Original article

Contribution of a manually coded part in an optically readable, precoded seven-day food record for the intake of energy, nutrients and foods

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Abstract

Objective: This study investigated the contribution of a manually coded part (MP) in a precoded 7 day food record for the intake of energy, nutrients and foods.
Design: The dietary intake was assessed in a cross-sectional study using an optically readable precoded 7 day food record. Biological markers for the intakes of protein, sodium and potassium were measured in 24 h urine samples. Underreporters were identified according to the Goldberg cut-off for energy intake:basal metabolic rate. The study setting was an outpatient clinic at Karolinska Hospital, Stockholm, Sweden. The subjects were 301 healthy men aged 63 years.
Results: The MP represented 20% of the energy intake. Intakes recorded as free text were foods commonly eaten between meals, especially in the evening and were, with the exception of fruits, characterized as less healthy. The agreement between using the food record with and without the MP, respectively, was low for energy, carbohydrates, α-tocopherol and vitamin C, and high for retinol, vitamin D and vitamin B_{12}. Underreporters recorded their food intake as free text to a lesser degree than did non-underreporters. When the MP was included in the food record, the percentage of energy from fat and carbohydrates increased and the percentage of energy from protein decreased. The biological markers for protein, sodium and potassium confirmed an improved validity of the dietary data when the MP was included.
Conclusions: Inclusion of the food consumption recorded in free text influenced the dietary quality and indicated improved validity of the optically readable precoded food record. To increase the possibility of catching underreporting in dietary surveys, these findings emphasize the importance of the recording/reporting of between-meal eating.

Keywords: *biological markers*; *dietary assessment*; *in-between meals*; *precoded food record*; *underreporting*

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Introduction

In studies where a large number of participants are required, the possibilities of obtaining detailed dietary data at a reasonable cost are limited. Commonly used methods are 24 h recalls and food frequency questionnaires (1–3). A higher accuracy has been obtained with recording methods (4). Unfortunately, food recording is linked with a high work load and low compliance, and it also tends to underestimate dietary intake. A simplified food record, easily handled by both the investigators and the participants, is therefore an attractive alternative to obtain reasonably good and detailed information without losing too many participants.

A simplified, precoded 7 day food record was used in a Swedish nation-wide dietary survey carried out by the National Food Administration and Statistics Sweden in 1989 (5, 6). The record consisted of preprinted alternatives for commonly eaten foods and meals, and space for writing down

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intakes not included in the booklet. One of the authors (I-BG) developed an optically readable version of this record-book, which has been used in other studies (7). However, manually written foods need to be manually coded (allocating codes and weights) and entered into the computer, which is still time-consuming.

The optically readable food record was used in a study in which 301 healthy men were investigated regarding dietary intake and the metabolic syndrome. In this study, all manually coded foods were denoted when the data were entered into the computer, which enabled the foods recorded manually to be separated from the foods recorded as preprinted alternatives. The aim of this study was to investigate the contribution of the manually coded part of the food record to the total food intake. These analyses will make it possible to evaluate to what extent the manual coding-work improved the quality of the dietary data and whether it is worthwhile including it in a precoded instrument. The study also provides information that can be used for future large-scale nutritional epidemiological studies.

Methods

Subjects

The subjects were recruited from a cohort of men and women who had attended a health screening study in 1997–1999. Every third 60-year-old person in Stockholm County was invited and 78% ($n =$ 4232) agreed to take part. The healthy men in the cohort that fulfilled the criteria for the study (born in Sweden, no diagnosis of cardiovascular disease, no pharmacological treatment of diabetes, hypertension or hypercholesterolaemia, a body mass index between 20 and 35, and no other serious disease, $n = 995$), were divided into three groups defined from the tertiles of their fasting insulin concentrations. Requests to participate in a study concerning diet and the metabolic syndrome were sent randomly within each tertile until the number of positive responders reached approximately 100 in each group. This classification was used only to recruit subjects with a wide range of insulin levels, and it was not used for the analyses in this paper. The study was conducted between March 2000 and October 2001 and the participation rate was 71%. Two men did not complete the 7 day food record and were therefore excluded, leaving 301 63-year-old men (range 61.8–64.2) for this study. The ethical committee at Karolinska Institutet approved the study.

