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# Reproducibility of an Italian Food Frequency Questionnaire for Cancer Studies: Results for Specific Food Items

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**To evaluate the reproducibility of a quantitative food frequency questionnaire (FFQ) used in a case–control study on cancer of the breast, ovary and digestive tract, we compared the result of a 98-item questionnaire administered twice at an interval of 3–10 months (median = 5.4 months) to 452 volunteers (144 males and 308 females, median age = 50 years) from three Italian provinces (Pordenone, Genoa and Forlí). Spearman correlation coefficients ($r$) for intake frequency of 87 dietary items ranged from 0.35 ("chicken or turkey, boiled") to 0.84 ("wine"). Most coefficients were between 0.60 and 0.80, only two being below 0.40 and five equal or above 0.80 (mean $r = 0.59$). The concordance of the two measurements tended to be somewhat better for alcoholic and non-alcoholic beverages, bread, cereals and first courses, fruits and summary questions at the end of each section of the questionnaire than for side dishes, sweets and desserts. Also, the reproducibility of 11 subjective questions, such as those concerning the amount of fat in seasoning and the intake of garlic or salt, seemed to be high. Age, sex, educational level of the volunteers and interval between the two FFQ did not have a large or systematic impact on the concordance of the two measurements. In conclusion, the present study has shown a good level of reproducibility of our questionnaire and has provided a few important hints on ways of improving the description of various food items.**
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## INTRODUCTION

DIFFERENT APPROACHES have been used in the past decades for assessing nutritional intake in humans [1], but the most widely used method nowadays is the food frequency questionnaire (FFQ). This is a form where the frequency of consumption of various food items, listed according to the food group they belong to or according to the meal in which they are consumed, is questioned with (quantitative) or without (semi-quantitative) assessment of the amount of food consumed [2–5]. The FFQ can be self-administered, i.e. the subject receives the form by mail or from the research staff, and fills it out without any external guidance (self-administered). In other instances the questionnaire is administered by trained interviewers (interviewer-administered).

Food frequency questionnaires are used for epidemiological studies, such as cohort and case–control studies since they substantially simplify inteviewers' training, data collection, coding, and data entry as compared with other dietary survey methods [6]. A questionnaire, as well as any other nutritional assessment instrument, needs to be tested for reproducibility to verify that the same tool, if repeated, will produce the same results, and for validity, to verify that what is recorded by the FFQ corresponds with the subject's real diet [7]. Questionnaires used in several large epidemiological studies have been tested in such ways [1, 7–11]. In Italy, to the best of our knowledge, no validation studies of dietary questionnaires have been published to date, although several case–control studies on diet and neoplastic diseases have been published [12–16].

In the attempt to develop a reproducible and valid method to assess nutritional intake in various parts of Italy, we designed a FFQ and pilot tested it in three different provinces in Italy for a case–control study of the relation between dietary habits and cancer of the breast, ovary and digestive tract. This study is ongoing within the framework of a multinational programme of the Division of Epidemiology and Biostatistics of the European Institute of Oncology in Milan, Italy [17]. We also designed a validation and reproducibility study of the questionnaire, and the results of the latter are presented in this paper.

## MATERIALS AND METHODS

### *Study population*

Three provinces participated in the validation study of this FFQ: Pordenone (Friuli Venezia Giulia region), located in the

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north-east of Italy; Forlì, located in the central part of northern Italy (Emilia-Romagna region), and Genoa, located in the north-west, on the sea coast (Liguria region).

In each centre, volunteers were recruited by means of a 2-month advertisement in the local press and on television. A few non-profit organisations, including blood donors, associations for the fight against cancer and "third-age universities", were also contacted and their members invited to join the study. The announcement of the study specified that volunteers had to be above the age of 35 and had to contact the study centre by telephone or letter. All persons willing to participate were first questioned on their health status, in order to exclude chronically ill people and individuals on special diets.

The distribution of study participants according to centre of recruitment, sex, age, marital status, education, occupation and time interval between the two interviews are shown in Table 1. The median age of the study population was 50 years and the majority (68%) were females.

*Study design*

A first FFQ was administered to subjects at the beginning of the validation study, during the autumn and winter of 1990–1991. To test for reproducibility, the same subjects were re-interviewed 3–10 months later, with the same instrument (median interval between the two questionnaires: 5.4 months), either by the same or by a different interviewer. To test for validity, in the period between the first and the last administration of the FFQ, participants were also invited to fill out two 7-day diet records in two different seasons, to allow for seasonal variation in food consumption (data not shown in the present paper).

