Seven unique food consumption patterns identified among women in the UK Women's Cohort Study

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Abstract

Objective: To identify groups of subjects with similar food consumption patterns so that complex disease - diet relationships can be investigated at the level of the whole diet, rather than just in terms of nutrient intake.

Subjects: 33,971 women in the UK Women's Cohort Study. 60,000 women on the World Cancer Research Fund mailing list were initially invited to take part. Subjects were selected to include a high proportion of vegetarians.

Design: The cohort completed a 217 item food frequency questionnaire. Cluster analysis was used to identify groups of women with similar food consumption patterns. Clusters were compared on socio-demographic characteristics, indicators of health and diet, and nutrient intakes.

Results: Seven clusters were identified including two vegetarian clusters. Groups appeared to be differentiated by differences in food types and in diversity of diet. Socio-demographic, health and diet characteristics and nutrient intakes all differed significantly between groups.

Conclusion: Classifying diets in more pragmatic terms than just nutrient intake should provide valuable insight into understanding complex diet-disease relationships. Dietary advice, whilst based on nutrient content of meals, needs to take account of the combinations of different food types that people naturally choose to use together.

Sponsorship: World Cancer Research Fund.

Descriptors: cohort studies; multivariate analysis; diet; food habits

Introduction

In nutritional research it is more common to consider food consumption in terms of nutrient intake, rather than type of food consumed. Conventionally nutrient intake is compared with recommended levels or adherence to dietary guidelines to identify groups of people with various levels of intake of specific nutrients. These groups can then be described in terms of their socio-demographic characteristics. This enables the researcher to identify individuals or more often subgroups of the population whose diets may be nutritionally deficient in some way.

Whilst researchers have concentrated on classifying people on the basis of their nutrient intake, consumers consider more than nutrient content when choosing food. In addition, it is unlikely that the aetiology of diseases such as cancer can be explained by levels of single nutrients and it may be that non-nutritive substances, such as phytochemicals, may be involved. Most consumers eat foods in certain combinations or patterns, and interest is therefore now focussing on whole diets and lifestyles rather than single nutrients. Identification of these patterns would be useful to explore complex diet-disease relationships (such as investigating potential effects of the Mediterranean diet) and also to intervene to provide relevant nutritional advice and education.

Cluster analysis has been used in similar contexts to identify groups or clusters of people with similar characteristics (Wirfalt & Jeffery, 1997; Schroll et al, 1996; Tucker et al, 1992; Hulshof et al, 1992; Bisgrove et al, 1989; Farchi et al, 1989; Akin et al, 1986; Windham et al, 1985). We aimed to classify people in terms of their chosen patterns of food consumption, rather than nutrient intake, to identify broad food groupings that naturally tend to be used together. This would also identify food types that are consumed to the exclusion of others. In other words, we hoped to identify consumption patterns or habits that classify people according to the types of food they choose to consume, forming natural groupings of people characterized by similar food consumption patterns.

In this investigation we used the UK Women's Cohort Study, a large national cohort funded by the World Cancer Research Fund (WCRF), to investigate food consumption patterns.

Methods

The UK Women's Cohort Study consists of 33,971 women aged 35 - 69y at recruitment, identified from responses to a brief questionnaire sent to potential supporters by the WCRF. Between 1995 and 1998, 61,000 potential subjects received a 217 item food frequency questionnaire (FFQ), which had been adapted from the FFQ used in the

European Prospective Investigation into Cancer (EPIC) study (Riboli, 1992). Subjects were selected to ensure a high proportion of vegetarians in the cohort. All self-defined vegetarians were chosen and matched for age to the next nearest red-meat eater. All meat eaters not eating red meat were also included. In this way we ensure a range in intake of foods and nutrients, with greater numbers of people consuming larger quantities of vegetables and fruit, and so be more likely to detect statistically significant associations between diet and disease outcomes. In particular, the design maximizes power to investigate associations between vegetarian or non-red meat diets and disease outcomes.

