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Variation in fruit and vegetable consumption among adults in Britain. An analysis from the dietary and nutritional survey of British adults

H Billson[1], JA Pryer[1]* and R Nichols[2]

[1]*Department of Epidemiology and Popution Health, London School of Hygiene and Tropical Medicine; and*
[2]*Department of Epidemiology and Public Health at Imperial College of Medicine, London, UK*

Objectives: Using a national representative sample to examine variation in fruit and vegetable consumption among adults in the UK, with particular reference to consumers with high and low reported intakes.
Design: National representative dietary survey using 7-d weighed diet records of men and women aged 16–64 y living in private households in the UK in 1986–1987.
Setting: The UK.
Subjects: 1087 men and 1110 women. The sample was selected by a multi-stage random probability design. The response was 70%. Subjects with low energy intake were subsequently excluded.
Main outcome measures: Food group, nutrient intake, physiological measures socio-economic, demographic and behavioural characterstics.
Results: Consumption of fruit and vegetables was estimated. The sample was divided by sex into four quarter groups according to fruit and vegetable consumption. There were significant similarities between quarter groups in fruit and vegetable and other food intake, nutrient intake, physiological measures, and socia-economic, demographic and behavioural variable. The lowest consumers of fruit and vegetables had a mean intake of 738 g/week (men) and 630 g/week (women), equivalent to 1.3 and 1.1 portion/d, respectively. Conversely, the mean intake of both men women with the highest consumption was 3137 g/week (5.6 portions day). There were more than twice as many adults in the age group 16–24 located in Q1 than in Q4. The Manual social class and those in receipt of benefits were negatively associated with fruit and vegetable consumption. Smokers were significantly associated with low fruit and vegetable intake. Being married was associated with increased fruit and vegetable intake and being single or divorced/separated was associated with low fruit and vegetable intake. Eating home grown produce was associated with hogh intake. Consumers who lived in London or the South-East were associated with higher fruit and vegetable intake.
Conclusions: The analysis draws attention to the wide variation in reported fruit and vegetable consumption among British adults. High consumers merit further investigation to elucidate practical strategies for increasing fruit and vegetable consumption. Strategies to increase consumption should be targeted at groups most likely to include low consumers of fruits and vegetables.
Sponsorship: London School of Hygience and Tropical Medicine.
Descriptors: fruit and vegetable; dietary surveys; nutrient and food intake; socio-economic variables

Introduction

Efforts to increase fruit and vegetable consumption in Britain have been a feature of health promotion policy for several years. A number of targets for both population and individual consumption of fruit and vegetables have been derived. The WHO in 1994 proposed a lower limit population goal of 400 g/d (with the added proviso that at least 30 g/d of this should be pulses, nuts and seeds; (WHO, 1990). The Committee on the Medical Aspects of Food Policy's Cardiovascular Review Group has recommended an increase of 50% in the mean population intake (Department of Health, 1994) based on a current mean intake of 295 g/d derived from the National Food Survey, which excludes foods eaten away from the home but includes the inedible portion of foods. An additional 50% would result in a mean intake of 443 g/d. Recommendations of the sub-group of the Nutrition Task Force examining this issue have advised the consumption of at least five portions/servings per day, approximately equivalent to 400 g/d (Williams, 1995).

Using data generated by the Dietary and Nutritional Survey of British Adults (DNS; Gregory *et al,* 1990), the purpose of this study was to investigate variation in fruit and vegetable consumption among adults in Britain, especially amongst consumers with the highest and lowest reported intakes.

Methods

The methods and conduct of the DNS have been described in detail elsewhere (Gregory *et al,* 1990). Briefly, it was

*Correspondence: Jane Pryer, Public Health Nutrition Unit, Department of Epidemiology and Population Health, London School of Hygiene and Tropical Medicine, 49/51, Bedford Square, London WC1B 3DP, UK.
Guarantor: JA Pryer.
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commissioned by the Ministry of Agriculture, Fisheries and Food (MAFF), and the Department of Health (DH) and undertaken in collaboration with the Office of Population Censuses and Surveys (OPCS). Fieldwork was carried out between October 1986 and August 1987. The sample was recruited using a multi-stage random probability design. In all, 1087 men and 1110 women aged 16–64 y completed the full dietary survey, a response rate of 70%.