*Table 1. Sociodemographic and other characteristics of the 452 participants in the reproducibility study, by centre. Italy 1990–1991*

| | Centre (Province) | | | Total |
|---|---|---|---|---|
| | Pordenone | Genoa | Forli' | No. (%) |
| Sex | | | | |
| Males | 105 | 25 | 14 | 144 (31.9) |
| Females | 153 | 93 | 62 | 308 (68.1) |
| Age (years) | | | | |
| < 40 | 64 | 7 | 17 | 88 (19.5) |
| 40–49 | 90 | 24 | 12 | 126 (27.9) |
| 50–59 | 65 | 46 | 24 | 135 (29.9) |
| ≥ 60 | 39 | 41 | 23 | 103 (22.8) |
| Education (years) | | | | |
| ≤ 10 | 137 | 46 | 39 | 222 (49.1) |
| > 10 | 121 | 72 | 37 | 230 (50.9) |
| Occupation* | | | | |
| Professional jobs | 57 | 18 | 9 | 84 (20.1) |
| Clerical jobs | 77 | 14 | 28 | 119 (28.5) |
| Shop keepers | 26 | 4 | 15 | 45 (10.8) |
| Manual workers | 44 | 2 | 6 | 52 (12.4) |
| Housewives | 49 | 54 | 15 | 118 (28.2) |
| Marital status | | | | |
| Never married | 39 | 17 | 8 | 64 (14.2) |
| Ever married | 219 | 101 | 68 | 388 (85.8) |
| Time between interviews (months) | | | | |
| < 5 | 7 | 84 | 9 | 100 (22.1) |
| 5–6 | 112 | 29 | 47 | 188 (41.6) |
| > 6 | 139 | 5 | 20 | 164 (36.3) |

*The sum does not add up to the total because of missing values.

*Food frequency questionnaire*

The purpose was to obtain a questionnaire capable of assessing the complete diet of subjects over the past year, including total calorific intake, as well as selected macro-nutrient and micro-nutrient intake. Several previous case–control studies of diet and cancer carried out in Milan and Pordenone with a simpler FFQ [15, 16] and an extensive dietary history method used in a multicentric investigation on gastric cancer in Italy [13] provided useful suggestions. With regard to the latter, we included food items that, in that study, explained the largest amount of variance in nutrient intake between control subjects in addition to those foods that made a large contribution to total absolute nutrient and caloric intake. Also, some foods were included because a hypothesis of interest related to a food rather than a nutrient (e.g. fried foods). Information on sex, age, weight and height and socio-economic status was also collected.

Several questions aimed at assessing fat consumption and various other aspects of dietary habits were included in the first part of the questionnaire. In particular, respondents were questioned about the kind of fat used in different dishes (i.e. none, butter, margarine, olive oil, seed oil, lard and cream). They were asked to give a personal judgement about their own fat consumption (i.e. low, average or high) and to report their habits of eating or not, the visible fat on meat, ham, etc. and eating or leaving on the plate the seasoning or sauces. Two questions concerning garlic and salt consumption, and meal patterns were also included.

Simple food items as well as complex recipes appear in the food list, and the questionnaire looks therefore more like a menu list from a restaurant than a shopping list. Seventy-seven food items or recipes were included, and divided into the following sections: (1) bread, cereals, first courses; (2) second courses; (3) side dishes; (4) fruits; (5) sweets, desserts, soft drinks, (6) milk, hot beverages, sweeteners; (7) alcoholic beverages. At the end of each section the respondents had the possibility to add one or two food items or dishes, consumed at least once per week (open-section). Items that were frequently consumed by a substantial number of subjects have been incorporated in the updated version of this FFQ, which is currently in use for the above-mentioned case–control study on cancer of the breast, ovary and digestive tract. Each of these sections included also up to two summary questions, inquiring about the total weekly frequency of consumption of the items included, for example total weekly frequency of consumption of meat and poultry and total weekly frequency of consumption of fish.

The questionnaire was interviewer-administered. The interviewer asked for the usual frequency of consumption of the food: frequency was coded as weekly frequency, where frequencies of less than once per week, but at least once per month, were coded as 0.5 per week, and never or less than once per month was coded as zero. No predefined frequency point scale was provided to the interviewees. The interviewers also tried to assess the portion size. The reference portion is indicated on the questionnaire. For 40 of the 77 foods or food groups, a serving size was indicated using "natural" units (such as a glass of milk, one egg, one apple). For other foods, the possibility of specifying the use of a small, average or large portion was offered, where a small portion is a portion one third smaller than the average, and a large one is one third larger. At the beginning of each of the

seven sections, the interviewer showed the photograph of the corresponding dish, represented in three different portion sizes, and asked the subject to refer to those portions when thinking about the amount of food consumed. Since the number of available pictures was limited, subjects were asked to refer to portions of similar foods to assess the intake of dishes in the same section.

To account for the seasonal variation of food consumption, the frequency of use of some foods was asked for the season in which the food is mainly available (e.g. tomatoes in summer, oranges in winter, etc.). At the end of each section, the interviewee was offered the possibility to report other food items that were consumed at least once per week or, for seasonal fruits and vegetables, at least 20 times per year. The median duration of the questionnaire was 45 min (range = 20–95) at the first administration and 40 min (range = 15–90) at the second one.