Frequency of consumption of each food item in the previous 12 months was recorded on the same 10 point scale: `never', `less than once a month',`1 - 3 per month', `once a week', `2 - 4 per week', `5 - 6 per week', `once per day', `2 - 3 per day', `4 - 5 per day', and `6+ per day'.

For the purposes of this investigation, food items similar in type and nutrient content were merged to reduce the number of food items from 217 to 74 food types to ease interpretation and computation of the clusters.

The number of clusters into which the women's food use was grouped was identified using a scree plot. This showed for different numbers of clusters how well the groups represented the individuals assigned to them in terms of the sum of squared Euclidean distances between individuals and their particular cluster mean (measured by the trace of the within-groups dispersion matrix, Everitt, 1993). Increasing the number of clusters decreases the trace, showing improved fit. The number of clusters that the women were naturally grouped into was indicated by the number of clusters that gave the biggest improvement in fit compared to the previous clusters. This provided an objective method of determining the number of clusters.

Cluster analysis was performed using SPSS version 8. The k-means cluster algorithm (Everitt, 1993; Anderberg, 1973) was used because of the large size of the sample and to avoid imposition of a hierarchical structure on the clusters. It assigns each woman automatically to an initial cluster characterising a particular food consumption pattern closest to their own and then updates the cluster characteristics to represent all the women assigned to it, including the new individual. After updating all the clusters for all the women, the process then repeats, reassigning each woman to the nearest updated cluster. This continues until the characteristics of the clusters stabilize and the women in them remain unchanged. Through this iterative process the women will have been assigned to the cluster that most characterizes their patterns of food consumption. Robustness of the results was assessed by trying different initial cluster centres, and different rules of convergence for the iterations.

The variables were not standardized to unit variance prior to the cluster analysis because all the variables were measuring the same thing (consumption), standardizing would dilute differences between clusters, and standardizing would also ignore correlations between variables (Everitt, 1993). The sensitivity of the results to the method used was assessed by repeating the analysis with standardized variables.

The food consumption patterns, socio-demographic characteristics, indicators of health and diet, and nutrient intakes of the different groups of women identified by the cluster analysis were tabulated. The characteristics of the clusters which were measured by continuous variables were compared using analysis of variance (and non-parametric Kruskal - Wallis analysis of variance where appropriate). Characteristics measured by dichotomous variables were compared using chi-squared tests.

Ethics approval for the UK Women's Cohort Study was obtained individually from all 174 Local Research Ethics Committees representing all the women in the cohort.

Results

Description of cohort

The mean age of the women in the cohort was 52 y (standard deviation (s.d.) 9 y). The women were generally well educated, with 14,749 (43%) being educated to ` A' level standard or beyond. The mean age of leaving full-time education was 18 y (s.d. 4 y). A total of 18,217 (55%) of the women were in a managerial, administrative, professional, technical or associated professional socio-economic group.

Only 3608 (12%) reported levels of fruit and vegetable consumption meeting or exceeding the UK Department of Health recommendation of five portions of fruit and vegetables per day (Department of Health, 1994). The women's exercise levels, however, were high. The median length of time spent doing physical activity vigorously enough to cause sweating or raise the heartbeat was 60 (inter-quartile range (IQR); 0 - 120) min per week.

These figures are supported by slightly lower body mass indexes (BMIs) for our women, with a mean of 24.4 kg=m2 (s.d. 4.3 kg=m2) compared to those in the National Diet and Nutrition Survey (Gregory et al, 1990), 24.8 kg=m2 for women aged 35 - 49 and 26.2 kg=m2 for women aged 50 - 64). Based on a definition of obesity being BMI_30 kg=m2, just 3095 (9%) were obese. The mean waist-to-hip ratio was also low at 0.75 (s.d. 0.06).

A total of 9793 (30%) out of 32,849 who answered the question described themselves as vegetarian. A high proportion of the cohort (17,920 women, 58%) take vitamins, minerals, fish oils, fibre or other food supplements. This is a substantially higher proportion than in the National Diet and Nutrition Survey (Gregory et al, 1990). Only 3670 (11%) reported they were current smokers, either regular or occasional.

