

# **Report from the International Conference on Diet and Activity Methods, ICDAM 9**

**1-3 September 2015, Brisbane Australia**

This is the most prominent conference in the field, and a very well recognized and important triennial conference for researchers in the areas related to diet and physical activity. It is the only international conference completely devoted to improving methods and measures for diet and physical activity.

Accurate data on diet and physical activity are critical in understanding how these factors may impact health and functional status over the human lifespan. Furthermore, diet and physical activity are the major modifiable lifestyle factors with an important role in health and the aetiology, prevention, and treatment of many chronic diseases.

Besides the opportunity for listening to great and valuable talks in the field, and to network, we were given the chance to participate in this conference as described below;

*Oral communication:*

**“Dietary factors and low-grade inflammation in post-menopausal women of the Malmö Diet and Cancer cohort”** (Joana A. Dias, PhD student)

I had the great opportunity to present this project, which is part of my doctoral thesis, in a parallel session named “S3: Dietary Patterns and Health Implications”. I also got some valuable feedback in the end of my talk through some questions.

In short, in this cross-sectional study examining controls (n=910) from a nested case-control study within the MDC cohort, we used stepwise linear regression to identify dietary factors related to several biomarkers for low-grade inflammation. We found 21 dietary factors associated with the inflammation markers. Fruits were negatively associated with all biomarkers, except IL-1 $\beta$ . Sausage was positively associated with IL-1 $\beta$ , fatty meat with WBC, sweets with TNF- $\alpha$ , and soft drinks with IL-6. These results suggest that healthier food choices were associated with lower inflammation levels, and unhealthy choices with higher levels.

*Poster communication:*

**“Dietary patterns and risk of cardiometabolic disease in the Swedish Malmö Diet and Cancer cohort”** (Ulrika Ericson, Associate researcher)

A data driven dietary pattern mainly characterized by high intake of fibre-rich bread, but also with high intakes of breakfast cereals, fruits, vegetables, fish and fermented low-fat milk was

associated with decreased risk of T2D and coronary events in both genders, and in men also with lower risk of ischemic stroke and less pronounced weight gain during 17 years of follow-up.

Overall, it was important to attend this conference in the context of the MOS study. We acquired some tools for continuous improvement of both dietary assessment and data analysis. We got an up-date on new technologies in diet assessment including smartphone apps and image based recording to identify foods and portion sizes. The value of combining different diet assessment methods for data collection (as in MOS) was also brought up in a presentation. In addition three different interactive toolkits for guidance on diet method selection and diet data analysis, that will be freely available on internet, were presented (<http://dietassessmentprimer.cancer.gov/>, <http://dapa-toolkit.mrc.ac.uk>, <http://www.acaorn.org.au/> ). Topics such as measurement error and statistical modelling to mitigate effects of those, and statistical considerations for making the most of our data were touched upon. This will be of great value in future projects using dietary data, within MOS.

## **Highlights among the abstracts from ICDAM 9:**

- Invited speakers

### **Image based dietary assessment: Limitations and improvements for measuring dietary outcome**

Carol Boushey (University Of Hawaii Cancer Center)

Technology is transforming traditional assessment tools used by researchers and practitioners to assess adherence to dietary recommendations or intervention goals. This presentation highlighted novel applications developed to reduce respondent burden which will translate to enhanced monitoring of dietary goals associated with an intervention outcome. The innovative mobile food record (mFR) holds tremendous promise for improving the accuracy of the dietary record. With the image-based mFR, respondents simply 'snap a picture' of foods prior to consuming. A choice of review processes following the collection of images allows users to clarify or identify components of interest to researchers or practitioners. In turn, the images or other contextual information can be used as random prompts to deliver salient messages to intervention participants. To maintain engagement, reminders modeled after ecological momentary assessment have been incorporated into the system. Questionnaires have also been launched at specific times to capture changes after key food choices. The results and lessons from studies completed and ongoing using mobile devices will be described. These enhanced dietary assessment methods offer investigators and practitioners the opportunity to monitor progress in real-time, interact at impressionable moments, and minimize burden on both respondents and the research team. Ultimately, these advances will aid in better estimating dietary intakes and delivering interventions

