were categorized in tertiles. Logistical multinomial regression was used to assess the association between CQI and LQI with BNP. For BNP, the first tertile was the reference category; for both CQI and LQI, the highest tertile was the reference category, which indicated better diet quality and ($p \leq 0.05$).

Results: The analysis included 414 individuals (45-99 years old; 63% women). Mean BNP level was 32.3pg/dl (SD=119.3). Mean CQI was 12 (SD=3) and average LQI was 1.46 (SD=0.83). Among individuals in the lowest LQI tertile there was a strong association with higher BNP values (OR=2.1; 95%CI: 1.1; 3.8).

Discussion: The CQI did not show predictive ability for BNP levels. On the other hand, harmful dietary lipid profile was associated with the odds of having high BNP levels. The LQI may be a good indicator for screening individuals at risk of early physiological changes related to HF.

Keywords: carbohydrates, lipids, B-type natriuretic peptide, heart failure.

The carbon isotope ratio of alanine is a specific biomarker of sugar-sweetened beverage consumption in a 12-week clinical feeding study

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Introduction: The measurement of sugar-sweetened beverage (SSB) intake may be improved with the use of biomarkers, such as carbon isotope ratios (CIR). Nearly all SSB are sweetened with corn and sugarcane, which have elevated CIR relative to most other foods. Whole tissue CIR serve as biomarkers of SSB consumption in certain populations, but may be confounded in others by the intake of corn-fed meat or of fish that also has elevated CIR. We investigated more specific biomarkers of SSB intake in the CIR of nonessential amino acids (NEAA), especially alanine, which is closely linked to glucose metabolism.

Methods: We evaluated plasma and RBC CIR-NEAA in 32 United States (US) adult males in a 12-week, in-patient feeding study conducted between 2011 and 2018. Participants were randomly assigned to 1 of 8 diets, which manipulated the intakes (presence/absence) of SSB, meat, and fish in all possible combinations, and which comprised 50% carbohydrate, 30% fat, and 20% protein. Fasting blood samples were collected at baseline and biweekly thereafter. We measured 5 CIR-NEAA (in alanine, aspartic acid/asparagine, glutamic acid/glutamine, proline, serine) using gas chromatography-combustion-isotope ratio mass spectrometry. We analyzed post-intervention CIR-NEAA as a function of the 3 variable intakes and baseline CIR-NEAA. In a subset of 18 individuals, we measured CIR-NEAA in biweekly samples to characterize change over time from baseline.

Results: In general, post-intervention plasma CIR-NEAA were elevated in SSB consumers. The CIR-alanine showed the largest increase ($\beta=2.81 \pm 0.38$) in response to SSB, and was not increased by meat or fish intake. In RBC, all 5 CIR-NEAA increased with SSB intake, and did not increase with meat or fish intake. The CIR-alanine again had the largest response to SSB in RBC ($\beta=1.66 \pm 0.30$). The CIR-NEAA kinetics analyses are on-going, but plasma CIR-alanine appeared to stabilize before the end of the study, supporting the post-intervention effect size.

Discussion: This study supports the use of the CIR-alanine as a biomarker of SSB intake in US populations. The increase of the CIR-alanine with SSB, but not meat or fish, makes it a more specific biomarker than whole tissue CIR.

Keywords: biomarker, sugar-sweetened beverage, carbon isotope ratio, amino acid, alanine

Validity of a Semiquantitative Food Frequency Questionnaire in Men Assessed by Multiple Dietary Assessment Methods

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Introduction: Much of the literature on the relation between diet and chronic diseases has been based on epidemiologic studies using semi-quantitative food frequency questionnaires (SFFQs). This study evaluated the validity of a 152-item SFFQ compared to several other dietary assessment methods for estimating nutrient intake among participants of the Men's Lifestyle Validation Study (MLVS; 2011-2013).

Methods: Among 626 participants of the MLVS, the study team collected two paper SFFQs, one web-based SFFQ, two 7-day dietary records (7DDRs), four automated self-administered 24-hour dietary recalls (ASA24s), four 24-hour urine samples, one doubly-labeled water (repeated among 98 participants), and two fasting blood samples over a period of 15 months. Absolute total daily nutrient intakes from each of the dietary assessment methods were summarized as means and standard deviations. Spearman rank correlation coefficients and their 95% confidence intervals (CI) were used for correlation analyses.

Results: Compared to 7DDRs, SFFQs tended to underestimate energy intake, macronutrients, and sodium intake, but overestimate some micronutrients. The mean of Spearman correlation coefficients between 46 energy-adjusted nutrients estimated from 7DDRs and the SFFQ, de-attenuated for within-person variation in the 7DDRs, was 0.66 (range 0.38 to 0.88). These deattenuated correlations were similar using ASA24 as the comparison method. Relative to biomarkers, SFFQs tended to underestimate energy, sodium, and protein intakes, and the sodium:potassium ratio. The energy-adjusted correlations between nutrients

assessed by the SFFQ and the biomarkers were similar to the correlations between the SFFQ and the 7DDRs. Using the method of triads with biomarkers, the estimated validity coefficients between SFFQ and true intake were higher than when using only the 7DDR or ASA24 as the reference method. Conclusion: These data indicate that this SFFQ provided reasonably valid estimates for a wide range of nutrients when evaluated by multiple comparison methods among men. After accounting for within person variation, the ASA24 and 7DDR provided comparable results when validating the SFFQ.

Keywords: FFQ, biomarkers, ASA24, 7DDR, validity.

Food for Thought: Preliminary Feasibility and Baseline Characteristics from the Multicultural Healthy Diet to Reduce Cognitive Decline & Alzheimer's Disease Risk Study

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Background

Prior studies indicate that anti-inflammatory diets such as the Mediterranean dietary pattern are associated with reduced cognitive decline and Alzheimer's disease risk. In a pilot randomized clinical trial, we use novel real-time ambulatory methods to assess whether an anti-inflammatory dietary pattern can benefit cognition of 40-65 yrs old adults from diverse backgrounds in Bronx, NY.

Methods

Participants are randomized in a 1:1 ratio to the Multicultural Healthy Diet, an anti-inflammatory diet, or usual diet. We assess cognitive functions: spatial & visual working memory, processing speed, executive function and long-term associative memory using real-time ambulatory assessments in burst fashion over a 7-day period every 9 months to evaluate the time course over which positive impacts are detectable. We assess diet using the National Cancer Institute's automated self-administered food record (ASA-24). We present preliminary baseline results from n= 147 randomized participants. Diet-related results are based on a median of seven food records per person; 98.6% completed ≥ 2 food records; 91.9% completed $\geq 50\%$ of ambulatory cognitive testing.

Results

Participants are 78.2% female, 28.6% Hispanic, 57.8% Black, 23.1% White, 14.2% multi-racial and 3.4% Asian or Native Hawaiian/Other Pacific Islander. Mean age is 54.1 yrs (SD, 7.1); 56.5% have BMI ≥ 30 . Mean reading score is one year beyond high school; mean Montreal Cognitive Assessment Score score is: 25.0, (SD, 2.6).

Median (IQR) daily intake is: energy (kcal): 1580 (1273, 1942). Median (IQR) reported daily intake for food components associated previously with cognitive function is: fruits & fruit juices (cups): 0.63 (0.29, 1.27); dark green vegetables (cups): 0.26 (0.08, 0.55); fatty acids (g) - eicosapentaenoic acid: 0.03 (0.01, 0.09), docosapentaenoic acid: 0.02 (0.01, 0.04) & docosahexaenoic acid: 0.08 (0.03, 0.18); folate (food) (mcg): 182.1 (141.4,246.4), vitamin B12 (mcg): 3.67 (2.55,5.27), alpha-tocopherol (mg): 7.57 (5.43,9.24), alpha carotene (mcg): 229.9 (88.0,621.4), beta carotene (mcg): 2558 (1202, 4428), lycopene (mcg): 2555 (1118,5832), lutein + zeaxanthin (mcg): 1898 (952,3776).

Conclusions

These preliminary results indicate that it is feasible to assess cognition & diet in ambulatory fashion in diverse middle aged and older adults.

Keywords: cognition, anti-inflammatory diet

Metabolomic Amino Acids Profiles as Biomarkers to Identify Metabolic Alterations

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BACKGROUND. Metabolic alterations compromise physiological functions, triggering morbidities for humans. Therefore, would be valued to explore biomarkers to recognise metabolic changes using the metabolomics tools. **OBJETIVE.** This study aimed to investigate amino acids (AA) as biomarkers to classify metabolic variations. **METHOS.** Blood samples were obtained from 168 adults (≥ 20 years) who participated in the population based cross-sectional study "Health Survey of Sao Paulo". The targeted AA metabolome profiling was analysed by HPLC/MS methods. Principal Component Factor Analysis (PCFA) with varimax orthogonal rotation was performed to generate the AA patterns. Obesity was determined based on Body Mass Index ≥ 30 kg/m². HOMA-IR was estimated, considering the cut-off ≥ 2.7 for insulin resistance (IR) classification. Metabolic Syndrome (MS) was characterized by 3 or more health abnormalities parameters, such as medicine use, blood pressure (≥ 130 mmHg/85mmHg), fasting glucose (≥ 110 mg/dL), triglycerides (≥ 150 mg/dL), HDL-cholesterol (≤ 40 mg/dL for men; ≤ 50 mg/dL for women), and waist circumference (≥ 102 cm for men, ≥ 88 cm for women). The dyslipidaemia (DL) variable was considered one or more factors as followed: LDL-cholesterol (≥ 160 mg/dL); Total Cholesterol (≥ 190 mg/dL); triglycerides (≥ 175 mg/dL). The ability of the AA to discriminate the outcomes was assessed by using area under the receiver operating characteristic curve (AUC). **RESULTS.** The PCFA produced 5 profiles (P), but only the P1 (Leu, Val, Ile, Phe, Tyr, Trp, Lys, Met, His, Glu, Gly, Asn, Ala), which represented the β -catabolism of AA and lipids showed a promising outcome classification: IR (AUC=0,604); MS (AUC=0,657); Obesity (AUC=0.744); DL (AUC=0.622). **CONCLUSION.** The AA pattern revealed a noteworthy characteristic as biomarker for metabolic changes.

Keywords: amino acids, obesity, biomarker, metabolic syndrome, metabolomics

An Investigation of the repeatability of novel outcomes from stepping patterns in the iData study

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Research studies investigating the relationship between physical behaviour and health outcomes often use measures obtained from a short period of observation, typically 7 days or less. The assumption that these measured outcomes reflect an individual's habitual pattern of activity may not be correct. The iData study provides free-living physical behaviour data for over 1000 participants with many participants having two timepoints, constituting a dataset that can be used to test the repeatability of outcomes. This study investigated the repeatability of several putative biomarkers of physical behaviour. Demonstrating repeatability is important in demonstrating the utility of these outcomes before investigation their validity to quantify capacity and participation in other study populations.

We found a subset of 516 older adults from the iData study that had two separate recordings from a thigh-worn accelerometer with at least 7 days of valid wear time (over 10 hours/day). The outcomes calculated were mean daily step count, maximum steps taken in 30 seconds, median cadence for stepping bouts of duration 10 seconds to 1 minute and median cadence for bouts longer than 1 minute.

The mean daily step count (SD) was 7651(3219) steps with an average difference of 1751(1936) steps between the two measures for the same individual giving an intraclass correlation coefficient (ICC) of 0.67. The maximum steps taken in a 30 second period was 66.4(8.18) steps with a mean difference of 4.8(6.01) steps between paired measures (ICC 0.56). The median cadence for stepping less than 1 minute was 68.9 steps/minute, with a mean difference of 2.40(2.98) steps/minute between same-individual observations (ICC 0.73), while the median cadence for stepping bouts longer than 1 minute was 87.5 steps/minute (ICC 0.63) with a mean difference of 5.65(5.41) steps/minute between same-individual observations (ICC 0.63). For this study population, none of the outcomes were found to have good repeatability (ICC > 0.75), though median cadence for shorter stepping bouts came close to this threshold and was found to have the best repeatability. These findings suggest that outcomes obtained from a single period of observation may not provide a repeatable measure of an individual's actual ability or participation.

Keywords: Accelerometer, physical activity, capacity, participation, repeatability

Gut microbiota composition in relation to intake of added sugar, sugar-sweetened beverages and artificially sweetened beverages – combining intake assessment methods

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Introduction: It has been suggested that a high intake of sugar or sweeteners may result in unfavorable microbiota composition; however, evidence is lacking. A plausible mechanism could be through malabsorption in the gut. Since dietary misreporting challenges evidence generation, nutritional biomarkers of sugar intake and complementary dietary assessments are needed for improving nutritional research.

Methods: Participants in the Malmö Offspring Study (18-70 years) provided urine and fecal samples and completed both web-based 4-day food records (4DFR) and short food frequency questionnaires (FFQ). Fecal bacterial abundances were analyzed using 16S rRNA and were identified using QIIME and Greengenes (v.13.8), resulting in 64 included genera. Composite measures were created of 1) added sugar intake from 4DFR and the overnight urinary sucrose and fructose biomarker (U-sugars) using their first principal component (n=577) and both 2) sugar-sweetened beverage (SSB) intake (n=1086) and 3) artificially sweetened beverage (ASB) intake (n=1085) from 4DFR and FFQ by crosstabulation over three groups. Those reporting high added sugar intake but low urinary fructose were categorized as potential malabsorbers of fructose.

Results: Correlation coefficients were between added sugar from 4DFR and U-sugars $r=0.23$, between 4DFR and FFQ for SSBs $r=0.55$ and ASBs $r=0.59$. Among the 10 associations with lowest P-values after covariate adjustment, four genera agreed between added sugar and U-sugars, one genus agreed between 4DFR and FFQ for SSBs and four genera agreed for ASBs. Several genera associated nominally with the composite measures of added sugar, SSBs and ASBs, but none remained significant after multiple testing correction. SSB intake from 4DFR and as a composite measure associated with higher Firmicutes:Bacteroidetes ratio. Genus abundance did not differ in potential fructose malabsorbers.

Discussion: The association between intake of added sugar and sweetened beverages and the gut microbiota were very modest, but an association was seen between SSB intake and the Firmicutes:Bacteroidetes ratio. The moderate agreement between the genera associated with added sugar and U-sugars, SSBs and ASBs from 4DFR and FFQ, respectively, indicates the need for combining methods. Additionally, we raise a new application for the urinary fructose measurement, but cannot ascertain the accuracy of our method for finding fructose malabsorbers.

Keywords: gut microbiota, added sugar, urinary sugar biomarker, SSBs, ASBs

Associations of plasma, red blood cell and hair carbon and nitrogen isotope ratios with fish, meat and SSB intake in a 12-week inpatient feeding study

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Introduction Naturally-occurring carbon and nitrogen stable isotope ratios ($^{13}\text{C}/^{12}\text{C}$, "CIR" and $^{15}\text{N}/^{14}\text{N}$, "NIR") are promising dietary biomarkers. Because these candidate biomarkers have long tissue residence times, long-term feeding studies are needed for their evaluation. Our aim was to evaluate plasma, red blood cell (RBC) and hair CIR and NIR as biomarkers of fish, meat, and sugar-sweetened beverage (SSB) intake in a 12-week dietary intervention.

Methods Thirty-two men (age 46.2 ± 10.5 years; BMI 27.2 ± 4.0 kg/m²) underwent a 12-week inpatient dietary intervention at the NIDDK in Phoenix, AZ, USA. The effects of fish, meat and SSB intake on CIR and NIR were evaluated using a balanced factorial design, with each intake factor at two levels (present/absent) in a common, background diet (50% carbohydrate, 30% fat, 20% protein). Fasting blood samples were taken biweekly from baseline, and hair samples were collected at baseline and post-intervention. Data were analyzed using multivariable regression.