*Training of interviewers*

Interviewers were dieticians, nurses, nutritionists or women with experience in the administration of questionnaires (four interviewers in Pordenone, two in Genoa and two in Forlì). Periodic meetings were organised in order to make the interview process as similar as possible for all of them. A procedure manual was also developed, with detailed instructions related to each question of the FFQ. The manual was read and discussed at each meeting, and the interviewers were encouraged to periodically refresh their memories by reading it again, at least once per month.

*Statistical analyses*

The present communication concentrates on the reproducibility of the 98 questions regarding various aspects of the eating pattern included in the FFQ. For the purpose of assessing the reproducibility of the 87 questions concerning frequency of consumption (77 specific questions in addition to 10 summary questions), mean weekly intake frequency and standard deviations were calculated. To assess reproducibility, three methods were applied: Pearson product-moment correlation between pairwise measurements of reported intake frequencies, Pearson correlation of the log (natural) transformation of intake frequencies plus one and Spearman non-parametric rank correlations. Pearson correlations coefficients on log-transformed values were, on average, higher and more similar to Spearman correlation coefficients. The latter were chosen for presentation. Further, since differences in coefficients emerged between the three study centres and some imbalances also existed as concerns the distribution of participants between them (e.g. by sex, age, etc.), correlation coefficients ($r$) were corrected by centre.

$P$-values for individual correlation coefficients are not presented since our aim was to estimate reproducibility of results, rather than test for statistical significance. With 452 subjects, however, any coefficient greater than 0.13, which includes all those presented, is statistically significant at the 0.01 level. When comparing the reproducibility of the questionnaire in different categories of age, sex, education and interval between the two interviews we used Fisher's $Z$ transformation [18]. To assess the reproducibility of the 11 subjective questions, the statistic "gamma", which is based on the number of concordant and discordant pairs, was used [19].

No outlying values were excluded. All the analyses were replicated for each food or beverage after the exclusion of those individuals who reported no consumption of the specific item. Occasional intake (i.e. $\geq$ 1/month $<$ 1/week) was also tentatively made equal to no intake. Similarly, all the analyses were performed with or without taking the self-reported portion size (i.e. 0.7, 1 and 1.3) into account. These modifications yielded, however, very similar results, and will not be presented in this paper. Finally, various aggregations of food items which were similar to each other or turned out to be a source of misinterpretation or cross-classification (e.g. the same vegetable cooked differently) were considered in order to see whether the combination of certain items increased the questionnaire reproducibility.

## RESULTS

The mean weekly consumption of the 77 food items examined in each of the two questionnaires in addition to the correlation coefficients between their repeated measurements are presented in Table 2. For all foods the first and the second measurement yielded similar mean values and no significant difference or systematic change emerged (Table 2). In most instances, the dispersion around the mean frequency of consumption was substantial and the distributions were skewed towards higher values (see maximum value, MAX).

For "bread, cereals and first courses", correlation coefficients ranged from 0.39 ("risotto") to 0.69 ("broth or light soup"). With respect to "second courses", the highest correlation coefficient was found for "ricotta cheese and mozzarella as a main course" ($r$ = 0.64) and the lowest for "chicken or turkey, boiled" ($r$ = 0.35). Similarly, correlation coefficients above 0.50 were found for most fruits (above 0.70 for "citrus fruits", "apples and pears" and "grapes") and hot beverages, whereas the coefficients for a few vegetables, sweets and desserts tended to be lower (Table 2). In particular, correlation coefficients for frequency of consumption of "side dishes" ranged from 0.45 for "zucchini, eggplants and peppers (in season)" to 0.62 for "artichokes (in season)". They were below 0.50 for "pastry", "doughnuts with cream or custard", "plain cakes, Christmas and Easter cake" and "chocolate snacks". Among alcoholic beverages the reproducibility of "wine" (by far the most popular drink in the study areas) was more satisfactory than that of other alcoholic beverages. Most coefficients were, however, between 0.60 and 0.70, only two being below 0.40 and five equal or above 0.80.

The summary questions on dietary habits (Table 3) show, on the average, slightly higher correlation coefficients than those in Table 2, but partly confirm some relative difficulties in an individual's ability to report frequency of intake of vegetables. Overall, the mean correlation coefficient for the 87 considered items (Tables 2 and 3) was 0.59. Several foods and beverages eaten frequently or habitually tended to have high correlation coefficients. In fact, there was a significant positive association between mean frequency of use and degree of reproducibility of dietary habits in Tables 2 and 3 ($r$ = 0.42, $P < 0.001$).

