

The importance of composite foods for estimates of vegetable and fruit intakes

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Abstract

Objective: To evaluate the contribution of composite foods to vegetable and fruit intakes in Irish adults and to compliance with dietary guidelines for vegetable and fruit intake.

Design: Data were analysed from the North/South Ireland Food Consumption Survey of 18–64-year-old adults ($n = 1379$; 662 men, 717 women), which used a 7-day food diary to estimate food intake.

Results: The mean intake of vegetables (excluding potatoes) was 140 g day^{-1} (men 149 g day^{-1} ; women 132 g day^{-1}), of fruit was 136 g day^{-1} (men 133 g day^{-1} ; women 140 g day^{-1}) and of potatoes was 227 g day^{-1} (men 296 g day^{-1} ; women 163 g day^{-1}). The mean daily intakes of vegetables, fruit and potatoes from composite foods were 37 g (26%), 6 g (5%) and 17 g (7%), respectively. The mean intake of vegetables from composite foods was unrelated to age or gender, but increased with increasing social class and level of education attained. The proportions of men and women meeting the recommendation for $\geq 400 \text{ g day}^{-1}$ (5 servings of 80 g per day) of vegetables and fruit were 21% (15% excluding composite foods) and 19% (12% excluding composite foods), respectively. Compliance with the dietary recommendation decreased with decreasing levels of educational attainment and social class.

Conclusion: Intakes of vegetables and fruit are low compared with current dietary recommendations, particularly in those of lower levels of educational attainment and social class. Composite foods are an important source of vegetables (less importantly of fruit) and should be included when estimating vegetable intakes. Failure to do so may result in bias in estimates of intake and of compliance with dietary guidelines for population groups, as well as misclassification of individuals by level of intake.

Keywords
Vegetable intakes
Fruit intakes
Potato intakes
Adults
Composite foods
Dietary recommendations
North/South Ireland
Food Consumption Survey
Methodology

Substantial epidemiological evidence exists to support the hypothesis that vegetables and fruit are protective in the aetiology of cancer^{1–5}, coronary heart disease^{6–9} and other chronic diseases including stroke^{10,11}, diabetes¹² and osteoporosis^{13,14}. The most consistent evidence for a protective effect for vegetables and fruit against cancer has been reported for cancer of the lung, stomach and oesophagus, with less consistent but strong evidence for cancer of the oral cavity, pharynx, colon, breast, pancreas and bladder¹⁵. Raw/fresh vegetables and fruit show the strongest evidence for this protective effect, as 85% of studies have shown positive results¹⁶. Cooked vegetables and fruit have also been shown to be protective, although the body of evidence is less consistent¹⁵.

Recommendations for vegetable and fruit intakes have been made by many authorities based on epidemiological evidence showing that higher reported intakes of vegetables and fruit are inversely associated with rates of disease and death^{1,2,17–19}.

Intakes of vegetables and fruit have been estimated in many European countries from dietary intake survey data^{20–22}. However, the majority of studies report intakes of vegetables and fruit consumed as discrete portions only, and do not disaggregate vegetables and fruit eaten in composite foods. The importance of disaggregating composite foods in order to estimate intakes of individual foods accurately has been highlighted^{23–25}. The estimation of total vegetable and fruit intakes requires detailed information on intakes of individual foods as well as recipe information for composite foods and dishes. Data of this type have been collected in the North/South Ireland Food Consumption Survey²⁶, which established a database of habitual food and drink consumption in a representative sample of Irish adults, aged 18–64 years.

The objective of the present paper was to evaluate the contribution of composite foods to vegetable and fruit intakes in Irish adults and to compliance with dietary guidelines for vegetable and fruit intake.

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Methods

Estimation of food and nutrient intakes

In the North/South Ireland Food Consumption Survey²⁶, food intake data were collected in a randomly selected representative sample of 18–64-year-old adults ($n = 1379$; 662 men and 717 women) from the Republic of Ireland and Northern Ireland. Pregnant and lactating women were excluded²⁷.

A 7-day food diary was used to record food intake data. Respondents recorded each item of food and drink consumed on a separate line and each eating occasion was filled in on a separate page. A variety of different methods were used to quantify food intake²⁸. For quantifying fruit and vegetables consumed, a hierarchical approach was used as follows:

- a photographic food atlas²⁹ containing 70 sets of photographs depicting portion sizes of foods, developed specifically for the survey (used to quantify discrete portions of fruit and vegetables and portions of composite foods);
- a database of average weights of selected foods (e.g. fruits and vegetables obtained in supermarkets, portions of salads, takeaway food portions) compiled during the survey;
- serving sizes obtained from manufacturers' food labels; and
- food portion sizes estimated by the Ministry of Agriculture, Fisheries and Food (MAFF)³⁰.

The food diaries were analysed using WISP[®] (Tinuviel Software, Warrington, UK), which uses the food nutrient database in *McCance & Widdowson's The Composition of Foods*, fifth edition³¹ and supplemental volumes^{32–40}, along with additional data (manufacturers' data, data on nutritional supplements, data on new products and recipe data) to determine nutrient intakes. All database working files were exported to SPSS[®] for Windows[™] version 10.0 (SPSS Inc., Chicago, IL, USA) for analysis. A detailed account of the methodologies used in the survey is available²⁸.

