Precoded food records compared with weighed food records for measuring dietary habits in a population of Swedish adults

By Wulf Becker, Maria Lennernäs, Inga-Britt Gustafsson, Jóhanna Haraldsdóttir, Margaretha Nydahl, Bengt Vessby and Anne Ytterfors

Received: July 28, 1998; Accepted: November 23, 1998

Abstract

In a cross-over design, 82 women and men recorded their food intake by a precoded 7-day record book (PR) including both standard portions in household measures and photographs, and a weighed 7-day record (WR), respectively. Single 24-h urine samples, for determination of nitrogen excretion, were collected for 39 subjects during the WR period.

Comparing the PR to the WR method, the mean intake of some foods, as cheese, was higher, and bread and vegetables lower. For energy and nutrients, the fat energy percent (E%) was higher, and protein E%, dietary fibre, iron, thiamin, folate, carotene and α-tocopherol were all lower. Protein intake registered by the PR method was 20% lower compared to 24-h urine samples, and 11% lower for the WR method. The results indicate that some of the standard portion sizes, used by the PR method, contributed to the observed differences in food and nutrient intakes. The subjects found it easier and less time-consuming to record their food intake with the PR than with the WR method. The time spent on processing data was reduced by 50% when using the PR method. The results of the study will be used for improvements in the design of the PR for use in large-scale dietary surveys for monitoring dietary habits.

Introduction

A major obstacle to using food records in large population surveys is the large, costly workload linked with coding (e.g. allocating codes and weights to foods) and entering the data into the computer. Use of precoded food record forms could substantially reduce these costs and also simplify the work for the person recording his or her food intake, eliminating or reducing the need for weighing and writing. In 1989, a combined nation-wide household budget and dietary survey was carried out by Statistics Sweden in cooperation with the National Food Administration (1). The survey was originally designed to measure household acquisition of food (both expenditures and amounts), but in order to obtain data on individual dietary intake a precoded 7-day record book (PR) was developed and included in the survey (2,3). The record book was designed in such a way that it would give relatively detailed information about an individual's food intake but still be easy to fill in by the participant. This requirement was important since the survey was cumbersome for the household. The PR contains preprinted alternatives of food, where the meals were eaten (7 preprinted alternatives) and dishes commonly eaten at main meals (breakfast, lunch, dinner). Time of day and place where the meals were eaten (7 pre-printed alternatives) was indicated for each meal. Photographs were used to show the portion sizes (four alternatives, each on one plate) as a guide to estimate the portions of the meal components (meat/fish; potatoes/pasta/rice; vegetables/salad). The use of spreads on sandwiches was also estimated by photographs showing four alternatives. For other pre-printed foods the respondent indicated the amount consumed in household measures (pieces, glasses, cups, spoons, deciliters, etc.) and predefined standard portions were allocated in the data analyses. These portions were mainly derived from Swedish reference publications such as Viktateller (Food Weight Tables) (5). In addition, it was also possible to record, in free text, other types of foods eaten at these meals. Snacks and other in-between meals were

Precoded record book (PR): The PR gives pre-printed alternatives for foods and dishes commonly eaten at main meals (breakfast, lunch, dinner). Time of day and place where the meals were eaten (7 pre-printed alternatives) was indicated for each meal. Photographs were used to show the portion sizes (four alternatives, each on one plate) as a guide to estimate the portions of the meal components (meat/fish; potatoes/pasta/rice; vegetables/salad). The use of spreads on sandwiches was also estimated by photographs showing four alternatives. For other pre-printed foods the respondent indicated the amount consumed in household measures (pieces, glasses, cups, spoons, deciliters, etc.) and predefined standard portions were allocated in the data analyses. These portions were mainly derived from Swedish reference publications such as Viktateller (Food Weight Tables) (5). In addition, it was also possible to record, in free text, other types of foods eaten at these meals. Snacks and other in-between meals were