Each study participant was issued with a calibrated set of food scales and asked to keep a weighed record of all foods consumed both in and out of the home over a 7-d period. Body weight and height were measured in standard fashion. Additional information was collected by interviewer-administered questionnaire, including details of age, social class, ethnic origin, geographical area of residence, mineral and vitamin supplement use, cigarette smoking and whether the food diary was affected by the participant being on a slimming diet or by illness during the week of the study. Among those who completed a dietary record, 88% made a 24-h urine collection and 86% gave a blood sample.

The data were obtained from OPCS and the Essex archives. The data were checked by replicating selected analyses and by undertaking range checks.

The data was examined and statistically analysed using the SAS package for PC computers. The data was supplied and analysed separately for each sex. Due to the high prevalence of 'low energy reporting' in the DNS (Pryer *et al,* 1997), analyses were undertaken both on the full sample (1087 men and 1110 women) and on a sub-sample which excluded individuals whose reported intake was unlikely to be representative of habitual consumption patterns. Subjects excluded were those with a reported dietary energy intake less than 1.1 times estimated basal metabolic rate (BMR), those who reported that they were slimming (12% of women and 4% of men) and those who reported that their eating had been affected by illness (5% of men and 10% of women). Those excluded have been collectively called the 'Low Energy Reporters' (LERs). When the LERs were excluded, the remaining sub-sample consisted of 816 men and 628 women. The results from the analyses on this latter group were chosen for this report.

A calculation of fruit and vegetable consumption was made for each person by summing the weights of each type or group of fruit and vegetables consumed during the week. Potatoes were excluded; fruit juice was included up to a weekly maximum intake of 1120 g, equivalent to a daily serving of 160 g (proposed as a representative portion size by Williams, 1995 and personal correspondence). The samples were then divided by quartiles into four quarter groups according to their total fruit and vegetable consumption. Within each sample, the four quarter groups (subsequently referred to as Q1, Q2, Q3 and Q4) were used as the basis for comparison. Q1 comprised those with the lowest intakes and Q4 represented the consumers with the highest intakes.

Comparison was made between the quarter groups of total fruit and vegetable consumption, for the intake by type of fruits and vegetables and for variation in the consumption of other foods and food groups. The statistical significance of variations in food intake between quarter groups was examined by using non-parametric one-way analysis of the median values.

Comparison was made of the mean calculated daily intake of nutrients (excluding supplements) for each quarter group and also of selected mean physiological readings related to nutritional status. The results were statistically analysed using tests of analysis of variance. Some of the nutrients were transformed using natural logarithms prior to statistical analysis.The frequency distribution of socio-economic, demographic and behavioural variables between the quarter groups was examined and analysed using the chi-square test.

Due to the nature of the data some fruit and vegetables may have been omitted from the total consumption figures if they were coded in with a composite item, for example fruit pies, meat stews. Likewise other foods may have been included where it was not possible to separate them from a group containing fruit and vegetables, for example coleslaw, fruit and nut mixes.

Results

Comparison of the total sample and the sub-sample with LERs

Reported mean energy intake and total fruit and vegetable consumption for the original whole sample and the sub-sample (LERs excluded) are shown in Table 1. When the

Table 1 Comparison of report energy intake and total fruit and vegetable consumption of whole sample and sub-sample (LERs excluded)

	Whole sample	*Sub-sample*	*P*
Men			
n	1087	816	
Mean energy (kcal)	2450	2641	< 0.001
s.d.	(596)	(482)	
Mean friut and vegetable intake (g/week)	1716	1788	< 0.05
s.d.	(1047)	(1026)	
P25/p50/p75	982/1526/2245	1120/1616/2293	
Equivalent no. of 80 g portions/d	3.1	3.2	
Women			
n	1110	628	
Mean energy (kcal)	1681	1928	< 0.001
s.d.	(441)	(313)	
Mean friut and vegetable intake (g/week)	1657	1734	< 0.06
s.d.	(1029)	(1030)	
P25/p50/p75	887/1487/2190	966/1578/2242	
Equivalent no. of 80 g portions/d	3.0	3.1	

1. Value of *P* calculated from Z test.
2. From these figures the following values for the excluded LERs were calculated: Men (*n*=271), Energy=1875 kcal/d, total fruit and vegetables=1499 g/week (2.7 portions); Women (*n*=482), Energy= 1359 kcal/d, total fruit and vegetables=1557 g/week (2.8 portions/d).

