

Dietary assessment methods used for low-income populations in food consumption surveys: a literature review

Vesna Vucic^{1*}, Maria Glibetic¹, Romana Novakovic¹, Joy Ngo², Danijela Ristic-Medic¹, Jasna Tepsic¹, Maria Ranic¹, Lluís Serra-Majem^{2,3} and Mirjana Gurinovic¹

¹Department for Nutrition and Metabolism, Institute for Medical Research, University of Belgrade, Tadeusa Kosuska 1, Belgrade 11000, Serbia

²Community Nutrition Research Centre of the Nutrition Research Foundation, University of Barcelona Science Park, Baldori Reixac 4, 08028 Barcelona, Spain

³Department of Clinical Sciences, University of Las Palmas de Gran Canaria, PO Box 550, 35080, Las Palmas de Gran Canaria, Spain

(Received 7 January 2009 – Revised 3 April 2009 – Accepted 1 June 2009)

In order to assess nutritional adequacy, reliable estimates of nutrient intake are required. Specifically, the EUROpean micronutrient RECommendations Aligned (EURRECA) Network of Excellence needs clear guidelines on methods suitable for assessing micronutrient intakes among vulnerable population groups. The objective of this project was to collect, evaluate data and review the suitability of methods used to assess dietary intake of low-income groups across Europe. A comprehensive literature review methodology was employed, which involved structured search MEDLINE, from 1990 to 2008, on (nutrient intake methods) and (validity terms) and (human studies) and finally (low-income terms). In addition, manual searches were conducted for published books and national studies. Seven studies satisfied the selection criteria for inclusion in the review in which four dietary intake methods had been described and validated. Three other studies found in the grey literature used similar methods. Only one study tested a variety of methods to assess reliability and the method preferred by those having low incomes. Preferred methods were 24 h recalls and a FFQ which, compared with the weighed inventory, also yielded higher estimates of energy and nutrient intakes. Many of the methods used in low-income populations have not been subjected to evaluation and consequently may not demonstrate sensitivity and/or specificity when used in this population. Based on one study only, four multiple-pass 24 h recalls are recommended as the most appropriate method for the evaluation of nutritional adequacy in low-income households.

Dietary intake methods: Socio-economic status: Low-income population

Adequate and reliable assessment of dietary intake in nutritional research is key when attempting to understand dietary profiles linked to living conditions such as low income. There are many retrospective (24 h recalls, dietary history method and FFQ) and prospective (food records over 1, 2, 3, 4 and 7 d, duplicate portions) intake methods⁽¹⁾. However, none is suitable in and of itself to give sufficiently accurate dietary information for all purposes.

Dietary assessment methods including food diaries, dietary recalls and list-type methods, such as FFQ, are subject to considerable biases and errors, and none can be considered as a gold standard⁽²⁾. Moreover, there has been relatively little research on the comparability of these instruments across diverse ethnic and socio-economic groups. It is important to know whether and by how much the measurement characteristics of dietary assessment instruments differ, especially in research designed to address dietary quality,

food inequality or diet as part of health inequalities in at-risk populations compared to the rest of the population.

Much of the evidence of diets among low-income households until now has been based on national surveys in which the numbers of low-income households are few, cooperation rates are low and classification of households is based on receiving social benefit or on employment status⁽³⁾. The limitation, or outright lack, of published data and information on food intake and nutritional outcomes of those living on low incomes thus seems to be due to the difficulties faced when engaging such groups to participate in research projects for the purpose of measuring their food and nutrient intakes. As a result their circumstances are not well reflected in the literature, resulting in a knowledge gap in Europe.

Definitions of low income are often different depending on the country, the study purpose or even on the authors of the publications. Poverty, materially deprived, low

Abbreviations: MESH, medical subject heading; SES, socio-economic status.

On behalf of EURRECA's RA 1.1 'Intake Methods' members: Serra-Majem L (Coordinator), Cavelaars A, Dhonukshe-Rutten R, Doreste JL, Frost-Andersen L, García-Álvarez A, Glibetic M, De Groot L, Henríquez-Sánchez P, Naska A, Ngo J, Novakovic R, Ortiz-Andrellucchi A, Øverby NC, Pavlovic M, Pijls L, Ranic M, Ribas-Barba L, Ristic-Medic D, Román-Viñas B, Ruprich J, Saavedra-Santana P, Sánchez-Villegas A, Tabacchi G, Tepsic J, Trichopoulou A, van't Veer P, Vucic V, Wijnhoven T.