Wulf Becker, MD professor, Anne Ytterfors Dietitian.
National Food Administration, Uppsala, Sweden.
Dept of Medical Sciences, Nutrition Unit, Uppsala University, Dept of Culinary Art, University of Orebro, Research Department of Human Nutrition, Royal Veterinary and Agricultural University, Copenhagen, Denmark, Dept of Domestic Sciences, Uppsala University, Unit for Clinical Nutrition Research, Dept of Public Health and Caring Sciences. Uppsala University
Correspondence: Wulf Becker, National Food Administration, P.O. Box 622, SE-751 26 Uppsala, Sweden. E-mail: wube@svb.se

Scand J Nutr/Näringsforskning 4/98
Table 1. Average consumed amounts, mean and (SD), of some foods among adults (n=82) according to the precoded record book (PR) and the weighed record (WR), Spearman correlation coefficients and Kappa values (κ).

| Food group | PR     | WR     | \( p \) | \( \kappa \) | \( r \) |
|------------|--------|--------|--------|----------|--------|
| Spreads    | 26 (15) | 26 (15) | 0.28   | 0.47***  |        |
| Cheese     | 39 (31) | 32 (22) | *      | 0.51     | 0.69*** |
| Milk       | 278 (197) | 248 (175) | 0.47   | 0.73***  |        |
| Potatoes   | 138 (59) | 129 (61) | 0.24   | 0.37***  |        |
| Vegetables | 84 (63) | 109 (90) | **     | 0.28     | 0.47*** |
| Roots      | 9 (15)  | 17 (25)  | **     | 0.23     | 0.40*** |
| Fruit      | 114 (80) | 115 (76) | 0.50   | 0.70***  |        |
| Juice      | 63 (92)  | 51 (89)  | 0.44   | 0.55***  |        |
| Bread      | 89 (35)  | 104 (41) | **     | 0.57     | 0.74*** |
| Buns, cakes| 51 (34)  | 53 (33)  | 0.38   | 0.54***  |        |
| Porridge, gruel | 40 (76) | 29 (63) | 0.58 | 0.62***  |        |
| Pasta      | 28 (31)  | 40 (41)  | 0.23   | 0.38***  |        |
| Cereals, müsli | 5 (9)   | 11 (16)  | ***    | 0.61     | 0.73*** |
| Meat, poultry | 87 (41) | 96 (43) | 0.31   | 0.49***  |        |
| Sausages   | 30 (26)  | 32 (29)  | 0.19   | 0.35***  |        |
| Fish       | 35 (28)  | 36 (33)  | 0.23   | 0.35***  |        |
| Soft drinks| 102 (133) | 102 (130) | 0.41  | 0.59***  |        |
| Alcoholic drinks | 226 (182) | 193 (196) | **  | 0.41     | 0.63*** |
| Coffee, tea| 951 (385) | 868 (410) | 0.49  | 0.68***  |        |

The superscripts refer to level of significance, i.e. for difference in food intake and Spearman coefficients: *\( p<0.05; ** p<0.01; *** p<0.001 \).

The intake of food and nutrients was calculated using a commercial software program, MATs (7), and the food composition data from the National Food Administration (6). Individual food items are grouped into 35 main food groups.

Weighed food records (WR): The subjects also kept a weighed food record. At their first visit to the dietitian the subjects were instructed on how to use the scale (Soehnle, precision 1 g). Most of the participants were of working age, some of them had to eat at restaurants and then could not always weigh their food. For estimating the food intake at such meals, the participants were given a set of photographs and drawings showing portion sizes of food components in main meals, amount of spread used on sandwiches, portion sizes of fruits, bread, etc. However, they were instructed not to use estimations if they were able to use the scale. They kept the food records for seven consecutive days. The use of the scale or photographs/drawings for recording weights was evaluated. The same software package (MATs) as used for the PR was used to calculate the food and nutrient intake.