The issue of whether sex, age, educational level and interval between interviews affected the reproducibility of the questionnaire is also addressed. While a few highly significant differences emerged, no systematic pattern was observed. Mean correlation coefficients for the 87 items were rather similar in males ($r$ = 0.60) and females ($r$ = 0.58); in individuals below the age of 50 ($r$ = 0.58) and in those aged 50 or more ($r$ = 0.59). A better education conferred but a small gain in the concordance of the two subsequent measurements (mean $r$ = 0.60 for better educated subjects versus 0.58 in less educated ones). The degree of reproducibility was also slightly higher in subjects who repeated the interview at the time exactly planned in the study (i.e. 5–6 months) ($r$ = 0.61) than in those whose second

*Table 2. Comparison of mean weekly consumption* of 77 food items estimated by two food frequency questionnaires. Data are from 452 participants in the reproducibility study. Italy 1990–1991*

| Food | Portion | First | | | Second | | | Corr Coeff† |
|---|---|---|---|---|---|---|---|---|
| | | Mean | STD | Max | Mean | STD | Max | |
| Bread, cereals, first courses | | | | | | | | |
| Bread | 2 slices, 1 roll, 50 g | 11.2 | 9.5 | 70 | 11.6 | 9.3 | 56 | 0.68 |
| Crackers, grissini, melba toast | 30 g | 4.3 | 6.9 | 42 | 3.7 | 6.1 | 56 | 0.64 |
| Whole wheat bread | 2 slices, 1 roll, 50 g | 2.8 | 5.9 | 38 | 2.7 | 5.5 | 38 | 0.64 |
| Polenta (corn meal) | 1 slice, 100 g | 0.5 | 1.2 | 12 | 0.5 | 1.4 | 14 | 0.58 |
| Pizza | 200 g | 0.6 | 0.6 | 7 | 0.5 | 0.4 | 2 | 0.66 |
| Risotto | 80 g | 0.9 | 0.8 | 5 | 1.0 | 0.9 | 5 | 0.39 |
| Pasta/rice with butter/oil | 80 g | 1.3 | 1.5 | 10 | 1.3 | 1.5 | 10 | 0.61 |
| Pasta/rice with tomato sauce | 80 g | 2.1 | 1.8 | 10 | 2.2 | 1.8 | 8 | 0.67 |
| Pasta/rice with meat sauce | 80 g | 0.9 | 1.4 | 10 | 0.7 | 1.2 | 7 | 0.66 |
| Broth or light soup | 250 g | 1.2 | 1.7 | 14 | 0.8 | 1.3 | 7 | 0.69 |
| Vegetable soup | 250 g | 1.5 | 1.4 | 8 | 1.4 | 1.4 | 10 | 0.56 |
| Second courses | | | | | | | | |
| Boiled, poached or raw eggs | 1 | 0.7 | 0.9 | 4 | 0.9 | 1.0 | 7 | 0.46 |
| Fried eggs, omelettes | 1 | 0.8 | 0.9 | 8 | 0.7 | 0.8 | 6 | 0.55 |
| Chicken/turkey boiled | 200 g | 0.8 | 1.1 | 7 | 1.3 | 1.2 | 7 | 0.35 |
| Chicken/turkey/broiled, fried or stewed | 200 g | 1.3 | 1.3 | 7 | 0.9 | 0.9 | 8 | 0.41 |
| Steak/roast-beef/lean ground beef or veal | 120 g | 1.7 | 1.6 | 9 | 1.5 | 1.3 | 7 | 0.62 |
| Boiled beef | 150 g | 0.4 | 0.5 | 3 | 0.2 | 0.4 | 4 | 0.59 |