LERs were excluded, mean energy intake increased significantly ($P = < 0.001$), especially among the women. Mean fruit and vegetable consumption increased only slightly (by approximately 10 g/d). From these figures a subsequent calculation of the estimated energy and fruit and vegetable consumption of the LERs was made (see footnote to Table 1).

Fruit and vegetable consumption

Reported fruit and vegetable intake by each quarter group is shown in Table 2. Although total fruit and vegetable consumption was normally distributed in the sample, there was a wide range in reported intake. The mean intake in Q4 (3137 g/week for both men and women) was more than four times greater than in Q1 (738 g/week men, 630 g/week women). Men reported higher mean intakes than women in corresponding quarter groups, except in Q4. When the total intakes for the week were used to estimate the mean daily consumption of portions of fruit and vegetables (based on a portion size of 80 g), the number of portions consumed was found to range from just over 1 portion/d among the low consumers to more than 5+ portions/d for the high consumers.

The contribution to total intake made by fruit plus fruit juice rose from Q1 to Q4, increasing among the men from 16.7 to 47.9%; the relative proportions were greater among the women, rising from 21.9 to 56.2%.

When reported consumption of each type of fruit and vegetable category was examined (leafy green vegetables, carrots, tomatoes, salad vegetables, peas, baked beans, green beans, other vegetables, apples and pears, citrus fruits, bananas, canned fruit, other fruit, fruit juice), mean intakes increased significantly ($P < 0.01$) from Q1 to Q4, except for the consumption of peas, and also, among the women only, for baked beans (results not shown).

Consumption of other foods

A significantly positive association ($P < 0.01$) was found between the consumption of fruits and vegetables and the consumption of wholemeal bread/high-fibre cereals, biscuits/pastries/puddings, low-fat dairy products, polyunsaturated and low-fat spreads, non-fried fish and shellfish and liqueurs/spirits/wines; and additionally with potatoes for the women. There was a significant negative association ($P < 0.01$) between the consumption of fruits and vegetables and the consumption of white bread/refined cereals, 'other fats', prepared meat products, fried potatoes, sugar/confectionery and also, for the women, high-fat dairy products and soft drinks. There was no significant difference ($P > 0.05$) at varying levels of fruit and vegetable consumption in the reported intakes of pasta/rice, eggs, butter, bacon/ham beef/veal, lamb/pork, poultry, fried white fish, beer/cider/perry and tea/coffee. Among the men there was no significant difference in the consumption of high-fat dairy products, potatoes and soft drinks (results not shown).

Nutrient intake

The mean calculated intakes of energy and nutrients for the low and high consumers is reported, by sex, in Tables 3 and 4. Energy consumption increased significantly ($P < 0.01$) in association with increasing fruit and vegetable consumption, as did the consumption of fibre and sugars, plus the alcohol intake of females. The percentage of energy consumed as protein increased significantly from Q1 to Q4, but there was no significant association with the percentage of energy derived from carbohydrate. The percentage of energy derived from total fat decreased significantly from Q1 to Q4 among the women and the percentage of energy from saturated fat was found to be inversely associated with fruit and vegetable consumption among both men and women ($P < 0.05$ to < 0.001). There was a positive association between increasing fruit and vegetable consumpfion and an increasing percentage of energy from n6 polyunsaturated fats, and additionally for men, from n3 polyunsaturated fats.

Increasing fruit and vegetable consumption was very significantly and positively related ($P < 0.001$) to an increasing intake of the listed minerals and vitamins. The reported intake per 1000 kcal/energy of these micronutrients was also greater among the high consumers of fruits and vegetables than among the consumers in Q1. The greatest differences were seen in the reported nutrient intakes of carotene and vitamin C; the mean intake of those in Q4 was more than 100% higher than the mean intake of those in Q1.