24-hours urine collection: Protein intake was validated by comparing the calculated intake with the 24-hour nitrogen excretion (8). Thirty-nine of 82 subjects collected a 24-hour urine sample during the WR period. That period was chosen since the WR was considered to be the reference method and also to limit the work-load for the subjects. PABA (para-amino-benzoic acid) tablets were used to check the completeness of the urine collection (9). Three PABA tablets containing 80 mg each were taken during the 24-hour urine collection. One tablet was taken with each of the three main meals (breakfast, lunch, dinner). The urine collections containing less than 85% of the ingested PABA were considered incomplete. The urine collections were spread out over the week, so that each of the week-days would be represented at the same rate. Urine nitrogen excretion was converted to grams of protein ingested using the formula gram \( N \times 0.81 \times 6.25 \), since it has been found that, on average, 81% of the nitrogen is excreted with the urine (9).

Participants’ views of the PR: A questionnaire containing questions about the participants views of the two dietary record methods was sent to 25 of the participants after completion of the dietary study. The questionnaire contained questions about recorded, in free text, on a separate page for each day, and the amounts given in household measures as in an open-ended food record.

The participant visited the dietitian, who gave an introductory description of the PR to the subject. After a week the participant returned the completed book. Food that was not precoded in the PR was then coded according to the National Food Administration’s food composition database (6) before the data were entered. A special computer program was developed for direct conversion of the precoded alternatives into amounts and food codes.

Table 2. Intake frequencies and average amounts consumed per eating occasion among adults (n=82) according to the precoded record book (PR) and weighed record (WR).

| Food group | Frequency/day | Average portion (g) |
|------------|---------------|---------------------|
|            | PR | WR | \( p \) | PR | WR | \( p \) |
| Spreads    | 1.79 | 2.02 ** | 15 | 14 |       |
| Cheese     | 1.22 | 1.28 |       | 32 | 26 *** |       |
| Milk       | 1.14 | 1.36 ** | 245 | 196 *** |       |
| Potatoes   | 0.75 | 0.74 |       | 187 | 174 * |       |
| Vegetables | 1.73 | 1.95 * | 49 | 60 * |       |
| Roots      | 0.19 | 0.25 |       | 50 | 74 |       |
| Fruit      | 1.23 | 1.13 |       | 97 | 112 *** |       |
| Juice      | 0.28 | 0.28 |       | 231 | 174 *** |       |
| Bread      | 2.37 | 2.39 |       | 39 | 46 *** |       |
| Cereals, müsli | 0.24 | 0.27 |       | 21 | 45 *** |       |
| Pasta      | 0.19 | 0.20 |       | 150 | 207 *** |       |
| Porridge, gruel | 0.17 | 0.13 |       | 246 | 216 *** |       |
| Buns, cakes | 1.20 | 1.38 * | 49 | 40 ** |       |
| Meat, poultry | 1.03 | 0.98 |       | 86 | 104 *** |       |
| Sausages   | 0.41 | 0.44 |       | 80 | 87 |       |
| Fish       | 0.48 | 0.50 |       | 79 | 83 |       |
| Soft drinks| 0.37 | 0.41 |       | 280 | 248 |       |
| Alcoholic drinks | 0.78 | 0.74 |       | 298 | 273 |       |
| Coffee, tea| 4.36 | 4.58 |       | 225 | 191 *** |       |

Values significantly different from weighed record: *\( p<0.05; ** p<0.01; *** p<0.001 \).
the time spent recording food intake, use of pictures in the PR, ease of recording food intake, etc. In addition, the time spent on coding and entering the data was estimated.

Statistics: Calculations were carried out with the SAS program (10) and included statistic procedures such as paired t-tests, Spearman’s ranked correlations, and weighted Kappa (κw) analysis (11). κw >0.40 indicates good agreement, and ≤0.40 poor agreement.

Results
Food intake
The average daily intake of foods (aggregated into major food groups) obtained by the two methods is shown in Table 1. The intake of cheese and alcoholic drinks was higher (p<0.05) and that of bread, breakfast cereals, vegetables, roots (excluding potatoes), lower (p<0.01) with the PR than with the WR. Otherwise, no statistical differences between the two methods were found. Also the relative differences between men and women were similar in the two methods (data not shown).