* **Corresponding author:** Vesna Vucic, fax +381 11 2030169, email vesna.vucic.imr@gmail.com

socio-economic status (SES) or position, low social class and food insecurity are the most commonly used terms in research projects, reports and papers reporting on the studies of low-income populations. SES in scientific studies is often represented by multiple indicators including: income, educational level, occupation, profession and cultural aspects, or indices where several of these indicators are used (for example, disability-adjusted life year or DALY, a composite index used by WHO). All may operate independently or interact in ways that influence food choices. For households with limited resources, income and the cost of food (both being determinants of diet composition) are two important factors influencing food choice, which also interact with each other⁽⁴⁾. Based on Euro Stat data (2007), for the European union-25 as a whole, an average of 16% of the population was currently at risk of being impoverished and had an equivalised household disposable income below 60% of the national median for the country in which they lived⁽⁵⁾. The percentage of income spent on food may indicate how severe the lack of food is likely to be, but this would depend on how income is categorised – either as personal income, household income or defined in another way. Low-income families have the highest percentage (23%) of income expenditure designated for food acquisition in comparison to the highest income families in each country (13%)⁽⁵⁾. According to the indicators of income inequality and objective poverty, there was a divide among former European union member states (European union 15), with the UK, Ireland and South European countries having higher and the Continental and Nordic countries lower indicators of inequality and poverty. Among new member states, the Baltic countries and Poland had the highest and Slovenia and the Czech Republic showed the lowest indicators of inequality and poverty⁽⁶⁾. The data for 2002–2007 in Serbia defined low-income households as those who have monthly incomes of 8883 dinars (RSD) per equivalent scale (approximately 100 €)⁽⁷⁾.

People from low-income households typically have less nutritionally adequate diets, especially those who live for long periods of time on limited incomes. There is growing evidence to suggest that poor nutritional status is a specific cause of higher disease rates in low-income households^(8–10). Health inequalities revealed striking differences in many countries between social groups showing that lower socio-economic groups have greater incidences of premature babies, low-birth weight babies, heart disease, stroke and some cancers, in addition to risk factors like smoking, physical inactivity, obesity, hypertension, the lack of breast feeding and poor diet^(11,12). In addition, among other factors, lower literacy, numerical and language skills, physical disabilities and mental health problems are more common in low-income groups, as well as low motivation, and as such, constitute obstacles when identifying and assessing this population's food and nutrient intakes.

The above-mentioned evidence indicates the need to identify different intake methods that are appropriate for low-income groups. Thus, the aim of the present paper was to examine dietary intake methods available for use by researchers in order to screen or assess nutrient intake in low-income populations in Europe. Moreover, the extent to which validity, specificity and acceptability of these methods have been addressed was also evaluated. By examining

these issues, the understanding of the science of dietary intake assessment and recommended measures to improve food and nutrient data reproducibility and validity in low-income populations will therefore be enhanced.

Methods

Search strategy

The electronic database MEDLINE was utilised to identify dietary validation studies addressing nutrient intake from 1990 to March 2008 using text terms with appropriate truncations and relevant indexing terms. The reference lists in the articles, reviews and textbooks retrieved were also to be referred. The search terms were as follows:

1. Block A: Descriptors of low income: Medical subject heading (MESH) term 'low income' (includes indigency, indigents and indigent); poverty; material deprived; low SES; social class; low socio-economic position.
2. Block B: Descriptors of dietary intake: MESH term 'nutrition assessment' (includes nutrition survey and diet survey) and 'diet assessment'; MESH term 'dietary habits' (includes food habits and diet modification); MESH term 'diet records' (includes food diary, 24 h dietary recall and FFQ); MESH term 'feeding behaviour' (includes feeding pattern, eating behaviour), 'food consumption', 'nutritional status' and 'nutrient intake'.
3. Block C: Descriptors of validity: MESH term 'validity and reproducibility'; 'validation study'; 'replication study'; 'correlation coefficient'; 'correlation study'.

Two independent reviewers (V. V. and R. N.) ran the electronic searches and screened all titles and abstracts for studies that might have met the following inclusion/exclusion criteria. The articles were excluded when both reviewers determined that titles/abstracts met the exclusion criteria. When a title/abstract could not be rejected with certainty, the full text of the article was obtained and further evaluated. Reviewers excluded studies that were not conducted in Europe, studies exclusively focused on diseased or institutionalised persons, as well as studies exclusively focused on energy and/or macronutrients. Studies evaluating the physiological effects of foods, nutrients and those assessing their relationship to genetic determinants, calibration studies and those discussing statistical methods, studies in animals and those without abstracts in PubMed were also excluded.