Clinical procedure

The participants were interviewed and underwent a medical examination. Written and oral instructions on how to fill in a 7 day food record were given individually by a nutritionist (MR). The participants were told not to change their eating habits during the study. After approximately 1 week, the participants met with the nutritionist again. The completed food record was looked through and unclear information, if any, was resolved. The participants collected one 24 h urine sample at the start of the food registration.

The food record

The food record was an optically readable version of a record-book used by the Swedish National Food Administration and Statistics Sweden in a national dietary survey in 1989 (5). The booklet contained preprinted alternatives for commonly eaten foods and meals (PP, precoded part) and there were also space included for recording foods as free text (MP, manually coded part).

There were five choices for the amount in the preprinted alternative. The amounts were estimated using household measures (pieces, glasses, spoons, decilitres, etc.) and eight photographs. Four of the photos showed a dish of different sizes (size 1–4), consisting of vegetables, rice and meat. For example, a participant could choose size 1 for the vegetables, size 3 for the rice and size 2 for the meat. It was also possible to choose a half size. Foods such as pasta and mashed potatoes were compared with the picture of rice, and foods such as fish and poultry were compared with the meat. The other four photographs showed different amount of fat spread on bread. For the present study, the food record was slightly changed: two extra pages were added for recording in-between meals, resulting in a total of three pages for in-between meals incorporated after each section for breakfast, lunch and dinner. Originally, the preprinted foods for in-between eating were coffee, tea, sugar and water. In the new version, buns and biscuits were added. In addition, small adjustments were made to match the codes of the preprinted foods to a later version of the food-composition data, and the predefined portion sizes allocated in the data analyses were increased according to a validation study (6): the meat and fish dishes were increased by 15 g (size 1) and 30 g (size 2–4), the pasta by 20, 40, 75 and 100 g (size 1–4), the carrot and broccoli/cauliflower by 5, 10, 15 and 20 g (size 1–4), the salad and cabbage by 10, 20, 30 and 40 g (size 1–4), the white bread by 5 g, the crispbread by 3 and 5 g (rye and wheat, respectively), the cheese slice by 5 g and the spoon of breakfast cereals by 2 g.

The participants were instructed to record foods not found in the PP as free text. They were encouraged to do so, rather than to fill in a preprinted alternative that poorly corresponded to the food they ate. When the completed food record was returned, some questions were routinely asked: If the single preprinted alternative for breakfast cereals, coded as muesli, was filled in, the participant was asked whether he had eaten muesli or some other breakfast cereal. If the latter was the case, this intake was moved to the MP. Similarly, if the single preprinted alternative for soft drink, coded as "non-light", was filled in and the participant stated that he had drunk a light (sugar-free) type of soft drink, this intake was moved to the MP. These changes were made for 15 subjects, and they should therefore only marginally influence the results. The participants were also asked whether they had eaten dressings, which were not included in the PP and may therefore easily be forgotten.

The manual coding was done by the nutritionist (MR). A weight guide was used to convert the amount food written in free text to grams (8). All foods written as free text were manually coded except when the food obviously was represented in the PP, when the food was moved to the PP. The intake of foods and nutrients was calculated using the food-composition database of the Swedish National Food Administration, version 1/99 (9) and the software program SAS (SAS Institute, Cary, NC, USA). Individual food items were grouped into main food groups (fruits, milk, bread, etc.) according to the code-list of the food-composition database (9).

Classification of underreporters

The classification of underreporters and the validation of the food record have been reported in detail elsewhere (10). Underreporters were identified according to the Goldberg cut-off (11), which compares the reported energy intake with the energy expenditure, both expressed as multiples of the basal metabolic rate. Physical activity during the latest year was recorded during the interview, where the subjects were categorized into four levels of physical activity at work and five levels of physical activity during leisure time. Based on this, the physical activity level (PAL) was systematically estimated for each individual on a 0.1 scale (range 1.4–2.3) and used in Goldberg's equation.