The correlation coefficients (Spearman) between the daily intake of the foods measured by the two methods ranged from 0.35 to 0.74 (Table 1). Kappa values, which reflects the agreement between the two methods with respect to classification of intakes into quintiles, were above 0.4 for foods like milk, cheese, bread and fruit, but below 0.4 for foods like spreads, potatoes, vegetables, meat and fish (Table 1).

Food portions and frequencies: Intake frequencies for most foods were relatively similar in the two methods (Table 2). Compared with the WR, the intake frequencies for spreads, milk, vegetables and sweet bakery products were lower (p<0.05) in the PR. To obtain a picture of differences between portion sizes recorded in the two methods, average portions of milk, cheese, potatoes, vegetables, meat and fish were similar in the two methods (data not shown).

Energy and nutrient intake: The average daily intakes of energy and nutrients as measured by the two methods are shown in Tables 3 and 4. The intake of energy and most nutrients did not differ significantly between the two methods. Significant differences were, however, seen for protein, monosaccharides, dietary fibre, β-carotene, α-tocopherol, thiamin, preformed niacin, folate, iron, zinc (lower in PR) and polyunsaturated fatty acids (higher in PR). The proportions of energy from protein and monosaccharides were significantly lower (p<0.01) for the PR than for the WR, while the proportions of energy from total fat, saturated and polyunsaturated fat were higher (p<0.01).

The correlation coefficients (Spearman) between the daily intake of energy and nutrients measured by the two methods were generally 0.5-0.7 (p<0.001). For cholesterol, retinol and the proportion of energy from total fat, monosaturated

| Table 3. Average daily intake of energy and nutrients, mean and (SD) measured by the record book (PR) and the weighed record (WR) among adults (n=82), Spearman correlation coefficients and Kappa values (κw). |
| PR | WR | p | κw | r |
|-----|-----|-----|------|-----|
| Energy | MJ | 8.9 (2.0) | 9.0 (2.1) | 0.45 | 0.62 *** |
| Protein | g | 74 (19) | 80 (19) | ** | 0.45 | 0.58 *** |
| Total fat | g | 88 (24) | 85 (23) | | 0.40 | 0.61 *** |
| Saturated fat | g | 37 (11) | 36 (10) | | 0.46 | 0.66 *** |
| Monounsaturated fat | g | 31 (8.8) | 31 (8.6) | | 0.40 | 0.56 *** |
| Polyunsaturated fat | g | 13.4 (4.3) | 12.5 (3.8) | * | 0.36 | 0.51 *** |
| Cholesterol | g | 0.32 (0.11) | 0.33 (0.11) | | 0.32 | 0.38 *** |
| Total carbohydrates | g | 242 (52) | 251 (63) | | 0.42 | 0.63 *** |
| Monosaccharides | g | 29 (12) | 33 (15) | ** | 0.32 | 0.44 *** |
| Sucrose | g | 43 (20) | 46 (21) | | 0.53 | 0.68 *** |
| Dietary fibre | g | 16.5 (4.0) | 18.3 (5.8) | *** | 0.48 | 0.59 *** |
| Alcohol | g | 9.7 (8.4) | 10.0 (10.1) | | 0.44 | 0.61 *** |