Results The post-intervention CIR of plasma was elevated when diets included meat ($\beta = 0.89$ 95% CI (0.73, 1.05)) and SSB ($\beta = 0.48$ (0.32, 0.64)). The post-intervention NIR of plasma was elevated when diets included fish ($\beta = 0.85$ (0.64, 1.05)) and meat ($\beta = 0.61$ (0.42, 0.81)). Results were similar for RBC and hair. Post intervention RBC CIR and NIR had strong associations with baseline, suggesting that turnover to the intervention diets was incomplete after 12 weeks. Estimates of isotopic turnover rate further confirmed incomplete turnover of RBC.

Discussion These results support stable isotope ratios as candidate biomarkers of long-term dietary intake. Overall, the CIR and NIR discriminated between dietary fish and meat, and to a lesser extent SSB, indicating their potential utility as biomarkers of intake in United States diets. Approaches to make these biomarkers more specific are needed.

Keywords: biomarkers, carbon isotopes, nitrogen isotopes, meat intake, fish intake

Validity Measures and Statistical Modeling Choices in Recovery Biomarker-based Validation Studies: A Systematic Literature Review

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Self-reported dietary data are prone to both random and systematic measurement errors. The validity of new dietary assessment methods can be determined by comparing it with a reference method, preferably with objective recovery biomarkers. However, validation studies have shown to have different measures of validity and statistical modelling choices. This paper aims to give an overview of validity measures and statistical modelling choices reported in recovery biomarker-based validation studies of dietary intake. A systematic literature review following PRISMA guidelines was conducted to identify the range of validity measures and statistical modelling choices in dietary validation studies. PubMed, Scopus and Web of Science were searched to identify recovery biomarker-based validation studies published in English from January 2006 to November 2019. General information and information on validity measures and statistical modelling choices were extracted.

Of the 421 papers identified, 114 papers were found that matched the inclusion criteria. Preliminary results based on analyzing 77% of the papers shows that measures of bias were the most frequently reported validity measures (78% of papers identified at least one measure of bias), followed by measures of the strength of the biomarker self-report association (66%) and lastly measures of attenuation (14%). For the statistical modelling choices, procedures to deal with a non-normal intake distribution were most commonly mentioned (66%), of which the log-transformation was most popular (41%). If energy and additional nutrients were measured (16%), absolute intake and energy-adjusted intake were both reported. Procedures to handle outliers (31%) and to take seasonality into account (4%) were reported less often. The review demonstrated a wide variety in the reporting of validity measures and statistical modelling choices. Moreover, the majority of papers reported only one or two validity measures. This hinders the comparability of results across studies, populations and over time. Although the choice of validity measures partly relies on the research question, it is recommended that at least three validity measures are reported: one reflecting bias, one reflecting the association between the biomarker and self-reported intake and one reflecting attenuation.

Keywords: recovery biomarkers, epidemiologic methods, validation, dietary intake assessment, validity measures

4. Combining methods to enhance measurement

The relationship of dietary intake and physical activity with muscle strength among Malaysian adolescents

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Background: The relationship between muscle strength, dietary intake and physical activity among adolescents is not well understood.

Objective: The longitudinal effects of dietary intakes and physical activity scores on muscle strength in this adolescent was investigated.

Design: This prospective cohort study consisted of 436 adolescents (134 males; 302 females), aged 13 years at baseline in 2012 and were followed up at the age of 15 (2014) and 17 (2016) years, respectively. We measured muscle strength using a calibrated hand dynamometer, estimated dietary intake with a seven-day dietary history and physical activity scores with validated PAQ-C questionnaire. A generalised linear model was used to examine the effect of dietary intakes and physical activity changes on muscle strength changes.

Results: The muscle strength of the males had increased within the five-year period, with visible trends observed between females aged 13 and 15 years. The dietary intakes also increased initially but plateaued after those aged 15 years for both sexes. Both sexes recorded a declining trend in physical activity scores as they grew older. The longitudinal analysis found that changes in energy intake affect muscle strength among females between 13 to 15 years ($p=0.041$). As for males, neither changes in dietary intakes nor physical activity were associated with changes in muscle strength over the five-year period. The findings of this study suggested that there is a trend for protein intake and physical activity among males between 13 to 15 years.

Conclusion: Higher protein intake among males compared to female appeared to be associated with higher muscle strength during early adolescence. Nutrition and physical activity focusing on strength building are required in early adolescence and need to be tailored to each sex accordingly.

Keywords: conceptualisation, data collection, data entry, interpretation and write up

Measuring consumer preferences of food quality attributes: A review of existing methods

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Introduction:

Measuring consumer preferences for different food quality attributes in low- and middle-income countries (LMIC) is increasingly important for interventions and policies to better address poor nutrition and health outcomes in the context of rapidly changing food environments. Despite the importance of measuring preferences, limited research has been conducted in LMICs to develop a better understanding of what matters most to consumers. This paper reviews the various methods and proposes a way forward for the nutrition public health community.

Methods:

Relevant papers were identified in PubMed using pre-selected Mesh terms and by searching reference lists of key review articles. Approaches identified span the fields of marketing, economics, psychology, and nutrition public health. The papers reviewed used different methods to measure preferences of various types of food attributes.

Results:

In marketing and economics, the term conjoint analysis is used to describe a category of methods that measure the stated preference of respondents by asking them to rate, rank, or choose between competing alternatives. Within conjoint analysis, several different methods exist including discrete choice experiments, ranking conjoint analysis, and best-worst scaling and each can be used to elicit preferences about observable and unobservable attributes of foods (e.g. price, taste etc.). Within the field of psychology, several techniques have been used including the Food Choice Questionnaire and Food Choice Values. Other approaches, mostly used in nutrition public health include pile sorting, and Likert scales-based instruments.

Discussion:

Most methods have been primarily developed, validated, and used in high-income countries with much less application in LMICs. Each method has strengths and weaknesses but in general, those from marketing and economics appear more easily adaptable to different contexts (including LMICs) and have the benefit of forcing clear trade-offs between options. In contrast to Likert scales and pile sorting which can be difficult to interpret and cognitively burdensome to rank multiple items, respectively. Further research is required to adapt and develop preference elicitation methods for LMICs to better measure food preferences in the context of rapidly evolving food environments.

Keywords: Choice experiments, food quality attributes & values, preference elicitation, food environments

Measurement error correction of 24-hour physical activity recall by accelerometry in Brazilian adults

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Introduction: Physical activity (PA) is a complex behavior that involves several characteristics, which makes it challenging to measure. Subjective methods are extensively used to measure PA because of their practicality and low cost, yet they are self-report instruments, which makes them liable to under and overestimation. In this scenario, the validation of these subjective tools is recommended to reduce measurement errors. Thus, our aim was to correct the measurement error of 24-h physical activity recall (24hPAR) with accelerometry for metabolic equivalent (MET) values. **Methods:** This study was conducted with a sub-sample (n=74) of a larger survey, performed with adults from Brasília, the capital of Brazil. The volunteers responded one to two 24hPAR in the same days of use of the accelerometer, to obtain and compare METs values. The relationship between total MET/day for the two methods and the measurement error correction of 24hPAR were executed by a simple linear regression and correction model using R statistical software. **Results and discussion:** The correlation between the two methods was moderate and significant ($r=0.55$, $p<0.001$). The calibration equation to correct total MET/day for measurement error was determined and made it possible the approximation of MET/day values from 24hPAR to accelerometry. **Conclusion:** The 24hPAR is a valid tool to assess PA level in large adult samples when measurement error is implemented. The present study provided the calibration equation that enables this correction for the present and future surveys.

Keywords: questionnaire, method, exercise, accelerometer, movement

Dietary assessment from different perspectives in night shift working nurses

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Introduction: Night shift workers are at higher risk of making errors than day shift workers because of shift work-related fatigue and reduced alertness levels. Various nutritional strategies have been suggested to mitigate these reduced alertness levels. It is unclear what the best advice is for night shift workers for food choice including taste, diet composition, meal timing and frequency for the best alertness. To investigate these aspects by diet assessment, methodology should be adapted.

Objective: We adapted diet assessment methodology to investigate the association of diet composition, meal timing and frequency with alertness and assess taste differences between night shift working nurses and the general population.

Methods: This observational study was conducted in 118 female nurses, aged 20 to 61 years. Nurses completed an alertness test (Psychomotor Vigilance Test) and filled out a web-based 24-hour dietary recall (24hR) during three night shifts. Nurses had to specify what but also when they consumed foods to assess timing and meal frequency. The time frame of the 24hR started with the dinner prior the night shift. The food composition and taste databases were used to assess nutrient intakes and taste profiles. Taste profiles were compared with the Dutch National Food Consumption Survey 2012-2016.

Results: Total fat intake 1 to 2 hours before the PVT was negatively ($\beta=-2.04\text{ms}$, 95% CI: -3.75 - -0.33, $p=0.019$), while total carbohydrate intake was positively ($\beta=0.82\text{ms}$, 95% CI: 0.03 - 1.61, $p=0.041$) associated with reaction time. The number of eating occasions during the night shift was associated with faster reaction times ($\beta=-4.81\text{ms}$, 95% CI: -9.14 - -0.43, $p=0.030$), and less number of lapses ($\beta=-0.04$, 95% CI: -0.07 - -0.00, $p=0.030$). Nurses consumed a higher percentage of energy from foods with a sweet/sour taste and a lower percentage from foods with a salt/umami/fat taste than the general population.

Conclusion: This study gives more insight in the diet and taste patterns of nurses. Diet composition, meal frequency and timing may all improve objective alertness levels in nurses during the night. Optimizing dietary guidelines in terms of timing, frequency, and composition of a meal may lead to less errors and a better wellbeing of nurses.

Keywords: shift workers, alertness, diet assessment, meal frequency, taste pattern

Combining eating behaviour and dietary intake analysis to predict body composition outcomes in New Zealand women

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Background: Internationally, eating behaviour has been linked with both optimal and adverse body composition in women. However, no study has examined eating behaviour in New Zealand women with different ethnicities and body compositions.

Aim: To investigate eating behaviours as predictors of body composition and dietary intake in New Zealand European (NZE), Māori and Pacific women, participating in the women's EXPLORE study.

Methods: Women aged 16-45 years (N=368) completed the validated Three Factor Eating Questionnaire assessing eating behaviour categories of Restraint (Flexible and Rigid), Disinhibition (Habitual, Emotional and Situational) and Hunger (Internal and External).

The validated New Zealand Women's Food Frequency Questionnaire was used to assess usual dietary intake. Weight, height, circumferences and body composition was measured using dual x-ray absorptiometry and air-displacement plethysmography, and used to devise body composition profiles (normal-fat, hidden-fat and apparent-fat) based on BMI and body fat percentage.

Results: Restraint behaviour was significantly higher in NZE than Pacific women ($p=0.015$); Disinhibition in apparent-fat profiles ($p<0.001$); whilst Hunger, Habitual Disinhibition and External Hunger were higher in Pacific women ($p<0.001$, $p<0.05$, $p<0.05$ respectively) and in apparent-fat profiles ($p=0.034$); External Hunger was more prominent in the hidden-fat profile than normal-fat profile ($p = 0.001$). Accounting for age and ethnicity, the most significant predictors of body mass index (BMI) and body fat percentage (BF%) respectively were Restraint ($\beta=-0.12$, $p=0.007$; $\beta=-0.14$, $p=0.005$), Disinhibition ($\beta=0.36$, $p<0.001$; $\beta=0.40$, $p<0.001$), Habitual Disinhibition ($\beta=0.23$, $p<0.001$; $\beta=0.19$, $p<0.001$) and Emotional Disinhibition ($\beta=0.20$, $p<0.001$; $\beta=-0.08$, $p<0.001$). Non-ideal behaviour combinations (Low Restraint High Disinhibition; High Hunger High Disinhibition) were related to significantly higher body composition markers and dietary intake ($p<0.05$), and increased by 12% and 11% respectively from the normal-fat to hidden-fat profile (both $p<0.001$). Women with the apparent-fat profile had the highest rates of Low Restraint High Disinhibition and increased body composition markers (abdominal adiposity, total adiposity and adipose distribution), particularly BMI (31.7 ± 7.60 kg/m²) and BF% ($40.4 \pm 6.90\%$).

Conclusions: Tailored behaviour-based weight management interventions in New Zealand women should be aimed at resolving poor self-regulation, specifically routine, circumstantial, and emotional eating practices, whilst improving the conscious ability to restrict unnecessary energy intake.

Keywords: Eating behaviour, body composition, dietary intake, obesity, women

Main barriers and communication challenges in promotion of protein consumption in community-dwelling seniors – 3 qualitative studies

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Introduction

Recent studies revealed that 15.4% of community-dwelling older adults do not meet the recommended daily intake of 0.8 g/kg BW/day, and it appears difficult to increase protein intake in this setting.

Opportunities for modifications of current dietary behavior of community-dwelling (CD) older adults were investigated in three qualitative studies in which we aimed to identify needs and preferences (study 1), barriers and promoters (study 2) and level of knowledge (study 3) regarding the use of high protein products.

Methods

Ninety CD older adults (age ≥ 65 y) were recruited at daily activity centers. Risk on low protein intake was assessed using ProteinScreener 55+. To gain insight in needs and preferences of older adults with regard to meals and meal products (study 1, n=30), visual information on eating behavior was assessed using photovoicing. Participants were asked to photograph all consumptions for 3 consecutive days (2 week days / 1 weekend day) and data was verified during post photovoice interviews. In studies 2 & 3, semi-structured interviews were conducted to identify protein consumption related barriers, opportunities (n=20) and knowledge and communication challenges (n=40) respectively.

Results and discussion

From ninety CD older adults (mean age: $75.6y \pm 7.8$) 61% scored a chance on low protein intake. Photovoicing data (study 1) showed that dietary patterns of 16 participants (n=30) consisted mainly of traditional products, such as potatoes, dairy, fruits, cheese and meat. Most participants followed a strict meal pattern. In post-photovoice interviews, participants indicated not to be willing to change their current eating behavior. Barriers for inadequate use of protein products were 'lack of knowledge', 'inflexibility', and no urge to receive dietary advice. Examples of promoters were 'trust in professionals' and 'product offers' (studies 2,3). Comparison of Pro55+ reported protein intake with interviews showed that seniors have no good idea of adequateness of protein intake.

Conclusion

Older adults have no sense of urgency to increase protein intake, possibly linked to low or incorrect knowledge on the importance of protein. One of the challenges for professionals would be to motivate inflexible seniors to change their eating pattern, to optimize protein intake.

Keywords: protein, elderly, photo voicing, qualitative, proteinscreener

Chrononutrition profile: How do Asian pregnant women eat?

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Recent evidence reveals that the time profile of food intake is metabolically relevant above and beyond food portion and composition. Food timing has been documented as an important determinant of circadian rhythms in metabolic pathways. Chrononutrition, defined as food administration according to body's circadian rhythms has emerged as a novel field of research in nutritional epidemiology, and linked to metabolic implications. However, this area remains largely unclear among pregnant women, where pregnancy serves as a critical window of opportunity to influence future maternal and offspring health. Here, we describe how we assess maternal chrononutrition profile and present evidence showing their links with birth outcomes and metabolic health during and after pregnancy. Using data from a prospective cohort study in Singapore of ~1000 pregnant women, we studied components of chrononutrition in terms of period (clock time and interval) and periodicity (eating frequency), which were measured using the 24-hour dietary recall and verified using the 3-day food diary. Day-night period was determined based on local time of sunrise (~0700h) and sunset (~1900h) in equatorial Singapore. Glycaemic levels at 26-28 weeks' gestation, gestation length/ prematurity and postpartum weight retention were examined. During the late-second trimester, 15% pregnant women had their food intake predominantly at night; while mean fasting intervals at night and eating frequency per day were 9.9 h and 4.2 times, respectively. Generally, pregnant women who engaged in night-eating, with shorter night-fasting intervals and greater eating frequency per day had a higher plasma glucose level during pregnancy, compared to those with day-eating. Additionally, women with night-eating have shortened gestation with an increased risk of prematurity and substantial postpartum weight retention. These associations were accounted for related behavioural indicators, including sleep duration, bedtime, physical activity, anxiety/ depression. Overall, the findings raise the potential of incorporating time-related dietary approaches, especially alignment of eating time with day-night cycle, as a target of intervention to improve birth outcomes and metabolic health of women. There is ongoing work to comprehensively study maternal chrononutrition profile in relation to other maternal and child health outcomes.