Estimation of vegetable and fruit intakes

The working file used for this current analysis was derived directly from the food diary and contained a line of data for every line of information entered into the diary. Therefore, each food was listed as consumed along with its descriptors and nutrient content. A total of 3060 different food codes were recorded as having been consumed in the survey. Food codes were identified for vegetables and fruit consumed as discrete portions and as composite foods containing vegetables and fruit. The following vegetables and fruit were recorded: potatoes, peas, baked beans, other beans (including pinto beans, kidney beans, black-eye beans), lentils, carrots, lettuce, cucumber, asparagus, green beans,

spinach, broccoli, Brussels sprouts, cabbage, broad beans, tomatoes, cauliflower, courgette, mushrooms, onions, peppers, parsnip, turnip, celery and leeks; and fruit juice, orange juice, bananas, oranges, other citrus fruit (including lemons, limes, mandarins), apples, pears, dried fruit (including currants, sultanas, raisins, dried apricots) and other fruit (including fruit salad, berries and melon).

For estimating vegetable and fruit intakes from composite foods, recipes and manufactured foods consumed in the survey were reviewed. Five hundred and fifty-eight recipes and 96 manufactured foods were identified as containing one or more vegetables. In addition, 118 recipes and 27 manufactured products were identified as containing one or more fruits. The contents of individual vegetables and fruits in each recipe were estimated from the recipe database compiled from information collected during the survey as well as recipe details from *McCance & Widdowson's The Composition of Foods*, fifth edition³¹ and supplemental volumes^{32–40}. Information obtained from manufacturers was used to estimate the contents of individual vegetables and fruits in manufactured food products. When manufacturers' information was not available, a recipe was used from *McCance & Widdowson*³¹ and supplemental volumes^{32–40}, the survey recipe database or popular cookery books. Vegetables and fruit in dry sauces and soups and tomato ketchup were excluded from the calculations.

The recipe and manufacturers' information detailing the contents of vegetables and fruit in composite foods was used to restructure the working SPSS file, to create three variables for each vegetable and fruit consumed: (1) weight consumed as a discrete portion, (2) weight consumed from composite foods and (3) total weight consumed (discrete portion plus composite foods). These variables were then aggregated to create total intake for categories of vegetables and fruit. This allowed estimates of vegetable and fruit intakes and compliance with dietary guidelines for vegetables and fruit to be calculated including and excluding vegetables and fruit from composite foods. Cut-off values were established separately, both including and excluding composite foods, which divided individuals into thirds of intake for vegetables, fruit, and total vegetables and fruit. The effect of excluding composite foods from estimates of intake on the classification of individuals into thirds was determined.

The impact of misreporting on estimates of vegetable and fruit intake was assessed in the current analysis by using Goldberg's cut-off of energy intake over basal metabolic rate (EI/BMR) of < 1.05 ⁴¹.

The mean daily intake (g day^{-1} and g per 10 MJ food energy per day) of each vegetable/fruit group, total vegetables (excluding potatoes) and total fruit was determined for men and women by age. The mean contribution of composite foods to vegetable and fruit intakes was estimated in g day^{-1} and as mean percentage of the total, for men and women by age and also for those

in different categories of social class, education level attained and smoking behaviour. The average serving sizes were estimated for vegetables and fruit consumed as discrete portions and from composite foods, for men and women.

Estimation of the contribution of vegetables and fruit to nutrient intakes

The mean daily intake of individual nutrients was determined for each subject from each vegetable and fruit group, consumed as discrete portions and as components of dishes and manufactured foods. For each nutrient the percentage contribution of each vegetable and fruit group to the total intake of that nutrient was estimated. All recipes accounted for nutrient losses in cooking according to guidelines from McCance & Widdowson³¹ and supplemental volumes^{32–40}.

Statistical analysis

Differences in mean vegetable and fruit intakes between men and women were assessed using parametric independent *t*-tests and between age groups using a parametric one-way analysis of variance (ANOVA) (using Scheffe's *post-hoc* test). Values of $P < 0.01$ were taken as statistically significant. Differences in the percentage of consumers of vegetables and fruit between men and women were assessed using Cramers' V chi-squared test. Differences in the mean contribution (g) and (%) were assessed with a one-way ANOVA using the *post-hoc* Scheffe test for values complying with Levene's homogeneity of variance ($P > 0.05$) and the Games–Howell *post-hoc* test for those that did not comply with Levene's test ($P < 0.05$). Differences in the percentage of individuals meeting current recommendations for vegetable and fruit intake were assessed using Cramers' V chi-squared analysis. Values of P for statistical significance and the test used are indicated in each table.

Results

Intake of vegetables (excluding potatoes)

All subjects consumed vegetables at least once during the 7-day period of recording (Table 1). Apart from potatoes, the most commonly consumed vegetables were onions, carrots, tomatoes and peas. The vegetable foods eaten in the largest quantities in both men and women were tomatoes and carrots (Table 1). Significantly fewer men than women consumed salad vegetables, broccoli, tomatoes and peppers, and significantly more men than women consumed beans (Table 1).