Cluster analysis

Increasing the number of clusters to seven produced the largest improvement in the trace, suggesting that the women were naturally grouped into seven clusters. The cluster centres were examined and the groups subjectively given the labels ` monotonous low-quantity omnivores', ` health conscious', 'traditional meat chips and pudding eaters', ` higher-diversity, traditional omnivores', ` conservative omnivores', ` low diversity vegetarians' and ` high diversity vegetarians'. The food consumption characteristics of these groups are shown in Table 1. The food groups identified as having relatively high or low levels of consumption for a particular cluster, marked out that cluster from the others. Certain food items from the 217 item FFQ illustrate these differences well. Typical food consumption frequencies for a selection of food items are shown for the seven clusters in Table 2. The food items have been selected for illustrative purposes, out of those that differentiate most clearly between the clusters, whilst covering a range of food types.

The characteristics of the clusters were essentially unchanged by using different initial cluster centres or convergence rules. In addition, clusters with similar interpretations were obtained using the less sensitive but more robust approach of standardizing the variances of the variables before performing the cluster analysis, demonstrating the robustness of the results.

The clusters whose characteristics were most similar (ie whose centres were closest together) were cluster 3 (traditional meat, chips and pudding eaters) and cluster 5 (conservative omnivores), though cluster 4 (higher-diversity, traditional omnivores) was also relatively close to the other two. The clusters whose centres were furthest apart were cluster 1 (monotonous low-quantity omnivores) and cluster 2 (health conscious).

Comparison of clusters

Comparison of the socio-demographic characteristics of the groups identified by the clusters is shown in Table 3. Vegetarian and health-conscious groups were generally better educated, smoked less, and contained more women in higher socio-economic groups.

Indicators of reported vegetarian status, health and healthy lifestyle are shown in Table 4. Women with healthier food consumption patterns had lower BMIs and, in particular, both the vegetarian clusters had the lowest mean BMIs. However, the mean BMIs for all groups were quite low, and levels of obesity were around 10% for all but the vegetarian groups, which were 5 - 6%. The proportion of women meeting the UK Department of Health's guidelines for eating five portions of fruit and vegetables per day (Department of Health, 1994) was assessed using a cross-check question to avoid over-reporting of fruit and vegetable consumption in the FFQ (Calvert et al, 1997), although this may have led to some under-reporting. Group 1, labelled ` monotonous low-quantity omnivores' were least likely to meet the guidelines for eating five portions of fruit and vegetables per day. Women with healthier food consumption patterns were also more likely to take vigorous physical exercise (activity vigorous enough to cause sweating or raise the heartbeat). Women with less healthy eating patterns such as the ` traditional meat, chips and puddings' group were the least likely to take vitamins and other food supplements, although overall levels were still high.

The two consumption patterns identified in the cluster analysis which are labelled as vegetarian patterns contain some women who do not describe themselves as vegetarians. However, these women are less likely to eat red meat than non-vegetarians in the other clusters (71% vs 98% eating red meat, P<0.00l), and where they do eat red meat, they eat substantially less (mean of 0.28 portions per day vs 0.87, P<0.00l). The five clusters not labelled as vegetarian do contain some women who call themselves vegetarians. Of these people who say they are vegetarians, 59% do eat meat, most of which is fish. Only 12% a of the women in these clusters who call themselves vegetarians eat red meat, and those women who do eat red meat do so less than those in the same clusters who describe themselves as nonvegetarians (0.02 portions per day vs 0.87 portions per day, P<0.001).

Daily nutrient intakes for each cluster are shown in Table 5 for a range of important nutrients. The ` health conscious' group had the lowest percentage of total energy intake from fat (30%), and the ` traditional meat, chips and pudding eaters' had the highest (35%) despite similar absolute values. This was due to higher carbohydrate intakes diluting the effect of fat in the ` health conscious' group. The ` conservative omnivores' also had 30% of total calorific intake from fat with a low total fat intake.