The superscripts refer to level of significance, i.e. for difference in food intake and Spearman coefficients: *p<0.05; **p<0.01; ***p<0.001

| Table 4. Average daily intake of micronutrients, mean and (SD) measured by the precoded record book (PR) and the weighed record (WR) among adults (n=82), Spearman correlation coefficients and Kappa values (κw). |
| PR | WR | p | κw | r |
|-----|-----|-----|------|-----|
| Retinol | mg | 0.93 (0.63) | 0.84 (0.50) | 0.22 | 0.26 * |
| β-carotene | mg | 1.93 (1.32) | 2.41 (2.00) | ** | 0.33 | 0.54 *** |
| Vitamin D | µg | 5.5 (1.9) | 6.0 (3.0) | | 0.36 | 0.49 *** |
| α-tocopherol | mg | 7.0 (2.2) | 7.9 (2.7) | ** | 0.38 | 0.49 *** |
| Thiamin | mg | 1.36 (0.37) | 1.54 (0.41) | *** | 0.35 | 0.45 *** |
| Riboflavin | mg | 1.67 (0.47) | 1.68 (0.49) | | 0.48 | 0.59 *** |
| Niacin (pref.) | mg | 15.9 (3.5) | 18.0 (4.6) | *** | 0.41 | 0.54 *** |
| Vit B12 | µg | 1.94 (0.44) | 2.00 (0.48) | | 0.45 | 0.49 *** |
| Vit B6 | µg | 6.2 (4.3) | 5.5 (3.6) | | 0.34 | 0.61 *** |
| Folate | µg | 206 (52) | 225 (55) | ** | 0.28 | 0.43 *** |
| Vitamin C | mg | 74 (34) | 79 (40) | | 0.44 | 0.41 *** |
| Calcium | mg | 1000 (388) | 939 (317) | | 0.46 | 0.67 *** |
| Potassium | mg | 3260 (625) | 3160 (761) | | 0.34 | 0.62 *** |
| Sodium | mg | 3350 (884) | 3340 (1150) | | 0.28 | 0.52 *** |
| Magnesium | mg | 328 (63) | 319 (75) | | 0.45 | 0.64 *** |
| Iron | mg | 14.3 (3.3) | 16.4 (4.6) | *** | 0.39 | 0.56 *** |
| Zinc | mg | 10.3 (2.6) | 10.8 (2.7) | * | 0.43 | 0.61 *** |
| Selenium | µg | 31 (9) | 32 (11) | | 0.34 | 0.43 *** |

The superscripts refer to level of significance, i.e. for difference in food intake and Spearman coefficients: *p<0.05; **p<0.01; ***p<0.001
foods preprinted, instead of doing urinary nitrogen excretion (PABA recovery >85%) (UP), the precoded record book (PR) and the weighed record (WR). Men and women (n=33), mean and (SD).

| UP  | PR  | WR  |
|-----|-----|-----|
| Protein intake (g/d) | 91 (23) | 73 (21) | 81 (23) |

*** p<0.001; 1 Collected during the weighed record period.

Table 6. Participant attitudes to using the precoded record book (PR). Percent of answers (n=25).

| When filling in the PR, it was | Very easy | Easy | Cumbersome | Very cumbersome |
|-------------------------------|-----------|-----|------------|----------------|
| More easy                     | 65        | 4   | 22         | 9              |
| Less easy                     |           | 68  | 24         | 0              |
| No difference                 |           |     |            |                |
| Cannot say                    |           |     |            |                |

| What did you think of having most foods preprinted, instead of doing the writing yourself? | (n=23) |
|-------------------------------------------------------------------------------|-------|
| More easy                                                                     | 65    |
| Less easy                                                                     | 4     |
| No difference                                                                 | 22    |
| Cannot say                                                                    | 9     |

| When estimating portion sizes with the help of the pictures, it was (n=23) | Very easy | Easy | Difficult | Very difficult |
|--------------------------------------------------------------------------|-----------|-----|-----------|----------------|
| Very easy                                                                | 57        | 26  | 17        | 0              |
| Easy                                                                      |           |     |           |                |
| Difficult                                                                 |           |     |           |                |
| Very difficult                                                            |           |     |           |                |

| Did the precoding affect your eating?                                    | No | Yes, to some degree |
|--------------------------------------------------------------------------|----|---------------------|
| No                                                                        | 92 | 8                   |
| Yes, to some degree                                                       |    |                     |

| How did the selection of foods in the PR reflect your food choice? | Well | Relatively well | Less well | Not at all |
|-------------------------------------------------------------------|------|----------------|-----------|-----------|
| Well                                                              | 28   | 72             | 0         | 0         |
| Relatively well                                                   |      |                |           |           |
| Less well                                                         |      |                |           |           |
| Not at all                                                        |      |                |           |           |

Table 5. Intake of protein measured by 24-h urinary nitrogen excretion (PABA recovery >85%) (UP), the precoded record book (PR) and the weighed record (WR). Men and women (n=33), mean and (SD).