The mean daily total vegetable intake for the total population was 140 g day^{-1} ($170 \text{ g per } 10 \text{ MJ food energy per day}$) and intakes were significantly higher ($P < 0.001$) in men (149 g day^{-1}) than in women (132 g day^{-1}) (Table 1). When adjusted for energy, mean intakes were significantly higher ($P < 0.001$) in women ($188 \text{ g per } 10 \text{ MJ}$

food energy per day) than in men ($150 \text{ g per } 10 \text{ MJ food energy per day}$). The 18–35 year age group had the lowest intakes of total vegetables, particularly green vegetables and peas, and the highest intakes of baked beans (Table 2). The percentage of consumers of green vegetables (broccoli and cabbage) and cauliflower increased significantly ($P < 0.001$) with age.

Potato intake

Most potatoes were consumed as mashed, boiled or baked potatoes, and chipped, fried and roasted potatoes were also consumed in substantial quantities. The mean daily intake of total potatoes was significantly higher ($P < 0.001$) in men than in women even when intakes were adjusted for food energy (Table 1).

Total potato consumption increased significantly ($P < 0.01$) with age. Mashed, boiled and baked potatoes were consumed in the highest quantities in the 51–64 year age group, while chipped, fried and roasted potatoes were consumed in the highest quantities in the 18–35 year age group (Table 2). The number of consumers of chipped, fried and roasted potatoes decreased significantly ($P < 0.001$) with age (Table 2).

Fruit intake

Ninety per cent (88% of men, 92% of women) of the population consumed fruit. The fruits consumed most commonly and those consumed in the largest quantities were apples, bananas and orange juice (Table 3). The mean daily intake of fruit in the population was 136 g day^{-1} ($165 \text{ g per } 10 \text{ MJ food energy per day}$) (men, 133 g day^{-1} ($135 \text{ g per } 10 \text{ MJ food energy per day}$); women, 140 g day^{-1} ($193 \text{ g per } 10 \text{ MJ food energy per day}$)) (Table 3). Mean daily total fruit intake (g day^{-1}) was not significantly different between men and women; however, when adjusted for energy, mean intakes ($\text{g per } 10 \text{ MJ food energy per day}$) were significantly higher ($P < 0.01$) in women than men (Table 3).

Mean daily fruit consumption was lowest in the 18–35 year age group in both men (113 g day^{-1}) and women (115 g day^{-1}), and fruit intake increased with age in women. Mean daily intakes of bananas and 'other fruits' (including apples, pears and dried fruit) increased significantly ($P < 0.01$) with age (Table 4). Differences between age groups in mean intakes of total fruit (g day^{-1}) were not significant but increased significantly ($P < 0.01$) with increasing age when adjusted for food energy (Table 4).

Contribution of composite foods to vegetable and fruit intake

Table 5 shows the contribution of composite foods to the total intake of vegetables and fruit for men and women by age.

The mean intake of vegetables from composite foods was 37 g day^{-1} , which represents 26% of total vegetable

Table 1 Mean daily intake of vegetables in Irish men and women aged 18–64 years

	Men (n = 662)				Women (n = 717)				Total (n = 1379)			
	† % Consumers	Mean (g day ⁻¹)	SD	Mean (g/10MJ food energy/day)	† % Consumers	Mean (g day ⁻¹)	SD	Mean (g/10MJ food energy/day)	† % Consumers	Mean (g day ⁻¹)	SD	Mean (g/10MJ food energy/day)
Peas, beans & lentils	*	30.9 ^a	33	31.5 ^a	78	17.1	19	24.2	82	23.8	27	27.7
Peas		13.6 ^a	19	13.3	64	8.1	10	11.4	65	10.7	15	12.3
Baked beans	*	16.4 ^a	26	17.1 ^a	37	8.2	14	11.7	41	12.1	21	14.3
Green vegetables	*	15.8	20	16.1 ^b	72	13.9	16	20.2	70	14.8	18	18.3
Broccoli		5.1	10	5.3 ^a	43	5.3	9	7.7	39	5.2	9	6.6
Cabbage		7.0	16	6.7	37	5.5	10	8.0	37	6.2	13	7.4
Green beans		1.6	5	1.7	13	1.3	4	1.8	13	1.4	5	1.7
Carrots	**	20.2	25	19.8 ^a	84	17.3	18	24.7	82	18.7	22	22.3
Salad vegetables	**	4.2 ^a	8	4.3 ^a	68	6.5	11	9.4	61	5.4	10	6.9
Lettuce	**	3.4 ^a	6	3.4 ^a	66	4.6	8	6.6	59	4.0	7	5.1
Tomatoes	**	26.3 ^b	29	26.7 ^a	89	29.5	28	41.7	85	27.9	29	34.5
Other vegetables		51.3	40	52.0 ^a	99	47.9	36	67.2	98	49.6	38	59.9
Mushrooms		5.8	11	5.8	51	4.9	8	6.9	50	5.3	10	6.4
Onions		14.6 ^b	15	14.3 ^b	88	12.1	12	16.6	88	13.3	13	15.5
Peppers	*	4.1 ^b	11	4.3 ^b	44	4.3	8	6.3	40	4.2	10	5.3
Cauliflower		3.5	8	3.6	27	3.1	7	4.6	25	3.3	8	4.1
Total vegetables (excluding potatoes)	100	148.7^a	78	150.3^a	100	132.3	68	187.5	100	140.2	73	169.7
Total potatoes	100	296.0 ^a	198	285.7 ^a	99	162.5	110	223.5	99	226.6	172	253.4
Potatoes (e.g. mashed, boiled, baked)	95	210.6 ^a	200	203.2 ^a	95	109.7	87	152.9	95	158.1	165	177.1
Processed and home-made products	50	11.2	23	10.8	49	9.2	0	12.5	49	10.1	21	11.7
Chipped, fried and roasted potatoes	85	75.1 ^a	70	72.5 ^a	80	44.3	34	59.2	83	59.1	60	65.6
Total vegetables (including potatoes)	100	444.8^a	221	436.1	100	294.8	128	411.0	100	366.8	194	423.1