There were statistically significant differences (P<0.001) between the seven clusters for all the characteristics listed in Tables 3 - 5, even where the sizes of the differences were of little practical importance. This is because of the large sample size. Attention should be focussed on the estimates, rather than the P-values.

Discussion

The women in general had healthier diets, healthier lifestyles and were better educated than would be seen in a random sample of UK women of the same age. This is largely because of the source of the cohort from the WCRF questionnaire data targeted at potential supporters, and to include a large proportion (one-third) of vegetarians. It is also to be expected that women most interested in taking part in a study such as this would be those who have a keener interest in diet and health. As such, the cohort forms a unique group of women, and this context needs to be taken into account when considering the clusters identified. The food consumption patterns, however, are likely to be relevant to all UK women because they are drawn from internal comparisons, although the relative size of each cluster may not be applicable outside this cohort.

While previous studies have identified diets with similar nutritional content, this analysis has identified patterns of food choice. The FFQ on which the patterns are based covers a 12-month period, but it is known that individuals' dietary behaviours and patterns do change over longer periods of time (Ministry of Agriculture, Fisheries and Food, 1991). It may therefore be expected that the basic groupings identified by the clusters will remain, but that over time individuals may change which group most closely reflects their eating habits. Repeated food frequency questionnaires to the cohort over 10 y will facilitate exploration of individuals' patterns and habits which are more resistant to change than others. This may provide a focus for targeting nutritional advice.

Interpretation and labelling of clusters has a large subjective component. In addition, the inclusion of nonvegetarians in the two vegetarian groups and vegetarians in the clusters labelled as non-vegetarian could be seen as a limitation of the method. However, investigating these apparent inconsistencies further reveals that the women's food consumption patterns of some vegetarian women are closer overall to some non-vegetarians. The results suggest that for many their diet may be similar to non-vegetarians, without the diversification into other food types more common amongst vegetarian diets, but with red meat consumption reduced or cutout, prompting them to call themselves vegetarians. Similarly, the non-vegetarians who have been placed in one of the two vegetarian groups have consumption patterns which overall are more similar to the vegetarian groups than the non-vegetarian. This could indicate a group who follow a vegetarian diet as far as possible, but occasionally allow themselves fish.

The FFQ is based on frequency and range of foods consumed. The key differences between the patterns of food choice identified by the cluster analysis are based not just on differences in food types, but also in diversity of diet. For example, two separate groups of vegetarians were identified. The type of food they consumed was similar in that they both chose vegetarian diets, but one group consumed a wider variety of such items than the other. Whilst both vegetarian clusters and the women with health conscious behaviour apparently more easily met recommended levels of fruit and vegetable consumption, we have also identified groups of women with eating patterns for which these levels are harder to attain. In particular, in addition to the type of food chosen, it appears that the level of diversity is important here. Encouraging movement from a monotonous, conservative diet to a more diverse one could be one way to help people improve the quality of their diet, within the framework of their personal food preferences or restrictions. The poorer food consumption patterns were also reflected in slightly higher levels of obesity, although a causal relationship cannot necessarily be implied. Previous work identifying dietary patterns in two US Metropolitan populations found that food choice patterns with more evenly distributed food energy sources were related to lower BMIs and more favourable nutrient intakes (Wirfalt & Jeffery, 1997). In our study, the mean BMI levels differed by only about 2 kg=m2, with the vegetarian groups being slightly lower than the other groups. In our cohort the groups displaying greater diversity of food choice also have fewer obese women and more favourable nutrient intakes than those labelled ` monotonous', ` conservative' or ` low diversity', in broad agreement with this previous work. Our analysis therefore adds to a growing interest in the effects of and the concepts surrounding dietary diversity (Dowler & Calvert 1995; Krebs-Smith et al, 1987).

