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NUTRIENT INTAKE VARIABILITY INDUCED BY PROCESSING OF FOOD DIARY DATA: A PILOT STUDY

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Nutrient intake variability induced by processing of food diary data: A pilot study

Accurate assessment of nutrient intake of the population represents one of the main challenges in food and nutritional science. Evaluation of food diary is a complicated process, involving choosing the appropriate nutritional database and having well qualified personnel (coders) to work with it. The aim of this study was a comparison of nutrient intake data obtained from one weighed 5-day food diary processed by five master degree students, studying nutrition, focusing on coding errors. Nutrition evaluation was done by Prodi 5.7 Expert Plus computer programme and IBM SPSS Statistics 20 for statistical analysis. Results of our pilot study show that variability of calculated data induced by food coding lonesome is acceptable. Nevertheless putting other errors into account, results can be misleading. On a five-day level macronutrients intake variability is between 5 and 15%, while energy intake variability is within 6%. Uncommon food items and complex composition of the meal have the major impact on observed high standard deviations on a separate meal level. In conclusion the main reason of food coding errors is inaccuracy and incorrect identification of specific food items.

Key words: human nutrition / food diary / energy intake / macronutrient intake / food coding errors

Variabilnost podatkov o zaužitih hranilih posameznika kot posledica natančnosti obdelave prehranskih dnevnikov: pilotna študija

Pridobivanje podatkov o vnosu hranil pri posamezniku predstavlja enega od bistvenih izzivov v prehrani. Obdelava prehranskih dnevnikov je kompleksen proces, poleg primernih računalniških programov potrebujemo tudi primerno usposobljen strokovni kader. Naš namen raziskave je bil določiti variabilnost pridobljene informacije o zaužitih hranilih enega posameznika, ki je po metodi tehtanja dosledno izpolnil pet dnevni prehranski dnevnik. Le-tega smo dali v obdelavo petim študentkam Biotehniške fakultete druge stopnje bolonjskega študija Prehrane kot del njihovega magistrskega dela. Za obdelavo smo uporabljali računalniški program Prodi 5.7 Expert Plus in IBM SPSS Statistics 20. Rezultati pilotne študije kažejo, da je variabilnost izračunanih podatkov, ki so jih posredovali različni obdelovalci prehranskih dnevnikov, sprejemljiva. Na tedenski ravni podatki za makrohranila odstopajo med 5 in 15 %, medtem ko variabilnost podatkov o zaužiti energiji ne presega 6 %. Največja odstopanja smo opazili pri obrokih s kompleksnejšo sestavo ter nevsakdanjimi živili. Zaključimo lahko, da je eden najpomembnejših vzrokov za nastanek napak pri obdelavi prehranskih dnevnikov nenatančnost ter neustrezna zamenjava nepoznanih živil.

Ključne besede: prehrana ljudi / prehranski dnevnik / energija / makrohranila / živila / vnos / napake

1 INTRODUCTION

Food intake reflects what either individuals or groups consume in terms of solid foods, beverages, including drinking water, and supplements. Food consumption can be estimated through food consumption surveys at an individual (Individual dietary surveys) or household level (Household budget surveys) or approximated through food supply data derived from food balance sheets (EFSA, 2009).

Several dietary assessment tools directed at the individual are available. In general, these methods can be

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divided into two basic categories: those that record data at the time of eating (prospective methods, i.e. so-called weighed and estimated records methods) and those that collect data about the diet eaten in the recent past or over a longer period of time (retrospective methods, interview methods) (Van Staveren and Ocké, 2006).

The dietary record method is considered to be the most accurate of all available methods. It can be either a record of food as it is consumed (weighed inventory) or a much more detailed record of the weights of ingredients, final cooked weights of prepared foods, the weights of foods eaten and any plate waste (precise weighing method). The latter approach is used when tables of food composition contain little information on mixed dishes and when it is possible for the information to be collected by the investigator. Weighed records kept by the respondent usually use the weighed inventory method and are kept for periods of only 1–4 days because of the high respondent burden involved. Weighed records have the potential to provide the most accurate description of the types and amounts of the foods actually consumed over a specified period of time. However, weighing all food is time-consuming and the method requires a high level of cooperation from respondents. In most individuals the method probably affects the amounts and kinds of food eaten. While the method may accurately reflect actual intake during the record-keeping period, this intake may not reflect habitual intake (Rutishauser, 2005).