Urine collection

Detailed description of the urine collection has been reported elsewhere (10). The PABA check method was used to verify the completeness of the collections (12). In 46 collections, the content of nitrogen, sodium and potassium was adjusted as suggested by Johansson et al. (13). Thirty-one collections were excluded because two had PABA recovery $< 50\%$, four had PABA recovery $> 100\%$, one person had eaten paracetamol, six forgot to eat all of the PABA tablets and 18 people had made their collection on day 5 or later in the food record week. This left 270 collections acceptable for the study.

Biological markers of food intake

The nitrogen content in 24 h urine was used as a biological marker of dietary intake of protein (14). The nitrogen content in urine was converted to dietary protein by multiplying it by 7.72 (14). The sodium content in urine was used as a biological marker of dietary intake of sodium (15). The biological marker of potassium intake was taken as the potassium content in urine divided by 0.77 (15).

Statistics

The data are presented as means and standard deviations (SD) or, in the case of skewed distributions, as medians and 25th and 75th percentiles. To analyse the agreement between the PP only and the total food record (PP+MP), the intraclass correlation coefficient (ICC) was calculated (16), which is the variance between individuals (using the mean of the two methods) divided by the total variance (the variance between individuals + the variance between the two methods). A p-value for the difference in proportion of underreporters and non-underreporters at various levels of energy from the MP was computed using the χ^2-test (see Table 4). In this calculation, the groups of 3.0–7.5 MJ day^{-1} were combined into one group owing to low numbers of individuals in these cells. The differences between using the PP alone and the total food record regarding the percentage of energy from macronutrients and the ratios of dietary intake:biological marker are presented as means and 95% confidence intervals. The analyses were carried out using SPSS (release 10.0.5; SPSS) and SAS software (SAS Institute).

Results

The MP represented on average 22% of the total energy intake (Table 1). Higher proportions were seen in intakes of fats and carbohydrates, whereas the figure was lower for protein. The corresponding proportions of the micronutrients were between 13 and 20%, except for α-tocopherol and vitamin C, where the proportions were higher. The ICC was <0.5 for the intake of energy, carbohydrates, α-tocopherol and vitamin C, indicating a low agreement between the PP and the total food record. The agreement was higher for retinol, vitamin D and vitamin B_{12}, where ICC was ≥ 0.8.

When the MP was added to the PP, the percentages of energy from all macronutrients except for fibre and alcohol changed compared with when the PP was used alone (Table 2). The largest difference was seen in the percentage of energy of protein and carbohydrates, which decreased and increased, respectively. The largest increase was seen in the percentage of energy from sucrose. The percentage of energy from total, as well as saturated, monounsaturated and polyunsaturated fat, decreased, although these changes were smaller.

Table 1. Daily intakes of energy and nutrients, from the total record book (Total), the precoded part (PP) and the manually coded part (MP), and the proportions of the intakes that derived from the MP