Keywords: chrononutrition, pregnancy, meal timing

Misreporting of energy intake in adolescents from the Growth and Obesity Chilean Cohort Study (GOCS)

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Introduction: Misreporting of energy can affect the validity of studies exploring diet and health outcomes. In adolescents little is known about determinants of misreporting. The present study aimed to evaluate the prevalence of energy intake misreporting and its relationship with nutrient and foods intake in a cohort of Chilean adolescents from low to middle income families.

Methods: We collected data for 882 adolescents from the Growth and Obesity Cohort Study (mean age 12 years old, 50.8 % girls). Dietary intake was assessed through standardized 24-h recalls collected by trained dietitians. Anthropometrics measurements (weight and height) were obtained during clinical visit. Obesity was defined as The ratio of energy intake to total energy expenditure requirements (EI:TEE) was used to categorize as under-reporters (UnR) (EI:TEE<0.78), over-reporters (OvR) (EI:TEE>1.22) or plausible reporters (PR) (EI:TEE=0.78-1.22). Food items of the 24-h recalls were grouped in 26 categories. We estimated the energy and nutrient contribution of every food group based on the percentage of total energy intake.

Results: more than half of adolescents (51%) were classified as UnR and 9% were OvR. UnR was higher in boys (58.5%) and adolescent with obesity (81.7%). UnR had lower energy share from total fat and saturated fat while higher energy share from proteins and higher sodium intake; OvR girls had a higher contribution of added sugars. Food items that were most frequently UnR were: junk food, cookies and cake, crackers and salty snack, chocolate and confectionary, mayonnaise and ketchup while Vegetables were OvR.

Discussion: The frequency of misreporting was high, particularly UnR among adolescents with excess weight and boys. Adolescents underreported consumption of unhealthy foods and overestimated consumption of healthy foods indicating that poor dietary behavior at this age is not due to nutrition education gaps.

Keywords: misreporting, adolescents

Assessing appetite sensations in the postpartum period under conditions in which energy intake and expenditure were precisely matched

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Introduction: Postpartum weight retention (PPWR) is an important risk factor for long-term obesity. Appetite control may be a key factor regulating body weight during the postpartum period. The objectives of this study were to 1) determine the association between PPWR and appetite sensations under conditions in which energy intake and expenditure were precisely matched, and 2) examine the association between appetite sensations, lactation, and other metabolic characteristics in postpartum women. **Methods:** Data from 49 women at nine months postpartum contributed to this cross-sectional analysis. Energy expenditure and macronutrient oxidation were assessed in a whole-body calorimetry unit for 24 hours. Physical activity level (PAL) was defined as total energy expenditure divided by resting energy expenditure. Appetite sensations were rated 17 times throughout the 24 hours using visual analogue scale, the results of which were then used to calculate a composite appetite score (CAS). Lactation (total min/day) was measured using a 3-day breastfeeding diary. **Results:** PPWR was negatively associated with fullness ($\beta \pm SE$, 14h-area under the curve $\times 10^{-3}$; -2.97 ± 0.72 ; $P < 0.001$), and satiety (-2.75 ± 0.81 ; $P = 0.002$), and positively associated with hunger (2.19 ± 1.02 ; $P = 0.039$), prospective food consumption (PFC; 2.19 ± 0.91 ; $P = 0.021$), and CAS (0.34 ± 0.09 ; $P = 0.001$). Average daily duration of lactation episodes was associated with higher CAS ($\beta \pm SE$; 39.68 ± 15.56 ; $P = 0.015$), hunger (3.56 ± 1.61 ; $P = 0.033$), and PFC (4.22 ± 1.78 ; $P = 0.023$), and with reduced sensations of fullness (-4.18 ± 1.94 ; $P = 0.038$) and satiety (-3.83 ± 1.87 ; $P = 0.048$). Daily carbohydrate oxidation and PAL were also associated with appetite sensations. **Discussion and conclusions:** We determined that daily duration of lactation, daily carbohydrate oxidation, and PAL were associated with appetite, which in turn was related to body weight regulation during the postpartum period. Variation in appetite sensations during the postpartum period may reflect possible underlying biological factors influencing PPWR, which might contribute to the high variability in body weight and composition after childbirth. Therefore, our findings suggest that appetite control, especially in lactating women, should be explored to support weight management strategies in postpartum women.

Keywords: Appetite, lactation, postpartum weight retention, postpartum women, whole-body calorimetry

Comparison of daily glycemic index and glycemic load with average glycemic index and glycemic load of meals related to insulin resistance in adolescents

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Introduction: Glycemic Index (GI) is a characteristic of carbohydrates available in foods, whereas Glycemic Load (GL) is related to portion size. Low GI foods are effective in controlling blood glucose in type 2 diabetes, but it is unknown whether peaks of high GI/GL are more related to insulin resistance (IR) compared to daily GI/GL. Objective: To compare the association of daily GI/GL, and average GI (AvGI) and GL (AvGL) of meals with IR in adolescents. Methods: Fasting insulin, glycosylated hemoglobin, HOMA-IR were evaluated in a national school-based representative sample of Brazilian students, 12-17 years, from public and private schools. Food intake was based on one 24-hour recall, but in 10% of the sample, a non-consecutive second day of 24-h recall was collected. GI values were based on <http://www.glycemicindex.com/> and daily GL was calculated by the FAO (1995) approach. Linear regression accounted for the complex sampling and GI and GL values were standardized to allow comparison. Analyzes considered non-diabetic and were adjusted for sex, sexual maturation, age, and physical activity. Results: Of 35,737 students with blood samples about 74% were from public schools and 72% were classified as normal weight and 8% as obese . There was a large variation in the GI and GL during the day with minimum values observed at lunchtime and higher values at night. The average of Insulin was 8.08 (7.98-8.19) mU/L, among normal weight adolescents and 12.71 (12.49-12.94) among overweight/obese ones, with respective HOMA-IR means of 1.72 and 2.75. GI and AvGI were about 59, without differences by weight status. GL and AvGL were not associated with any markers of IR (p-values > 0.16) among the overweight/obese group; whereas all markers were highly associated with the GL and AvGL among normal weight adolescents, with the greatest values of the regression coefficient for AvGL with insulin ($\beta=0.12$, p-value<0.001). For those overweight, the most important association was between AvGI and insulin ($\beta=0.23$, p-value <0.001). Discussion: Loads, especially AvGL, predict IR only in normal weight adolescents, with weight gain, the quality of carbohydrate counts more for the IR possible due to the small variation in portions size among those overweight/obese.

Keywords: Insulin resistance, Glycemic Index, Glycemic load, Carbohydrate, Adolescents.

Cost Comparison of Paper and Tablet Based 24-Hour Individual Dietary Recall

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Objective:

Information on populations' diets is essential to design effective nutrition programs, but availability is hindered by perceived high costs, complexity, and delays in obtaining results. The International Dietary Data Expansion (INDDEx) Project is developing a tablet-based system (INDDEx24) for conducting individual 24-hour dietary recalls (24HR), linked to a set of web-based dietary data inputs to facilitate analysis. Our objectives were to compare monetary and time costs and cost per unit of accuracy of a 24HR using INDDEx24 versus a pen-and-paper (PAPI) approach.

Methods:

To estimate the cost of both modalities, we integrated an activity-based cost study into 24HR validation studies conducted with adult women in Burkina Faso (n=234) and Viet Nam (n=234) to measure the accuracy of INDDEx24 and PAPI compared to a weighed food record (WFR). To estimate time of survey administration, we surveyed an additional 60 respondents per country who were not exposed to the WFR. Costed activities included: developing dietary data inputs and questionnaires, survey implementation, data entry, cleaning, processing, and analysis. Monetary and time costs were compared in total and for each activity.

Results:

Time differences in administration of the 24HR using INDDEx24 vs PAPI were minor compared to time required for survey preparation and analysis. INDDEx24 required more time prior to data collection; PAPI required more time between data collection and results. Preparation time is expected to reduce as INDDEx24 populates its database of country-specific dietary data inputs, greatly reducing its relative cost.

Conclusions:

INDDEx24 has potential to streamline 24HR process from implementation to results.

Keywords: Cost study, dietary assessment, low- and middle-income countries, technology

Beyond efficiency in dietary self-assessment tools for sustained user engagement

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INTRODUCTION

While recognising the opportunities of self-reporting assessment tools, both dieticians and clients have experienced negative engagement with dietary assessment. Research on engagement has primarily focused on the cognitive and physical burden of the measurements with technological advancements aiming to address them. However, user engagement also requires an understanding of the emotional impact of the tools. This work presents a multi-disciplinary effort to capture a contextual understanding of user engagement on dietary assessment tools, with a focus on users' perceived relevance and appropriateness of the reporting activity.

METHODS

Researchers from the nutritional and health, and creative-industry fields have combined their inquiry and creative methods to generate the contextual knowledge. These methods included, eleven contextual interviews with adults under dietary treatment (8), and obese children's parents from a family-oriented clinical treatment; followed by a co-creation session involving seven of the interviewees using generative methods. The sessions were recorded, transcribed, coded, and analysed using thematic analysis.

RESULTS

Participants experienced a variety of reporting tools: the majority worked with known dietary assessment questionnaires instructed by their dieticians, while few had implemented their own food tracking systems. The latter reported personal benefits on the act of reporting itself while they did not implement ways to reuse the information. The former discussed the misalignment between what they considered relevant to report and what the tools requested. While the tools focus on food intake, participants' discussions revolved around personal, biological, social and situational issues that they are constantly managing with regards to their eating behaviour. Participants reported feelings of frustration, confrontation, and judgement in their overall interactions with food professionals and assessment tools, media and social circles.

DISCUSSION

The relevance to communicate what makes obese people unique in their condition is unattended by the perceived generic qualities of their interactions with others and tools. Additionally, reinforcement strategies are perceived as overlooking the wide spectrum of related daily efforts in managing food intake, like reporting. To achieve positive engagement with assessment tools, further research explores design qualities (e.g. anonymity and humour) to enable interactions that minimise the perception of judgement and acknowledge the effort of self-reporting.

Keywords: dietary assessment, self-reporting, user engagement, multi-disciplinary

Development of a photographic food atlas to support food portion estimation among adolescents in Nairobi, Kenya

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Introduction

There is a shortage of data on food intake habits of children and adolescents in the rapidly changing urban environments of transitioning economies, e.g. Nairobi in Kenya. To be able to reliably measure food intake, accurate food portion size estimation is required. Adolescents' ability to recall foods consumed can vary widely. Using a photographic food atlas, with age-appropriate portions, can improve estimation of food portion sizes. The aim was to develop a photographic food atlas to use for assessing portion sizes among Kenyan adolescents aged 9-14 years to support a semi-quantitative 7-day food frequency questionnaire.

Methods

Participants were recruited in Nairobi sub-counties Embakasi and Langata to represent low and middle-income socioeconomic status respectively. Twenty-one 9-14-year-olds participated in the weighing of portion sizes. Three portion sizes (A, B, C) were calculated for almost all food items (90). Use of a series of three portion sizes is associated with relatively small errors. Portion size B was the average of weighed portions, A was half of B, and C time-and-a-half of B. Cooking demonstrations were arranged with the adolescents' mothers where the portion sizes were photographed. The atlas' usability was tested amongst eight adolescents and four nutrition professionals. The usability survey consisted of Likert scale and open-end questions to ascertain acceptability of the atlas.

Results

Overall acceptability was high amongst adolescents and professionals. The mean Usability Scores given by adolescents was 'OK' and 'Good' by professionals. All eight adolescents agreed the atlas helped them recall portion sizes, but four disagreed when asked if they could use the atlas on their own. All four professionals agreed they would use the atlas in their work, but all four found the quality of photographs not optimal. Professionals also gave verbal feedback and suggested foods to be included and different portion shapes.

Discussion

Based on the feedback, a second version was created including 173 food items. Photography was done in laboratory settings and atlas layout was improved. Instructions of use should be included with the atlas. The improved atlas has been used in a cross-sectional study in Nairobi. Future research is recommended to validate the atlas.

Keywords: food photographs, dietary assessment, portion size, children, middle-income country

Actualization of the Dutch food composition database NEVO

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Introduction

Food composition data is one of the key elements of food intake research, monitoring food reformulation, dietary advice and nutrition education. Providing good and up to date data, representative for the food supply and food pattern in a country, is essential to fulfill user needs.

Aim

To elucidate the actualization of the Dutch food composition database NEVO.

Methods

Dutch food composition data was updated between 2016 and 2019. Analytical values were used when available, remaining values were updated using e.g. literature, food labels, calculations such as recipes. Foods in NEVO are mainly generic foods, including several averaged branded foods with data from the Dutch branded database LEDA. Data was validated by consistency checks (e.g. sum of macronutrients is 100 g), checks on outliers and comparison with other food composition databases and literature.

Results

The updated version of NEVO-online was launched in November 2019, containing data on 2152 foods, including 181 new foods, reporting on 133 components (macronutrients, minerals, vitamins, fatty acids). New analytical values were added for oils (n=20) and pulses (n=19). Nuts (n=28) were updated based on literature.

In this version individual fatty acids are published in g/100 g of food, instead of % of total fatty acids, allowing users to directly calculate absolute amounts, thus reducing the risk of errors.

Discussion

To better reflect the food supply, combining branded and generic food composition data using modern technics, is one of the challenges for coming years, taking into account advantages and disadvantages of both.

Although users might expect differently, due to lack of resources, not all values in food composition databases are analyzed or updated for each database version. To efficiently use resources, sharing analytical data and exchanging knowledge at international level is increasingly important. Food composition data for NEVO online was created and documented following EuroFIR guidelines, to allow for international comparison. These aspects all contribute to fulfill user's needs in the area of food intake research, dietary advice and nutrition education.

Keywords: food composition database, NEVO-online2019, branded foods, food consumption, reformulation

5. Statistical aspects, including measurement error

Different methodologies to quantify food consumption and calculate proportion of inadequacy

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Introduction: An appropriate comparison of nutrition-health indicators across populations is dependent of standardized methods of assessment, treatment and analysis of data. This study aimed to compare different methodologies of quantifying and analysing food consumption and their effect on estimation of its “inadequacy” in population.

Methods: A representative sample of 5005 individuals (3-84 years old), from the National Dietary Survey, Portugal (IAN-AF,2015-2016), selected by multistage sampling was included. Following the guidelines of EU-Menu (EFSA), dietary intake was estimated by non-consecutive 2*food diaries in children (<10 years) or 2*24-hrs recalls for the other age groups, by using the software eAT24, and a food propensity questionnaire. Estimation of food consumption was performed using Method1: food items as purchased (raw, crude); Method2: food items Raw/cooked, crude; Method3: food items raw, edible; Method4: food items as consumed (raw/cooked, edible). We also compared the average of 2*diaries/24hrecall vs. usual intake (removing the intra-individual variability and zero inflation effect-SPADE software). Cut-off points for estimate proportion of consumers were: Fruit&vegetables (F&V)<400g/day; Red Meat>100g/day; Processed meats>50g/day; Fish<80g/day; Rice/pasta>150g/day; soft drinks>220/day.

Results: The mean intake of the analysed food groups differ particularly when comparing Method4 vs. Method1 for F&V, fish, red meet and Rice/pasta (-25%; -28%; -39%; -146%, respectively). The prevalence of inadequacy of F&V was 48%, 50%, 68%, 70%, using methods 1, 2, 3 and 4, respectively. Also the higher differences were observed when comparing proportion of consumers of fish and red meet using Method4 vs. Method1 (dif:13%, and 37%). The effect of different methods was in general higher in elderly than other age groups.