Nutritional assessment by diet analysis is a two-stepped process. The first step is the evaluation of food consumption, and the second the conversion of food into nutrient intake. To do this we need a food composition database, which lists the mean nutritional values for a given food portion. Then multiplying food intake by the mean nutrient content of that amount of food (obtained from the food composition database) (Willett, 1998).

The major sources of error in dietary studies have been reviewed in detail by Bingham (1987). Four possible sources of error occur to some degree with all dietary methods, but can be minimized by careful study design and execution: sampling bias, response bias, inappropriate coding and use of food composition tables in place of chemical analysis (Maclntyre, 2009).

Coding is generally carried out using an electronic database, which the coder searches to find a food code to match to each item reported in a diet record (Bingham, 1987). Errors arising during the coding (data entry) and processing of individual dietary methods (24 HR, diet history, weighed and estimated records) need to be avoided. Misclassification can arise due to human error if incorrect foods are chosen during coding, for instance, if milk was consumed in the full-fat form but was coded for skimmed milk (Welch, 1999).

Coding errors arise when the food that has been consumed is not described in sufficient detail to enable unambiguous allocation, by an investigator/coder, to a food category in a food composition table or database. Making it easy for respondents to describe foods with the level of detail required is therefore an important consideration in study design. This is increasingly difficult, particularly in industrialized countries where the food supply now consists of thousands of different manufactured foods, the names of which are often no longer a good guide to their nutrient content (Maclntyre, 2009) Therefore it is important coders should have knowledge of food composition and food preparation techniques.

Coding errors are also likely to arise when more than one person is involved in coding and there is no agreed procedure and/or comprehensive coding manual. Coding errors arising exclusively from inadequate description of foods have resulted in coefficients of variation ranging from 3% to 17% for different nutrients (Maclntyre, 2009). Other potential errors are entry of incorrect quantities or multiplication factors for portion weights and missed items, problems that can occur even with structured computer programs. So, systematic post-entry checks to identify extremes of portion weights or nutrient values and the verification and correction of data are necessary (Welch, 1999).

The aim of this study was the comparison of nutrient intake data obtained from one weighed 5-day food diary processed by five master degree students, studying nutrition, focusing on coding errors.

2 MATERIAL AND METHODS

Our pilot study is based on one weighed 5-day food diary. Each food item was weighed (per gram precision) before consumption and noted down with all specifications (weight, brand name, special details…). Regarding cooking recipes, all used food items were weighed before used in cooking procedures and as meals afterwards. All procedures were also written down in food diary. Described 5-day food diary was copied and given for evaluation to five students of University of Ljubljana, Biotechnical faculty, studying nutrition as a part of their final master's degree work. Using national nutritional database (Golob *et al.*, 2006) would be the most appropriate thing to use, however due to its insufficiency we used database fit for central European population. Nutrition evaluation was done by Prodi 5.7 Expert Plus computer programme based on SFK 2005, BLS II.3 extract nutritional database, user defined food and commercial products (Kluthe, 2010). IBM SPSS Statistics 20 was used for statistical evaluation.

3 RESULTS

Results shown in table 1 represent 5-day sum of energy and macronutrient intake with variability due to food coding. 5-day sum variability (CV%) of carbohydrate intake with 5.3% is the lowest calculated, whereas protein and fat quantity coefficient of variation is 11.8 and 14.2%, respectively. To put things into perspective, measured fat intake ranges between 75.2 and 109.1 g per day. As a result of macronutrient intake 5-day energy was assessed within deviation of 5.8%.

Table 1: *Descriptive statistics of 5-day energy and macronutrient intake*
Preglednica 1: *Opisna statistika za v petih dneh zaužito energijo in makro hranila*

Nutrient	Average	Minimum	Maximum	Standard deviation	Coefficient of variability (%)
Energy (kJ)	41851.3	38918.6	44304.1	2418.9	5.8
Carbohydrates (g)	1042.3	984.2	1126.5	55.2	5.3
Protein (g)	391.9	344.3	455.3	46.3	11.8
Fat (g)	470.2	375.8	545.2	66.8	14.2

Energy intake was evaluated by each day separately. It is evident (Table 2) that on Monday variability of data is significantly different (CV = 3.1%) than other days, where coefficient of variability varies between 9.5 and 12.7%. Calculations show that is quite wide span between min and max of each day even on Monday when range is 635.3 kJ. With the highest energy intake variability, difference between min and max on day 2 is staggering 3510.4 kJ.