	Total (per day)	PP (per day)	MP (per day)	MP (% of total intake)	ICC
Energy (MJ)	9.5±2.0	7.3±1.7	2.2±1.2	22±11	0.34
Protein (g)	88±19	75±18	13±9	15±9.1	0.68
Total fat (g)	88±28	68±24	21±13	23±13	0.63
Saturated fat (g)	39±14	30±12	9±6	23±13	0.71
Monounsaturated fat (g)	32±10	24±9	8±5	24±13	0.60
Polyunsaturated fat (g)	11±3.5	8±3	3±2	24±14	0.51
Cholesterol (mg)	356±117	292±100	64±53	18±12	0.73
Total carbohydrates (g)	245±58	183±43	62±38	24±12	0.27
Monosaccharides (g)	33±13	21±8	11±10	32±19	0.28
Disaccharides (g)	64±28	41±19	23±16	36±16	0.41
Sucrose (g)	46±23	26±15	20±15	42±19	0.34
Alcohol (g)	18±16	14±12	4±9	17±24[a,b]	0.78
Dietary fibre (g)	20±6.2	15±5	5±3	22±13	0.56
Retinol (mg)	1.0±0.7	0.8±0.6	0.2±0.2	20±16	0.90
β-Carotene (mg)	1.7±1.1	1.3±0.9	0.3±0.6	19±19	0.76
Vitamin D (μg)	6.7±2.6	5.5±2.3	1.2±1.2	17±14	0.80
α-Tocopherol (mg)	7.7±2.1	5.7±1.7	2.0±1.5	25±14	0.32
Thiamin (mg)	1.4±0.4	1.1±0.3	0.3±0.2	20±12	0.50
Riboflavin (mg)	2.0±0.5	1.6±0.5	0.4±0.3	18±11	0.61
Niacin (mg)	19±4.2	16±3.8	2.9±2.2	15±10	0.65
Vitamin B_6 (mg)	2.1±0.5	1.8±0.4	0.4±0.3	18±11	0.53
Vitamin B_{12} (μg)	7.2±3.1	6.2±2.7	1.0±1.2	13±12	0.87
Folate (μg)	222±57	181±48	41±30	18±11	0.60
Vitamin C (mg)	78±39	52±26	26±28	29±21	0.44
Calcium (g)	1.1±0.4	0.9±0.4	0.2±0.2	19±12	0.79
Potassium (g)	3.5±0.8	2.9±0.7	0.6±0.4	17±9.6	0.59
Sodium (g)	3.5±0.8	3.0±0.8	0.6±0.4	16±9.9	0.66
Magnesium (mg)	355±78	292±65	64±45	17±9.8	0.51
Iron (mg)	12±3.0	10±3	2.4±1.7	19±12	0.53
Zinc (mg)	12±2.9	11±3	1.8±1.3	14±9.6	0.72
Selenium (μg)	39±11	34±10	5.4±4.7	13±10	0.79

Data are presented as means±SD, and also as intraclass correlation coefficients between Total and the PP (ICC). The number of subjects was 301.

[a] $n = 284$, 17 subjects did not report any alcohol intake.

[b] 5 (0, 28), median (25th, 75th percentiles).

Table 2. Percentage of energy from macronutrients in the total food record (Total), the precoded part (PP) and the manually coded part (MP)

Energy%	Total[a]	PP[a]	MP[b]	Total − PP
Protein	16.0±2.1	17.7±2.3	10.1±3.6	−1.67 (−1.81 to −1.54)
Total fat	34.2±5.5	33.6±6.1	35.6±11.7	0.54 (0.25 to 0.82)
Saturated fat	15.0±3.2	14.8±3.4	15.4±6.1	0.16 (0.02 to 0.29)
Monounsaturated fat	12.4±2.1	12.1±2.3	13.0±4.7	0.26 (0.13 to 0.39)
Polyunsaturated fat	4.4±0.9	4.3±0.9	4.9±3.1	0.15 (0.08 to 0.22)
Total carbohydrates	44.2±6.1	43.1±6.1	48.7±13.1	1.10 (0.79 to 1.42)
Monosaccharides	5.9±2.2	5.0±1.8	9.0±6.7	0.88 (0.72 to 1.04)
Disaccharides	11.4±3.9	9.5±3.8	18.6±7.8	1.96 (1.74 to 2.18)
Sucrose	8.1±3.4	6.0±3.2	15.7±7.6	2.12 (1.90 to 2.34)
Alcohol	5.7±5.2	5.7±5.1	5.5±10.5	0.02 (−0.22) to (0.27)

Data are presented as means ± SD. Differences between Total and PP are presented as means (95% confidence interval).

[a] $n = 301$.

[b] $n = 299$; two subjects did not record any food intake in the manually coded part of the food record.

Regarding the proportion of food groups represented in the MP, a majority had a median of $< 15\%$, whereas a median of $\geq 35\%$ was seen in the groups "oil, dressing", "fruit", "buns, cakes", "pie, pizza, pirogue" and "soft drinks" (Table 3). Foods belonging to "chocolate, sweets", "potato crisps,

Table 3. Daily intake of food groups from the total food record (Total), the precoded part (PP) and the manually coded part (MP), and the proportion of the intakes that derived from the MP