Physiological measurements

The mean physiological readings of quarter groups 1 and 4 are shown in Table 5. The mean BMI of the high consumers was greater than for the low consumers, but a

Table 2 Reported consumption of total fruit and vegetables by fruit and vegetable quarter groups (after exclusion of LERs

	All	*Q1*	*Q2*	*Q3*	*Q4*
Men					
n	816	205	203	204	204
Total fruit and vegetables mean (g/week	1788	738	1353	1927	3137
s.d.	1026)	(254)	(149)	(191)	(977)
Equivalent no. of 80 g portions/d	3.2	1.3	2.4	3.4	5.6
Percentage of total fruit and vegetables from vegetables mean (%)	67.0	83.3	72.8	59.9	52.1
s.d.	(23.9)	(21.6)	(21.7)	(21.3)	(18.0)
Percentage of total fruit and vegetables from fruit/fruit juice mean (%)	33.0	16.7	27.2	40.1	47.9
s.d.	(23.9)	(21.6)	(21.7)	(21.3)	(18.0)
Women					
n	628	157	157	157	157
Total fruit and vegetables mean (g/week)	1734	630	1271	1897	3137
s.d.	(1030)	(225)	(181)	(183)	(833)
Equvalent no. of 80 g portions/d	3.1	1.1	2.3	3.4	5.6
Percentage of total fruit and vegetables and vegetables mean (%)	59.3	78.1	62.5	53.1	43.8
s.d.	(23.5)	(22.9)	(21.7)	(18.6)	(15.5)
Percentage of total fruit and vegetable from fruit/fruit juice mean (%)	40.7	21.9	37.5	47.0	56.2
s.d.	(23.5)	(22.9)	(21.7)	(18.6)	(15.5)

Table 3 Reported nutrient intake of men with low and high fruit and vegetable consumption (LERs excluded)

	Q1 (low), n=205;mean(s.d.)	*Q4 (high, n=204;mean(s.d.)*	*P*
Energy kcal	2579 (515)	2738 (481)	**
Total fat (% energy)	37.4 (5.7)	37.0 (4.5)	ns
saturated fat (% energy)	15.6 (3.1)	14.9 (2.7)	*
Monounsaturated fat (% energy)	11.6 (2.0)	11.1 (1.6)	**
n3 polyunsaturated fat (% energy)	0.68 (0.24)	0.74 (0.26)	*
n6 polyunsaturated fat (% energy)	4.5 (1.62)	5.6 (2.3)	***
Protein (% energy)	13.0 (2.4)	14.2 (2.0)	***
Carbohydrate (% energy)	41.9 (7.0)	42.1 (6.0)	ns
Starch (g)	167 (45)	168 (42)	ns
Sugar (g)	118 (50)	137 (42)	***
Fibre (g) (Southgate method)	21.6 (6.1)	33.0 (9.6)	***
Fibre (g/1000 kcal)	8.5 (2.2)	12.2 (3.6)	***
Alcohol (g)	31.2 (42.0)	27.3 (31.7)	ns
Potassium (mg)[a]	3016 (64.8)	3921 (713)	***
Calcium (mg)[a]	916 (260)	1116 (282)	***
Magnesium (mg)[a]	304 (84)	407 (107)	***
Iron (mg)[a]	12.7 (4.1)	16.9 (4.5)	***
Zinc (mg)[a]	10.8 (3.1)	13.2 (3.1)	***
Retinol equivalents (μg)[a]	1401 (1586)	2056 (1912)	***
Carotene (μg)[a]	1653 (1425)	3657 (2368)	***
Folate (μg)[a]	300 (114)	378 (98)	***
VitaminC (mg)[a]	42 (16)	107 (47)	***
VitaminE (mg)[a]	8.9 (3.6)	12.9 (6.2)	***

[a] Variables transformed before analysis. *** $P < 0.0001$; ** $P < 0.01$; * $P < 0.05$; ns=$P > 0.05$ (P measures analysis of variance all quarter groups).