When comparing the average of 2*24h recall vs. usual intake the differences in mean estimates is smaller than 3% for F&V, processed meet, fish and soft drinks and about 11% and 7% lower when using usual intake for Rice/pasta and red meet. However, for meats and fish the differences in medians were about 30%. Also the proportion of consumers of fish (>80g/day) differ -43% (24% vs. 14%).

Conclusions: The different studied methods have a relevant impact on the estimation of the different food groups, that need to be accounted when comparing data across populations.

Keywords: Nutritional Epidemiology, Dietary assessment, Usual Intake, Surveys, nutrition-health indicators

Limiting the number of surveyed days maintained dietary data quality for each observed day: experience from the French national food consumption study (INCA3)

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Context:

In 2009, Efsa recommended to limit the number of surveyed day (2 or 3) in food consumption studies, in order to both reduce the response burden and ensure the collection of high-quality dietary data. Anses changed accordingly its dietary data collection methodology by using 3 non-consecutive 24h-recalls in its last national food consumption study (INCA3) instead of 7 consecutive days in the previous studies (INCA1 and INCA2). Indeed, the daily food intake decreased by 10% between the 1st and the 7th day in the adult population with the former methodology (INCA2).

Objective:

The present study aimed at estimating the day-by-day quality of the national dietary data after applying the Efsa methodology in France.

Methods:

Data from the third French food consumption study (INCA3) conducted in 2014-15 on a representative sample of 2121 adults were used. Energy intake was estimated using the French nutritional composition database (CIQUAL 2016). The total daily food amount, the intake of 43 food-groups (occurrence and amount), and the energy intake were assessed for each surveyed day and compared day-by-day.

Results:

No significant difference in total food intake amount and energy intake was observed between the first and the third studied day. When focusing on the intake of 43 food-groups, a significant decline appeared only for few food-groups: “white bread and similar products” (-10%) and “fish-based dishes” (-38%) for the daily intake amounts, and “sweets and chocolate” (-24%), “hot beverages” (-6%) and “fish-based dishes” (-36%) for the daily occurrence.

Conclusion:

The methodological changes applied in the INCA3 study managed to limit the measurement error and maintain the quality of the dietary data throughout the three surveyed days. This result is of importance particularly for acute food safety risk assessment where each day is considered individually. However, the differences highlighted for some food-groups (bread, beverages, sweets) questioned the need to adapt more particularly the methodology to their specificities (reminders).

Keywords: dietary data, error measurement, 24h-recalls, France

Differences in breastfeeding estimates based on the 24-hour dietary recall questionnaire and the Diet Behavior Questionnaire in NHANES

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Background: Data on breastfeeding surveillance have been obtained from different instruments throughout the world. In the United States, estimates are based on questions of historical feeding practices among mothers of children 19-35 months of age. Global monitoring guidance and global goals track breastfeeding practices using indicators related to breastfeeding in the previous 24 hours. The purpose of this analysis is to compare U.S. prevalence estimates using these 2 indicators.

Methods: Data from 1703 children birth to 24 months of age in the National Health and Nutrition Examination Survey, 2011-2016 were used to compare breastfeeding estimates obtained from the 24-hour dietary recall (24HR) and the Diet Behavior and Nutrition Questionnaire (DBQ).

Results: Breastfeeding prevalence in the U.S. among children birth to 24 months of age in 2011-2016 was 24.6% (95% Confidence Interval (95% CI): 21.3-28.1) based on the 24HR and 27.3% (95% CI: 23.7-31.2) based on the DBQ ($p < 0.001$). Breastfeeding estimates from the DBQ were significantly higher than those from the 24HR for both boys and girls, non-Hispanic whites, non-Hispanic blacks, non-Hispanic Asians, mothers <35 years of age, and infants who were not low birth weight. Among infants birth through 5 months (0-5 mo.), the prevalence of breastfeeding was 48.5% (95% CI 40.2-56.8) based on the 24HR and 52.9% (95% CI 45.9-59.8) based on the DBQ ($p = 0.11$). The prevalence of exclusive breastfeeding among infants 0-5 mo was higher based on the 24HR (28.7%, 95% CI: 21.7, 36.5) compared to the DBQ (21.2%, 95% CI: 15.3, 28.1); however, differences were not statistically significant.

Conclusion: Estimates of any breastfeeding based on the DBQ were consistently higher than the 24HR. Though not statistically significant, estimates of exclusive breastfeeding (0-5 mo) were higher based on the 24HR compared to the DBQ. The timing of instrument administration could account for differences in any breastfeeding; however, differences in exclusive breastfeeding likely stem from the limitations associated with each instrument (i.e. generic memory vs. specific memory, distant past vs. near past, for DHQ vs. 24HR). Comparison of breastfeeding estimates derived from different instruments requires caution and calls for more research to understand the errors introduced by each instrument.

Keywords: Breastfeeding, United States of America, standard indicator definitions

Evaluating the risk of excessive intakes using the tolerable upper intake level (UL): the effect of using different age categories for children

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Background

Tolerable upper intake levels (ULs) for children are extrapolated from those set for adults based on bodyweight and are categorized in age groups. Within age-groups mean body weight of children may substantially increase with age-unit. The choice of the age category may affect the estimated proportion with intakes above the UL. This may not only be the case for the age category chosen to set the UL for, but also the age category used in the evaluation of the intake. The objective of this study is to evaluate the effect of extrapolation of the UL for different age categories (and body weights) on the proportion children with intakes exceeding the UL.

Methods

ULs for adults of the European Food Safety Authority (EFSA) were extrapolated using reference bodyweights from European and Dutch populations, categorized per age-unit (year) and for different age categories. Habitual intake was estimated with the Dutch National Food Consumption Survey 2012-2016 (N=2235; 2x 24 hr. recall; 1-18 years.) and Statistical Program to Assess Dietary Exposure (version 3.2.58) and proportion exceeding the UL was calculated. Micronutrients zinc and copper were used as example.

Results

61% of the one-year-olds had intakes above the UL for zinc calculated per year of age, compared to 15% above the UL set by EFSA. For three-year-olds, 1% of the children had intakes above the UL for copper and 16% for zinc calculated per year of age, compared to 22% above the UL for copper set by EFSA and 33% for zinc. Effects of extrapolation were highest in younger ages (1-8 years) and in ULs calculated per year of age.

Discussion

Categorization of children in specific age categories has a substantial effect on both the UL-value as well as the percentage exceeding the UL, especially for the younger ages (1-8 years). ULs set by different institutions for age categories are based on assumptions, using ULs in different age categories may lead to invalid outcomes. This study has focused on the ULs, however it is expected age categorization also has effect on other dietary reference values. Future research can confirm these expectations.

Keywords: tolerable upper intake level, exceedance, micronutrient, children, age category

Towards low-carbon diets – usual intake modelling in evaluating dietary differences between socio-economic groups

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Introduction

Dietary transition towards low-carbon diet shifts the consumption from animal-based to plant-based foods, which affects the intakes of certain nutrients. This may impact differently on different socio-economic groups. This study compared the intakes of foods and nutrients important in transition towards low-carbon diets in different socio-economic groups of Finnish adults. Also, proportions of population achieving the average requirements (AR) or recommended intake (RI) were compared in different socio-economic groups using usual intake modelling.

Methods

The FinDiet 2017 Survey was carried out in a nationally representative sample of adults aged 18–74 years using two non-consecutive 24-hour dietary recalls (n=1655, response rate 53%). Education tertiles and income quintiles were used as socio-economic factors. Usual intake and the proportions of the population below AR or RI (if AR unavailable) were estimated with statistical program SPADE (RIVM, The Netherlands). Regression analysis was used to test the mean differences between socio-demographic groups.

Results

Red meat consumption was the lowest and fruit/vegetable consumption the highest in the highest educational group. In the highest educational group, 35% of men and 84% of women, compared with only 15% of men and 60% of women in the lowest educational group, consumed red meat according to dietary guidelines (max. 500g/week). Differences in the proportions of population reaching the fruit/vegetable guideline (500g/day) were 13 and 16 %-units for men and women, respectively. The proportion of plant-based protein was higher in the diets of the highest educated women than of the lowest tertile. Folate intake differed between the educational groups both from diet only and from food and dietary supplements together, being the highest in the highest educational group. Folate intake from food differed also by income quintiles for women. For vitamin D and calcium, only the total intakes differed between the educational tertiles.

Discussion

Diet of the highest educated tertile of Finnish population is closer to the low-carbon than the diet of the lowest tertile. Diet varies also by income quintiles but not in linear manner. The low-carbon dietary transition may improve the nutrition of the least educated but also be more demanding for them due to the existing differences in nutrition.

Keywords: Usual intake, total intake, SPADE, dietary recommendations, low-carbon diet

Reproducibility of dietary patterns using short-term instruments with within-person measurement error

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Background: It is unknown how reproducible dietary patterns from factor analysis are, and in which extension patterns derived from short-term instrument can describe usual dietary patterns. **Objective:** To assess the reproducibility of the loading factors (LF) from factor analysis using Monte Carlo simulation. **Methods:** A multi-component multi-dimensional daily intakes were simulated (150 days for 50.000 individuals) comprising 22 foods. The parameters for the simulation (correlations, proportions, means, variances, and distributions) were obtained from previous study based on 20 non-consecutive collection-days for each participant (n=302). The simulated usual intakes were defined as the mean over the 150 simulated days of intake. Three usual patterns (F1, F2, and F3) were retained using factor analysis with varimax rotation. Monte Carlo technique was performed to simulate 1000 datasets with 1- and 2-days intakes using the same parameters as above but with different size: n=20000, 10000, 5000, 1000 individuals. To be comparable, the LFs within each factor from the n-day samples were matched to the corresponding usual factor, we then obtained the 2.5th and 97.5th percentile for each loading factor). **Results:** The usual factors were: F1 (rice, beans, margarine, beef, bread, coffee), F2 (leafy vegetables, low-fat dairy, juices, nuts, olive oil), and F3 (soda, processed meat, sweets, pizza, butter, cake, manioc flour). When using 2-days mean intakes: two out of six LF in F1 (all sample sizes), four out of five in F2 (n=1.000), and two to seven out of seven in F3 were not reproducible. Three, four, and ten foods that do not belong to the usual F1, F2, and F3 respectively were identified in their corresponding 2-days pattern in many iterations. Results were similar when using only 1-day of intake. **Conclusion:** In this context, dietary patterns were poorly reproducible mainly in the smaller sample size. Usual factors are not fully described when using up to 2 days of intake. Interpretation of the results based on insufficient sample size and that doesn't take into account the effect of the measurement error might be misleading. Bootstrap with alignment can be used to assess LF reproducibility.

Keywords: dietary pattern, measurement error, reproducibility, usual intakes, 24-h recall

Trained analyst approach to image-based dietary assessment – investigation of measurement errors through comparison to known food weights from a controlled feeding study

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The trained analyst (TA) approach to image-based dietary assessment will be needed in multiple use contexts. Objectives of this analysis were to investigate and quantify the error between three different TA's estimates of food portion weights and energy (kJ) from images in comparison to known weights and energy.

A controlled feeding study (n=30 adults) was conducted in which the food weights (FW) of all foods and beverages for 3 meals were known. Before and after eating images of meals were taken using an image-based mobile food record (mFRTM) app. The three experienced trained analysts were blinded to the true weight of the foods and estimated food portion weights and kJ from the images from the mFRTM.

Differences in known mean energy intake and from that estimated from images by the TAs and differences between known FW and TA estimates of FW were examined using paired t-tests (significance $p < 0.05$). For seven foods found difficult to estimate, the ratio of estimated weight to known FW was calculated and the mean of the ratio from three TA's data determined.

One-day total energy intakes showed no differences between the known FW calculated mean energy value to that estimated from images by each of the three TA or to the combined TA mean estimate (known energy 8892 ± 3315 kJ, combined TA mean estimate energy 9118 ± 2542 kJ, $p = 0.613$).

For the seven difficult to estimate foods, the mean ratio of TA's weight estimate to known FW ranged from 0.73 to 1.34, with sushi (0.73 n=17), potato salad (0.86 n=25), rolls/sandwiches (0.88 n=20) and curry (0.93 n=24) underestimated; and muffin/biscuits (1.04 n=21), rice (1.17 n=24) and stir-fry noodles (1.34) overestimated.

Sushi was the only food where all three TA calculated a mean estimated weight significantly different from actual weight. Further examination found a systematic error in which the TA use of the food composition database weight for a single unit food (sushi piece) did not match the consistent higher weight of that food provided in the study.

These results will inform training methods in image-based dietary assessment.

Keywords: Image-based dietary assessment, mobile food record, measurement error

6. Machine learning and data science approaches

Temporal Dietary Patterns are Associated with Body Mass Index, Waist Circumference and Obesity

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Introduction: The integration of time with dietary patterns throughout a day, or temporal dietary patterns (TDPs), have been linked with dietary quality but relationships to health are unknown. The association between TDPs and selected health status indicators and obesity, type 2 diabetes (T2D) and metabolic syndrome (MetS) were determined.

Methods: The first-day 24-hour dietary recall from 1,627 non-pregnant U.S. adult participants 20-65 y old from the National Health and Nutrition Examination Survey (NHANES) 2003-2006 was used to determine timing, amount of energy intake, and sequence of eating occasions (EOs). Modified dynamic time warping (MDTW) and kernel k-means algorithm clustered participants into four groups representing distinct TDPs. Multivariate regression models determined associations between TDPs and health status, controlling for potential confounders, and adjusting for the survey design and multiple comparisons ($P < 0.05/6$).

Results: A cluster representing a TDP with evenly spaced, energy balanced EOs reaching up to 1,200 kcal between 06:00 to 10:00, 12:00 to 15:00, and 18:00 to 22:00, had statistically significant and clinically meaningful lower mean body mass index (BMI) ($P < 0.0001$), waist circumference (WC) ($P < 0.0001$) and 75% lower odds of obesity compared to three other clusters representing patterns with much higher peaks of energy: 1,000–2,400 kcal between 15:00 to 18:00 (Odds Ratio (OR): 5.3; 95% Confidence Interval (CI): 2.8, 10.1), 800–2,400 kcal between 11:00 to 15:00 (OR: 4.4; 95% CI: 2.5, 7.9), and 1,000–2,600 kcal between 18:00 to 23:00 (OR: 6.7; 95% CI: 3.9, 11.6).

Discussion: Individuals with a TDP characterized by evenly spaced, energy balanced EOs had significantly lower mean BMI, WC, and odds of obesity compared to the other patterns with higher energy intake peaks at different times throughout the day, providing evidence that incorporating time with other aspects of a dietary pattern may be important to health status.

Keywords: temporal; dietary patterns; obesity; waist circumference; adults

7. Patterns (multidimensionality and dynamism)

The Effect of Timing of Exercise Relative to Meal Consumption on Postprandial Response in Adults

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Introduction: Type 2 diabetes is a major public health concern. Management of this condition has focused on behavior modification through diet and exercise interventions. A growing body of evidence has focused on temporality of dietary intake and exercise and potential effects on health. This review summarizes current literature that investigates the question “how does the timing of exercise relative to eating throughout the day effect postprandial response in adults?”

Methods: Databases PubMed, Scopus, Cochrane Library, CINAHL, and SPORTDiscus were searched between March–May 2019. Experimental studies conducted in healthy adults (>18 y) and those with type 2 diabetes were included. Full texts were examined by at least two independent reviewers. Seventeen studies with a total of 332 participants met the inclusion criteria.

Results:The primary finding supports that exercise performed post-meal regardless of time of day had a beneficial impact on postprandial glycemia. There was insufficient evidence regarding whether timing of exercise performed pre- vs. post-meal or vice versa in a day is related to improved postprandial glycemic response due to inherent differences between studies.

Discussion: Future studies focusing on the investigation of timing and occurrence of meal intake and exercise throughout the day are needed to inform whether there is, and what is, an optimal time for these behaviors regarding long-term health outcomes.