It is possible that diversity is influenced by cost (Dowler & Calvert 1995; Cade 1999; Ministry of Agriculture, Fisheries and Food, 1996; Bolton-Smith et al, 1991). The health conscious and vegetarian groups were more likely to have a higher educational level and do more vigorous exercise than the other groups. They were also more likely to take food supplements consistent with the hypothesis that supplement use is associated with a healthier lifestyle profile and an adequate nutritional intake (Kirk et al, 1999; Draper et al, 1993).

Nutrient intakes were overall quite high. The ` health conscious' group had the highest intakes of the vitamins and minerals considered. Their energy intakes were similarly high to the ` higher diversity traditional omnivores' who were also high quantity consumers, but the health-conscious group had a lower percentage of their energy coming from fat (30% vs 34% respectively). The lowest nutrient intakes were seen in the ` monotonous low-quantity omnivores' group.

Dietary patterns have been described for people living in the Mediterranean region. Trichopoulou et al (1995) created a diet score for elderly subjects in rural Greece based on eight components characteristic of the Mediterranean diet (Trichopoulou et al, 1995). A higher score indicated a more typically Mediterranean diet. They found that a one unit increase in diet score was associated with a significant (17%) reduction in overall mortality. The individual components of the diet score had weak and generally nonsigni ficant associations with survival, implying that it is the pattern of consumption which maybe more important in health terms. We intend investigating associations between the maintenance of consumption patterns identified in our study and subsequent incidence of cancer over a 10 y period.

Not all diets which are potentially healthy in one aspect, eg low-fat, will be healthy in others, eg micronutrient intake. It may be that high-fat diets which are high in fruit and vegetables are associated with lower health risks than similar fat intakes with low fruit and vegetable intakes (Wirfalt & Jeffery, 1997). There is a danger of focussing on single nutrients when dietary intake is a multidimensional behaviour (Ursin et al, 1993;

Patterson et al, 1994). Therefore, investigating whole diets as in this study, taking into account not only frequency of eating specific items but also the range and diversity, may better describe groups of people in different risk groups. In particular, the identification of two distinct types of vegetarian diet is useful in this regard.

Following our approach, classifying diets in more pragmatic terms than just nutrient intake should provide valuable insight into understanding complex diet - disease relationships. Effects of diet are more than just the nutrients they contain; there are complex interactions between nutrients, other dietary constituents, and the processing and preparation of food. Information about such interactions is largely lost in conventional dietary analyses, which ignore the different patterns of food intake. Associating the maintenance of consumption patterns identified in this study with subsequent cancer incidence will take these interactions into account, allowing early dietary recommendations to be made. This will also provide pointers towards the underlying mechanisms, informing the investigation of the complex underlying interactions. In addition, dietary advice, whilst based on nutrient content of meals, needs to take account of the combinations of different food types that people naturally choose to use together. Identifying these food consumption patterns will inform the development of health interventions aiming to improve people's diets.

Acknowledgements

The UK Women's cohort is funded by the World Cancer Research Fund. We thank the members of the steering group: David Forman, Barrie Margetts, Margaret Thorogood and Rhys Williams. We also thank Cathy Britton, Barbara Bailey and Carole Burton for data processing.

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Table I Food consumption characteristics of the seven clusters

Label	*Number of women*	*Characteristic food types consumed*		
		High quantities	*Moderate quantities*	*Low quantities*
1. Monotonous low-quantity omnivores	5416	White bread, milk, sugar	Potatoes, meat	Most other foods, especially bran and wholemeal food, soya products, yoghurt, nuts, pulses, fruit and vegetables, alcohol
2. Health conscious	2131	Bran, potatoes, wholemeal food, yoghurt, low-fat dairy products, pulses, fish, vegetables, salad, fruit	Most other foods including meat and wine	Chips, sugar
3. Traditional meat, chips and pudding eaters	6087	White bread, chips, meat, sugar, high-fat and creamy food, biscuits, cakes	Most other foods including alcohol	Wholemeal food, soya products, vegetables, salad, fruit
4. Higher diversity, traditional omnivores	4819	Chips, white pasta and rice, high-fat and creamy food, eggs, meat, fish, chocolate, biscuits, crisps. More fish and salad than 3. More diversity than 3	Vegetbles, fruit, alcohol	Less cakes and puddings than 3
5. Conservative omnivores	5946		Most food, including potatoes, meat, fish, eggs, fruit, vegetables	Cereals, chips, wholemeal food, nuts, pulses, spreads and dressings, chocolate, crisps, biscuits. Less red meat, less chips and less puddings than 3 and 4
6. Low diversity vegetarians	5190	Wholemeal bread, soya products, pulses, fruit (apart from exotic fruit), vegetables	Cereals	Butter, eggs, meat, fish
7. High diversity vegetarians	4379	Wholemeal bread, cereals, wholemeal pasta and rice, soya products, spreads, nuts, pulses, vegetables, fruit, herbal tea (generally higher consumption of these products than 6)		White bread, meat, fish