	Total[a] (g day^{-1})	PP[a] (g day^{-1})	MP[a] (g day^{-1})	MP[b] (% of total intake)	n^c (%)	n^d (%)
Spreads	18 (7, 34)	15 (6, 30)	1 (0, 4)	7 (0, 19)	91	55
Oil, dressing	4 (0, 9)	0 (0, 4)	0 (0, 4)	53 (0, 100)	64	40
Cheese	41 (24, 69)	32 (17, 54)	6 (0, 14)	14 (0, 31)	97	69
Milk	257 (128, 400)	235 (107, 371)	0 (0, 29)	0 (0, 13)	91	40
Potatoes	129 (88, 187)	118 (81, 181)	0 (0, 0)	0 (0, 0)	100	19
Vegetables	78 (43, 142)	63 (34, 98)	7 (0, 37)	11 (0, 40)	98	60
Roots	6 (0, 17)	4 (0, 13)	0 (0, 0)	0 (0, 51)	63	21
Fruit	105 (55, 183)	38 (15, 81)	47 (12, 120)	58 (23, 82)	93	77
Juice	14 (0, 82)	0 (0, 76)	0 (0, 0)	0 (0, 0)	53	12
Bread	107 (85, 137)	95 (76, 123)	5 (0, 16)	5 (0, 15)	100	62
Buns, cakes	47 (21, 81)	21 (5, 51)	20 (3, 37)	44 (16, 75)	94	79
Porridge, gruel	0 (0, 43)	0 (0, 43)	0 (0, 0)	0 (0, 0)	33	2
Pasta	21 (0, 38)	21 (0, 32)	0 (0, 0)	0 (0, 0)	61	5
Cereals, muesli	3 (0, 16)	0 (0, 8)	0 (0, 3)	0 (0, 100)	54	26
Meat, poultry	101 (71, 139)	97 (66, 130)	0 (0, 4)	0 (0, 4)	99	34
Sausages	23 (10, 44)	17 (1, 36)	0 (0, 9)	0 (0, 38)	81	33
Fish, shellfish	42 (26, 69)	39 (20, 62)	0 (0, 6)	0 (0, 14)	95	36
Pie, pizza, pirogue	0 (0, 20)	0 (0, 0)	0 (0, 0)	35 (0, 100)	28	15
Chocolate, sweets	3 (0, 14)	0 (0, 0)	3 (0, 14)	100 (const.)	57	57
Potato crisps, snacks	0 (0, 0)	0 (0, 0)	0 (0, 0)	100 (const.)	24	24
Desserts (sweet cream, soup, pie)	0 (0, 26)	0 (0, 0)	0 (0, 26)	100 (const.)	34	34
Ice cream	0 (0, 14)	0 (0, 7)	0 (0, 0)	0 (0, 98)	49	22
Soft drinks	29 (0, 131)	0 (0, 57)	0 (0, 47)	41 (0, 94)	56	39
Alcoholic drinks	243 (114, 423)	203 (93, 343)	0 (0, 70)	1 (0, 21)	93	47

Data are presented as medians (25th, 75th percentiles).

[a] $n = 301$ (all participants)

[b] $n =$ number of subjects who reported an intake of that particular food.

[c] Percentage of subjects who reported an intake of that particular food (based on the total intake).

[d] Percentage of subjects who reported an intake in the MP of that particular food.

Table 4. Proportion of subjects at different levels of energy intake from the manually coded part (MP) of a 7 day food record, in the whole group (All), underreporters (UR) and non-underreporters (non-UR)[a]

	Energy from the MP (MJ day^{-1})					
	0 to <1.5	1.5 to <3.0	3.0 to <4.5	4.5 to <6.0	6.0 to <7.5	*n*
All	99 (33)	136 (45)	57 (19)	6 (2)	3 (1)	301
UR	51 (58)	34 (39)	3 (3)	0 (0)	0 (0)	88
Non-UR	48 (23)	102 (48)	54 (25)	6 (3)	3 (1)	213

Data are presented as number of subjects (%).

[a]UR and non-UR were defined using the Goldberg cut-off for reported energy intake/basal metabolic rate (see Methods).

snacks" and "desserts" were not included in the PP and therefore entirely manually coded.