The full text of all articles collected was screened for definitive exclusion by the first reviewer, with independent duplicate assessment of a random sample of 50% by a second reviewer. Where the two reviewers disagreed, the study was discussed and a consensus decision reached where possible. If this was not possible then a third reviewer was asked to consider the results. Data from each study were extracted onto an Excel database file.

This review includes cross-sectional or validation studies published in English language journals presenting validated results of dietary intake methods in low-income adults, assessing data on their micronutrient intake.

Results

The literature search yielded 1216 references. Figure 1 depicts a flow chart of studies assessed and excluded at various stages

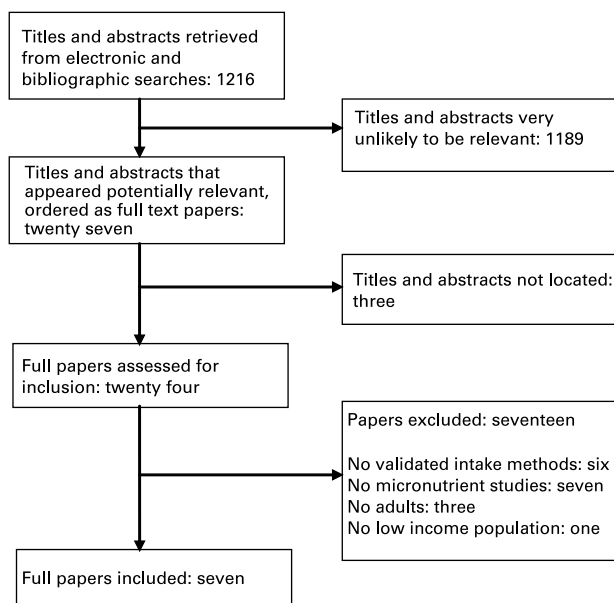


Fig. 1. Summary of search strategy process and results.

of the review. Out of 1216 studies, twenty-seven abstracts were retrieved for more detailed evaluation. The reasons for exclusion were: studies were not conducted in Europe, studies focused on patients or on children, studies did not examine micronutrients or did not have validated intake methods. Three abstracts could not be traced, but twenty-four full papers were evaluated. After examination, only seven studies (Table 1) met the inclusion criteria. Most of the examined studies were either applied nutritional studies or observational studies, with the exception of a comparison (validation) study.

The characteristics of studies involved in this review are presented in Table 1. The comparison study published by Holmes *et al.*⁽³⁾ compared three 4 d dietary survey methods (multiple-pass 24 h recall, FFQ and semi-weighted method) against a 4 d weighed inventory. The present study provided useful insight into the assessment of validity for different dietary intake methods applied to low-income populations. It suggested that in terms of acceptability and effectiveness of the methods:

1. The 24 h recall was the method most preferred by interviewers for reporting diet.
2. The food frequency was the method most preferred by respondents for reporting diet.
3. The semi-weighted method was least liked for reporting diet by both interviewers and respondents.
4. The greatest number of difficulties reported by the interviewers was with the weighed inventory.
5. The 24 h recall and FFQ yielded higher estimates of energy and nutrient intakes more often than either the semi-weighted or weighed inventory.
6. The 24 h recall was more likely to have a significantly higher number of food items reported.
7. The 24 h recall provided the most consistent results across all age and sex groups compared with the other methods.

Besides the validation study presented earlier, in another study the same authors compared a 4 d assessment of diet by 24 h recall to a FFQ, semi-weighted method and weighed inventory

over 10–12 weeks. The obtained results confirmed the 24 h recall as the most reliable dietary assessment method⁽¹³⁾. Freisling *et al.*⁽¹⁴⁾ assessed diet of pregnant women by a single 24 h recall plus interview. A trained master's student of nutritional sciences interviewed women individually about their food and beverage intakes from the previous day. The field work covered all days of the week, including weekends. All portion sizes were described in household measures and for manufactured food items by the manufacturer's information. The diet records were coded by the same master's student using specifically designed food composition software⁽¹⁴⁾. Two other studies used FFQ: a self-administered, semi-quantitative FFQ, where participants were asked about consumption of 100 food items and their serving sizes, and then converted into daily energy, nutrient and alcohol intakes⁽¹⁵⁾ and an interview-based FFQ estimated by a variety of visual aids, e.g. a display of a series of dishes (slices of meat, cakes, cups and glasses) of recognisable weights and volumes⁽¹⁶⁾. Haste *et al.*⁽¹⁷⁾ applied 7 d weighed records to low-income pregnant women, while Andrie *et al.*⁽⁸⁾ chose estimated 7 d diet records aided by a photographic manual of portion sizes (Table 1).