Keywords: *time, exercise, dietary intake, postprandial response, type 2 diabetes*

Dietary patterns characterized by fat quality and associations with Framingham risk score: application of reduced rank regression in the UK Biobank cohort study

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Introduction

Evidence suggests that dietary fat quality is associated with cardiovascular disease (CVD) risk. However, few studies have used a posteriori dietary pattern (DP) methodologies to better understand the combined effect of foods high or low in saturated fat (SFA), polyunsaturated fat (PUFA) and monounsaturated fat (MUFA) on CVD risk. In addition, the non-laboratory Framingham risk score (FRS) is a validated alternative to investigating CVD risk in populations where laboratory test may not be available, although few studies have used it for DP research. Thus, this study aimed to derive DP associated with intake of SFA, PUFA and MUFA and to examine their longitudinal associations with the FRS.

Methods

This study was based on secondary data analysis of UK Biobank prospective cohort. Reduced rank regression (RRR) was used to derive DPs at baseline from an average of two or more 24 hours dietary assessments. Percentage energy from SFA, PUFA and MUFA were used as response variables. Framingham Risk Score (< or >10% risk, high values indicate increased CVD risk) was calculated at follow up using data on age, sex, smoking, body mass index, diabetes, systolic blood pressure and medication. Multiple logistic regression, adjusted for socio-demographics and health behaviours, was used to investigate the association between the RRR-derived DPs and FRS.

Results

A total of 10,325 participants (M=55 years, 52% female) were included and followed up for a mean of 8.4 years. Two DPs were identified. DP1 characterised by high-SFA foods (e.g. butter and bacon); DP2 characterised by high-PUFA foods (e.g. nuts and seeds) and low in high-SFA foods (e.g. beef). There was no evidence that DP1 was associated with FRS, whilst DP2 was associated with lower odds of a high FRS (OR:0.95;95% CI:0.91 to 0.99).

Discussion

A DP high in SFA was not associated with elevated CVD risk, whilst a DP high in PUFA foods had a protective role. As fat quality is an integral part of many dietary recommendations for reducing disease risk, understanding the dietary patterns based on fat quality will help inform food-based dietary guidelines for prevention of CVD risk in the wider population.

Keywords: Dietary patterns, dietary fat, reduced rank regression, cardiovascular risk, longitudinal

Dietary patterns derived by reduced rank regression as predictors of blood pressure

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Introduction: The reduced rank regression (RRR) is an approach both hypothesis-oriented and an exploratory statistical method used to identifying dietary patterns, that requires the definition of response variables, based on the scientific knowledge of the disease.

This study aimed to identify dietary patterns and to evaluate its ability in predicting systolic (SBP) and diastolic (DBP) blood pressures.

Methods: Data are from the DIGITALIS study (2011-2012) carried out in the population assisted by the Family Medical Program in Niteroi, Rio de Janeiro, Brazil. A food frequency questionnaire (81 items) was used to assess food consumption. Food items were grouped into 14 groups. The RRR was used to derive dietary patterns using PROC PLS in SAS. Sodium and potassium were used as response variables due their effect on blood pressure, and items with loadings ≥ 0.20 were included in the patterns. Linear regression analysis was performed to estimate the association between patterns scores and SBP and DBP ($p < 0.05$).

Results: The analysis included 414 individuals (45-99 years old; 63% women). Two dietary patterns were derived. The Mixed pattern was characterized by the consumption of sugar sweetened beverages, processed meats, fruits, vegetables, salty snacks, sauces and fats, milk and dairy, roots and tubers, sweets and desserts, and rice/bread/pasta and explained 50.1% of sodium and 56.6% of potassium intake with high weight on potassium (0.722) and low weight in sodium (-0.692). The Western pattern included processed meat, sauce and fats, snacks, and rice/bread/pasta, with negative factor loads for fruits, vegetables, and beans. This pattern explained 66.8% of the sodium and 70.2% of the potassium intake, with low weight on sodium (-0.721) and potassium (-0.692). The linear regression models were adjusted by sex and skin color and showed that the increase in the Mixed pattern score was associated with a decrease in SBP ($\beta = -1.9 \text{ mmHg}$; $p = 0.035$) and DBP ($\beta = -1.0 \text{ mmHg}$; $p = 0.046$).

Discussion: The use of RRR to identify dietary patterns allowed to identify patterns strongly related to micronutrients involved in the etiology of high blood pressure. A Mixed pattern that inversely associated with sodium intake was associated with a reduction in SBP and DBP.

Keywords: Reduced Rank Regression, Dietary Patterns, Blood Pressure, Linear Regression Models

Dietary patterns and nutrients intake of elderly in São Caetano, São Paulo, Brazil

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Introduction: Diet is an important factor in the quality of life of the elderly and food choice, availability and variety of foods can interfere with their current health. Identifying the food intake of this population is essential to verify the nutritional status and correlate with observed clinical outcomes. Objective: The objective of the research is to analyze the nutrient intake of dietary patterns of the elderly. Methods: For the research, we used data from the study "Evaluation of the diet quality of the elderly residents of São Caetano do Sul, Brazil". Elderly (n = 300) aged 60 and over were studied and three dietary patterns were identified by factor analysis, the traditional pattern consisting of beans, rice, vegetables, olive oil, vegetables and chicken (DP1), the second pattern by pasta, pork and pastries (DP 2) and the third (DP 3) coffee with milk and buttered bread. For the evaluation of the nutrients, the individuals adhering to the standard were considered those who were in the first adhesion tertile. Analysis of the nutritional intake of individuals to dietary patterns was performed under the following aspects: total energy (kcal), total supply (g) and percentage of proteins and amino acids (leucine and arginine), lipids (saturated and unsaturated), carbohydrates, fiber, and vitamins and minerals. Data for this analysis were statistically processed by STATA® 12.0 software, adopting a significance level of 5%. Results: A higher consumption of energy, carbohydrate and fiber was observed in the traditional pattern (DP1) and lower protein in the coffee with milk pattern (DP3). The coffee with milk pattern also had low intake of beta carotene, vitamin E and vitamin K. Complex B vitamins, niacin and folate intake was higher in the traditional pattern (DP1) and minerals such as magnesium, iron, copper and potassium had a lower intake in coffee with milk pattern (DP3), as well as the amino acids leucine and arginine. Conclusion: By analyzing the nutrient intake of dietary patterns identified in the elderly population, it is possible to highlight aspects of inadequacy and direct strategies for the promotion of adequate and healthy eating.

Keywords: dietary pattern, nutrient, elderly

Discretionary food intake is associated with varying fat and carbohydrate intake but higher energy intakes: An application of the Geometric Framework for Nutrition

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BACKGROUND: There is growing consensus of the need to determine the relationship between different dietary patterns and health, beyond the single nutrient, single food approach of the past. A critical example of this is the lack of consensus on the dietary patterns necessary to prevent obesity with both fat and carbohydrate implicated in the obesity epidemic and often separately the sole target of obesity prevention policies. The Geometric Framework for Nutrition (GFN) has been used in nutritional ecology to examine the multidimensionality of diet and its relationship with health outcomes. The aim of this study was to describe the application of the GFN to assess how the consumption of energy-dense, nutrient poor ‘discretionary foods’, changes the intake from macronutrients and energy.

METHODS: Secondary analysis of the cross-sectional National Nutrition and Physical Activity Survey (NNPAS-2011-2012) was conducted. Diet was assessed with 24-hour recall for adults aged 18 years and over (n=9,435). The percentage energy from carbohydrate, fat and protein were plotted in right-angled mixture triangles for: 1. discretionary foods and five food group foods reported in the survey and 2. participants categorized by quartiles of percentage of energy from discretionary food (Q1 <16.2% and; Q4 ≥46.7%). Total mean energy intake from macronutrients for each quartile of discretionary food was calculated. Generalized linear modelling, was used to determine mean differences, adjusted for age and sex.

RESULTS: Discretionary foods varied in carbohydrate and fat content but were protein dilute, compared to other foods. Energy from carbohydrate and fat also varied within and between quartiles, whereas percentage energy from protein decreased with increased intake of discretionary food. Energy from non-protein sources increased between each quartile of discretionary food intake and was +2333 kJ greater for those in Q4 compared with Q1 (P<0.001).

CONCLUSIONS: Discretionary foods consumed by participants varied in their carbohydrate and fat content, but higher intakes were associated with substantially higher energy intakes. These results suggest a dietary pattern with reduced discretionary food will reduce energy intake and demonstrates the utility of the GFN in examining dietary patterns.

Keywords: Geometric Framework for Nutrition, precision medicine, nutrients, dietary patterns

The NOVA framework: Characterization of food processing level and its association with incident cardiovascular disease in the Framingham Offspring Study

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Introduction: NOVA is a novel, specific, coherent and comprehensive framework to evaluate processing level and identify food groups with similar health effects. Food processing can modify the nutritional (e.g. macro- and micronutrient content), physical (e.g. food matrix) and chemical (e.g. additives, glycemic index) characteristics of foods in ways that alter their nutritional quality and health effects but has been overlooked in nutrition research. We determined the association between NOVA processing levels and incident cardiovascular disease (CVD) in the Framingham Offspring Study (FOS).

Methods: NOVA categorizes foods into 4 processing levels according to the extent and purpose of processing: (1) unprocessed/minimally processed foods, (2) culinary processed ingredients, (3) processed foods and (4) ultra-processed foods. Analyses used prospectively collected data from the FOS (1971-2014; N:3,003), an ongoing cohort study designed to investigate CVD risk factors. Data on diet, measured by a food frequency questionnaire (FFQ), anthropometric measures, sociodemographic and lifestyle factors were collected at clinical examination 5 (1991; mean age:54.3 years), which was used as baseline for these analyses. Data regarding incident CVD was available until 2014. Intakes per NOVA processing level were calculated as energy-adjusted servings/day. We created an additional category, “culinary preparations” to accommodate FFQ-items specified as homemade. Multivariable Cox proportional hazards models determined the association between processing levels and incident CVD.

Results: From 1991-2014, 648 cases of incident CVD were identified. On average, participants consumed 11.3 servings/day of minimally processed foods, 7.5 servings/day of ultra-processed foods and ≤ 2.0 servings/day of processed foods, processed culinary ingredients and culinary preparations at baseline. Each additional daily serving of ultra-processed food was associated with a 7% increase in the risk of CVD, controlling for age, sex, education, alcohol consumption, smoking and physical activity (HR:1.07, 95%CI:1.03-1.12). Additional adjustment for BMI and total energy intake did not alter the association (HR:1.07, 95%CI:1.02-1.11). Intake of the remaining processing levels was not associated with CVD.

Conclusion: Our findings support the value of NOVA to differentiate foods with beneficial and hazardous health effects owing to processing. Consideration of processing level is needed to provide a more complete understanding of the role of diet quality and dietary patterns in chronic disease development.

Keywords: NOVA, Dietary patterns, Food processing, Cardiovascular disease

Winter and summer meal patterns from the south (56°N) to the north (69°N) of Sweden – dietary habits or a role for chrono-nutrition?

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Introduction

Research in seasonal dietary variation has mainly focused on differences in types and quantities of foods consumed; however, with recent interest in the role of chrono-nutrition and health, we studied seasonal variation in meal frequency, time and size, in Sweden where daylight varies from south to north from 17-24 h in summer to 7-0 h in winter.

Methods

In the national dietary survey in Sweden, Riksmaten adults 2010-11, a representative section of the population between ages 18-80 years was sampled. Participants completed an online self-administered food diary on four consecutive days, with mealtimes recorded in 15-minute slots. We calculated hourly and daily energy intake (DEI) and the frequency of small and large eating and drinking occasions (EDO; small: time slot >210 kJ and <15%DEI; large: \geq 15%DEI). We divided the acceptable energy reporters (men/women) into three regions, from South to North: Götaland (N=308/404), Svealand (N=257/355) and Norrland (N=76/114). Mixed linear models were used to account for correlations between days and adjust seasonal and regional associations for: age (categorical), day of the week (week vs weekend), education and DEI.

Results

Mean DEI and EDO frequency were not significantly different between seasons, regions or their interaction; however, in weekend vs week days, DEI was significantly higher ($P<0.001$) by ~ 0.5 MJ/d, whereas EDO frequency -driven by small EDO- was significantly lower ($P<0.001$) by ~ 0.3 , thereby increasing meal energy density. Up to age 55 years, time of first EDO was ~ 75 -90 min later at the weekend; however, 15 min by 65 years. Time of first EDO was not associated with region or season; however, in women ($P=0.021$), time of last large EDO was earlier in Norrland, except in summer time when meals were ~ 60 min later, exceeding other regions. These differences were driven by weekend days.

Discussion

Habitual patterns overrule seasonal and regional variation, potentially helping with daylight adaptation; however, week and weekend days were associated with different meal patterns, delaying breakfast by 1 hour and consuming higher energy dense meals. Short-term dietary assessment instruments require balanced week days to study the potential role of meal pattern irregularity for health consequences.

Keywords: season, latitude, time, frequency, chrononutrition

Comparison of three diet quality scores for associations with cardiovascular events and mortality: a longitudinal analysis of 77,234 UK Biobank participants

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Introduction

Understanding the role of diet quality and health is complicated by the variety of diet quality methodologies. Methods include assessing foods to encourage and to discourage (Mediterranean Diet Score, MDS), only foods to encourage (Recommended Food Score, RFS) and both food and nutrient recommendations (WHO Healthy Diet Indicator, HDI). Comparison of these approaches will inform the international standardisation of diet quality methodologies for assessing health outcomes. This study examined the association of three diet quality indices and a polygenic risk score with incidence of all-cause mortality, CVD-related mortality, myocardial infarction (MI) and stroke.

Methods

The UK Biobank is a prospective study that recruited 500,000 adults between 2006 and 2010. Dietary intake was assessed using the Oxford WebQ diet recall at four timepoints (2011-2012). Mean diet quality was derived using the MDS, HDI and RFS. Hospital records identified all-cause mortality, CVD-related mortality, MI and stroke. Cox proportional hazard ratios (HR) were used to estimate risk of death and events for each diet quality score, adjusted for age, sex, deprivation, smoking, physical activity, medication and family history of CVD. Participants were excluded if they were pregnant, non-Caucasian, had <2 diet recalls, previous CVD and missing data.

Results

A total of 77,004 adults (M=56.2 years, 55% female) were included. New MI (n=1,141) and stroke (n=748) events and deaths due to CVD (n=364) and all-cause death (n=2,409) were identified during a mean follow-up of 7.8 years. The HR associated with one-point higher RFS was 0.96 (95% CI:0.94,0.98) for all-cause mortality, 0.94 (0.90,0.98) for CVD-related mortality, 0.97 (0.95,1.00) for MI and 0.94 (0.91,0.98) for stroke. The HR for all-cause mortality associated with one-point higher HDI and MDS was 0.97 (0.93,0.99) and 0.95 (0.91,0.98), respectively. The HR associated with one-point higher MDS was 0.93 (0.87,1.00) for stroke. There was little evidence of associations between HDI and risk of CVD-related mortality, MI or stroke. There was only evidence of an interaction between diet quality and genetic risk for MI.

Discussion

Higher diet quality (RFS, HDI and MDS) predicted lower risk of all-cause mortality, independent of genetic risk. Higher RFS was also associated with lower risk of CVD-related mortality and MI. These findings demonstrate the benefit of following a healthy diet, regardless of genetic risk, and that different indices may be more applicable for certain health outcomes.

Keywords: diet quality, cardiovascular events, death, longitudinal, UK Biobank

Dietary patterns by sex: Adolescence as a critical window

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Introduction: sex differences in dietary patterns have been established; however, there is no clear temporality of the emergence of these dietary differences. Adolescence is a critical period for several biological and behavioral risks, but it is unclear how it relates to sex dietary differences. Thus, the aim of the present study was to describe the dietary patterns according to sex and to examine their associations with excess body weight in male and female adolescents.

Methods: We collected data for 882 Chilean adolescents from the Growth and Obesity Cohort Study (mean age 12 years old, 50.8 % girls). Dietary intake was assessed through a standardized 24-h recall by a trained dietitian, as well as anthropometric measurements. Dietary patterns were obtained through exploratory factor analysis. Logistic regression models adjusted for potential confounding variables, were used to examine the association between dietary patterns and body weight.