### **Dietary exposure assessment using new methodologies**

Janet Cade (Nutritional Epidemiology Group, University of Leeds, UK)

We are in a new era of dietary assessment. Our diets are now more complex than ever before; with over 40,000 different products available in the average supermarket. At the same time, web-based and mobile eHealth technology is developing rapidly. This gives us the potential to capture detailed dietary data on large numbers of individuals without the need for costly and time-consuming manual nutrition coding. In this talk, I focus on both web-based tools and apps for measuring diet. I discuss how we developed a web-based tool to assess diet myfood24. This is a practical exploration of what users wanted in the tool and the development of our new food composition database using back-of-pack information. The importance of usability testing and the need for validation will be highlighted. I also review smartphone apps used to measure diet with a focus on obesity; reporting on a randomised controlled trial of a dietary self-monitoring app to support weight loss. I consider strengths, limitations and challenges of this approach. Finally, I report on a systematic review of the

potential for new technologies to be used in national diet and nutrition surveys. New methodologies applied to dietary assessment provide us with a step-change in our ability to reliably characterise food and nutrient intake in population studies. These new approaches may help to reduce measurement error and advance our understanding of nutritional determinants of disease.

## **Current approaches and future directions for dietary assessment in children**

Emma Foster (Newcastle University, Human Nutrition Research Centre)

Assessing the dietary intake of children can be extremely challenging. Young children may lack the skills required to keep a record of their food intake and may have limited knowledge about the types of foods and drinks they consume. While parents may be able to provide accurate information on the foods their child eats while in their care, they have limited ability to report on the significant amount of food and drink which is provided for their child at nursery, school or whilst their child is in the care of others. In addition staff at nurseries and schools are unlikely to be able to provide detailed information on the individual food intake of the many children in their care. Traditional pen and paper based methods, such as weighed or estimated food diaries, have been found to under-estimate children's intake. Technology including smart phones and wearable cameras offer the opportunity to capture more accurate information on food intake in this population. Adolescents may possess the skills required to keep a reasonable account of their food intake but may lack the motivation. Using technology based methods may increase the engagement of participants in the process and reduce the burden associated with keeping a food diary or record. Text messages can be a useful adjunct to remind participants to record their intake. Some of the key challenges in assessing dietary intake in children and young people were discussed along with some of the novel methods employed by researchers rising to these challenges.

## **Making the most of your dietary data: Energy adjustment, categorization and measurement error**

Laurence Freedman (Gertner Institute Of Epidemiology)

Working with self-reported dietary data is very challenging, not the least due to inaccuracies of reporting and in food composition databases. However, there are some statistical practices that enhance the accuracy of our analyses and some practices that detract from their accuracy. In this talk review and illustrate the advantages and disadvantages of practices related to energy-adjusted versus unadjusted nutrient intakes, use of continuous versus categorized intakes, and adjustment versus no adjustment of estimates for measurement error. Much of the evidence that I bring regarding energy-adjustment and regarding adjustment of estimates for measurement error comes from the Validation Studies Pooling Project, a collaborative project between investigators of five large studies that studied the validity of self-reported dietary data by comparison with recovery biomarkers.

## **The impact of dietary methodology when translating research into practice: Clinical advice for liver disease as a test case**

Ingrid Hickman (Department of Nutrition and Dietetics, Princess Alexandra Hospital, and The Mater Research Institute - University of Queensland; Brisbane, Australia)

For nutrition research in chronic disease to impact broadly on clinical practice, scientific data needs to be translated into practical health information for patients, and for those health professionals providing their treatment. Nutrition research is complex not only due to the confounding nature of free living environmental conditions but also due to the variety of methodologies used to capture the frequency, duration and type of dietary intakes. This presentation uses chronic liver disease as a test case to illustrate examples where evidence of links between nutritional intake and disease severity, obtained through observational or cross sectional methodologies, have been translated into dietary recommendations for disease treatment. Discussion includes recent developments on the role of dietary factors across the spectrum of liver disease severity including fructose, coffee consumption and the Mediterranean Diet. It highlight the importance of understanding the methodologies used in clinical research and question how much we are willing to compromise the representation of pure scientific results in order to develop an effective, pragmatic health message.