Table 4 Repored nutrient intake of women with low and high fruit and vegetable consumption

	Q1 (low), n=157;mean (s.d.)	*Q4 (high, n=157;mean (s.d.)*	*P*
Energy kcal	1857 (278)	2021 (336)	***
Total fat (% energy)	40.2 (4.6)	38.8 (5.0)	*
saturated fat (% energy)	17.4 (2.9)	16.0 (2.9)	***
Monounsaturated fat (% energy)	12.2 (1.8)	11.4 (1.9)	***
n3 polyunsaturated fat (% energy)	0.71 (0.26)	0.72 (0.20)	ns
n6 polyunsaturated fat (% energy)	9.6 (1.6)	12.9 (2.1)	***
Protein (% energy)	13.6 (2.3)	14.7 (2.2)	***
Carbohydrate (% energy)	44.0 (6.3)	43.2 (5.7)	ns
Starch (g)	119 (25)	121 (28)	ns
Sugar (g)	97 (40)	110 (29)	**
Fibre (g) (Southgate method)	16.1 (3.7)	25.7 (6.4)	***
Fibre (g/1000 kcal)	8.7 (1.9)	12.8 (2.9)	***
Alcohol (g)	6.6 (11.0)	9.9 (11.8)	*
Potassium (mg)[a]	2262 (443)	3150 (600)	***
Calcium (mg)[a]	739 (247)	895 (228)	***
Magnesium (mg)[a]	213 (47)	315 (77)	***
Iron (mg)[a]	9.8 (3.1)	13.6 (4.4)	***
Zinc (mg)[a]	8.1 (2.0)	10.0 (2.1)	***
Retinol equivalents (μg)[a]	1426 (1938)	1905 (1830)	***
Carotene (μg)[a]	1275 (1030)	3413 (2265)	***
Folate (μg)[a]	188 (43)	284 (66)	***
Vitamin C (mg)[a]	36 (18)	106 (38)	***
Vitamin E (mg)[a]	6.6 (2.3)	10.2 (3.9)	***

[a] Variables transformed before analysis. *** $P < 0.001$; ** $P < 0.01$; * $P < 0.05$; ns=$p < 0.05$ (P measures significance of variance between all quarter groups).

comparison between the four quarter groups showed no significant difference in relation to fruit and vegetable consumption. The mean BMI in all the groups was less than 25 kg/m^2. There were no significant inter-quarter differences in serum haemoglobin or MCV, while mean serum ferritin was higher among women m Q4 only. Observed differences in the mean serum levels of vitamin E (adjusted for serum cholesterol), and the carotenoids, beta-carotene, alpha-carotene, lycopene and cryptoxanthin, were all highly significant and increased in association with increasing fruit and vegetable intake. The urinary excretion of potassium and the ratio of excreted sodium : potassium was significantly associated with increasing fruit and vegetable consumption.

Social and behavioural profile

The socio-economic, demographic and behavioural profile of the low and high consumers of fruits and vegetables is shown in Table 6. Overall, increasing age was positively associated with fruit and vegetable consumption, but this association was particularly marked in the youngest and oldest age-groups. There were more than twice as many adults of the age-group 16–24 y located in Q1 than in Q4. More than twice as many women from the age-group 50–64 y were located in Q4 rather than in Q1. Men and women from Scotland and the north of England were most heavily represented in Q1, although the variation in region only reached statistical significance among women living in Scotland. Greater numbers of consumers who lived in

Table 5 Biomarkers of nutrient for lowest and highest consumers of fruit and vegetables (LERs excluded)