Another important part of each study was the way SES was defined and how this was used in sampling. Detailed sampling methods used for the evaluation of social status are presented in Table 2. As can be seen in Table 2, social class was categorised in different ways in these studies, suggesting that there is no consistent method for identifying low-income groups in Europe.

Discussion

Evaluating intake methods in low-income populations require that the following two key factors are taken into consideration: determination or definition of low income and choosing the most appropriate method of intake assessment to apply.

Presently, there is no consensus about how to define low-income populations in Europe. A variety of definitions of low income have been described, including low-income families (whose income is at the level of income support), households below average income (usually expressed as numbers of households with incomes <40 or 50% of the national average household income) and quantitative indices of material and social deprivation. Deprivation factors in the deprivation index for identifying low-income/'deprived' households were used in an analysis of the Health Survey in England data and proved to be the strongest household-level predictor of poor general health⁽¹³⁾. Furthermore, Nelson *et al.*⁽¹³⁾ state that low-income families have 'low cost but acceptable' diets. The low cost but acceptable food budget standard identifies a basket of foods and corresponding menus, which provides (for a given household composition) a palatable diet that is consistent with prevailing cultural norms, and that satisfies existing criteria for health in relation to dietary reference values, food-based dietary guidelines and safe levels of alcohol consumption⁽¹³⁾. The level of poverty in Britain was defined as <60% of the contemporary mean, e.g. the threshold for a two-adult household, i.e. 180 pounds/week⁽¹⁸⁾. In France, low socio-economic groups or food-insufficient individuals are those whose estimated cost of the mean diet is below 2.5 €/d. This represents a

Table 1. Characteristics of studies on intake methods in low-income populations

Author, year	Country	Study year	Subjects	Response rate	Dietary assessment method
Holmes <i>et al.</i> , (2008) ⁽³⁾	UK	2001	General population, <i>n</i> 252 households age range: 2–90 years	80 % (252 out of 315)	Three 4 d dietary survey methods (multiple-pass 24 h recall, food checklist and semi-weighed method) against a 4 d weighed inventory
Nelson <i>et al.</i> , (2002) ⁽¹³⁾	UK	2000–2002	General population, excluded pregnant and breast feeding women, <i>n</i> 349 (219 households) age range: all	31 % (252 out of 810)	Twenty-four hours recalls based on the triple pass method. Four day assessments of diet by 24 h recall, food checklist, semi-weighed method and weighed inventory over 10–12 weeks
Freisling <i>et al.</i> , (2006) ⁽¹⁴⁾	Austria	2001	Pregnant women, <i>n</i> 261 age range: below 45 years	90 % (261 out of 290)	Single 24 h recall + interview. A trained master student of nutritional sciences interviewed the women individually about their food and beverage intake from the previous day. The field work covered all days of the week, including week-ends. All portion sizes were described in household measures and by the manufacturer's information.
Galobardes <i>et al.</i> , (2001) ⁽¹⁵⁾	Swiss	1993–1998	General population, <i>n</i> 2929 m + 2767 w age range: 35–74 years	63 %	Self-administered, semi-quantitative FFQ. Mean values obtained from a 24 h recall diary were very similar between the two questionnaires. It asked about hundred food items and their serving sizes, and could be converted into daily energy, nutrient and alcohol intakes.
Rebato <i>et al.</i> , (2001) ⁽¹⁶⁾	Spain	NA	Adults <i>n</i> 297 (115 m + 182w) age range: 18–65 years	NA	FFQ (over 1 month), estimated by a variety of visual aids, e.g. a display of a series of dishes (slices of meat, cakes, cups and glasses) of recognisable weights and volumes.
Haste <i>et al.</i> , (1990) ⁽¹⁷⁾	UK	1982–1984	Pregnant women, <i>n</i> 206 first week, <i>n</i> 178 second week age range: below 45 years	71 % (206 out of 288)	Seven days weighed dietary intake in the 28th and 36th weeks of pregnancy. Five or 6 d records were accepted if they included weekend days.
Andrieu <i>et al.</i> , (2006) ⁽⁸⁾	France	NA	General population, <i>n</i> 1474 (672 m + 802 w) age range: over 15 years	74 % (1474 out of 1985)	Seven days estimated diet records aided by a photographic manual of portion sizes.

NA, not applicable.