Table 2 Food frequencies for an illustrative selection of food items from the 217 item food frequency questionnaire. Food items have been selected for illustrative purposes, out of those that differentiate most clearly between the clusters, whilst covering a range of food types. The cluster(s) with the most frequent consumption of each item is(are) shown in **bold type**

	Median food frequencies Food type:								
	Bread	*Potatoes*	*Nuts*	*Meat*	*Vegetables*		*Fruit*		*Puddings*
Label	*Wholemeal bread*	*Chips*	*Pecan nuts and walnuts*	*Roast beef*	*Celery*	*Peppers*	*Oranges*	*Plums*	*Sponge cake*
1. Monotonous low quantity omnivores	Once per week	1–3 per month	Never	Less than once a month	Less than once a month	Less than once a month	1–3 per month	Less than once a month	Less than once a month
2. Health conscious	**Once per day**	Less than once a month	Less than once a month	Never	**Once per week**	**2–4 per week**	**5–6 per week**	**5–6 per week**	Less than once a month
3. Traditional meat, chips and pudding eaters	Once per week	**Once per week**	Less than once a month	**1–3 per month**	1–3 per month	1–3 per month	Once per week	1–3 per month	**1–3 per month**
4. Higher diversity traditional omnivores	2–4 per week	1–3 per month	Less than once a month	**1–3 per month**	**Once per week**	Once per week	2–4 per week	2–4 per week	**1–3 per month**
5. Conservative omnivores	2–4 per week	Less than once a month	Less than once a month	Less than once a month	1–3 per week	Once per week	2–4 per week	Once per week	Less than once a month
6. Low diversity vegetarians	**Once per day**	Less than once a month	Less than once a month	Never	1–3 per month	Once per week	Once per week	1–3 per month	Less than once a month
7. High diversity vegetarians	**Once per day**	Less than once a month	**1–3 per month**	Never	**Once per week**	**2–4 per week**	2–4 per week	Once per week	Less than once a month

Table 3 Socio-demographic characteristics of the seven clusters

Label	*Mean age (s.d.)*	*Current Smoker (%)*	*Meam age of leaving full-time education (s.d.)*	*'A' level education or higher (%)*	*Managerial administrative, professional or technical job (%)*
1. Monotonous low quantity omnivores	53 (10)	903 (17%)	17 (3)	1594 (29%)	2319 (44%)
2. Health conscious	53 (9)	163 (8%)	19 (4)	1015 (48%)	1344 (64%)
3. Traditional meat, chips and pudding eaters	52 (9)	754 (13%)	18 (3)	2176 (36%)	2782 (46%)
4. Higher-diversity, traditional omnivores	53 (9)	393 (8%)	18 (3)	2181 (45%)	2621 (55%)
5. Conservative omnivores	55 (9)	548 (9%)	18 (3)	2300 (39%)	3088 (53%)
6. Low diversity vegetarians	49 (9)	574 (11%)	19 (4)	2847 (55%)	3139 (61%)
7. High diversity vegetarians	50 (9)	333 (8%)	19 (4)	2636 (60%)	2924 (68%)

Percentages for each question are based on the number of women completing that question.