## **Image based dietary assessment: Limitations and improvements for dietary interventions**

Deborah Kerr (Curtin University, Perth, Australia)

Dietary assessment in interventions is challenging as methods need to be sensitive enough to track change over time. Concern with participant burden and analysis costs, particularly with repeated assessments, has led researchers to use less precise methods such as brief assessment methods. Diet records, whilst prone to reactivity bias allow the capture of detailed information on the types of foods consumed and the combination of foods eaten together. The presenter shared her experiences in the use of diet records in various interventions targeting nutrition and physical activity conducted over the years and how this work has led to a 10-year collaboration on the Technology Assisted Dietary Assessment or TADA [1]. The drive to undertake this work was to improve the accuracy and precision, whilst addressing respondent burden. The mobile food record (mFR) application runs on various devices (iPhone, iPod and Android). A strength of the mFR is that the food and beverage images contain a time and date stamp for each eating occasion providing metadata to explore changes in eating occasions over time. Findings from intervention studies in community dwelling young adults and overweight and obese adults will be presented. In both of these interventions, a trained analyst undertook the dietary assessment. The mFR images were analysed for eating occasions and food groups serve. Participants ranged in age from 18 to 60 years. Future improvements in machine learning algorithms will lead to upscaling and automation of the process. Potential applications of the mFR for dietary interventions were discussed.

Boushey, C.J., et al., Use of technology in children's dietary assessment. *European Journal of Clinical Nutrition*, 2009. 63: p. S50-S57.

## **Use of the Automated Self-Administered 24-Hour Dietary Recall (ASA24) in the real world**

Amy Subar<sup>1</sup>, Beth Mittl<sup>2</sup>, Thea Zimmerman<sup>2</sup>, Sharon Kirkpatrick<sup>3</sup>, Tusa Rebecca Schap<sup>4</sup>, Amy Miller<sup>2</sup>, Magdeline Wilson<sup>1</sup>, Christie Kaefer<sup>1</sup>, Nancy Potischman (1, US National Cancer Institute; 2, Westat; 3, University of Waterloo; 4, US Department of Agriculture)

### **Objective**

To describe the use of ASA24 in real - world studies

### **Methods**

Descriptive statistics were generated to summarize usage characteristics of ASA24 across studies.

### **Results**

From September 2011 until July 2015, 1303 studies (28/month) registered to use ASA24 and 125,000 recalls were completed (2733/month). Mean and median numbers of participants/study were 643 and 80, respectively (range: 10-420,000) and mean and median numbers of recalls/participant were 11 and 3, respectively. Mean (median) times to complete with and without the supplement module were 34(27) and 26(21) minutes for the 2011/12 versions and 30(25) and 22(18) minutes for the 2014 versions, respectively. Mean time to complete was higher in first versus subsequent recalls, indicating a learning effect. Mean numbers of foods and beverages reported/day were 13 and 12 for the 2011/12 and 2014 versions, respectively. The percentages of studies using the following options in the 2014 version were: unscheduled logins - 86%; multiple vs. single logins - 72% (adults), 58% (kids); midnight-to-midnight vs. past 24-hrs - 63% (adults), 49% (kids); completion time restricted to 24 hrs - 72%. The percentages including optional modules were: supplements - 49% (adults), 34% (kids); location of meals - 80%; source of foods - 36%; with whom meals were eaten - 43%; electronic device use during meals - 44%. Most researchers (80%) were affiliated with academic or government institutions. Applications included epidemiologic, surveillance, intervention and clinical research as well as teaching.

### **Conclusion**

Researchers are making use of the various features of ASA24 to meet diverse research and teaching needs.