Table 2: *Descriptive statistics of daily energy intake*
Preglednica 2: *Opisna statistika za dnevno zaužito energijo*

Daily energy intake (kJ)	Average	Minimum	Maximum	Standard deviation	Coefficient of variability (%)
Monday	8061.6	7813.6	8448.9	252.8	3.1
Tuesday	10365.2	8588.0	12098.4	1313.1	12.7
Wednesday	9856.8	8389.8	11421.5	1234.7	12.5
Thursday	6930.2	5922.1	7682.9	693.9	10.0
Friday	6637.4	6042.4	7695.4	633.8	9.5

Beside daily energy evaluation, nutritional status assessment is based on macronutrient intake. Therefore Fig. 1 represents an average daily macronutrient intake with standard deviations. Calculations show relatively high within daily variations. Overall on Monday variations are among the lowest of all which is in compliance with daily energy intake. On the other hand the highest variation is noticed on Tuesday, when deviation of carbohydrates almost reached 30%. Beside that protein and fat intake coefficient of correlation is 23.6 and 17.6%, respectively. Variability of daily carbohydrate intake varies between 3.6% and 29.7%. On average variability of carbohydrate intake is 13.4%. Weekly highest coefficient of variation in proteins is with 24.7% reached/picked on Thursday, whereas on Friday variation dropped to 6.1%. On average protein as well as fat intake coefficient of variation is 17%. Fat intake variations range from 17.6 to 21.5%, except on Monday when variation is considerably lower (CV = 4.6%).

Average energy intake according to daily meal with standard deviation, induced by processing of food diary data, is presented in Fig. 2. In general the lowest variation of calculated energy intake perceived is at the most important daily meal. On average variability of data at breakfast is 6.1% and ranges from 2.4% on Monday to 9.6% on Wednesday. These results are most likely as a consequence of plain and simple meal composition. On the contrary the variations of energy intake at lunch are among the highest of all weekly meals. The coefficient of variability of energy intake at lunch varies between 6.9 and 32.3%, on average 20.5%. Weekly lowest variation of energy intake recorded is 0.3% at dinner on Thursday, on average CV at dinner is 10.6%. Despite the fact that afternoon snacks are relatively simple meals, results show that variability for forenoon snacks ranges between 1.8 and 33.3%. Furthermore afternoon snacks are with CV around 4% for three days among the lowest within all the meals, however the other two days are the highest recorded variations of energy intake within 5 days.

4 DISCUSSION AND CONCLUSIONS

4.1 DISCUSSION

Habitual nutrient intake estimation of a population is a vital process in nutritional research. Information on the usual macronutrient and therefore energy intakes of individuals is frequently a central component of nutri-

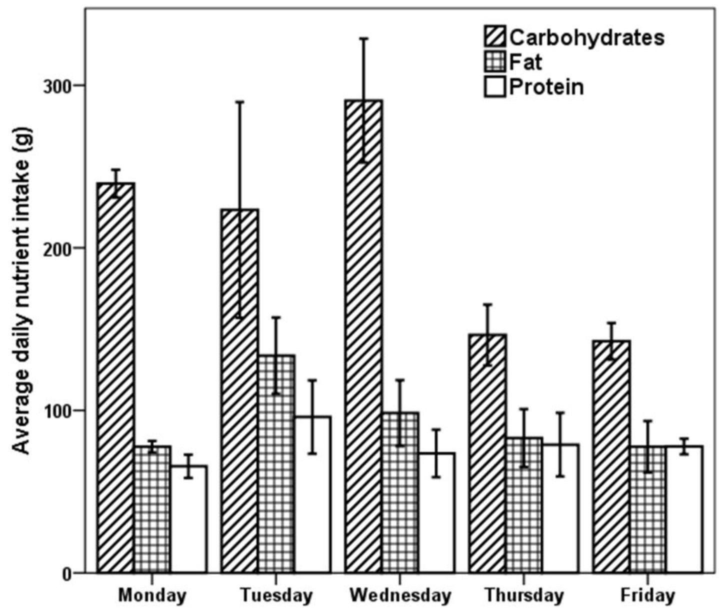

Figure 1: *Average daily macronutrient intake with standard deviations*
Slika 1: *Povprečno dnevno zaužita makro hranila in standardni odkloni*