	Q1 (low);mean (s.d.)	*Q4 (high;mean (s.d.)*	*P*
Men	$n = 144-179$[a]	$n = 161-188$[a]	
Serum haemoglobin (g/cm^3)	14.9 (1.1)	14.7 (0.9)	ns
Serum MCV	92.5 (4.0)	91.7 (4.3)	ns
Serum ferritin (μg/l)	100.0 (84.1)	104 (63)	ns
Serum b-carotene (μmol/l)	0.20 (0.15)	0.40 (0.25)	***
Serum a-carotene (μmol/l)	0.05 (0.04)	0.11 (0.09)	***
Serum lycopene (μmol/l)	0.25 (0.20)	0.36 (0.20)	***
Serum cryptoxanthin (μmol/l)	0.11 (0.11)	0.24 (0.15)	***
Serum vitamin E: cholesterol ratio	4.3 (1.0)	5.0 (1.3)	***
Urine Na^+ excretion (mmol/l)[b]	164.4 (79.2)	166.2 (60.9)	ns
Urine K^+ excretion (mmol/l)[b]	67.5 (35.3)	86.7 (33.1)	***
Urine Na^+ / K^+ excretion ration[b]	2.73 (1.28)	2.23 (2.43)	*
Women	$n = 113-116$[a]	$n = 120-145$[a]	
BMI (kg/m^2)	22.8 (4.1)	23.8 (3.8)	ns
Serum haemoglobin (g/cm^3)	13.1 (1.2)	13.2 (1.0)	ns
Serum MCV	90.9 (5.6)	92.2 (5.0)	ns
Serum ferritin (μg/l)	41 (34)	60 (66)	***
Serum b-carotene (μmol/l)	0.27 (0.20)	0.51 (0.29)	***
Serum a-carotene (μmol/l)	0.06 (0.03)	0.15 (0.16)	***
Serum lycopene (μmol/l)	0.25 (0.17)	0.32 (0.17)	**
Serum cryptoxanthin (μmol/l)	0.13 (0.10)	0.30 (0.16)	***
Serum vitamin E: cholesterol ratio	4.21 (1.09)	5.05 (1.06)	***
Urine Na^+ excretion (mmol/l)[b]	122.8 (53.2)	122.3 (52.0)	*
Urine K^+ excretion (mmol/l)[b]	51.5 (20.6)	68.5 (23.1)	***
Urine Na^+ / K^+ excretion ration[b]	2.0 (1.13)	1.86 (0.70)	***

$^{***}P < 0.001$; $^{**}P < 0.01$; $^{*}P < 0.05$; ns = $P > 0.05$. [a]n is variable; *P* measures significance of variation between all quarter groups due to variation in sample number; [b]Subject taking diuretic drugs were excluded.

London and the South-East were represented in Q4 than in any other group. This trend was statistically significant among the women ($P < 0.01$). Classification into a manual social class was negatively associated ($P < 0.001$) with fruit and vegetable consumption, as was being in receipt of benefits. More than 20% of both men and women in Q1 were in receipt of benefits compared with only 7.2% of women and 5.4% of men in Q4. Among the men, being married was significantly associated with increasing fruit and vegetable consumption. Conversely, men who were single or widowed/divorced/separated were significantly over-represented in the quarter groups with lower consumption.

Smoking was very significantly associated with a low consumption of fruits and vegetables. Approximately half of the men and more than 50% of the women in Q1 were smokers. In contrast, the use of food supplements was positively associated with fruit and vegetable consumption among men and women. The consumption of 'home grown' produce during the week of reporting was also very significantly associated with high fruit and vegetable consumption. More than 40% of the men and women in Q4 had consumed 'home grown' produce during the study week.

Discussion

The Adult Nutrition Survey currently constitutes the most comprehensive cross-sectional investigation of eating patterns among adults in Britain, and will remain invaluable as 'baseline' data for comparison with other and subsequent surveys.

Using data generated from the Adult Nutrition Survey, food consumption patterns and their outcomes have been examined by grouping the sample into four groups and analysing the data by socio-economic and behavioural variables. It is believed that this is the first analysis to classify the respondents according to their reported fruit and vegetable consumption.

Reported mean consumption figures for fruit plus vegetables for the total sample were found to be approximately 3 portions/d, but this masks the wide variation found between the highest and lowest consumers. Mean total fruit and vegetable consumption in Q4 was found to be more than 50% higher than the mean consumption of the whole sample. At 3137 g/week for both men and women in Q4, this exceeds the notional weekly intake of 2800 g, which would represent an average daily intake of 400 g (approximately equivalent to 5×80 g portions daily). Therefore these results testify to the feasibility of a population achieving recommended intakes of fruits and vegetables, (for example 'at least five a day'). From this set of data, it was not possible to determine whether the high consumers achieved this level of consumption by eating larger and/or more frequent portions of fruit and vegetables than those with a lower total intake, nor whether this level of intake mirrors habitual consumption.