Table 2. Sampling methods and determination of material deprivation

Author, year	Sampling
Holmes <i>et al.</i> , (2007) ⁽³⁾	Deprivation of households was assessed by asking the doorstep respondent twelve questions, based on those used in the Health Survey for England household-level deprivation index.
Nelson <i>et al.</i> , (2002) ⁽¹³⁾	Low incomes were identified in three stages: first, sixty most deprived postal sectors in London were identified using the Health Survey for England. Second, addresses were selected to provide geographical cross section of deprived areas in London. Third, doorstep screening interview.
Freisling <i>et al.</i> , (2006) ⁽¹⁴⁾	Household income was classified as follows: the lower class refers to an income of € < 1090 (approximately £750) a month, which is slightly below the poverty line for a two-person household in Austria. The middle household income class refers to an income between €1090 (£750) and € < 2180 (£1500), whereas the high-income level refers to an income of € > 2180 (£1500).
Galobardes <i>et al.</i> , (2001) ⁽¹⁵⁾	Subjects were randomly identified from the residents' register published each year. According to the type and level of schooling, education was categorised as: low (8 years of schooling), medium (9–12 years of schooling) and high (13 years and including people, who obtained the Swiss baccalaureate). Occupational level was measured using the respondent's own occupation: present occupation at the time of the survey or the longest occupation ever held for those not currently working. They grouped them in three occupational levels based on the British Registrar General's Scale: high (I and II from the original British classification: professional and intermediate professions), medium (III-N: non-manual occupations) and low (III-M, IV and V: manual or lower occupations).
Rebato <i>et al.</i> , (2001) ⁽¹⁶⁾	The type of poverty and marginality of the participants can be summarised as follows. (1) Homeless, attending communal dining rooms for lunch and dinner. (2) Long-duration marginal and homeless, receiving temporary bed and breakfast assistance or older people lodged in public institutions. (3) Low class, receiving economic, psychological and/or legal assistance to meet urgent necessities. (4) Low class, attending educational programs for literacy, dress-making, hairdressing, cooking, gardening, etc.
Haste <i>et al.</i> , (1990) ⁽¹⁷⁾	Social class was categorised by the occupation of partner if she was married or cohabiting, according to the registrar general classification. Single women were excluded.
Andrieu <i>et al.</i> , (2006) ⁽⁸⁾	French adults being nationally representative according to socio-demographic factors by the quota method of sampling.

population facing very severe food choice restrictions because of economic constraints⁽¹⁹⁾. The poverty in Serbia is defined as households that have monthly income of 8883 dinars per equivalent scale (approximately 100 €)⁽⁷⁾.

A number of studies in Europe^(20–23) have clearly identified differences between socio-economic subgroups of the population on the level of foods, food groups and nutrients, pointing – in general – to a healthier diet in persons with higher levels of education. Several European studies^(24,25) have also shown the relationship between lower SES and poorer micronutrient density in the diet. A large body of epidemiological data shows that diet quality follows a socio-economic gradient, higher-quality diets are associated with greater affluence, whereas energy-dense diets that are nutrient poor are preferentially consumed by persons of lower SES and of more limited economic means⁽²⁶⁾. The Pan-European Survey of Consumer Attitudes to Food, Nutrition and Health found that the top five influences on food choice in fifteen European Union countries are quality/freshness (74%), price (43%), taste (38%), healthy eating (32%) and family preferences (29%)⁽²⁷⁾.

The consumption of whole grains, lean meats, fish, low-fat dairy products and fresh vegetables and fruit (containing considerable amounts of vitamins, minerals and fibre) was consistently associated with higher SES groups, whereas the consumption of fatty meats, refined grains and added fats was associated with lower SES groups⁽⁸⁾. Low-SES groups also had the lowest consumption of vitamin C, vitamin D, carotene, folate, vitamin E, plant-based polyphenols, as well as low Fe, Ca and K intakes. Studies of plasma biomarkers of dietary exposure provide additional evidence that SES affects diet quality^(8,26). Increased health inequalities and micronutrient deficits are also a result of poverty and social inequalities⁽¹¹⁾.

There are also many difficulties in dietary assessments for low-income population: literacy – level of education of respondents, biases, respondents not informed and not accessible, low motivation and the need to design special tools for nutrient intake assessment, especially in those whose primary source of nutrition is based on social and welfare systems (i.e. public kitchens). Variations in the level of language and numeric skills across the whole sample could mediate against comparable record keeping in all households⁽²⁸⁾. Those with the lowest skills may have difficulty in completing dietary records unless assistance is provided by either interviewers or other household members. Physical problems of record keeping exist among some subgroups, especially the elderly and disabled. Poor eyesight, impaired hearing and other physical disabilities such as being chair- or bed-ridden make weighing and recording of diet difficult or impossible⁽³⁾. A higher incidence of mental health problems also exists among individuals living on limited incomes, particularly the elderly. Dementia creates adverse consequences for data collection, particularly when using retrospective methods of dietary assessment that are reliant on memory⁽²⁹⁾. Drug and alcohol abuse may create similar problems, impacting not only on the quality of the data but also on the safety and welfare of the interviewers⁽³⁾. All these difficulties may affect the application of intake assessment methods as well as their results.