A majority of the subjects had an energy intake of <3 MJ day^{-1} from the MP (Table 4). An energy intake of ≥ 3 MJ day^{-1} from the MP was seen in 22% of the subjects. When the study sample was divided into subgroups of underreporters and non-underreporters, the corresponding figures were 3% and 29%, respectively. The p-value for the difference in the proportions of underreporters and non-underreporters at various levels of energy from the MP was <0.001.

Of the total energy intake, 81% was from main meals and 19% was from between-meal eating (Table 5). The energy from the MP was distributed over all types of meals, with the largest figure in eating in the evening. When the energy from the MP was compared with the energy intake at the separate eating events, the proportion of energy from the MP was highest in the in-between meals, ranging from 66 to 89%. In the main meals, in contrast, the MP contributed to <10% of the energy.

The validity of the dietary intake of protein, sodium and potassium, as estimated by the biological markers in 24 h urine collections, was increased by approximately 20% when the MP was included compared with when the PP was used alone (Table 6).

Discussion

This study investigated how food intakes recorded as free text by participants, and therefore manually coded, contributed to the quality of dietary data in a study of 301 healthy men aged 63 years where the dietary intake was assessed using a precoded, optically readable 7 day food record. The analyses enabled the importance of the manual coding-work to be evaluated, and also provided information that may be useful to the elaboration of simplified dietary assessment tools.

The total energy intake in this study of 9.5 MJ day^{-1} is comparable with results from the latest national dietary survey in 1997–1998 (Riksmaten), where the energy intake among the men was 9.9 MJ day^{-1} ($n=589$, age 43 years (range 17–79)) (17). The percentages of energy from the macronutrients were similar, although there was a slightly lower percentage of energy from carbohydrates in this study (44 E% compared with 46 E% in Riksmaten),

Table 5. Energy intake (EI) derived from the total food record (Total) and from the manually coded part (MP), from breakfast, lunch, dinner and in-between meals

	EI from the Total[a] (% of total EI)	EI from the MP[a] (% of total EI)	EI from the MP[b] (% of EI at eachmeal event)	n^c (%)
Breakfast	20 (15, 24)	0.8 (0.0, 2.6)	4.2 (0, 13)	100
Between-meal eating morning	3.3 (1.1, 5.8)	1.6 (0.1, 3.5)	66 (27, 95)	91
Lunch	27 (22, 30)	2.2 (0.5, 4.5)	9.1 (2.3, 18)	100
Between-meal eating afternoon	6.6 (3.9, 10)	4.1 (1.8, 6.9)	67 (41, 91)	98
Dinner	34 (30, 40)	3.1 (0.7, 5.7)	8.7 (2.2, 17)	100
Between-meal eating evening	7.3 (3.4, 12)	5.4 (1.8, 9.2)	89 (60, 99)	95
Sum between-meal eating	19 (13, 25)	13 (7.5, 18)	76 (55, 88)	100

Data are presented as medians (25th, 75th percentiles).

[a]$n=301$.

[b]$n=$ number of subjects who reported an intake of that particular meal.

[c]Percentage of subjects who reported intakes at that particular meal.

Table 6. Intake of protein, sodium and potassium measured by the total food record (Total), the precoded part (PP) and the manually coded part (MP), and biological markers (BIOL)[a]

Nutrient	Total (g day^{-1})	PP (g day^{-1})	MP (g day^{-1})	BIOL (g day^{-1})	PP:BIOL	Total:BIOL	(Total:BIOL) − (PP:BIOL)
Protein	89±18	76±17	13±8	102±22	0.77±0.20	0.90±0.21	0.13 (0.12–0.14)
Sodium	3.6±0.8	3.0±0.7	0.6±0.4	4.2±1.4	0.78±0.29	0.93±0.31	0.15 (0.14–0.16)
Potassium	3.5±0.8	2.9±0.7	0.6±0.4	4.3±1.1	0.70±0.20	0.85±0.22	0.14 (0.13–0.15)

Data are presented as means±SD. Differences between the ratios PP:BIOL and Total:BIOL are presented as means (95% confidence intervals). The number of subjects was 270.

[a]Nitrogen in 24 h urine times 7.72 (14), sodium in 24 h urine (15) and potassium in 24 h urine divided by 0.77 (15). The completeness of the urinary collections was verified by the PABA method (12).

and a somewhat higher percentage of energy from alcohol (5.7 *E*% compared with 3.8 *E*%).