Table 4 Additional health and dietary characteristics of the seven clusters

Label	*Describes herself as vegetarian (%)*	*Mean BMI (s.d.)*	*Obese (%) (BMI ≥ 30 kg/m^2)*	*Mean waist-to-hip ratio (s.d.)*	*Use food supplements (%)*	*Consume recommended 5 portions of fruit and vegetables per day (%)*	*Median time in vigorous physical activity (minutes per week (IQR))*
1. Monotonous low quantity omnivores	1057 (20%)	25 (5)	602 (12%)	0.75 (0.07)	2621 (53%)	197 (5%)	0 (0–120)
2. Health conscious	709 (35%)	24 (4)	192 (9%)	0.74 (0.08)	1243 (65%)	551 (30%)	70 (0–180)
3. Traditional meat, chips and pudding eaters	198 (3%)	25 (4)	724 (12%)	0.75 (0.06)	2809 (50%)	232 (4%)	20 (0–120)
4. Higher diversity, traditional omnivores	226 (5%)	25 (4)	465 (10%)	0.75 (0.06)	2437 (55%)	517 (12%)	60 (0–120)
5. Conservative omnivores	940 (16%)	25 (4)	637 (11%)	0.75 (0.06)	3004 (56%)	715 (14%)	30 (0–120)
6. Low diversity vegetarians	3517 (71%)	23 (4)	277 (6%)	0.74 (0.06)	3102 (66%)	531 (12%)	60 (60–120)
7. High diversity vegetarians	3146 (75%)	23 (4)	198 (5%)	0.74 (0.06)	2704 (69%)	865 (23%)	60 (0–180)

Percentages for each question are based on the number of women completing that question.

Table 5 Mean (s.d.) total daily intake of energy (including alcohol) and seven clusters with percentage meeting Reference Nutrient Intakes (RNI)

	Energy intake (including alcohol)		*Protein*		*Fat*		*Carbohydrate*		*Vitamin C*		*Vitamin A*		*Iron*		*Zinc*	
Label	*kcal (s.d.)*	*MJ (s.d.)*	*g (s.d.)*	*Percentage energy intake*	*g (s.d.)*	*Percentage energy intake*	*g (s.d.)*	*Percentage energy intake*	*mg (s.d.)*	*Percentage who meet RNI*	mg (s.d.)	*Percentage who meet RNI*	*g (s.d.)*	*Percentage who meet RNI*	*g (s.d.)*	*Percentage who meet RNI*
1. Monotonous low quantity omnivores	1842 (576)	7.7 (2.4)	72 (22)	16	66 (26)	32	241 (87)	49	113 (61)	97	922 (532)	74	14 (7)	60	9(3)	73
2. Health conscious	2957 (1063)	12.4 (4.4)	106 (38)	14	97 (47)	30	427 (154)	54	383 (172)	100	1623 (818)	99	26 (10)	96	14 (5)	97
3. Traditional meat, chips and pudding eaters	2521 (671)	10.5 (2.8)	96 (26)	15	98 (32)	35	316 (94)	47	149 (62)	100	1308 (560)	97	18 (7)	80	12 (4)	98
4. Higher-diversity, traditional omnivores	2978 (789)	12.4 (3.3)	112 (29)	15	113 (36)	34	383 (111)	48	226 (78)	100	1632 (623)	100	22 (8)	95	14 (4)	100
5. Conservative omnivores	2033 (508)	8.5 (2.1)	80 (22)	16	68 (22)	30	278 (82)	51	192 (76)	100	1123 (538)	89	17 (7)	79	10 (3)	87
6. Low diversity vegetarians	2199 (585)	9.2 (2.4)	76 (22)	14	79 (28)	32	297 (87)	51	160 (64)	100	1029 (421)	89	17 (7)	73	10 (3)	83
7. High diversity vegetarians	2682 (724)	11.2 (3.0)	91 (26)	14	97 (34)	33	372 (107)	52	236 (86)	100	1293 (533)	98	22 (8)	92	12 (4)	96