Results: In girls, we identified three dietary patterns (20.4% variance of the diet): “Breakfast” pattern consisted of tea, sugar, bread, margarine/butter, yogurt, cold cuts (positive loading) and flavored milk (negative loading); “Meat and Vegetables” consisting of meats, vegetables, oil/lemon/vinegar/salt to salad (positive loading) and “Modern” pattern consisting of yogurt, cold cuts, rice/pasta/potato, ready to eat cereal (positive loading) and traditional dishes (negative loading). In boys, we identified three dietary patterns (20.5% variance of the diet): “Breakfast” (same food groups that girls), “Meat and Vegetables” consisted of meats, vegetables, rice/pasta/potato (positive loading); traditional dishes (negative loading) and “Modern breakfast” pattern consisting of yogurt, milk, ready to eat cereal (positive loading) and bread, flavored milk (negative loading). In girls the “Meat & Vegetables” pattern was associated with overweight (OR=2.08, 95% CI 1.21-3.55), while in boys we no found association between dietary patterns and overweight.

Discussion: our results suggest that dietary patterns of adolescents differ by sex, highlighting the need of promoting public health messages that take into account sex differences observed at this age.

Keywords: dietary pattern, adolescent, sex, overweight

Application of the NOVA framework to food frequency questionnaire data: Lessons from the Framingham Offspring Study

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Introduction: Food processing level is receiving increasing attention in nutrition research, yet data regarding processing level is not routinely collected. We propose using the NOVA framework to uniformly assess processing level across populations, however there are challenges in operationalization. We examined the application of NOVA to food frequency questionnaire (FFQ) data.

Methods: We applied NOVA to dietary data collected by the 131-item Harvard FFQ in the Framingham Offspring Study (FOS) exam 5 (N=3,003; mean age:54.3years). NOVA categorizes foods into 4 processing levels according to the extent and purpose of processing: (1) unprocessed/minimally processed foods, (2) culinary processed ingredients, (3) processed foods and (4) ultra-processed foods. We created a fifth category, “culinary preparations” to accommodate FFQ-items specified as homemade (e.g. home-baked cookies) and mixed dishes lacking detail regarding source (e.g. soup/chowder). FFQ-items including foods of different processing levels (e.g. plain/flavored yoghurt) were classified according to the most frequently consumed form among adults in the National Health and Nutrition Examination Survey (NHANES) 2004-2015. Breakfast cereals were categorized based on product ingredients, as FFQ-respondents specify brand names. Intakes per processing level were calculated as servings/day, as calories per FFQ-item was unavailable. Descriptive statistics of dietary characteristics were generated across quintiles of energy-adjusted ultra-processed food consumption, and linear trends across consumption-quintiles were assessed by linear regression.

Results: FOS participants consumed 11.3 servings/day of minimally processed foods, 7.5 servings/day of ultra-processed foods, 2.0 servings/day of processed culinary ingredients, 1.6 servings/day of processed foods and 0.6 servings/day of culinary preparations. Compared to the bottom quintile of ultra-processed food intake (<5.3servings/day), participants in the top quintile (>9.5 servings/day) consumed more fat (28.9vs.32.0%kcal) and saturated fat (10.2vs.11%kcal) but less protein (17.5vs.15.8%kcal) and fiber (10.7vs.9.9gram/1000kcal; p for trend<0.01).

Discussion: It is plausible to estimate intake of NOVA processing levels as servings/day from FFQ-data and data-driven approaches using national nutrition surveys can support classification decisions. However, we were unable to estimate calories per processing level. Differences in macronutrient intakes between high- and low consumers of ultra-processed foods in FOS align with results from NHANES based on 24h-recall data, supporting the value of applying NOVA to FFQ-data.

Keywords: NOVA, Food frequency questionnaire, dietary patterns, Ultra-processed foods

8. Database development and resources

Enabling between-country comparative analyses of dietary intake through linked food and nutrient databases

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Surveillance of population-level dietary patterns is critical to inform policies to support healthy eating. Comparative studies that leverage policy contrasts between contexts can lend particularly valuable insights, with linked food and nutrient databases uniquely enabling such studies. Linkage of codes within the United States Food and Nutrient Database for Dietary Surveys (FNDDS) and the Canadian Nutrition Surveillance System (NSS) was initially pursued to support the development of a Canadian adaptation of the Automated Self-Administered 24-hour Dietary Assessment Tool (ASA24). Subsequently, all food codes within FNDDS and NSS were matched based on food and beverage names and descriptions, enabling several lines of inquiry using dietary data collected in each country. For instance, the linkage facilitates between-country comparisons of usual intake and sources of nutrients and food groups, with standardized estimation of food group intakes based on the United States Food Patterns Equivalents Database. Further, recent applications of FNDDS, such as identification of food codes reflecting foods and beverages containing low-calorie sweeteners, can be applied to data coded using NSS, enabling examination of Canadians' exposure to low-calorie sweeteners for the first time, as well as between-country comparisons of the prevalence of low-calorie sweetener consumption. Applying country-specific food and nutrient databases to dietary intake data is critical for accounting for unique aspects of the food supply, such as fortification. Linking such databases across contexts can subsequently facilitate novel analyses to inform promising approaches to improve eating patterns, as well as supporting the development and maintenance of tools such as ASA24 that enable collection of detailed dietary data. Future enhancements will seek to extend the linkage to additional countries to allow broader policy-relevant analyses of dietary intake data.

Keywords: databases, comparative analyses, dietary intake

Key food matchings: assessing the suitability of a nutrient database for a national dietary survey

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Introduction: Properly matching available nutrient values to food consumption data is a continuous challenge for national dietary surveys considering the costs for developing and updating high quality food composition databases. Here, we combine a key food approach and a quality assessment of food matchings to identify strengths and limitations of the Brazilian Food Composition Table version 7.0 (TBCA 7.0) in the context of a national dietary survey. Methods: Population-based food consumption data of Brazilians aged >10 years was obtained in the first Brazilian National Dietary Survey (INA/POF 2008–2009) using individual food records (n = 34.003). All food codes from INA/POF 2008-2009 were manually aligned to counterparts in TBCA, based on their closest names/synonyms, descriptors and classifications. When a not exact match was needed, a set of divergent characteristics possible affecting the final nutrient contents was documented, such as differences in cooking methods, fat and sugar contents, food taxonomy, etc. Using the built nutrient database, the key foods approach proposed by the United States Department of Agriculture (USDA) was employed to identify major foods contributing to up 75% of nutrient intakes. For all identified key foods, the quality of their matchings with the TBCA are being classified according to guidelines of the International Network of Food Data Systems (INFOODS). Results: Of the 1442 foods included in the survey, 145 (10%) were identified as key foods. So far, 54 of them had their matching quality assessed. For majority (64.8%), high quality data was available for all assessed nutrients. Not exact matchings (n = 19) occurred mainly due the use of recipe calculations rather than analytical data (57,8%), absence of multiple entries for generic items (57,8%) and lack of data on alternative cooking methods for specific foods (1.8%). Discussion: These preliminary results signalize that the TBCA 7.0 have a good coverage of data to support the evaluation of Brazilian dietary components with public health significance. Major limitations of the current database version seems to relate to food biodiversity and nutritional modification of foods by common processing methods, pointing out priority aspects for future improvements and updating.

Keywords: food matching, dietary survey, nutrient intake, data quality

Food-based clinical trial dataset: development, content and applications to practice

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Introduction

Excess weight is a risk factor for many chronic diseases and is associated with increased mortality. Pooled clinical data derived from food-based randomised controlled trials (RCT) for weight loss allows re-analysis, and testing of new hypotheses for weight management. The aim of the study was to collate dietary and clinical measures derived from food-based clinical trials.

Methods

Data from previously published food-based parallel RCTs for weight loss in Australia over a 15 year period were pooled. Participants of the trials were adult overweight residents of the Illawarra Region of New South Wales, Australia with food intake data was assessed via a dietitian-administered diet history interview. Dietary intake data was standardised by using the AUSNUT 2011-13 food composition database and the Australian Dietary Guideline database. Demographics, body composition, pathology tests, psychological and other measures were integrated using participant identification codes.

Results

A total of 842 participants were identified from five food-based trials. The pooled dataset includes demographics (gender, age, date of birth, country of birth, education, occupation, smoking status), body composition (body weight, height, body mass index, dual energy X-ray absorptiometry, computed tomography scans results), pathology tests (lipid fractions, fasting blood glucose, insulin, HbA1c, 24-hour urine sodium and potassium, heart rate, blood pressure) and psychological profiles (survey results of physical mental health short form, acceptance and action with 11 questions, depression anxiety stress short form, rigid control of diet).

Discussion

The pooled data forms an individual-level integrated dataset of detailed dietary intake and clinical measures creating a community-based cohort. The dataset not only allows new research questions to be answered on the diet-disease relationship, but also new clinical research questions for weight loss, such as attrition in clinical trials. The dataset is a useful new resource to facilitate the new discoveries for weight management.

Keywords: dietary intake, diet history, database, weight loss, clinical trial

Objective physical activity assessment in a large population-based cohort: the Rotterdam Study

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Introduction: Physical activity (PA) is often measured with self-reported questionnaires, particularly in large population-based studies. Some of their major limitations, such as recall bias, can be overcome by objective measurements, which also provides opportunity to study the composition of daily movement behaviours within 24 hours of the day. We present the current objective PA data collection in the Rotterdam Study. As an example of how we use the data we present the association of physical activity, sedentary behaviour (SB) and sleep within the 24-hour clock with mental health using compositional analyses.

Methods: The Rotterdam Study is an ongoing prospective population-based cohort study, originating in 1990, of adults aged 45 years and over. The cohort has a total sample of 14,926. From 2011 onwards, objective measurements were added using triaxial accelerometry (GeneActiv). To examine the association of the composition of physical activity, sedentary behaviour and sleep with mental health we used compositional isotemporal substitution analyses.

Results: Between 2011 and 2016, 2,338 participants agreed to participate in accelerometry measurements (84%), of which 1,945 had complete and valid data (mean age 71±9 years, 52% women, mean wear time 5.9 days). Participants that agreed to participate were more often men (48% of included vs 39% of excluded participants) and more often highly educated (25% of included vs 19% of excluded participants).

On average, participants spent 6h26min (±62min) sleeping, 13h32min (±79min) sedentary, 2h28min (±32min) in light PA and 1h23min (±29min) in moderate-to-vigorous PA. Participants with a higher age or BMI, and those with chronic disease or disability, generally spent less time physically active.

Replacing any of the activity domains (light PA, SB or sleep) with more moderate-to-vigorous PA, was associated with less depressive symptoms.

Discussion: Objectively measured physical activity data in large population-based studies provides insight regarding descriptive data, determinants and health outcomes of PA. More detailed and mechanistic insight in PA may be gained by ongoing and future work on specific types, distributions and longitudinal assessments of PA.

Keywords: physical activity, cohort study, accelerometry, compositional analyses, middle-aged & elderly.

Development of a food composition database for the intake estimation of total, added and free sugars in different EU countries and age groups

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Introduction: The database development is a part of the protocol for the Scientific Opinion on the Tolerable Upper Intake Level of dietary sugars of the European Food Safety Authority (EFSA) Panel on Nutrition, Novel Foods and Food Allergens, supported by the ad-hoc Working Group on sugars.

Since only total sugars are subject to mandatory labeling in Europe and there are no analytical methods to distinguish between naturally-occurring, added and free sugars present in foods, available data on total sugars was used as starting point.

Methods: A single European database for total sugars was developed from the information available in the national food composition databases included in the EFSA Nutrient Composition Database. A comprehensive data cleaning including outlier analysis was performed. Total sugars content of foods and beverages was checked in the online Mintel's Global New Products Database according to the nutrition information indicated on the labels of the packaging. For each food category, the mean value of the corresponding available total sugar values was taken as a unique value.

A systematic procedure developed from previous methods to estimate added and free sugars in foods was used to calculate or assign the best fitting added and free sugars values to the different food categories for which a total sugars value was available.

Results: Estimates of intake for total, added and free sugars from all dietary sources will be obtained using food consumption data from the EFSA Comprehensive Food Consumption Database in combination with the developed food composition databases for total, added and free sugars. The intake of total/added/free sugars will be calculated at individual level by multiplying the average daily consumption of each food by the corresponding concentration of total/added/free sugars, summing up the respective intakes throughout the diet. Data on the contribution of different food groups to (total/added/free) sugars intake by survey and age group will also be presented.

Discussion: The accuracy and uncertainty of the developed food composition databases is discussed in view of their use to estimate the intake of total, added and free sugars in different EU countries and age groups.

Keywords: sugars, intake, estimation, composition, database

NutriDiary – a framework for collecting 3-day weighed food records

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Introduction: Smartphone technology has the potential to facilitate dietary assessment in epidemiological studies. Real time recording might be more feasible with mobile methods and with this, measurement error could be reduced. We developed NutriDiary, a smartphone app for conducting 3-day weighed food records (FR). Our aim is to describe the current framework and future improvements.

Methods: The NutriDiary beta version was developed as a text-based app. Users initially enter the date, time and place of consumption. Next, a food or drink item is selected from the integrated database using a free-text search. Branded food products (BFP) currently not included in the database are added to the users' personal databases after the first logging. Finally, users enter the amount consumed, mode of preparation, and quantity of left-overs. For collecting information on BFP, NutriDiary includes a photo function. Data are submitted to a server, which also provides administration tools to researchers. The integrated database LEBTAB comprises both BFP and generic items. For the inclusion of new BFP, a recipe simulation based on the list of labelled ingredients and nutrients is conducted manually. To optimize the app, a barcode scanning function (NutriScan) and an automated recipe simulation should be added to the framework.

Results: For improving the data collection and ensuring the correct coding of food items, the function NutriScan was developed. The app component is tasked with data collection and will be integrated into the NutriDiary app to facilitate the search for food items. Next, a data extraction algorithm from photos is built, which will be fulfilled by the back-end service of the NutriScan framework. Specific computer-vision and machine learning algorithms will be applied in order to extract information on ingredients and nutrients. A moderation platform will provide error correction capabilities to the researcher. In the end, an automated recipe simulation algorithm will complement the overall NutriDiary framework.

Discussion: The development of reliable dietary assessment tools with low participant burden is of high interest for epidemiological studies. Our approach will lead to a FR smartphone app with a self-expanding up-to-date database including detailed food information in research-quality.

Keywords: dietary assessment, smartphone application, machine learning, barcode scanner, food record

Development of a FODMAP scoring database to measure habitual dietary FODMAP consumption

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Introduction:

'Fermentable Oligo-, Di-, Mono-Saccharides and Polyols' (FODMAPs) are a group of short chain carbohydrates associated with gastro-intestinal (GI) symptoms. The 'low-FODMAP diet' effectively reduces symptom burden, however, growing evidence indicates the diet may have negative biological effects including gut microbiome dysbiosis. FODMAP research is difficult due to limited resources available for dietary measurement. Currently, the only comprehensive FODMAP composition data resource is 'Monash University Low FODMAP Diet' app and habitual dietary consumption can be estimated using Monash University's 'Comprehensive Nutrition Assessment Questionnaire'. Both of these resources focus on the Oceanic diet so may not be suitable for research in the United Kingdom. It is therefore important to evaluate if there is sufficient FODMAP composition data that can be applied to a local UK Food Frequency Questionnaire (FFQ) to further investigate how FODMAP intake impacts health.

Methods:

FODMAP score database for the UK diet was compiled and linked to the 661 food and drink item 'electronic Scottish Collaborative Group-FFQ' (eSCG-FFQ). Each item was assigned a 1-3 score (low, moderate or high FODMAP content) utilising the traffic light system within the Monash University app. Unaccounted items were assigned scores with one of three standardised assumption processes depending on the items contents. FODMAP scores for food and drink items were averaged into 18 groups (to analyse FODMAP distribution in UK diet) and 169 types (to calculate FODMAP intake scores for participants in a sub-sample of an Inflammatory Bowel Disease cohort (n= 686) where eSCG-FFQ data was collected).