SD – standard deviation.

^a Significant difference between men and women, $P < 0.001$ (*t*-test).^b Significant difference between men and women, $P < 0.01$ (*t*-test).† Significant differences between men and women: *, $P < 0.01$; **, $P < 0.001$ (Cramers' V chi-square test).

Table 2 Mean daily intake of vegetables in Irish adults, by age group

	18–35 years (n = 522)				36–50 years (n = 522)				51–64 years (n = 335)			
	† % Consumers	Mean (g day ⁻¹)	SD	Mean (g/10MJ food energy/day)	% Consumers	Mean (g day ⁻¹)	SD	Mean (g/10MJ food energy/day)	% Consumers	Mean (g day ⁻¹)	SD	Mean (g/10MJ food energy/day)
Peas, beans & lentils	81	26.4	30	29.8	81	21.7	25	25.3	83	22.8	27	28.2
Peas	*	10.8	16	12.2	66	10.3	15	11.7	72	11.4	16	13.6
Baked beans		14.8 ^a	24	16.7	39	10.3 ^b	18	12.2	38	10.9 ^{abc}	21	13.9
Green vegetables	**	10.2 ^a	14	11.9	76	16.8 ^{ab}	18	21.3	78	18.7 ^{bc}	23	23.5
Broccoli	**	3.8 ^a	8	4.5 ^a	44	6.1 ^b	10	7.9 ^b	45	6.1 ^{bc}	10	7.8 ^{bc}
Cabbage	**	3.8 ^a	8	4.2 ^a	37	6.6 ^b	12	7.9 ^b	48	9.2 ^{bc}	20	11.4 ^{bc}
Green beans		1.2	4	1.4	14	1.7	6	2.1	12	1.4	5	1.6
Carrots	80	15.5 ^a	24	17.4 ^a	84	20.5 ^b	20	23.9	84	21.1 ^{bc}	20	27.5 ^{bc}
Salad vegetables	61	5.1	8	6.5	62	5.8	9	7.2	58	5.4	12	7.3
Lettuce	59	3.8	6	4.8	61	4.3	7	5.1	57	4.1	10	5.4
Tomatoes	84	24.5 ^a	26	30.1 ^a	87	30.5 ^b	30	37.0 ^b	84	29.4 ^{abc}	30	37.7 ^{abc}
Other vegetables	98	46.3	38	55.4	98	52.3	39	63.1	98	50.4	37	61.8
Mushrooms	50	5.0	8	5.8	52	5.6	10	6.8	45	5.4	12	6.8
Onions	89	12.4	12	14.3	88	13.3	12	15.5	87	14.7	16	17.6
Peppers	*	4.1 ^a	7	5.0	41	5.2 ^{ab}	13	6.6	32	2.8 ^{ac}	6	3.9
Cauliflower	**	2.1 ^a	6	2.5 ^a	29	4.1 ^b	9	5.1	31	4.0 ^{bc}	8	5.0 ^{bc}
Total vegetables (excluding potatoes)	100	128.0^a	69	151.1^a	100	147.6^b	75	177.9^{ab}	100	147.8^{bc}	75	185.8^{bc}
Total potatoes	100	217.7 ^a	163	239.3 ^{ab}	99	220.1 ^a	168	241.6	99	250.5 ^{bc}	187	293.7
Potatoes (e.g. mashed, boiled, baked)	*	130.5 ^a	150	143.7	95	157.2 ^{ab}	161	171.2	97	202.5 ^{bc}	184	238.2
Processed and home-made products	50	9.0	17	10.5	50	11.1	22	12.6	47	10.3	24	12.0
Chipped, fried and roasted potatoes	**	78.7 ^a	69	85.7 ^a	84	52.6 ^{ab}	51	58.9 ^b	69	38.7 ^{bc}	49	44.7 ^c
Total vegetables (including potatoes)	100	345.7^a	184	390.4^a	100	367.7^b	192	419.5^{ab}	100	398.4^{bc}	206	479.5^c

SD – standard deviation.

ab*Significant differences between age groups, $P < 0.01$ (ANOVA).†Significant differences in percentage consumers between men and women: *, $P < 0.01$; **, $P < 0.001$ (Cramers' V chi-square test).