Urinary nitrogen excretion
The daily protein intake found with the PR was 20% lower (p<0.001), and the protein intake found with the WR 11% lower (p<0.001) than that calculated from the 24-h urine (Table 5). The correlation coefficient between the urinary protein data and the intake found with the PR was 0.74 (p<0.001) and 0.68 (p<0.001) for the WR (men and women combined). If the six subjects for which PABA recovery was less than 85% are included, the results were not affected to any significant extent.

Use of scale in the WR
In the weighed 7-day food record, the men and women reported, on average, 43 and 47 eating events, respectively. Among those, the scale was used to weigh all the food items in 89% (men) and 92% (women) of the eating events. This corresponded to 89% and 92% of the total energy intake coming from weighed eating events among men and women, respectively. The remaining energy came from estimated amounts of food by use of pictures, drawings, etc. There were no significant differences in the proportion of energy intake from weighed and estimated eating events between men and women.

Of the different meal categories, the scale was used in more than 90% of the breakfast meals, dinners and other meals, while it was used in 70-80% of the lunch meals. There were no significant differences between men and women for any of the meal categories.

Table 7. Comparison of average time (min) required for data handling of the precoded record book (PR) and the weighed record (WR).

|                        | WR min | PR min |
|------------------------|--------|--------|
| Coding                 | 90     | 20     |
| Entering data          | 45     | 45     |
| Data checking          |        |        |
| - nutrient calculation | 20     | 15     |
| Total time required    | 155    | 80     |

The participants found it easier and less time-consuming to record their food intake with the PR than to weigh the foods. Typically, a person spent 10-15 min per day filling in the PR and 20-30 min for the 7-day WR.

Coding and entering of data
In connection with the study, the time spent on coding and entering the data from the PRs and the WRs was estimated. The total times spent on these activities were ca. 150 min for a WR and ca. 80 min for a precoded PR, with most of the time saving in the coding step (Table 7).

Discussion
An analysis of the data indicated that the noted differences in food intake in most cases were associated with the amounts eaten at each meal, rather than with intake frequencies. This might indicate that some of the standard portions used in the PR did not reflect actual portion sizes, e.g. for some types of bread (a slice of white bread and a piece of Swedish crisp bread), cheese (slices), milk (a glass) and certain types of foods that were to be estimated with the help of the photos, e.g. prepared vegetables, salads and pasta. For milk, some of the observed differences might have arisen due to the fact that use of “a glass” would tend to overestimate the amount of milk used for porridge. Also for some other foods, e.g. fruit and meats, average portions differed between the methods, but without resulting in significant differences in the average daily intakes.

The average intake of energy and most nutrients did not differ significantly between the two methods. However, the intake of protein and monosaccharides, dietary fibre, iron, β-carotene, α-tocopherol, thiamin, folate and zinc was lower and the %E from fat was higher with the PR than with the WR. The difference was generally within 5-10%, except for carotene (ca. 20%). These differences could largely be attributed to the apparent overestimation of the intake of cheese and the apparent underestimation of the intakes of bread and cereals, meat dishes and vegetables.