In the papers reviewed in the present study, one of the commonly used methods for dietary assessment was the weighed food record, which was also used as a gold standard in two studies that evaluated three other methods^(3,13). However, they differed in the length of time of assessment, for example 4 d v. 7 d^(3,8,13,17), as well as adjunct administration of 24 h recalls or FFQ⁽¹³⁾. These results are similar to published data for the general population. Maillot *et al.*⁽³⁰⁾, for example, used an estimated 7 d record aided by a photographic manual

of portion sizes in French adults. Andersen *et al.*⁽³¹⁾ applied a pre-coded food diary with lists of 277 drinks, food items and dishes for overweight and obese Norwegian schoolchildren, who indicated an eating event by filling in how many units they ate of each food item in the correct time span. Some studies show that there were no striking differences between different socio-economic groups in the proportion of underreporters⁽³²⁾, but the Whitehall II Study shows that the proportion of low-energy reporters was approximately four times higher in the lowest compared to the highest socio-economic group⁽³³⁾. Moreover, the person's attitude towards consumption was found to be a good predictor of reported consumption⁽³⁴⁾.

Methods for measuring food intake are not standardised across Europe and data in low-income populations are generally inadequate. Based on the results of one study, the dietary survey method preferred by the interviewers of low-income populations was the 24 h recall. Most respondents preferred the FFQ. The FFQ constitutes another method that was one of the most utilised by studies reviewed in the present paper. However, compared with the weighed inventory, repeat 24 h recalls and FFQ yielded higher estimates of energy and nutrient intakes. The semi-weighed method was least liked and yielded the lowest estimates of intake. Other intake methods appear not to have been subjected to specific and/or reliability testing, but are used in many other population groups⁽³⁾. Thus, four multiple-pass 24 h recalls were shown to be the most appropriate method for a study of diet and nutrition in low-income households. However, problems with this method include errors in recall, poor estimations of serving size and poor generalisability from a specific day to overall dietary habits⁽¹⁾. Therefore, a single 24 h recall is not appropriate to analyse associations between nutrition intakes and status biomarkers or health endpoint and several measurements are required.

Moreover, there is a lack of data for these kinds of studies in Central and Eastern Europe⁽³⁵⁾. However, data presented as grey literature sources (national studies, monograph, theses, etc.) could be an important and additional source of valuable information. Food consumption of low-income groups in Poland and Belgium (grey literature, data not shown) applied two intake methods: 24 h recalls administered by trained interviewers using an album of food portions and a forty-two item FFQ representing all food groups where the respondent is asked about usual frequency of food and drink consumption⁽¹²⁾. Another study consists of the Low Income Diet and Nutrition Survey in the United Kingdom (*n* 3728 individuals aged >2 years) in which four 24 h recalls were administered on random days (including at least one weekend day) within a 10 d period by trained interviewers and nurses in a face-to-face interview as well as self-administered questionnaires⁽³⁶⁾. In a large national study in Serbia, 7 d food records were used as the method of determining nutrient intake in schoolchildren and their families (age 10, *n* 1318 and age 15, *n* 960)^(37,38). Even though the present study was not specified for low-income groups, Serbia was classified by the World Bank definition⁽³⁹⁾, based on gross national income per capita, as a low-income European country. The paucity of literature highlights the difficulties in conducting intervention studies that show how economic constraints orient food choices due to intentional or non-intentional

bias/misreporting. This is a clear knowledge gap that requires further investigation into the development of optimal tools for dietary assessment for this population.

Conclusions

The present paper centres on the use of various methods for obtaining dietary information applied in evaluating diets of low-income populations. Based on the previously cited validation study, four multiple-pass 24 h recalls were shown to be the most appropriate method for a study of diet and nutrition in low-income households. Compared with the weighed inventory, repeat 24 h recalls and food frequency checklists yielded higher estimates of energy and nutrient intakes. The semi-weighed method was least liked and yielded the lowest estimates of intake. Other intake methods appear not to have been subjected to specific and/or reliability testing, but are used in many other populations groups. The decision to use a particular method must therefore be considered carefully. In general, the findings of this literature review will help in defining the optimal methods of dietary assessment to be used for collecting nutrient data in future surveys targeting low-income populations. Future research studies should include an examination of validity, specificity and acceptability; furthermore, they should also shed light on recommendations for best practice in harmonisation, obtaining and using dietary intake data to compare intakes in low-income populations from different regions throughout Europe.