tion studies. A major distinction between food consumption and nutrient intake is at the level of analysis. When food consumption is measured, the nutrient intake of an individual is often estimated by use of food composition tables. In our study the lack of complete Slovenian nutritional database obliged us to use the computer programme Prodi 5.7 Expert Plus based on SFK 2005 and BLS II.3 extract nutritional database as the primary nutrient data source as it is the most suitable for central European area.

Coding diet records is a basic element of most dietary surveys, yet it often receives little attention even though errors in coding can lead to flawed study results. The objective of our pilot study was the analysis of energy and macronutrient data variability induced only by coder errors. Moreover, weighed dietary protocol was used and

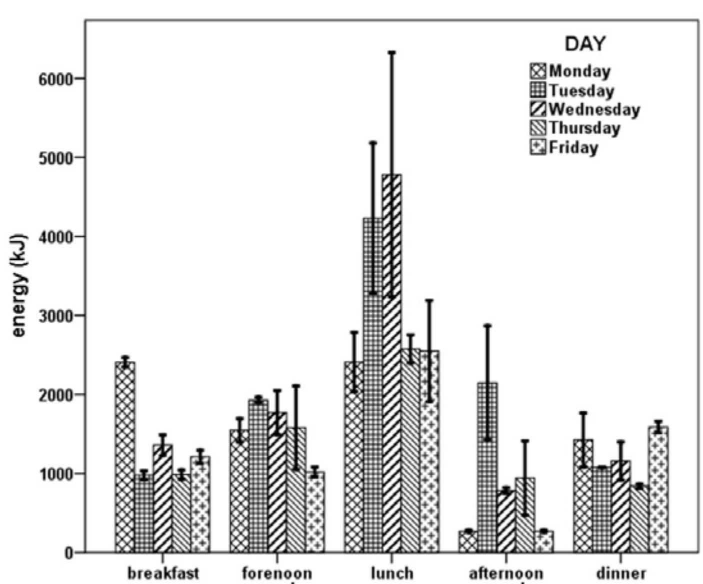

Figure 2: *Average energy intake according to daily meal with standard deviation*
Slika 2: *Povprečno zaužita energija glede na dnevni obrok in standardni odkloni*

input quantity data was carefully revised to avoid errors induced by entering food amount. Coders should have knowledge of food composition and food preparation techniques, in order to meet the demand in our study coders were students in few months becoming masters of nutritional studies.

Results of our study showed that variability of calculated 5-day data is in compliance with previous studies (Conway *et al.*, 2004; Maclntyre, 2009). On the contrary variability in our study on the separate meal level was significantly higher, reaching coefficient of variability up to 50%. Uncommon food items and complex composition of the meal have the major impact on observed high standard deviations. That should be taken into consideration when 24 hour recall instead of longer food diaries are being used, as only up to 5 meals are under investigation. When processing data, food items not listed in nutritional database have to be replaced with substitute. It is the fact that the coder chooses alternative food item on a basis of his knowledge of food composition of the food item in food diary. This is the focal point of coding errors source. In order to avoid this kind of errors, a coder should research the food composition of possible substitutes to determine which of the alternatives will be the most suitable. In addition, detailed information how a coder should act when he meets the mentioned situation must be provided.

5 CONCLUSIONS

Results of our pilot study show that variability of calculated data induced by food coding lonesome is acceptable. Nevertheless putting other errors into account, results can be misleading. On a five-day level macronutrients intake variability is between 5 and 15%, while energy intake variability is within 6%. In summary, variability of energy intake and therefore range widens when we shorten the time of the study. To put it simply the highest variation found was on a meal basis as oppose to lowest average variation in 5-day diet. Further analysis showed that the highest variations are due to food complexity and consumption of unusual food items. In conclusion the main reason of food coding errors is inaccuracy and incorrect identification of specific food items.

6 ACKNOWLEDGEMENTS

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