Results:

286 items (43.4%) were assigned FODMAP scores utilising the app. 371 items (56.1%) required assumptions to assign their scores. Two items were not assigned a score. FODMAPs were widely distributed in the UK diet with only 3 of the 18 food and drink groups not containing high-FODMAP items. The median calculated FODMAP intake score for the sub-sample was 67.2 (54.3, 83.8).

Conclusions:

Local UK FODMAP composition data is required for reducing assumption requirements to improve accuracy of database. Further testing and validation of the eSCG-FFQ with the database link is required to assure FODMAP diets can be effectively monitored for future research.

Keywords: FODMAP, Low FODMAP Diet, Food Frequency Questionnaire

Development of an updated Central Asia Food Composition Database for nutrition research in the CIS

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Background: Out of all 195 countries surveyed, the proportion of diet-related deaths was high in several CIS member states (1). It was highest in Uzbekistan, Turkmenistan ranked second and the third was Kyrgystan followed by Ukraine, Moldova, Azerbaijan, Belarus, Tajikistan and Kazakhstan(1). Carrying out accurate and reliable dietary assessment is vital for effective nutrition surveillance in order to implement public health programmes to reduce these diet-related deaths. No matter the choice of any dietary assessment method, an appropriate and updated food composition database is needed to help to improve the consistency and comparability of dietary data. To date, to the best of the authors' knowledge there is very limited published information on any Central Asia food composition table in the English literature.

Objective: To potentially help to improve accuracy of dietary assessment and nutrition research as well as data sharing, a Central Asian specific electronic food composition database containing about 2500 contemporary and traditional food and drink items are currently being developed.

Methods: Firstly, we sourced food composition data from literature published in Kazakh or Russian. Then we carried out cleaning and processing of the source data to ensure correct translation and avoid duplicates. Starting with beverages, we carried out a mapping exercise to match nutrient data to nutrition labels from labelled food products with shopping bar codes. Several quality checking procedures were applied. These included identifying foods above and below the expected range for a particular nutrient within that food or beverage group. The new electronic food composition database will then be subsequently incorporated into an online dietary assessment tool and potentially, a smartphone application.

Conclusion: The current development will help to reliably characterise food and nutrient intake in population studies in the CIS.

Keywords: food composition database, Central Asia, Traditional foods

The intake and main sources of added sugar in the diet of Finnish preschool children according to parental educational level

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Introduction

Studies show that lower parental education is associated with less healthy diet in children. In many countries, children's added sugar intake exceeds the recommendation (<10 E%). We aimed to examine the intake and main sources of added sugar in the diet of preschoolers according to parental educational level (PEL).

Methods

A cross-sectional study in Finnish preschoolers (the DAGIS Study) was carried out in 2015–2016. Parents and preschool personnel filled in children's 3-day food records. To capture seasonal variation, a part of the families kept an additional 2-day food record. In this analysis we included children (n=811) with data for PEL and at least 1-day food record. We analyzed the diet using the Fineli food composition database. Since Fineli does not contain added sugar values, we estimated added sugar intake ourselves. We assigned each food item to a food group and gave each food group containing significant amounts of sugar a formula for estimating the relative amounts of naturally occurring and added sugar. To create these formulas, we used the information on relative proportions of ingredients from package labels, composition values of ingredients in Fineli, added sugar values on manufacturer's websites, and commonly used recipes. We used Kruskal-Wallis test and highest PEL in family in the statistical analysis.

Results

On average, the intake of added sugar was as recommended (<10 E%) in all PEL's with no socioeconomic differences (low: 9.5 E%, middle: 9.4 E%, high: 9.0 E%; p=0.460). The main sources of added sugar in all PEL's were milk products (especially yoghurts), sugar and sweets, and beverages. The PELs differed in terms of added sugar obtained from sugar-sweetened soft drinks (low: 1.6 g (5.0 %), middle: 1.1 g (3.5 %), high: 0.7 g (2.2 %); p=0.002). Otherwise there were no statistical differences in the main sources of added sugar.

Discussion

In preschoolers, the intake of added sugar was in line with recommendations and there were no differences in the intake according to PEL. Children in lower PEL obtained more added sugar from soft drinks, but the consumption of soft drinks was quite low in all children in our data.

Keywords: sugar, sugar-sweetened beverages, socioeconomic status, children

Developing a mobile app for food consumption surveys: pros and cons of barcode data.

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Introduction. Modern techniques using mobile devices and the availability of barcode specific product data may alleviate some of the challenges in collecting large-scale food consumption data. A mobile phone food diary app with an integrated barcode scanner is easy to use for study participants and may result in enhanced product characterisation for the researcher. Yet, the use of barcode data poses new challenges. This paper will address the pros and cons of barcode specific data for use in a mobile phone food diary app.

Methods. A food diary app was developed which allows the participant to search for food items using text search options or an integrated barcode scanner. Barcodes were obtained from a database covering approximately 100,000 food products available in the Netherlands. In addition 4,000 generic food items were defined. The text search function was designed to allow the study participant to search all available foods. An algorithm was defined to show the most relevant products first, with priority for generic products over barcode specific products. Filters can be applied to narrow down the results. Preliminary versions of the app were tested in various small-scale settings.

Results. Study participants were enthusiastic about the use of the barcode scanner, it offers the fastest manner to identify the consumed food. Without filtering the text search option may yield a large number of results. It proved to be impossible to define a general algorithm, suitable for all products, to display products according to their relevance. As a result the relevant products were not always shown at the top of the list making suboptimal product selection more likely.

Discussion. Using barcode data offers advantages when the product can be found using the barcode scanner. However, including the barcode specific products in the text-search results presents the study participant with a list of results too large to handle. The large variety in the names of similar foods makes it difficult to define algorithms to assess the relevance of search results. Options will be discussed to deal with this drawback of using barcode specific data in a food diary app.

Keywords: Food consumption survey, mobile device, diary app, barcode, data handling

A multi-classifier machine learning approach to matching barcode specific foods to generic foods

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Introduction

Using barcode specific food data in food consumption surveys facilitates quick and reliable food identification. As study participants scan a barcode, associated food product data, such as ingredients and (macro)nutrients, can instantaneously be retrieved. This data needs to be complemented with for instance micronutrient content data of generic foods, residing in a food composition database. Doing so requires a labour intensive process of matching barcode specific foods to generic foods. This paper describes how a semi-automatic machine learning approach can be used to match barcode specific foods to generic foods.

Methods

Data from approximately 100.000 barcode specific foods were taken from the Dutch LEDA-database, consisting of both textual and numeric data. Generic foods were taken from the Dutch Food Composition Database (NEVO). Using a combination of multiple supervised and unsupervised machine learning techniques, a Multi-Classifer System (MCS) was designed to match barcode specific foods to generic foods. The supervised algorithms inside the MCS were trained on a dataset manually matched by expert dietitians. This training dataset contained 384 generic NEVO foods matched to 8548 barcode specific foods. Relevant knowledge for some of the unsupervised algorithms in the MCS was provided by means of an ontology (i.e. semantic web technology). The MCS was validated using 5-fold stratified cross-validation.

Results

The MCS correctly predicted the matching NEVO product for 86% of the barcode specific foods in the training data set. Exploration of the most frequent misclassifications showed that misclassification (mostly) occurs when NEVO products are similar, for instance “chicken breast raw” and “chicken with skin raw”, or “peanut butter” and “chunky peanut butter”.

Discussion

The current results show that the MCS can reliably predict the matching generic NEVO food for barcode specific foods in the training dataset. It can be expected that the performance will decrease when more generic NEVO foods are included. Further extension of the ontology is in progress to improve the unsupervised techniques. These preliminary results suggest that these techniques have the potential to substantially reduce the work load involved in matching barcode specific foods to generic foods.

Keywords: Food data, classification, data science, machine learning, artificial intelligence

9. Contextual factors (e.g. environmental modifiers)

Pregnant women's adherence to the Dutch food-based dietary guidelines assessed using the DHD15-index

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Background: Promoting a healthy diet in antenatal care is promising, as diet during pregnancy affects both maternal and child health, pregnant women are typically open to dietary changes during this critical transition, and midwives are their first and most important source of information. Unfortunately, nutrition communication by Dutch midwives is currently limited. Therefore, the aim of our project is to develop a toolbox for midwives to promote healthy nutrition among pregnant women. To inform the development of this toolbox, we assessed how well low SES pregnant women in the Netherlands adhere to the 2015 Dutch food-based dietary guidelines compared to those with a higher SES.

Methods: Intake assessed by a 185-item interviewer-administered, Dutch diet history questionnaire (DDHQ) was scored with the 2015 Dutch Healthy Diet index (DHD15-index). Scores ranged from 0 (no adherence) to 10 (full adherence) per component. Index scores for twelve components were compared between the current population of low SES pregnant women (n=37), higher SES pregnant women in the GLIMP2 study (n=55) and non-pregnant women of reproductive age in the NQplus study (n=57).

Results: Overall diet quality according to the mean DHD15-index scores was significantly lower in our low SES population (M=4.2, SD=1.1) than in GLIMP2 (M=6.2, SD=1.1) and NQplus (M=6.5, SD=1.2) populations. More specifically, the low SES pregnant women scored significantly lower on the adequacy components wholegrain products, fruit, nuts, tea and vegetables, and the optimum component dairy. On the other hand, the low SES group scored significantly higher on the moderation component red meat.

Conclusion: Low SES pregnant women have a lower overall diet quality than higher SES pregnant women and non-pregnant women of reproductive age. It could be useful to develop a tool to assess diet quality in antenatal care, to provide more personalized nutrition communication.

Keywords: diet quality, pregnancy, socioeconomic status

Cycle path use and physical activity level in urban Brazilian adults

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Introduction: The use of bicycles, as transportation, has been increasing in Brazil with the implementation of cycle paths in urban centers. However, only 7% of Brazilian population considers bicycles as the main means of transportation. It is known that active transportation, besides reducing traffic congestion and air pollution, is capable of improve health, and stimulating physical activity practice. Thus, the aim of this study was to evaluate the use of cycle paths and its association with physical activity level (PAL) in adult population of Brasília, the capital of Brazil. Methods: Cross-sectional study with 506 adults (age>20 years), residents in central area of Brasília. Use of cycle paths was assessed through questions about the use (yes or no), agreement about construction of cycle paths in the city (yes or no) and purpose of use (walking/running/cycling). PAL was evaluated by 24-h physical activity recall (measurement error corrected by accelerometry), and categorized by metabolic equivalent per hour (MET-h) values. During the fieldwork period (2016-2017), no publicity or government promotion was conducted to implement and favor cycle path use. The association between use of cycle paths and PAL was tested through Poisson regression, adjusted by sex, age and socioeconomic class. Significance level of 5% was adopted. Results and discussion: Users profile was individuals between 31 and 50 years old, high schooling, median socioeconomic class, non-smokers, and with body mass index (BMI) < 25kg/m². In our study, 92% of respondents agree with cycle paths construction, but only 38% of sample reported use of cycle paths. From users, only 35% utilized exclusively for cycling, 58% used for running/walking, and 7% for walking, running and cycling. It was observed a significantly association between use of cycle paths and PAL ($p<0.001$), with a prevalence ratio of 1.02 (95% CI 1.008–1.029). Conclusion: The results demonstrate an underutilization of cycle paths with a diverse use of this city transport apparatus. The use of cycle paths has an ample possibility for increase and should be stimulated by government campaigns. The observed 2% increase in PAL by users may be important to promote cycling transportation in cities with cycle path availability.

Keywords: bicycling, transportation, locomotion, exercise, urban population

BigO: A public health decision support system for measuring obesogenic behaviors of children in relation to their local environment

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Introduction Obesity is a complex disease and its prevalence depends on multiple factors related to the local socioeconomic, cultural and urban context of individuals. Many obesity prevention strategies and policies, however, are horizontal measures that do not depend on context-specific evidence.

Methods In this paper we present an overview of BigO (<http://bigoprogram.eu>), a system designed to collect objective behavioral data from children and adolescent populations as well as their environment in order to support public health authorities in formulating effective, context-specific policies and interventions addressing childhood obesity.

Results We present an overview of the data acquisition, indicator extraction, data exploration and analysis components of the BigO system, as well as an account of its preliminary pilot application in 14 schools and 2 clinics in four European countries, involving over 5,000 participants. Preliminary data will be presented.

Discussion Big data platforms may be used to give insight in the efficacy of obesity prevention strategies taking into account the multifactorial nature of the problem.

Keywords: obesity, obesogenic environment, children

Adherence to the goals of a lifestyle intervention among overweight pregnant women

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Introduction: Studies that evaluate the adherence of lifestyle program in overweight pregnant women are scarce. The aim of the present study is to evaluate the preliminary results of adherence to the goals of a lifestyle intervention in overweight pregnant women.

Methods: This is a randomized controlled clinical trial conducted at primary healthcare units in Ribeirão Preto, SP, Brazil. Those enrolled into the intervention group participated in three individualized nutritional counseling sessions, consisting of diet and physical activity, whereas the participants in the control group received only the usual prenatal care. Adherence to the goals related to food consumption was assessed by a screener and the practice of physical activities was assessed by questionnaire adapted, at baseline and after the intervention. The proposed goals were: (1) at least 10 times a week of homemade food; (2) at least 10 times a week of vegetables; (3) at least five days a week of fresh fruit; (4) maximum two days a week of sugary drinks; (5) a maximum two days a week of ultra-processed food; and (6) at least 150 minutes of regular physical activity per week among pregnant women without obstetric contraindications. A score (ranging from 0 to 6) was calculated, giving a point to each goal achieved, as described above. Achieving at least four out of six points was considered adherence, independent of the group of allocation. To compare the adherence of the study goals, the chi-square test was used and significance was set at $p < 0.05$.

Results: In the intervention group the mean (SD) age of women was 27,3 (5,4) years, 9,7 (2,2) years of schooling and a body mass index of 30,8 (1,9) kg/m². At enrolment, there was no statistical difference ($P=0.31$) between the groups in relation to the goals (score ≥ 4). However, after the lifestyle intervention, participants in the intervention group showed greater adherence to the first goal ($P=0.048$) and greater adherence to overall goals ($P<0.001$), compared to control group participants.

Discussion: The pregnant women in the intervention group presented better adherence to nutritional goals. Thus, it is essential to promote effective nutritional intervention strategies during pregnancy.

Trial registration: ReBEC RBR-2w9bhc June 27th 2018

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Keywords: *Pregnancy, Overweight, Lifestyle intervention, Food processing, Physical activity.*

Diet intervention improves body composition in weight stable patients with Rheumatoid Arthritis: insights from the randomized controlled cross-over trial ADIRA

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Background & aims:

In Rheumatoid Arthritis (RA), a substantial loss of lean mass while retaining total body mass, i.e. Rheumatoid Cachexia (RC), is common. Pharmacological treatment fails to improve body composition in RA, but the role of diet is unknown. In a randomized controlled crossover trial, we tested the effects of a proposed anti-inflammatory, Mediterranean style diet regimen versus a western diet in patients with RA (n=45).

Methods:

Body composition was measured using bioimpedance spectroscopy (Impedimed SFB7). Primary outcomes in this report are fat mass (FM), fat free mass (FFM) and fat mass percentage (FM%).

Results:

There were no significant differences in any measures of body composition between intervention and control periods. Weight was stable throughout the study duration. FFM increased significantly during both intervention (0.935 kg, 95% CI 0.278 1.591) and control period (0.778 kg, 95% CI 0.123, 1.434). FM% decreased during both intervention (-1.364 %, 95% CI -2.251, -0.476) and control period (- 1.219, 95% CI - 2.105, -0.333). FM decreased during intervention period only (-0.995 kg, 95% CI -1.889, -0.101).