Table 3 Mean daily intake of fruit in Irish men and women aged 18–64 years

†	Men (n = 662)			Women (n = 717)			Total (n = 1379)					
	% Consumers	Mean (g day ⁻¹)	SD	Mean (g/10MJ food energy/day)	% Consumers	Mean (g day ⁻¹)	SD	Mean (g/10MJ food energy/day)	% Consumers	Mean (g day ⁻¹)	SD	Mean (g/10MJ food energy/day)
Fruit juices	41	33.1	65	32.9 ^a	48	33.8	55	46.7	45	33.5	60	40.1
Orange juice	35	29.3	55	28.9 ^b	40	28.6	51	39.6	37	28.9	53	34.5
Citrus fruit	34	22.9	55	25.6	41	23.4	47	32.4	38	23.2	51	29.1
Oranges	28	20.3	50	22.5	34	20.8	45	28.8	31	20.5	48	25.7
Bananas	44	27.9	51	26.9 ^a	55	26.6	37	36.9	49	27.2	44	32.1
Apples	62	29.5	44	30.1 ^a	66	32.7	47	45.5	64	31.2	46	38.1
Other fruit	50	19.4	41	19.4 ^a	62	31.8	61	31.8	56	25.8	53	25.8
Pears	13	5.6	20	5.7	17	6.2	19	8.7	15	5.9	20	7.2
Dried fruit	18	1.7	6	1.6	12	1.4	5	1.8	21	1.5	5	1.7
Total fruit	88	132.8	148	134.9^a	92	139.6	136	193.1	90	136.3	142	165.2

SD – standard deviation.

^a Significant difference between men and women, $P < 0.001$ (t-test).

^b Significant difference between men and women, $P < 0.01$ (t-test).

† Significant differences between men and women: *, $P < 0.01$; **, $P < 0.001$ (Cramers' V chi-square test).

Table 4 Mean daily intake of fruit in Irish adults, by age group

†	18–35 years (n = 522)			36–50 years (n = 522)			51–64 years (n = 335)					
	% Consumers	Mean (g day ⁻¹)	SD	Mean (g/10MJ food energy/day)	% Consumers	Mean (g day ⁻¹)	SD	Mean (g/10MJ food energy/day)	% Consumers	Mean (g day ⁻¹)	SD	Mean (g/10MJ food energy/day)
Fruit juices	46	34.4	57	40.1	44	34.0	65	40.7	43	31.1	55	39.2
Orange juice	40	31.2	54	36.1	36	28.1	54	33.4	35	27.0	49	33.7
Citrus fruit	34	18.7	43	23.7	38	25.4	56	32.5	42	26.8	54	32.3
Oranges	28	17.3	43	22.0	33	23.2	52	29.2	34	21.6	48	26.2
Bananas	43	22.9	42	25.8 ^a	55	29.1	43	34.4 ^{ab}	50	31.1	49	38.4 ^{bc}
Apples	55	25.1	41	30.0 ^a	68	33.1	47	39.5 ^{ab}	71	37.5	49	48.5 ^{bc}
Other fruit	45	15.9	38	15.9 ^a	62	29.1	56	29.1 ^{ab}	65	36.3	64	36.3 ^{bc}
Pears	11	3.9	16	4.3 ^a	17	6.1	18	7.6 ^{ab}	19	8.8	26	11.4 ^{bc}
Dried fruit	15	0.9	3	1.0 ^a	21	1.6	5	1.8 ^{ab}	29	2.4	7	2.6 ^{bc}
Total fruit	87	114.4	120	135.3^a	92	145.8	150	176.2^b	91	155.7	156	194.5^{bc}

SD – standard deviation.

^{ab} Significant differences between age groups, $P < 0.01$ (ANOVA).

† Significant differences in percentage consumers between men and women: *, $P < 0.01$; **, $P < 0.001$ (Cramers' V chi-square test).

Table 5 Mean intake and mean contribution of composite foods (CF) to total mean intakes of vegetable and fruit in Irish men and women, by age group