- Symposium speakers

## **Design and analysis of dietary validation studies when true intake is modeled as a time-varying process**

Laurence Freedman (Gertner Institute of Epidemiology, USA)

Most statistical methods that adjust analyses for dietary measurement error treat an individual's usual intake as a fixed quantity. However usual intake, if defined as average intake over a few months, varies over time. We describe a model that accounts for such variation and for the proximity of biomarker measurements to self-reports within the framework of a meta-analysis, and apply it to the design of validation studies and to the

analysis of data on energy, protein, potassium and sodium from a set of five large validation studies of dietary self-report instruments using recovery biomarkers as reference instruments. We show that this time-varying usual intake model fits the data better than the fixed usual intake assumption. Using this model, we estimated attenuation factors and correlations with true longer-term usual intake for single and multiple 24 hour dietary recalls (24HRs) and food frequency questionnaires (FFQs) and compared them with those obtained under the ‘fixed’ method. Compared to the fixed method, the estimates using the time-varying model showed slightly larger values of the attenuation factor and correlation coefficient for FFQs and smaller values for 24HRs. In some cases the difference between the fixed method estimate and the new estimate for multiple 24HRs was substantial. With the new method, while four 24HRs had higher estimated correlations with truth than a single FFQ for absolute intakes of protein, potassium and sodium, for densities the correlations were approximately equal. Accounting for the time element in dietary validation is potentially important, and points towards the need for longer-term validation studies.

### **Time-varying models for longitudinal data measured with error, with application to physical activity and sleep**

Victor Kipnis (Biometry, US National Cancer Institute, Bethesda, MD, USA)

Modern accelerometers provide interesting and objective longitudinal data on different characteristics of physical activity that may influence important health outcomes. Those characteristics may fluctuate over a short span of time due to life demands, and their dynamic nature at the individual level is often of principal interest. The current research is motivated by the problem of estimating the temporal effect of moderate and vigorous physical activity on sleep using accelerometry measurements. We analyze weekly data from the BodyMedia study of 3650 women and 1009 men who wore accelerometers continuously for 12 consecutive weeks. On an appropriate scale, we propose a joint multivariate linear mixed model when both the exposure and bivariate outcome (lying down minutes and sleep minutes) vary over time and are subject to measurement error. To accommodate the possibility that heterogeneities in person-specific trajectories in physical activity and sleep characteristics may be related, we allow random effects in the corresponding parts of the model to be correlated. This correlation leads to important differences among the individual-level (or within-person), between-person, and population-level (or marginal) effects, as is exemplified by our data. Our simulations also demonstrate that ignoring correlated random effects, as is common in the mixed model approach to longitudinal data that are subject to measurement error, leads to substantial biases in estimated exposure effects.

## **Integrating metabolomics in the measurement error arena**

Pietro Ferrari (Nutrition and Metabolism Section, International Agency For Research On Cancer, Lyon, France)

Statistical procedures to correct for exposure misclassification the relationship between diet and the risk of disease, like linear regression calibration (LRC), rely on the comparison between reference measurements, often 24-hour dietary recalls or weighed food records, and assessments of habitual intake, usually food frequency questionnaires. The accurate use of LRC is conditional on a number of assumptions, which in practice are not fulfilled. Based on evidence from the OPEN and the EPIC cross-sectional studies the performance of LRC to provide accurate estimates of risk association was evaluated. Under scenarios involving two or more error-prone variables, the bias could be substantial. Methods have been proposed to introduce objective measurements of intakes, like biomarkers of intake. Although extensive research, the list of concentration biomarkers remains rather limited. In this work metabolomics was used for biomarker discovery. The European Prospective Investigation into Cancer and Nutrition (EPIC) cross-sectional study offered the unique opportunity to measure the urinary excretion of 36 individual polyphenols measured using UPLC-ESI-MS-MS. A single 24-h urine sample was collected the same day of the 24-hour dietary recall (24-hdr) in 475 participants from 9 centres in 4 European countries (France, Germany, Greece, and Italy). Reduced rank regression models were used to relate mixtures of urinary polyphenols to the intake of specific 24-hdr food groups, for the identification of composite biomarkers. The level of agreement with 24-hdr and questionnaire measurements was evaluated in measurement error models, and findings and discussed. This strategy offers a promising way to identify biomarkers of dietary intake using information from a large number of metabolites. This analytical strategy finds natural applications in observational investigations, possibly beyond the use of urinary samples.