Increasing consumption of fruit and vegetables was associated with the consumption of other foods with a 'healthy' image, for example wholemeal bread, high-fibre cereals, low-fat dairy products, polyunsaturated and low-fat spreads and non-fried fish, and was negatively associated with some foods which could be said to have a less 'healthy' image, for example fried potatoes, prepared meat products, sugar and confectionery, and refined bread and breakfast cereals. However, the consumption of several other food groups did not significantly alter in relation to increasing fruit and vegetable consumption, for example pasta/rice, eggs, butter, bacon/ham, beef/veal,lamb/pork, poultry, fried white fish, beer/cider and tea/coffee. Additionally, high consumers of fruit and vegetables were also

Table 6 Frequency distribution of socio-demographic and behavioural characterstics of lowest and highest consumers of fruit and vegetables (LERs excluded)

	Q1	*Q4*	*P*
Men			
n	205	204	
Age group, Percentage aged:			
16-24y	29.5	12.4	***
25-34y	21.9	24.0	ns
35-49y	26.7	34.4	ns
50-64y	21.9	29.6	ns
Region, Percentage in:			
Scotland	11.6	6.4	ns
North	30.3	20.0	ns
Midlands/S. West	29.9	36.0	ns
London/S. East	28.3	37.2	ns
Percentage manual social class	70.5	38.4	***
Percentage receiving benefits	20.1	5.4	***
Marital status:			
Percentage married	54.7	78.4	*
Percentage single	36.6	20.1	***
Percentage widowed/divorced/separated	6.9	1.5	*
Percentage smokers	45.9	18.6	***
Percentage taking food supplements	4.4	11.8	***
Percentage ate home grown produce	20.1	40.3	***
Women			
n	157	157	
Age group, Percentage aged:			
16-24y	26.1	12.1	*
25-34y	22.4	22.4	ns
35-49y	34.4	27.6	ns
50-64y	17.2	38.4	***
Region, Percentage in:			
Scotland	13.2	4.0	*
North	32.4	20.4	ns
Midlands/S. West	28.0	30.4	ns
London/S. East	26.0	45.2	**
Percentage manual social class	46.4	15.6	***
Percentage receiving benefits	21.6	7.2	***
Marital status:			
Percentage married	58.8	70.8	ns
Percentage single	24.4	15.0	ns
Percentage widowed/divorced/separated	17.2	13.2	ns
Percentage smokers	55.6	16.0	***
Percentage taking food supplements	10.8	25.6	**
Percentage ate home grown produce	17.2	46.0	***

$^{***}P < 0.001$; $^{**}P < 0.01$; $^{*}P < 0.05$; ns $= P > 0.05$

the highest consumers of biscuits/cakes/puddings and liqueurs/spirits/wines. It may be concluded that an adequate consumption of fruits and vegetables may be achieved without the necessity of completely altering other components of the diet.

Although this analysis is not able to distinguish which components of nutrient intake were associated with the variation in fruit and consumption, those in Q4 had the lowest percentage of total energy as saturated fat, which may have been influenced by the ability of fruit and vegetables to displace other fat-containing foods in the diet. Additionally, a high consumption of fruits and vegetables as in Q4 resulted in high calculated intakes of the micronutrients found in these food, such as carotenes, folates, potassium and vitamin C. Only in the group of Q4 men did the calculated mean intake of potassium exceed the recommended nutrient intake of 3500 mg for adults aged 19–50y (Department of Health, 1991)

The intake of carotene and vitamin C was more than 100% greater in Q4 than in Q1. Only in this quarter group did the intake of vitamin C surpass 80 mg/d, which figure has been suggested may be the requirement for smokers (Department of Health, l991). However, smokers were least likely to be in this group. Although the overall energy intake of those in Q4 was higher than in the other quartile groups, the differences in mean BMI between the groups were not significant and were within the desirable range. Serum levels of the carotenoids, b-carotene, a-carotene, lycopene and cryptoxauthin were highest in Q4 as was the serum vitamin E: cholesterol level. Although the significance of these bio-markers is not fully elucidated, they may exert a beneficial anti-oxidant effect in the body.