	Men								Women							
	Mean intake of CF (g day ⁻¹)				Mean contribution from CF (%)				Mean intake of CF (g day ⁻¹)				Mean contribution from CF (%)			
	18–35 years	36–50 years	51–64 years	18–35 years	36–50 years	51–64 years	18–35 years	36–50 years	51–64 years	18–35 years	36–50 years	51–64 years	18–35 years	36–50 years	51–64 years	
Peas, beans & lentils	1.0	1.6	1.0	7.9	9.9	7.4	1.1	1.3	0.8	12.1	11.4	8.2	11.3	11.6	8.0	
Green vegetables	0.6	1.1	1.1	8.4	6.7	6.6	0.8	1.0	0.8	11.3	11.6	8.0	30.4	23.6	27.0	
Carrots	3.1	4.8	3.8	24.2	25.3	19.4	3.3	3.7	5.1	5.5	3.3	4.5	31.6 ^a	19.6 ^b	14.8 ^{bc}	
Salad vegetables	0.4	0.2	0.0	4.5	1.8	0.7	0.3	0.5	1.0	5.5	3.3	4.5	56.8 ^a	46.7 ^b	39.8 ^{bc}	
Tomatoes	6.7	5.4	4.7	32.2 ^a	22.7 ^{ab}	12.9 ^c	8.3	6.5	4.3	31.6 ^a	19.6 ^b	14.8 ^{bc}	41.5 ^a	34.0 ^{ab}	27.1 ^{bc}	
Other vegetables	24.0	25.7	24.6	55.0 ^a	50.3 ^{ab}	40.8 ^c	25.8	24.5	18.4	56.8 ^a	46.7 ^b	39.8 ^{bc}	53.9 ^a	52.6 ^{ab}	40.8 ^c	
Mushrooms	4.8	6.3	6.4	33.9	35.3	27.6	5.1	5.0	4.3	41.5 ^a	34.0 ^{ab}	27.1 ^{bc}	33.5	28.4	25.3	
Onions	13.3	14.9	16.0	54.0	53.2	48.3	11.5	11.9	13.2	53.9 ^a	52.6 ^{ab}	40.8 ^c	32.7 ^a	26.3 ^b	21.1 ^{bc}	
Peppers	3.5	5.7	2.7	29.9	28.8	21.4	4.5	4.8	2.9	33.5	28.4	25.3	39.7	37.5	30.5	
Total vegetables (excluding potatoes)	35.7	38.8	35.2	27.6^a	25.8^{ab}	21.3^{bc}	39.7	37.5	30.5	32.7^a	26.3^b	21.1^{bc}	11.0	9.7	10.6	
Potatoes	16.0	22.3	18.9	8.2	8.5	6.7	12.7	14.2	17.9	11.0	9.7	10.6	11.0	9.7	10.6	
Fruit juice	0.2	0.3	0.1	2.9	5.2	5.4	0.1	0.3	0.1	4.1	2.9	3.1	3.5	4.9	4.1	
Citrus fruit	0.4	0.8	0.2	4.0	4.9	6.2	0.4	0.5	0.5	2.0	0.3	0.1	2.0	0.3	0.1	
Bananas	0.1	0.3	0.7	0.5	2.1	1.6	0.2	0.1	1.6	14.4	20.6	22.0	14.4	20.6	22.0	
Apples	2.5	4.7	4.6	18.1	24.5	24.5	1.8	3.8	3.6	15.2	17.3	16.0	15.2	17.3	16.0	
Other fruit	1.4	2.0	3.1	14.8	16.6	21.8	1.4	1.8	1.6	8.3	10.0	11.2	8.3	10.0	11.2	
Total fruit	4.4^a	8.1^b	8.8^{bc}	12.1	16.2	12.4	3.9^a	6.5^{ab}	5.8^{abc}	8.3	10.0	11.2	8.3	10.0	11.2	

^{ab}Significant differences between age groups, $P < 0.01$ (ANOVA).

(excluding potatoes) consumption in the population. When adjusted for differences in energy intakes, mean intake of vegetables from composite foods was 44 g per 10 MJ food energy per day, and was significantly lower in men (37 g per 10 MJ food energy per day) than in women (50 g per 10 MJ food energy per day). The average contribution of composite foods to total vegetable intake in individuals was 26% (25% in men and 27% in women). The largest contributions made by composite food items to individual vegetable categories were in carrots, tomatoes and the 'other vegetables' category, which includes mushrooms, onions and peppers. Over 60% of all mushrooms, onions and peppers were consumed as part of a composite food (Table 5). The contribution of composite foods to total vegetable intake (g day^{-1}) was similar across the age groups for men and women and decreased with age in both men and women for most vegetable categories.

For potatoes, the mean intake from composite foods was 17 g day^{-1} , which represents 7% of total potato consumption in the population, with an average contribution of composite foods to total potato intake in individuals of 9% (8% in men and 10% in women). Men and women aged 18–35 years reported the largest contribution of composite foods to mean potato intakes (Table 5).

When adjusted for differences in energy intakes, mean intake of potatoes from composite foods was 19 g per 10 MJ food energy per day (men, 18 g per 10 MJ food

energy per day; women, 19 g per 10 MJ food energy per day).

The mean intake of fruit from composite foods was 6 g or 5% of total fruit consumption in the population. When adjusted for differences in energy intakes, mean intake of fruit was 7 g per 10 MJ food energy per day (men, 6 g per 10 MJ food energy per day; women, 7 g per 10 MJ food energy per day). The average contribution of composite foods to total fruit intake in individuals was 12% (14% in men and 10% in women). The contribution of composite foods to total fruit intake (g day^{-1}) was significantly different ($P < 0.01$) across the age groups for men and women (Table 5).