Acknowledgements

The studies reported herein have been carried out within the European micronutrient recommendations aligned Network of Excellence (www.eurreca.org), financially supported by the Commission of the European Communities, specific Research, Technology and Development Programme Quality of Life and Management of Living Resources, within the Sixth Framework Programme, contract no. 036196. This report does not necessarily reflect the Commission's views or its future policy in this area. V. V. developed and carried out the search strategy, undertook analysis and wrote the first draft of the paper. R. N. carried out the search strategy, contributed to writing the first draft and commented on the following drafts of the paper. J. N. participated in the development of the search strategy and commented on the following drafts of the paper. D. R.-M. developed the search strategy and commented on drafts of the paper. J. T. and M. R. commented on drafts of the paper. L. S.-M. participated in the planning of the strategy. M. G. and M. G. participated in the planning of the strategy, directed and supervised the work and commented on all drafts of the paper.

References

1. Biro G, Hulshof KFAM, Ovesen L, *et al.* (2002) Selection of methodology to assess food intake. *Eur J Clin Nutr* **56**, Suppl. 2, S25–S32.
2. Kipnis V, Midthune D, Freedman L, *et al.* (2002) Bias in dietary-report instruments and its implications for nutritional epidemiology. *Public Health Nutr* **5**, 915–923.