A key question in this type of validation study is how much of any observed difference in dietary habits can be attributed to the methods and to differences in the true dietary intake during two periods. Few studies have compared food intake measured with a 7-day record method during separate weeks. In a comprehensive study, Adelson (12) compared food and nutrient intake of 39 well-educated American men recorded during two consecutive weeks. Food eaten at home was weighed and
amounts of food eaten away from home were estimated in household measures. The average intake of major food groups varied within 10% between the first and second week. For sub-groups and individual items the variation was usually within 20%. These figures are probably close to the best that one could expect with respect to week-to-week correlation of food intakes since records were kept during two consecutive weeks and the mean energy and nutrient intakes were very similar (within 5%) between the two weeks. In the present study, the mean differences in average intake of foods (aggregated into food groups) between the WR and PR methods were within 10% or 20% for most foods, which is somewhat higher that the figures reported by Adelson (12).

Few studies have reported the intra-individual correlation of energy and nutrient intakes measured with a 7-day record method during two separate weeks (13-16). The ranked correlation coefficients in this study (0.5-0.7) are of an order that could be expected when food intakes during two separate weeks are compared and similar to those reported by Bingham et al. (13) between a 16-day weighed and a 7-day estimated record (0.5-0.8).

The weighed record has generally been regarded as one of the most reliable methods of measuring an individual’s dietary intake (18,19), although the extensive work for the subject might affect compliance. Therefore, this method was chosen as the reference method in this study. The participants were instructed to weigh carefully all foods they consumed. The participants also received a portion guide with photos and drawings of portions to be used in situations where it would be inappropriate to use the scale. Our results show that the scale was used in the majority of eating events. Estimation of portion sizes was only done for ca. 10% of the eating events, and about 10% of the total energy intake came from these eating events.

Recent developments in measurement of energy expenditure, i.e. the use of doubly labelled water, has, however, shown that underestimation of food intake by adults and adolescents is a general problem with record methods (19,20). The energy intakes in this study are comparable to those in other large dietary surveys in which 7-day records have been used (1,4,21). The average PAL-values were 1.3-1.4, with no differences between the two methods, indicating a substantial underestimation of the habitual energy intake. In our study, the protein intake was validated using 24-h urinary collections in a sub-sample of subjects. The results show that the dietary protein intake was 11% lower with the WR and 20% lower with the PR compared with the protein intake estimated from urinary nitrogen data for the WR period, thus indicating a significant underestimation of the protein intake for both methods. Correlation coefficients (Spearman) between protein intake calculated from urinary protein and dietary protein were 0.68 for the WR and 0.74 for the PR, respectively, which are similar to those obtained by Bingham et al. (18) for weighed (0.78-0.87) and estimated records (0.60-0.70) with eight 24-h urines per subject. The correlation coefficients from the present study were somewhat higher than expected, a priori, as only one 24-h urine was collected from each subject.

Most of the participants found it easier and less time-consuming to fill in the PR than to weigh their foods. The PR was included in an extensive household budget survey and thus it was important to limit the workload of the participants.

An important advantage of precoded record books, compared with open-ended records, is that considerable time may be saved in coding and entering of data. In the present study, the time reduction was almost 50%, so that coding and entering of data from the PR took 1.3 hours per person instead of 2.5 hours for the WR. In a study including 500 participants, this time saving would mean a saving of 4 months’ work. As precoded record books can easily be worked out in a form suitable for optical scanning, even more time could be saved in this way, thus avoiding the time-consuming step of entering the data manually (22).

The overall result of this comparative study is that the PR method gave a reasonably similar picture of the average food and nutrient intake in the studied group of adults, as compared to the WR method. However, both methods underestimated the energy and protein intake. The results also indicate that some of the standard portion sizes used in the PR could have contributed to the apparent over- or underestimation of the intake of certain foods, e.g. cheese, bread and vegetables. The results of the study will be used for improvements in the design of the PR for use in large-scale dietary surveys for monitoring dietary habits.

Acknowledgements

Lars Berglund, Dept of Medical Sciences, Uppsala, is acknowledged for assistance with statistical analyses and Maria Munoz, National Food Administration, for coding and processing the dietary data. The work was supported by the National Food Administration and the National Institute of Public Health.