In contrast to the levels of fruit and vegetable consumption found in Q4, the mean intake of those in the lowest quarter group of consumption was found to be extremely low, at 738 g/week for men and 630 g/week for women. This represents a daily average consumption of 105 g for men and 90 g for women or a little over 1 portion of 80 g/d. This group had levels of fruit and vegetable consumption lower than the figures obtained when classifying the population by other mean, e.g. men and women in socio-economic groups IV and V had the lowest consumption by social group and were estimated to have a mean intake of 192 g/d (Ministry of Agriculture, Fisheries and Food, 1994).

It may be argued that the low consumption figures in this quarter group (Q1) are due to under-reporting as this group also had the lowest reported energy intake and may be under-reporting energy intake and also fruit and vegetable consumption. Under-reporting is likely to remain a problem despite the exclusion of the most obvious LERs.

There is a strongly positive correlation between increasing levels of reported fruit and vegetable consumption in the quarter groups and the physiological readings in Table 5, such as serum carotenoid levels and urinary potassium excretion, which provides some validation that reported consumption reflects actual consumption. Additionally, the consumers in Q1 had the highest reported intakes of white bread/refined cereals, high-fat dairy products, prepared meat products, fried potatoes and sugar/confectionery, which is suggestive of particular patterns of food choice rather than under-reporting of all foods.

The mean intake of folate among the women in Q1 was found to be below the Reference Nutrient Intake (RNI) of 200 mg (for women aged 19–50y). This is of particular concern as this group also has the highest proportion of women in the 16–34y age group and thus the greatest number who would be liable to benefit from a high intake of dietary folate in the event of pregnancy, prior to or in the absence of folic acid supplementation. The mean vitamin C consumption of the women in Q1 was below the RNI of 40 mg.

Attention has previously been drawn to the fact that lower consumption of fruit and vegetables is more prevalent among the young, those in less affluent social classes, those on benefits, and smokers. (Gregory *et al,* 1990; Margetts these men are more likely to have a low consumption of fruits and vegetables than their married counterparts.

From this study it may be seen that increasing total fruit and vegetable consumption appears to be characterized by a greater increase in fruit and fruit juice consumption than in vegetable consumption. Thus, although fruit/fruit juice consumption represents just over 20% of the whole among the low consumers, approximately half of the total intake of the high consumers is fruit/fruit juice. Household consumption figures also indicate that fruit, especially fruit

juice consumption, is rising at a faster rate than vegetable consumption. Fruit and fruit juices may be perceived as more palatable and/or convenient than vegetables, although generally vegetables provide a wider range of nutrients. Currently there is insufficient evidence to determine which components of fruit/vegetables are most valuable in protecting health and whether there may be an optimum combination of fruit and vegetables. Current public health advice is to consume at least five different fruits and vegetables a day.

A positive trend to emerge from this analysis was that more than 40% of the consumers in Q4 had consumed 'home grown' produce during the week of reporting. It may be envisaged that much of this 'produce' would be fruit and/or vegetables. It may be expected that promoting the production of home grown produce would be one antidote to the problems of availability and affordability which are often cited as barriers to increased fruit and vegetable consumption.

In conclusion, this analysis draws attention to the considerable variation in the quantities of fruit and vegetables consumed by British adults, differences which are not apparent from population mean intake figures. The high consumers merit further investigation to elucidate practical strategies for increasing consumption among lower consumers and also to examine actual and perceived benefits of this level of fruit and vegetable consumption. It may be productive to examine whether there are differences between high consumers of fruit compared with high consumers of vegetables.

Strategies for increasing fruit and vegetable consumption may be targetted most beneficially at groups with the greatest numbers of low consumers. From this analysis, these appear more likely to be young adults, those with manual occupations, those in receipt of benefits, single men, and smokers. If low consumers are merely eating the quantities indicated above, there still remains much challenge in the task of promoting increased consumption of fruit and vegetables.

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