In this study, the manually coded part (MP) represented on average 22% of the total energy intake. The significance of this contribution is underlined by the different food composition in the MP compared with the precoded part (PP). The proportions of intakes of protein and micronutrients from the MP were lower than 22%, except for α-tocopherol and vitamin C, and the proportions of simple carbohydrates were higher, indicating a lower nutrient density in the MP compared with the PP. When the PP and the total food record (PP+MP) were considered as two separate assessment methods, the agreement between the two methods, indicated by the ICC, differed among the nutrients. The lowest agreements were seen in the intakes of energy, carbohydrates, α-tocopherol and vitamin C, whereas the agreements were high in the intakes of retinol, vitamin D and vitamin B_{12}. Therefore, the importance of the MP varies depending on which nutrient is being investigated. Nevertheless, if the nutrient intake is going to be adjusted for energy intake, it is crucial to use the assessment tool that also is valid for total energy intake.

The increased percentage of energy from fats and carbohydrates and the decreased intake of protein reflect a different food composition in the MP compared with the PP. The analyses of the food groups confirmed a selection of foods in the MP. Although alternatives for buns and small biscuits were added to the PP in this study, the percentage of manually coded "buns and cakes" was still quite large. This is because foods such as cakes, pastries, sponge cakes, mazarins and Danish pastries, which were commonly manually recorded, also belonged to the group "buns and cakes". The food groups "potato crisps, snacks" and "desserts" were entirely recorded in the MP; however, these kinds of food were eaten by less than 50% of the participants. Since there was a great variation in contribution from the different food groups, it is important to catch these intakes if dietary intake is analysed at an individual level.

Regarding the energy intake at breakfast, lunch, dinner and in-between meals, the distribution seen in this study (20, 27, 34 and 19%, respectively) is similar to findings from the latest nation-wide dietary survey in 1997–1998, where the corresponding figures were 20, 28, 33 and 20% (18). Most of the in-between eating occurred in the afternoon and the evening. The energy derived from the manually coded part was particularly high in the evening, implying that the preprinted alternatives of coffee, tea, buns and small biscuits do not cover what people eat later in the day.

Altogether, the foods identified by the MP may generally be characterized as foods commonly eaten between meals, especially in the evening and, with the exception of fruits, as unhealthy (i.e. with a low nutrient density). This agrees with how foods commonly underreported are described in the literature (19–21). In the present study, underreporters recorded their food intake as free text to a much lesser degree than non-underreporters did. Although this finding cannot exclude that underreporters truly do not eat between meals and they only underestimate their intake at main meals, a more likely explanation is that they tend to miss recording between-meal eating (20). An increased number of preprinted alternatives for between-meal eating would perhaps reduce the degree of underreporting by making it easier for the participants to record these kinds of food. The presence of fruits and the relatively high proportion of vitamin C in the MP indicate that intakes that are easily forgotten may not only be restricted to foods that are considered as less healthy. Because underreporting is a common problem that may affect the reported diet–disease relationships (22–24), the outcomes of this study highlight the value of making efforts to identify between-meal eating, and in particular eating in the evening.

The biological markers of protein, sodium and potassium indicated an improved quality of the dietary data. Although protein was not the most prominent nutrient in the MP, the inclusion of the MP decreased the underreporting of protein from 23% to 10%. This illustrates that the quantitative and qualitative aspects of the reported dietary intake may vary owing to the design of the dietary assessment instrument. The findings also reflect the limitation of the optically readable food record. Apparently, it is difficult to assess food intakes using preprinted alternatives only. Without the possibility of recording food as free text, the food record would be too simplified.

In summary, the results demonstrate that the manual coding-work was of considerable importance since these foods contributed to an increased energy content of the diet, an alteration in the selection of foods and nutrient composition, and possibly improved validity of the dietary data. To increase the possibilities of catching underreporting, and to reduce the manual coding-work when food intake is measured with precoded records, the findings suggest that emphasis should be placed on improving the recording of between-meal eating and also of foods such as dressings and desserts.

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