3. Holmes B, Dick K & Nelson M (2008) A comparison of four dietary assessment methods in materially deprived households in England. *Public Health Nutr* **11**, 444–456.
4. Darmon N, Ferguson EL & Briand A (2006) Impact of a cost constraint on nutritionally adequate food choices for French women: an analysis by linear programming. *J Nutr Educ Behav* **38**, 82–90.
5. Eurostat (2007) *Living conditions in Europe, Data 2002–2005*. European Communities. Luxembourg: Office for Official Publications of the European Communities. Available at http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-76-06-390/EN/KS-76-06-390-EN.PDF (accessed October 2008).
6. Matković T, Šućur Z & Zrinščak S (2007) Inequality, poverty, and material deprivation in new and old members of European union. *Croat Med J* **48**, 636–652.
7. Vukmirovic D & Smith Govoni R (editors) (2008) *Studija o životnom standardu: Srbija 2002–2007. (Study of Living Standards: Serbia 2002–2007)*. Beograd: Republički zavod za statistiku Srbije, Publikum (in Serbian).
8. Andrieu E, Darmon N & Drewnowski A (2006) Low-cost diets: more energy, fewer nutrients. *Eur J Clin Nutr* **60**, 434–436.
9. Darmon N, Briand A & Drewnowski A (2004) Energy-dense diets are associated with lower diet costs: a community study of French adults. *Public Health Nutr* **7**, 21–27.
10. Dowler EA & Dobson BM (1997) Nutrition and poverty in Europe: an overview. *Proc Nutr Soc* **56**, 51–62.
11. Robertson A (2001) Social inequalities and the burden of food-related ill-health. *Public Health Nutr* **4**, 1371–1373.
12. Januszewska R, Rejman K & Viaene J (2007) *Food consumption of low income groups in Poland and Belgium*. Warsaw: Warsaw University of Life Sciences Press.
13. Nelson M, Dick K & Holmes B (2002) Food budget standards and dietary adequacy in low-income families. *Proc Nutr Soc* **61**, 569–577.
14. Freisling H, Elmadfa I & Gall I (2006) The effect of socio-economic status on dietary intake, physical activity and body mass index in Austrian pregnant women. *J Hum Nutr Diet* **19**, 437–445.
15. Galobrades B, Alfredo Morabia A & Bernstein MS (2001) Diet and socioeconomic position: does the use of different indicators matter? *Int J Epidemiol* **30**, 334–340.
16. Rebato E, Rosique J, Vinagre A, *et al.* (2001) Nutritional status by socioeconomic level in an urban sample from Bilbao (Basque Country). *Am J Human Biol* **13**, 668–678.
17. Haste FM, Brooke OG, Anderson HR, *et al.* (1990) Nutrient intakes during pregnancy: observations on the influence of smoking and social class. *Am J Clin Nutr* **51**, 29–36.
18. Palmer G, Carr J & Kenoway P (2005) *Monitoring Poverty and Social Exclusion 2005*. York: Joseph Rowntree Foundation New Policy Institute.
19. Darmon N, Ferguson EL & Briand A (2002) A cost constraint alone has adverse effects on food selection and nutrient density: an analysis of human diets by linear programming. *J Nutr* **132**, 3764–3771.
20. Hulshof KF, Brussaard JH, Kruizinga AG, *et al.* (2003) Socio-economic status, dietary intake and 10 y trends: the Dutch National Food Consumption Survey. *Eur J Clin Nutr* **57**, 128–137.
21. Smith GD & Brunner E (1997) Socio-economic differentials in health: the role of nutrition. *Proc Nutr Soc* **56**, 75–90.
22. Vereecken CA, Inchley J, Subramanian SV, *et al.* (2005) The relative influence of individual and contextual socio-economic status on consumption of fruit and soft drinks among adolescents in Europe. *Eur J Public Health* **15**, 224–232.
23. Wandel M (1995) Dietary intake of fruits and vegetables in Norway: influence of life phase and socio-economic factors. *Int J Food Sci Nutr* **46**, 291–301.
24. James WP, Nelson M, Ralph A, *et al.* (1997) Socioeconomic determinants of health. The contribution of nutrition to inequalities in health. *BMJ* **314**, 1545–1549.
25. De Henauw S, Matthys C & De Backer G (2003) Socio-economic status, nutrition and health. *Arch Pub Health* **61**, 15–31.
26. Darmon N & Drewnowski A (2008) Does social class predict diet quality? *Am J Clin Nutr* **87**, 1107–1117.
27. Glanz K, Basil M, Maibach E, *et al.* (1998) Why Americans eat what they do: taste, nutrition, cost, convenience, and weight control concerns as influences on food consumption. *J Am Diet Assoc* **98**, 1118–1126.
28. Dowler EA & Dobson BM (1997) Nutrition and poverty in Europe: an overview. *Proc Nutr Soc* **56**, 51–62.
29. Elia M & Stratton RJ (2005) Geographical inequalities in nutrient status and risk of malnutrition among English people aged 65 y and older. *Nutrition* **21**, 1100–1106.
30. Maillot M, Darmon N, Vieux F, *et al.* (2007) Low energy density and high nutritional quality are each associated with higher diet costs in French adults. *Am J Clin Nutr* **86**, 690–696.
31. Andersen LF, Lillegaard IT, Øverby N, *et al.* (2005) Overweight and obesity among Norwegian schoolchildren: changes from 1993 to 2000. *Scand J Public Health* **33**, 99–106.
32. Lindström M, Hanson BS, Brunner E, *et al.* (2000) Socio-economic differences in fat intake in a middle-aged population: report from the Malmö Diet and Cancer Study. *Int J Epidemiol* **29**, 438–448.
33. Marmot M & Brunner E (2005) Cohort profile: the Whitehall II Study. *Int J Epidemiol* **34**, 251–256.
34. Towler G & Shepherd R (1992) Application of Fishbein and Ajzen's expectancy-value model to understanding fat intake. *Appetite* **18**, 15–27.
35. Gurinovic M, Glibetic M, Oshaug A, *et al.* (2008) *Report of the 4th Meeting of the UNU/SCN Network for Capacity Development in Nutrition in Central and Eastern Europe (NCDNCEE), NCDNCEE and EURRECA Training Workshop about Grey Literature, Belgrade 10th–12th November, 2008*. <http://www.srbnutrition.info/?page=Network> (accessed December 2008).
36. Nelson M, Erens B & Bates B, *et al.* (2007) (editors) *Low Income Diet and Nutrition Survey*. London: The Stationery Office.
37. Pavlović M, Kadvan A, Vukotić M, *et al.* (2006) The quality of nutrition in schoolchildren and adult members of families. In *Yugoslav Study of Atherosclerosis Precursors in Schoolchildren in Serbia from 1998–2003, Monograph*, pp. 262–285 [Nedeljkovic S, editor]. Medical Faculty University of Belgrade: CIBID (In Serbian).
38. Pavlović M & Kadvan A (2006) Methodology of the dietary survey in YUSAD study. In *Yugoslav Study of Atherosclerosis in Schoolchildren in Serbia from 1998–2003, Monograph*, pp. 254–261 [Nedeljkovic S, editor]. Medical Faculty University of Belgrade: CIBID (In Serbian).
39. World Bank Classification. <http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,contentMDK:20421402~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html> (accessed December 2008).