## **Measurement error, nutritional surveillance and epidemiology, and the evaluation of complex multivariate dietary pattern scores such as the HEI-2010**

Raymond Carroll<sup>1</sup>, Dennis Buckman<sup>2</sup>, Kevin Dodd<sup>3</sup>, Laurence Freedman<sup>4</sup>, Patricia Guenther<sup>5</sup>, Victor Kipnis<sup>3</sup>, Susan Krebs-Smith<sup>3</sup>, Jill Reedy<sup>3</sup>, Amy Subar<sup>3</sup> (1, Texas A&M University; 2, Information Management Services, Inc; 3, National Cancer Institute; 4, Gertner Institute; 5, U.S. Department of Agriculture (Retired))

Dietary pattern scores such as the Healthy Eating Index, the Alternative Healthy Eating Index and others represent summaries of complex, multivariate dietary patterns involving ratios to various dietary components, multivariate variables that equal zero with great frequency, complex patterns of inter-correlations, etc. Uncertainty in the measurement of diet (measurement error) in these situations can lead to many issues, including for example significant under-estimation of the percentage in a population of those with poor diets, underestimation of cancer risk, etc. We describe a new framework for adjusting for these uncertainties, and point to flexible SAS software than can be used for both surveillance and epidemiology.

## **Traditional methods vs new technologies: dilemmas for dietary assessment in population surveys**

Carol Boushey<sup>3</sup>, Birdem Amoutzopoulos<sup>1</sup>, Toni Steer<sup>1</sup>, Caireen Roberts<sup>2</sup> (1, MRC Human Nutrition Research, Cambridge, UK; 2, NatCen Social Research, London, UK; 3, University of Hawaii Cancer Center, Honolulu, USA)

Technology is expanding the menu of assessment tools used by researchers and practitioners to assess exposures related to health and disease. This expansion in choices allows researchers to consider new options, traditional options, or a combination of options within the context of resources, target audience, and study aims. Tested and emerging applications developed as part of an interdisciplinary research team to improve dietary assessment methods using images and mobile devices will be highlighted. Just as methods being used for years have particular shortfalls, new technologies have unique challenges to consider prior to adoption.

## **Use of new technologies for dietary assessment in population surveys: Experience from the UK**

Birdem Amoutzopoulos<sup>1</sup>, Caireen Roberts<sup>2</sup>, Toni Steer<sup>1</sup>, (1, MRC Human Nutrition Research, Cambridge, UK; 2, NatCen Social Research, London, UK)

Can new technologies for dietary assessment meet the needs of running population surveys? This is a challenging question to address when it comes to large population studies. In the UK, the National Diet and Nutrition Survey Rolling Programme (NDNS RP) provides the only source of high quality nationally representative data on the types and quantities of foods eaten by people aged 1.5 years and older living in the UK. Diet in the NDNS RP is currently assessed using a paper based 4-day estimated food diary. Recent technological advances are offering opportunities to possibly enhance the way in which dietary information is captured. However, new technologies have predominantly been used and validated in smaller intervention studies often in specific groups of the population. As little evaluation work has been carried out in large settings, it has so far, not been possible to make a decision on fully or even partially replacing the current method in NDNS RP with a new technology. Further research on feasibility, quality assurance, cost-effectiveness and validation on new technologies is required for this decision to be made. This talk discussed the strengths and weaknesses of traditional dietary data collection methods vs new technologies used in population surveys, with a focus on the UK NDNS RP. Options for the way forward in this particular area of dietary assessment work will also be addressed.