For mean daily intakes of vegetables (excluding potatoes), the 5th percentile (P5) and 95th percentile (P95) from composite foods were 0 and 106 g, respectively; for fruit, P5 and P95 from composite foods were 0 and 27 g, respectively; and for potatoes, P5 and P95 from composite foods were 0 and 257 g, respectively.

Mean intakes (g day^{-1}) of vegetables from composite foods were not significantly different for men and women in different age groups. Professional, managerial and technical workers consumed more vegetables in composite foods than semi-skilled and unskilled workers. Individuals educated to tertiary level also consumed significantly more vegetables as a component of composite foods than those educated to primary and secondary level (Table 6).

Table 6 Mean intake of vegetables, fruit, and total vegetables and fruit from composite foods (CF) in Irish men and women in different age groups and for different categories of social class, education level attained and smoking habits

	Mean intake from CF (g day^{-1})		
	Total vegetables	Total fruit	Total vegetables and fruit
Men			
18–35 years	35.7	4.5 ^a	40.2
36–50 years	38.8	8.1 ^b	47.0
51–64 years	35.2	8.7 ^{bc}	43.9
Total	36.7	6.9	43.6
Women			
18–35 years	39.7	3.9 ^a	43.6
36–50 years	37.5	6.5 ^b	43.9
51–64 years	30.5	5.8 ^{abc}	36.3
Total	36.7	5.4	42.1
Social class			
Professional, managerial & technical	41.9 ^a	7.3	49.2 ^a
Non-manual & skilled manual	37.3 ^{ab}	5.3	42.6 ^{ab}
Semi-skilled & unskilled manual	31.8 ^{bc}	5.4	37.3 ^{bc}
Unskilled	30.8 ^{bcd}	4.8	35.6 ^{bcd}
Education level attained			
Primary	26.2 ^a	5.7	31.9 ^a
Intermediate	30.2 ^{ab}	5.4	35.6 ^{ab}
Secondary	38.1 ^{bc}	7.0	45.2 ^{bc}
Tertiary	45.9 ^{cd}	6.3	52.2 ^{cd}
Smoking habits			
Current smoker	34.5	5.2	39.7
Ex-smoker	39.2	6.9	46.1
Non-smoker	37.3	6.2	43.5

^{abcd}Significant differences in mean intakes across categories, $P < 0.01$ (ANOVA). No significant differences between men and women.

Fruit intake from composite foods was lowest in men and women aged 18–35 years (Table 6). Intakes of fruit from composite foods were not significantly different between categories of social class and education level attained or in those with different smoking habits (Table 6).

Estimation of average serving size

Mean serving size of vegetables and fruit consumed as discrete portions was significantly higher ($P < 0.001$) in men than women (Table 7). Average serving sizes of vegetables and fruit consumed as a component of a composite food were not significantly different. However, the high P95 for vegetables indicates that some individuals consume quite large amounts of vegetables from composite foods (Table 7).

Misclassification into thirds of mean intake

Figures 1–3 show the impact of excluding composite foods from estimates of intake on the classification of individuals into thirds of intake for vegetables, fruit, and total vegetables and fruit combined.

Excluding composite foods from estimates of mean vegetable intakes resulted in misclassification across all three tertiles of intake, with the lowest and the highest tertile of intake being misclassified by between 23 and 26% (Fig. 1). Excluding composite foods from estimates of mean fruit intakes misclassified 27% of men and 14% of women as non-consumers, while 18% of men and 9%

of women low consumers were misclassified into the second third of intake and 9% of men and 4% of women were misclassified as high consumers (Fig. 2). Classification of individuals based on estimates of total vegetable and fruit intake resulted in misclassification of low and high consumers by between 8 and 10% (Fig. 3).

Compliance with dietary recommendations for vegetables and fruit

Table 8 reports the effect of excluding composite foods on estimates of the percentage of different population groups achieving current dietary recommendations for vegetable and fruit intake. Approximately 21% of men (15% excluding composite foods) and ~19% (13% excluding composite foods) of women achieved current dietary recommendations for vegetable and fruit intakes of $\geq 400 \text{ g day}^{-1}$ (5 or more servings of 80 g each) (Table 8).

Recommendations from the US Department of Agriculture of 3 servings of vegetables a day were achieved by 10% (4.5% excluding composite foods) of men and ~6% (2% excluding composite foods) of women, while recommendations for 2 servings of fruit a day were achieved by 31% (30% excluding composite foods) of men and ~33% (31% excluding composite foods) of women (Table 8).

The percentage of individuals achieving dietary recommendations for fruit and vegetables increased with increasing social class and increasing level of education (Table 8). Current smokers had the lowest level of compliance with current dietary recommendations for vegetable and fruit intake (Table 8). When composite foods were excluded the trends remained the same.

Contribution of vegetables and fruit to nutrients

The contribution of vegetables to nutrient intakes was similar for men and women. Vegetables (excluding potatoes) contributed $< 3\%$ to total energy intake but contributed ~17% to dietary fibre (Southgate), 63% of carotene, 32% of total vitamin A, 13% of vitamin E and 11% of folate (Table 9).