| Pork chop/paillard | 150 g | 0.4 | 0.5 | 4 | 0.3 | 0.4 | 3 | 0.57 |
| Beef or veal stew/meat balls, etc. | 150 g | 0.5 | 0.5 | 4 | 0.5 | 0.6 | 6 | 0.52 |
| Wiener Schnitzel | 120 g | 0.3 | 0.4 | 3 | 0.3 | 0.5 | 3 | 0.57 |
| Liver | 150 g | 0.2 | 0.3 | 2 | 0.2 | 0.3 | 2 | 0.57 |
| Prosciutto/lean processed meat | 50 g | 1.3 | 2.3 | 43 | 1.3 | 1.5 | 20 | 0.56 |
| Ham | 50 g | 0.7 | 1.0 | 7 | 0.7 | 1.1 | 9 | 0.54 |
| Salami/bologna/sausages | 50 g | 0.8 | 2.2 | 43 | 0.7 | 1.3 | 12 | 0.62 |
| Canned meat | 1 can | 0.1 | 0.4 | 7 | 0.1 | 1.2 | 25 | 0.48 |
| Fish/molluscs, boiled, broiled | 150 g | 1.2 | 1.1 | 7 | 1.3 | 1.1 | 8 | 0.63 |
| Fish/molluscs, fried | 150 g | 0.2 | 0.4 | 2 | 0.2 | 0.4 | 2 | 0.52 |
| Tuna/sardines, in oil pack | 80 g | 0.5 | 0.5 | 4 | 0.7 | 0.7 | 7 | 0.51 |
| Ricotta cheese/mozzarella, as a main course | 100 g | 1.0 | 1.1 | 7 | 1.0 | 1.1 | 7 | 0.64 |
| Other cheeses, as a main course | 80 g | 2.0 | 2.2 | 14 | 1.9 | 2.3 | 21 | 0.44 |
| All cheeses, in addition or as a snack | 25 g | 2.6 | 3.9 | 28 | 2.3 | 4.3 | 56 | 0.49 |
| Side dishes | | | | | | | | |
| Spinach/other greens | 200 g | 1.4 | 1.4 | 14 | 1.3 | 1.5 | 15 | 0.46 |
| Cruciferae | 125 g | 1.1 | 1.5 | 14 | 0.8 | 1.1 | 14 | 0.51 |
| Peas/beans | 100 g | 0.8 | 0.9 | 7 | 0.8 | 0.9 | 7 | 0.42 |
| Green and red salad | 50 g | 5.7 | 3.8 | 21 | 5.6 | 4.1 | 26 | 0.49 |
| Salads with carrots, cucumbers, peppers | 100 g | 2.1 | 2.8 | 15 | 2.5 | 3.2 | 20 | 0.43 |
| Tomatoes (in season) | 150 g | 3.0 | 2.1 | 14 | 2.8 | 2.0 | 18 | 0.58 |
| Raw carrots | 75 g | 1.5 | 2.2 | 18 | 1.3 | 2.2 | 32 | 0.55 |
| Cooked carrots | 130 g | 0.4 | 0.8 | 7 | 0.4 | 0.9 | 10 | 0.59 |
| Onions | 80 g | 0.6 | 1.3 | 11 | 0.8 | 1.6 | 9 | 0.48 |
| Artichokes (in season) | 1 | 0.4 | 0.4 | 2 | 0.4 | 0.5 | 4 | 0.62 |
| Boiled potatoes | 125 g | 1.2 | 1.3 | 10 | 1.1 | 1.4 | 14 | 0.53 |
| Fried or roasted potatoes | 200 g | 0.6 | 0.7 | 7 | 0.5 | 0.7 | 7 | 0.52 |
| Zucchini/eggplants/peppers (in season) | 150 g | 1.2 | 1.0 | 7 | 1.1 | 0.9 | 7 | 0.45 |
| Fruits | | | | | | | | |
| Citrus fruits (in season) | 150 g | 3.9 | 3.5 | 25 | 4.2 | 3.6 | 21 | 0.70 |
| Apples/pears (in season) | 1 | 4.7 | 3.6 | 25 | 4.6 | 3.7 | 25 | 0.73 |
| Peaches/apricot/prunes (in season) | 100 g | 4.9 | 4.3 | 32 | 4.9 | 3.9 | 23 | 0.55 |
| Melon (in season) | 75 g | 0.5 | 0.9 | 13 | 0.4 | 0.4 | 3 | 0.58 |
| Grapes (in season) | 230 g | 1.7 | 2.7 | 18 | 1.6 | 2.4 | 18 | 0.74 |
| Strawberries/cherries (in season) | 150 g | 0.6 | 1.2 | 16 | 0.6 | 1.0 | 12 | 0.55 |