References

1. Becker W: Befolkningens kostvanor och nä- ringsintag i Sverige 1989. Metod- och re- sultatanalys. Food habits and nutrient intake in Sweden 1989. (In Swedish with English summary). Statens Livsmedelsverk, Uppsala 1994.
2. Becker W, Johansson G: Menybokförring som komplement till hushållsböcker (Food record by menu as a complement to a household diary) Vår Föda 1987;39 (suppl. 1):95-102.
3. Becker W: Kostvanorna i södra Sverige – resultat från en provundersökning (Food habits in Southern Sweden. Results from a pilot survey) Vår Föda 1990;42:322-33.
4. Nydahl M, Gustafsson I-B, Moshen R, Vessby B: Thorough food intake of Swedish non-smokers and smokers. Scand J Nutrition/ Näringsforskning 1996;40:64-9.
5. Viktatabeller för livsmedel och maträtter. Statens livsmedelsverk, Uppsala: 1992.
6. PC-Kost 94. Statens Livsmedelsverk 1994.
7. Nordin M: MAFS. Nutrient calculation system developed for research and education, Rudans Lättdata, Västerås, 1992.
8. Isaksson B: Urinary nitrogen output as a validity test in dietary surveys. Am J Clin Nutr 1980;33:4-6.
9. Bingham SA, Cummings JH: Urine nitrogen as an independent validatory measure of dietary intake: a study of nitrogen balance in indivi- duals consuming their normal diet. Am J Clin Nutr 1985;42:1276-9.
10. SAS Institute Inc.: SAS user’s guide. Cary, NC: SAS 1982.
11. Fleiss JL: Statistical methods for rates and pro- portions. Second edition. John Wiley & Sons. New York: 1981.
12. Adelson SF: Some problems in collecting dietary data from individuals. J Am Diet Assoc 1960;36:453-61.
13. Bingham SA, Gill C, Welch A, Day K, Cassidy A, Khaw KT, Key TJ, Roe L, Day NE: Comparison of dietary assessment methods in nutritional epidemiology: weighed records vs. 24- h recalls, food-frequency questionnaires and estimated-diet records. Br J Nutr 1994;72:619-43.
14. Block G: A review of validations of dietary assessment methods. Am J Epidemiol 1982;115:92-105.
15. Marr J W: Individual dietary surveys: Purposes and methods. World Rev Nutr Diet 1971;13:105-37.
16. Jurgensen LM, Isaksson B, Schroll M: Reproducibility and validity of 7-day food records. Eur J Clin Nutr 1992;46:729-34.
17. Bingham S: The dietary assessment of indi- viduals; methods, accuracy, new techniques and recommendations: Nutr Abstr Rev 1987; 57:795-42.
18. Bingham SA, Cassidy A, Cole TM, Welch A, Runswick SA, Black AE, Thornham D, Bates C, Khaw KT, Key TJ, Day NE: Validation of weighed records and other methods of dietary assessment using the 24-h urine nitrogen tech- nique and other biological markers. Br J Nutr 1995;73:531-50.
19. Block AE, Goldberg GR, Jebb SA, Livingstone MB, Cole TJ, Prentice AM: Critical evaluation of energy intake using fundamental principles of energy physiology. 2. Evaluating the results of published surveys. Eur J Clin Nutr 1991;45: 583-99.
20. Brandtley L-E, Sandhagen B, Fan H, Samuel- son G: Total energy expenditure and physical activity as assessed by the doubly labeled water method in Swedish adolescents in whom energy intake was underestimated by 7-d diet records. Am J Clin Nutr 1998;67: 905-11.
21. Gregory J, Foster K, Tyler H, Wiseman M: The dietary and nutritional survey of British adults. Office of Population Censuses and Surveys. Social Survey Division. London: HMSO 1990.
22. Haraldsdottir J, Gustafsson I-B, Becker W: Pre- coded food records: An alternative to food fre- quency questionnaires in epidemiological sur- veys? Abstract. 7th European Nutrition Con- ference, Vienna, May 24-28, 1995.