Conclusions:

Body composition improved significantly in weight stable patients with RA by participating in a dietary intervention, regardless of intervention arm. This indicates a potential to treat RC by dietary manipulation and motivates further studies and evaluation of long-term effects.

Trial registration:

This trial is registered at ClinicalTrials.gov as NCT02941055.

Keywords: Rheumatoid Arthritis, Cachexia, Diet Therapy, Cross-Over Studies

Sleep duration of adolescents: associations with diet quality and eating behaviors in a population-based study from Brazil

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Introduction: Sleep and eating patterns are behavioral outputs of the circadian clock. Shorter sleep may be associated with poor diet quality and inadequate eating behaviors. Thus, this study associated sleep duration with diet quality and eating behaviors from a chrono-nutrition perspective among Brazilian adolescents. Methods: Data were collected from the Health Survey of São Paulo-2015, a population-based study with 480 adolescents of both sexes from São Paulo, Brazil. Dietary data were obtained from a 24h dietary recall and the diet quality was assessed using the Brazilian Healthy Eating Index– Revised (BHEI-R). Eating behaviors variables were evaluated encompassing aspects of chrono-nutrition (eating frequency and eating period), as performed in previous studies. Sleep duration was obtained through self-reported data and categorized in <8h, 8-10h, and >10h. Descriptive statistics, multiple linear and Poisson regressions adjusted for covariates examined these associations. Results: About 31% of the adolescents were classified as short sleepers. Lowest overall diet (M=53.6; 95%CI 53.2-54.0), increased total grains (M=4.6; 95%CI 4.6-4.7) and whole grains (M=0.30; 95%CI 0.28-0.32) scores were associated with the lower category for sleep duration. Longer hours of sleep were associated with higher score for oils (M=9.7; 95%CI 9.6-9.8), saturated fat (M=7.2; 95%CI 6.9-7.4) and SoFAAS (Solid Fats, Alcohol and Added Sugars) (M=8.4; 95%CI 8.0-8.7). Having a larger eating frequency in the morning (M=1.4; 95%CI 1.3-1.4) was associated with lower hours of sleep, and in the evening for longer hours of sleep (M=1.6; 95%CI 1.5-1.6). About eating period (in hours), long duration sleepers presented shorter eating period (M=9.8; 95%CI 9.5-10.2) compared to their counterparts. Discussion: Sleep deprived individuals appeared to be more prone to have poor diet quality, with higher consumption of energy-rich foods, such as fast foods and sweets. Short sleepers had higher eating frequency in the morning and the long ones, in the evening. Studies suggests the ability of food timing to alter peripheral tissue clocks, leading to internal disruption. These results support the need to assess the role of sleep duration and strategies for improving diet of adolescents.

Keywords: Sleep duration; Diet; Chrono-nutrition.

Chronotype, social jetlag and meal timing in the Spanish EPIC cohort

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Background: Recent studies link energy regulation to the circadian clock at the behavioural, physiological and molecular levels, emphasizing that the timing of food intake and chronotype itself may have a significant role in total energy consumption. We investigated the relationship between chronotype and social jetlag with caloric intake and distribution of macronutrient along the day.

Methods: Cross-sectional analysis of 3867 subjects from a sub-sample of the multicentre Spanish EPIC cohort (European Investigation into Cancer and Nutrition study) was performed. Data on food consumption was collected using a validated diet history. Chronotype was assessed by use of the Munich Chronotype Questionnaire. Social jetlag was defined as the difference between the midpoint of sleep on free days [(wake up time + sleep start time)/2 + sleep start time] and midpoint of sleep on workdays. Geometrics means adjusted by sex, age and centre were estimated.

Results: Preliminary analyses showed that after adjusting by sex, age and study centre, subjects with evening chronotypes consumed 20% more calories and a more rich-lipids meal at dinner than morning types. This tendency was also observed in subjects with more social jet lag (> 1.30 hs. Vs. < 30 min). In relation to eating timing, men who have lunch later than 3 pm, consumed 8% more calories than those who have lunch before 2 pm. This pattern was not observed in women. In addition, those who consumed any food after 11 pm had a total caloric intake 6 % higher compared to subjects that their last eating was before 9pm.

Conclusions: Preliminary results show that evening chronotypes and subjects with more social jetlag tend to consume more calories later on the day. Further analyses including follow-up information on sleep quality and body composition are needed to better explain these findings.

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Keywords: meal timing, obesity, social jet lag, chronotype

Diversity in dietary patterns by age, ethnicity and urbanicity in Malaysian adolescents: a reduced rank regression analysis

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Introduction: Reduced rank regression (RRR) is a hybrid dietary pattern analysis technique that is data-driven and incorporates hypothesised causal mechanisms. RRR has previously identified an energy-dense, high-fat, low-fibre dietary pattern associated with poorer cardiometabolic health in European and Australian adolescents. However, data-driven methods, like RRR, identify dietary patterns that are sample-specific and may not be generalisable if specific foods contribute differently to a dietary pattern across countries or population sub-groups. We applied RRR in the Malaysian Health and Adolescent Longitudinal Research Team study (MyHeARTs) to explore dietary pattern diversity.

Methods: Data on 44 food groups from 7-day diet histories from $n=1333$ adolescents aged 13-15 y from MyHeARTs were analysed. RRR identified a dietary pattern explaining variation in three intermediate variables (energy density, percent energy from fat, and fibre density) in the total sample at 13 y. RRR was repeated in subgroups including sex, age, ethnicity (Malay vs. other), and urbanicity (urban vs. rural). The dietary pattern explaining most variation in intermediates was retained for comparison of subgroup pattern loadings to the total sample at 13 y using a coefficient of congruence (COC).

Results: Overall among 13-year olds the dietary pattern explained 20% intermediate variation, individually explaining 43% energy density ($r = 0.7$), 16% fibre density ($r = -0.4$) and 2% fat ($r = 0.2$) intake variation. High pattern scores were defined by low intakes of fresh fruit, fried vegetables, and soups, and high intake of processed meat, other bread products, and chocolate and confectionary. Pattern structure was similar by sex (COC >0.94) but differed substantially by age, ethnicity and urbanicity (COC=0.83, 0.82 and 0.79 respectively). Energy density varied more in dietary patterns among other ethnicities (63%), whereas fat varied more in patterns in older and rural subgroups (37% and 16% respectively).

Discussion: Dietary patterns in Malaysian adolescents are more diverse than previously observed in RRR applied in European and Australian populations. Future research should investigate whether different intermediates result in more stable patterns. Understanding the role of dietary patterns in health within diverse cultures like Malaysia may require specific sub-group analyses and suggests generic dietary interventions may not be appropriate.

Keywords: *dietary patterns, reduced rank regression, adolescents, Malaysia*

Construct validity of the household food insecurity access scale among Finnish private sector service workers

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Introduction: Reliable, valid, and culturally appropriate assessment tools are essential to adequately address food insecurity in different subpopulations. In the PAMEL study, we aimed to investigate whether the Household Food Insecurity Access Scale (HFIAS) could be used in assessing food insecurity among the Service Union United members; female-dominated, low-income employees of the private service sector in Finland.

Methods: The HFIAS classification was based on 9 validated questions capturing respondents' perceptions on food scarcity and behavioral responses to food insecurity due to lack of resources. The questions represent a generally increasing level of severity of food insecurity with the response options from 0 (no) to 3 (often) and a recall period of one month. The final indicator categorizes respondents as food secure, and mildly, moderately, and severely food insecure. Construct validity of the HFIAAs was evaluated by assessing if levels of food insecurity distinguished groups with predictable differences in wellbeing: level of education, mode of housing, and self-perceived health, adequacy of income, and resource scarcity. Analyses were performed using cross-tabulations and regression models.

Results: Among the PAMEL participants ($n = 6\,437$, 5.8% of those invited via email), 35% were food secure, 29% mildly or moderately food insecure and 36% severely food insecure. All assessed variables were clearly directly related to food insecurity status ($p < 0.01$ for all).

Discussion: The majority of the participants demonstrated some degree of food insecurity, with a considerable proportion being severely food-insecure. Increased food insecurity was associated with socioeconomic predictors and self-perceived health demonstrating good construct validity. The HFIAS shows potential for measuring food insecurity in the predominantly low income group strongly affected by rapid changes in the labour market and social security systems.

Keywords: HFIAS, food security, validation, socioeconomic, food supply

Inflammatory index of maternal diet and birth outcomes

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Introduction: Previous studies suggest that diets with high inflammatory potential during pregnancy may be associated with an increased risk of adverse outcomes at birth, with possible long-term effects. The aim of this study was to evaluate the relationship between the maternal inflammatory diet index (IDI) with childbirth weight categories: low birth weight; macrosomia; small for gestational age and large for gestational age.

Methods: A cohort study was conducted among 600 pregnant women. Women were evaluated between the 24th and 39th weeks of gestation. Women with single gestation, age ≥ 20 years, pre-gestational BMI ≥ 20 kg/m², at least 24 complete gestational weeks and not previous diabetes mellitus or gestational diabetes mellitus were included. Data about the birth weight, sex and gestational age at birth were obtained. We used the Intergrowth21 for the birth weight classification. Food intake was assessed by two 24-hour recall surveys and the usual diet was estimated using the Multiple Source Method. The relationship between IDI (tertiles and energy-adjusted) with birth weight categories was investigated using confounding-adjusted logistic regression models.

Results: The pregnant women had a mean age of 28 ± 5 years and 43% had pre-gestational overweight. The average of energy-adjusted IDI was 1.6 ± 1.5 . In total, 7% of the babies were classified with low birth weight, 5% with macrosomia, 10% with small for gestational age and 13% as large for gestational age. In adjusted logistic regression models it was found that women in the third tertile of IDI had a higher risk of having large children for gestational age [OR 2.07 (95%CI 1.07- 4.02), $p = 0.03$] when compared to women in the first tertile. There was no association between IDI and the other birth weight categories investigated.

Discussion: The data from the present study suggest that diets with high inflammatory index during pregnancy may be a risk factor for large children for gestational age. Future studies are needed to confirm this hypothesis.

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Keywords: *Pregnant woman, Diet, Food consumption, Inflammatory diet index, Birthweight.*

The Effect of Climatic Factors on Nutrients in Foods- Evidence from a Systematic Map.

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Background. Climate change is predicted to negatively affect human health and nutrition. Specifically, climatic variability will affect health via impacts on malnutrition and nutrient deficiencies. While there is a large and growing literature on the effects of climatic and environmental changes on food availability, quantity, and agricultural production, the potential impact of climate change on the nutritional content of foods has not been widely studied. The aim of this paper is to systematically characterise literature exploring the effects of climatic drivers on nutritional content of foods.

Methods. We systematically map evidence from 68 peer-reviewed articles reporting on the effect of climatic drivers or their proxies on macronutrients and micronutrients in foods globally (2013-2019). We assess publication frequency and trends, and calculate estimates of change due to climatic conditions.

Results. The majority of articles analysed the association of nutrient changes between seasons over 1-2 years. No studies assessed the association between climatic or meteorological variability and nutritional content of foods over longer periods of time (e.g. decades). No data were available on the potential role of CO₂ changes or sea level rise as mechanisms for effect. 98.5% of the articles showed a change in nutrient content in relation to a seasonal or meteorological variable.

Discussion. There is relatively limited literature on associations between climate or climate proxies and nutrient content of foods. Where literature does exist, only crude proxies of climate (e.g. binary season) are used, with limited interrogation of the potential causal mechanisms linking climate or meteorological variability to nutrient content. Limited evidence precludes meta-analysis of food- and nutrient-specific patterns. Preliminary descriptive estimates, however, point to potentially substantial variation in nutrient content by meteorological variability, particularly in fish and plant products.

Conclusion. Further empirical studies are required to understand the potential magnitude of climatic change-related impact on nutrients. Specifically, robust assessment of potential climate impacts on nutrient content of foods would benefit from more precise estimation of specific causal pathways and variables that mediate climate impacts on food, going beyond season or simple proxies. Secondly, there is need for clear articulation and theory of change of how climate change – rather than only its meteorological proxies – might impact nutrient content given mechanisms linking meteorological and seasonal variation with food nutrients. This research highlights emerging evidence that climate change will have impacts beyond agricultural productivity by affecting food nutrient content, an understudied but potentially important pathway for climate impact on global food security.

Keywords: Climate, Nutrients, Environmental Changes, Food, Seasonality

Development of context specific food lists towards better Minimum Dietary Diversity for Women (MDD-W) data collection

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Introduction

Minimum Dietary Diversity for Women (MDD-W) indicates whether women of reproductive age (WRA) consumed at least five out of ten food groups on the previous day, with the cutoff ≥ 5 associated with a higher probability of achieving adequacy of eleven micronutrients. Qualitative methods for data collection for MDD-W include Open-recall and List-based. Challenges include measuring the 15 g minimum quantity due to differences in eating patterns and variety of mixed dishes. The purpose of this study is to describe the development and adaptation of food lists in Cambodia, Ethiopia and Zambia for MDD-W data collection.

Methods

For each mutually exclusive food group in MDD-W indicator, foods included per food group were identified based on nutrient composition. Culinary use rather than botanic characteristics was taken into consideration for group aggregation. An initial food list generated based on MDD-W Guide to Measurement was localized and expanded based on experts knowledge of local diets and inputs from focus groups participants (average of 20 enumerators and 3 nutritionists per country) and results of pre-test and piloting of the instruments for dietary collection.

Results

Knowledge of regional differences in food names such as local species specifically for wild foods as well as differences in cooking preparations have to be accounted for to come up with a robust food list. Ethiopia had the shortest food list, compared to Zambia and then Cambodia, which had the longest.

Discussion

The study illustrates how focus groups can be used to generate a country-specific nutrition-relevant food list that could be integrated into MDD-W data collection to enable comprehensive WRA dietary assessment. Traditional knowledge on wild foods is of great relevance for information on usual quantities consumed and for assigning foods in the correct group. Obstacles involved lack of food composition tables and food consumption surveys in countries, lack of information on nutritive content of indigenous and wild foods, as well as its nomenclature.

Keywords: dietary diversity, dietary assessment methods, food-lists, diet quality assessment

Foodsampler: the importance of reporting context in the treatment of overweight and obesity. A qualitative study.

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Introduction

Over the past decade, the use of self-reporting tools has become popular when registering dietary intake. Self-reporting helps overweight/obese people to become aware of their dietary intake. In addition, self-reports may be used by dietitians as a basis for personalized dietary advice.

Existing self-reporting tools with the aim to report dietary intake are often associated with under reporting and contextual factors, which are known to influence dietary behavior, are rarely included in these tools. It is largely unknown if and how overweight/obese people would want to report on contextual factors.

Consequently, the aim of this study is to identify contextual aspects that are considered relevant by people with overweight/obesity regarding self-reporting and dietary intake.

Methods

Semi-structured contextual interviews were conducted among different client groups: n=4 clients, after bariatric surgery; n=4 older adults ≥ 65 years with overweight/obesity and n=3 parents of overweight children from a family-oriented obesity treatment program. In total, 11 interviews were transcribed and coded with use of a theoretical framework. Quotes were analyzed using thematic analysis.

Results

Participants identified eight themes as relevant: 1) social environment, 2) situational factors, 3) attitudes and beliefs, 4) internal factors, 5) habits, 6) self-control, 7) psychological factors and 8) food literacy. For example: social environment include the presence of other people (relatives, colleagues), situational factors include being in a context that tempts to eat (train station, vacation) and internal factors include age and physical condition. These contexts were described as strong contributors to making wrong food choices or overeating. This frequently led to not adequately reporting dietary intake.

Discussion

Being overweight/obese is extremely challenging. Internal factors such as how people feel, their food intake habits and lack a of knowledge often compete with the environment. Overweight/obese people express the need to freely report on dietary intake, taking into consideration relevant contextual factors, without being judged or stigmatized. This is expected to add relevance to the reporting activities and to stimulate clients to report more frequently. Dietitians can use the contextual factors to personalize treatment.

Keywords: contextual factors, self-reporting, obesity treatment, dietary intake, patient perspectives