Continued on next page.

*Table 2. Continued*

| Food | Portion | First | | | Second | | | Corr Coeff† |
|---|---|---|---|---|---|---|---|---|
| | | Mean | STD | Max | Mean | STD | Max | |
| Bananas | 1 | 0.6 | 1.4 | 14 | 0.6 | 1.2 | 14 | 0.68 |
| Cooked fruits | 1 cup | 0.5 | 1.5 | 21 | 0.5 | 2.5 | 49 | 0.64 |
| Citrus fruit juice, fresh (unsweetened) | 150 g | 1.5 | 3.4 | 36 | 1.2 | 2.8 | 28 | 0.59 |
| Other fruit juices | 125 g | 0.6 | 2.3 | 28 | 0.8 | 1.9 | 14 | 0.40 |
| Sweets, desserts and soft drinks | | | | | | | | |
| Honey/jam | 1 tbsps | 5.1 | 10.8 | 97 | 5.1 | 10.5 | 90 | 0.72 |
| Biscuits | 50 g | 2.5 | 5.6 | 97 | 2.3 | 4.1 | 50 | 0.60 |
| Croissants/doughnuts | 50 g | 1.0 | 2.2 | 14 | 0.8 | 1.9 | 12 | 0.65 |
| Pastry/doughnuts with cream or custard | 50 g | 0.5 | 2.0 | 35 | 0.3 | 1.0 | 13 | 0.47 |
| Plain cakes/Christmas and Easter cake, etc. | 1 slice, 100 g | 0.8 | 1.7 | 14 | 0.8 | 1.6 | 14 | 0.48 |
| Fruit/jam pies | 100 g | 0.6 | 1.0 | 8 | 0.6 | 1.0 | 11 | 0.53 |
| Chocolate snacks | 1 | 0.2 | 0.8 | 7 | 0.1 | 0.7 | 7 | 0.47 |
| Ice cream (in season) | 100 g | 2.1 | 2.1 | 10 | 2.1 | 2.0 | 14 | 0.61 |
| Soft drinks | 1 glass, 150 g | 1.5 | 4.5 | 54 | 1.7 | 5.3 | 49 | 0.61 |
| Candies | 1 | 5.3 | 11.2 | 82 | 4.2 | 8.9 | 70 | 0.66 |
| Milk, hot beverages and sweeteners | | | | | | | | |
| Milk | 1 cup, 225 ml | 4.3 | 5.4 | 30 | 4.3 | 5.2 | 35 | 0.80 |
| Yoghourt | 1 jar, 125 ml | 2.0 | 3.1 | 28 | 2.2 | 3.1 | 22 | 0.76 |
| Cappuccino | 1 cup, 110 ml | 0.7 | 2.0 | 14 | 0.5 | 1.7 | 12 | 0.66 |
| Coffee | 1 cup, 75 ml | 14.4 | 10.3 | 56 | 15.1 | 10.2 | 56 | 0.75 |
| Decaffeinated coffee | 1 cup, 75 ml | 0.7 | 3.1 | 35 | 0.8 | 3.1 | 28 | 0.64 |
| Tea | 1 cup, 110 ml | 2.7 | 4.7 | 42 | 2.5 | 4.8 | 35 | 0.68 |
| Sugar | 1 tbsps | 19.2 | 18.7 | 97 | 18.5 | 19.4 | 97 | 0.80 |
| Saccharin | 1 tablet | 0.9 | 4.9 | 56 | 1.0 | 5.3 | 50 | 0.47 |
| Other artificial sweeteners | 1 tablet | 2.0 | 7.0 | 56 | 2.6 | 8.4 | 56 | 0.81 |
| Alcoholic beverages | | | | | | | | |
| Wine | 125 ml | 10.5 | 16.7 | 196 | 9.1 | 13.3 | 98 | 0.84 |
| Beer | 330 ml | 0.7 | 2.1 | 14 | 0.7 | 3.5 | 63 | 0.62 |
| Grappa | 30 ml | 0.3 | 1.0 | 7 | 0.3 | 1.2 | 14 | 0.62 |
| Other spirits | 30 ml | 0.7 | 1.4 | 14 | 0.7 | 1.4 | 14 | 0.52 |

*On a yearly basis when not otherwise specified; †Spearman correlation coefficient, corrected for centre.

*Table 3. Reproducibility of responses to summary questions about dietary habits, estimated by two food frequency questionnaires. Data are from 452 participants in the reproducibility study. Italy 1990–1991*

| Questions about dietary habits | First | | | Second | | | Corr Coeff* |
|---|---|---|---|---|---|---|---|
| | Mean | STD | Max | Mean | STD | Max | |
| Total weekly consumption of | | | | | | | |
| Pasta/rice | 5.3 | 2.4 | 13 | 5.4 | 2.5 | 14 | 0.64 |
| Soups | 2.5 | 2.1 | 10 | 2.0 | 1.9 | 10 | 0.66 |
| Meat and poultry | 4.7 | 2.5 | 14 | 4.5 | 2.3 | 12 | 0.67 |
| Fish | 1.5 | 1.1 | 7 | 1.7 | 1.2 | 8 | 0.59 |
| Raw vegetables | 7.8 | 4.4 | 56 | 9.1 | 4.2 | 54 | 0.53 |
| Cooked vegetables | 3.8 | 2.5 | 15 | 3.6 | 2.5 | 14 | 0.54 |
| Fresh fruits | 15.5 | 9.8 | 97 | 17.2 | 9.9 | 70 | 0.64 |
| Frequency of meals in different locations | | | | | | | |
| Number of meals consumed at home | 13.1 | 2.1 | 21 | 13.1 | 2.0 | 21 | 0.74 |
| Number of meals consumed at a restaurant | 0.5 | 1.2 | 8 | 0.7 | 1.6 | 14 | 0.46 |
| Number of meals consumed at a canteen | 0.4 | 1.3 | 7 | 0.5 | 1.3 | 5 | 0.87 |

*Spearman correlation coefficients, corrected for centre.

questionnaire was collected somewhat earlier ($r = 0.55$) or postponed ($r = 0.58$).

Other questions concerning various aspects of the eating habits are also considered. Study participants seemed to be able to identify consistently the type of fat used. Also the concordance of subjective questions such as those concerning the amount of fat in seasoning or the amount of fat left on the dish, and the intake of garlic and salt seemed to be well reproducible in above 70–80% of the subjects. The vast majority of participants (92%) reported consumption of two meals per day and very few gave a different answer in the two questionnaires. Conversely, a lower concordance was found with respect to snacks, where changes in the reported frequencies were not unusual.

## DISCUSSION

The present analysis considers the reproducibility of a new dietary questionnaire designed in order to investigate the association between diet and cancers of the breast, ovary and digestive tract in different Italian areas. Major aims of such a questionnaire were to estimate accurately the intake of single food items besides that of total energy and macro- and micro-nutrients known or suspected to be relevant to cancer aetiology. To this extent, a substantial effort was made to keep the questionnaire reasonably short (i.e. feasible in 40–50 min), but to cover a wide range of aspects of the eating pattern, including, in addition to questions on intake frequency of 77 food items, several questions about personal dietary habits, the consumption of fats and the ways various dishes were prepared, where meals were consumed, etc. Special attention was also paid, on account of the noteworthy variability of dietary habits in Italy, to building a questionnaire whose items and question formulation were as far as possible appropriate for the whole country.

This explains the present effort in order to assess the reproducibility of the individual foods, beverages and other information on dietary pattern. The study of associations between cancer and individual foods items, besides those with specific nutrients, retains a great importance on account of the persisting uncertainty of specific causal mechanisms. Furthermore, information about single items may identify foods for which a frequency questionnaire performs poorly, and for which changes in the formulation of the questions may improve validity [20].

A detailed analysis of the reproducibility of major nutrients is in progress, but it is reassuring to anticipate that the present questionnaire estimated a mean intake of 2550 and 2449 kilocalories on the first and the second measurement, respectively, i.e. a reasonable estimate in the light of the distribution of study participants by sex, age and occupation.

With respect to the reproducibility of individual food items, fewer investigations have been published than on the reproducibility of nutrient measures [20–26]. Furthermore, correlation coefficients for food items appear considerably more variable and, on the average, lower than for nutrients, especially for infrequently eaten foods [7]. Overall, the correlation coefficients which emerge from the present investigation compare well with those reported by other investigators and are, if anything, closer to the best degrees of reproducibility reported so far (see Table 4, for studies which published correlation coefficients for food items). Very few coefficients as low as some of those reported by Nomura and Hankin [23], Byers *et al.* [24] and Thompson *et al.* [26] were seen, perhaps also because the shorter interval of time between the administration of the two questionnaires, in the present investigation, diminished the problem of real changes in dietary habits. However, as in the study by Salvini *et al.* [20], the reproducibility seemed somewhat better for bread, cereals, first courses and alcoholic and non-alcoholic beverages than for vegetables, sweets and many meat dishes. As in most previous work, individual foods which are eaten habitually or regularly have a higher degree of reproducibility than those consumed infrequently, but such correlation was somewhat weaker in the present study than, for instance, in that by Colditz *et al.* [25].

To further assess whether the degree of reproducibility changed across the range of weekly intake, we repeated all the analyses after the exclusion of those individuals who reported no intake of the various food items and also after considering occasional consumption equal to no consumption (data not shown). While the way of dealing with occasional consumption seemed to affect the correlations very little, many coefficients were decreased by the exclusion of never users (an apparently well reproducible category). Food items eaten only in season, chiefly vegetables and fruits, showed a better degree of reproducibility when their frequency of intake was elicited for the specific season.

Sex, age and educational level, and (not shown) smoking, alcohol intake and weight had modest effect, if any, on the questionnaire reproducibility and these observations confirm and extend the findings of Colditz *et al.* [25]. The better performance of the individuals who had their interview repeated at 5–6 months is perhaps interpretable in terms of the best understanding and collaboration in the study of those subjects who best kept to the scheduled time for the replication of the interview. Also, the separate analysis (not shown) according to whether the interview was repeated by the same interviewer or by a different interviewer achieved very similar correlation coefficients.

A few aspects of the present reproducibility study require special attention since they suggest weak areas in the questionnaire format or particularly controversial issues. Among these, there is certainly the choice of the aggregation and formulation of food items. While food items which show similar composition and are largely interchangeable in the typical Italian meal (e.g. pasta and rice) were incorporated in the same question, an effort was made to disaggregate certain food items which could be part of recipes greatly differing from each other in respect to caloric content and/or other characteristics (e.g. "boiled, poached, raw eggs" versus "fried eggs, omelettes"). Although this distinction was meant to favour interviewees, particularly those who were not very familiar with food preparation techniques (e.g. males), it seems to underlie some of the lowest correlation coefficients observed. The best examples are represented by the correlation coefficients (not shown) for rice, total ($r = 0.69$ versus 0.39 and 0.61 for "risotto" and "pasta or rice with butter or oil", respectively) and poultry, any dish ($r = 0.60$ versus 0.35 and 0.41 for the "chicken and turkey, boiled" and "chicken, turkey, rabbit, broiled, fried or stewed"). It seems that grasping more than one feature of a food item contemporarily (as it is commonly done in the consultation of a restaurant menu) constituted a noteworthy difficulty for interviewees and/or interviewers. In a questionnaire meant to measure total calorific intake, therefore, the need to limit the number of questions must be carefully traded against the risk of confusion, loss of precision and, probably, accuracy in the recall of dietary habits [7].

Whether or not to collect data on portion in addition to intake frequency is another controversial topic. We chose to specify portion size as part of the question on frequency for all foods that come in natural units, such as one egg, one cup of yoghourt, etc. An additional item to describe the usual portion size was

*Table 4. Summary of findings from studies of the reproducibility of reported intakes of specific dietary items*

| Ref. | Food items | Subjects | Interval between questionnaires | Mean correlation coefficient | Range | Comments |
|---|---|---|---|---|---|---|
| 23 | 33 | 109 | 6–24 months | 0.30 | −0.08 (dried fish)<br>0.71 (coffee) | Only men |
| 24 | 47 | 323 | 6–10 years | 0.44 | 0.18 (roast beef)<br>0.71 (coffee) | |
| 25 | 61 | 1497 | 9 months | 0.46 | 0.34 (ready made pie)<br>0.76 (tea) | Correlation coefficient of reproducibility with intake frequency = 0.51. only women. |
| 26 | 83 | 1184 | 15 years | 0.36 | 0.15 (bean/pea soup, margarine)<br>0.74 (beer) | |
| 20 | 55 | 173 | 12 months | 0.44 | 0.09 (yellow squash)<br>0.83 (beer and tea) | Only women |
| Present study | 87 | 452 | 3–10 months | 0.59 | 0.35 (chicken/turkey, boiled)<br>0.84 (wine) | Correlation coefficient of reproducibility with intake frequency = 0.42; $P < 0.001$ |

included for all other foods. There is increasing evidence that the conceptualisation of the "standard" portion size and its relation to one's own habits is difficult and that, probably, this exercise did not add much to the assessment of dietary intake [7, 27] but this issue had never been explored with reference to Italian eating habits. With respect to the degree of reproducibility, we noticed that the multiplication of the frequency of intake by the reported portion size (i.e. by 0.7, 1.0 and 1.3) did not modify the correlation coefficients by more than one or two centesimal points in the majority of foods, generally in the direction of reducing slightly the degree of reproducibility (data not shown).

In conclusion, we think that the level of reproducibility of our questionnaire was satisfactory. Correlation coefficients on the order of 0.50–0.80 (mean $r = 0.59$) are consistent with the best previous experiences in the field and are also comparable with the reproducibility of many biological measurements (e.g. cholesterol and blood pressure) [7]. A reason for concern can be the limited representativeness of the study participants who, in order to volunteer for the investigation, were probably more health-conscious than the general population and, indeed, turned out to be selective in some of their dietary choices (e.g. low consumption of fat and salt). This problem may well weaken the information gathered on certain very seldom eaten foods (e.g. fried foods), but it is largely unavoidable in validation studies that require a high degree of involvement of participants. Further, since recruitment techniques allowed inclusion a large number of subjects of both sexes and over a rather wide range of ages, educational levels and occupations, we think that the conclusions of the present study retain a general value.

Finally, a high level of reproducibility does not ensure validity. This issue will be addressed elsewhere by means of the comparison of the present questionnaire with a better standard (i.e. two 7-day diet records).


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# Large-scale, Population-based Prospective Studies in Japan

**Shaw Watanabe**

**Large scale, population-based prospective studies have increasing importance for the study of common cancers in view of the possibility of advancing the understanding of different risk factors in the initiation, promotion and progression phases during what is thought to be the long process of human carcinogenesis. The permanent registration system in Japan ("Koseki") simplifies the follow-up of registered participants of such cohorts. The population-based cohort studied by Hirayama and the cohort of the atomic bomb survivors started during the 1960s are examples of such possibilities in Japan. Rapidly changing patterns of disease and lifetyles during the last 30 years require new population-based prospective studies focusing on a different set of exposures and with increased detail of exposure assessment. We have established a new population-based prospective study, the "Koseisho" cohort, between 1990 to 1992, following a cross-sectional study, using various biomarkers in five health centre districts. The Koseisho cohort comprises approximately 170 000 people aged 40–59 or 40–69 in 12 different health centre districts. The data are linked with the mass screening program registry data every year, and the sera and buffy coats collected at the beginning of the study will be stored at −80°C for at least 10 years. We intend to integrate various sources of information about health conditions for the prevention of chronic diseases in these cohort areas. Nutritional practices are one of our main interests, and repeated surveys by different methods are planned. Although all death certificates are collected through the health centres, disease registration committees were established in each district to register incident cases of both cancer and certain cardiovascular diseases. Representative population-based prospective studies in Japan are briefly reviewed and introduced.**
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## INTRODUCTION

FOR CHRONIC diseases, such as cancer and cardiovascular diseases, prospective population-based studies (frequently called cohort studies) are effective epidemiological study designs [1]. Longitudinal surveillance and recording of these events is a natural model of the study that will allow us to better understand the mechanisms of disease causation and progression. Long-term follow-up is necessary in cancer epidemiology, because the clinical appearance of most cancers can take 20 or more years from the initiation phase. The cases which occur in the few years after the establishment of the cohort portray the risk of progression only (Fig. 1). The hypothesis of initiation, promotion and progression in human carcinogenesis becomes plausible, because the multistage carcinogenesis theory has obtained generality and showed a close correspondence between the age–incidence curves predicted from this theory and those actually observed [2]. Cases that occur during the mid-period of

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