Peas, beans and lentils made the largest contribution to dietary fibre intakes (40% of the dietary fibre from vegetables) for both men and women. Carrots were the main contributor of carotene while 40% of the vitamin C from vegetables came from 'other vegetables' (including mushrooms, peppers and onions).

The contribution of potatoes to all nutrients was slightly higher in men than in women owing to the higher quantities of potatoes consumed by men. Potatoes contributed ~12% of total energy intakes and made a significant contribution to the mean daily intakes of total carbohydrate, starch, dietary fibre (Southgate), potassium, copper, magnesium, iron, vitamins C, E and B₆, folate, thiamin and pantothenate (Table 9).

Mashed, boiled and baked potatoes were the main contributors to vitamin C, total folate and fibre from total

Table 7 Mean serving size of vegetables and fruit consumed as discrete portions and as a portion from composite foods

	Mean serving size (g)		
	Men ($n = 662$)	Women ($n = 717$)	All ($n = 1379$)
Vegetables			
Discrete portion			
Mean	113.1 ^a	97.2	104.9
SD	46.1	36.9	42.3
P5	51.8	47.2	49.1
P95	196.4	165.9	182.5
Composite foods			
Mean	78.3	71.9	74.9
SD	59.2	55.8	57.5
P5	11.4	7.2	9.2
P95	192.7	165.6	172.9
Fruit			
Discrete portion			
Mean	179.7 ^a	159.3	168.6
SD	78.5	68.3	73.8
P5	75.9	72.1	73.1
P95	331.1	298.9	310.2
Composite foods			
Mean	41.7	35.7	38.6
SD	33.1	37.8	35.7
P5	8.9	3.3	5.6
P95	92.7	83.9	91.1

SD – standard deviation; P5 – 5th percentile; P95 – 95th percentile.

^aSignificantly different from women, $P < 0.001$ (t -test).

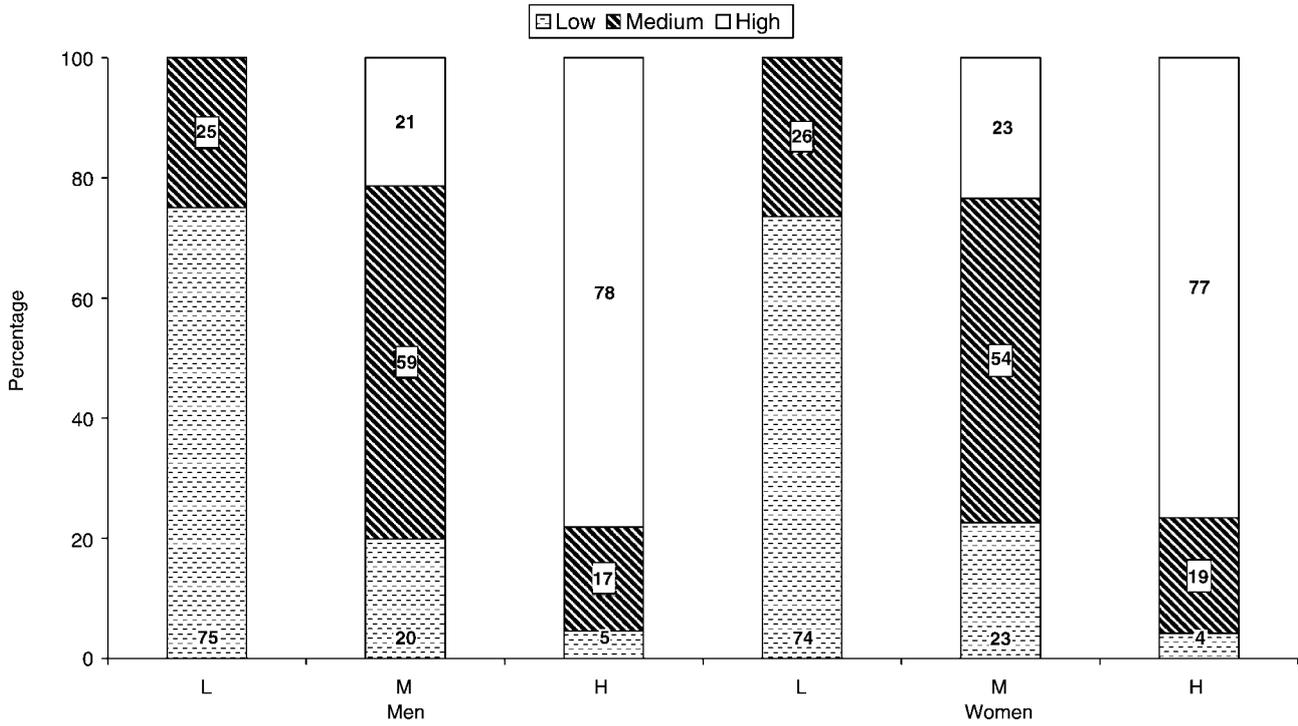


Fig. 1 Percentage of individuals misclassified as low, medium and high consumers of vegetables if composite foods are excluded from estimates of intake

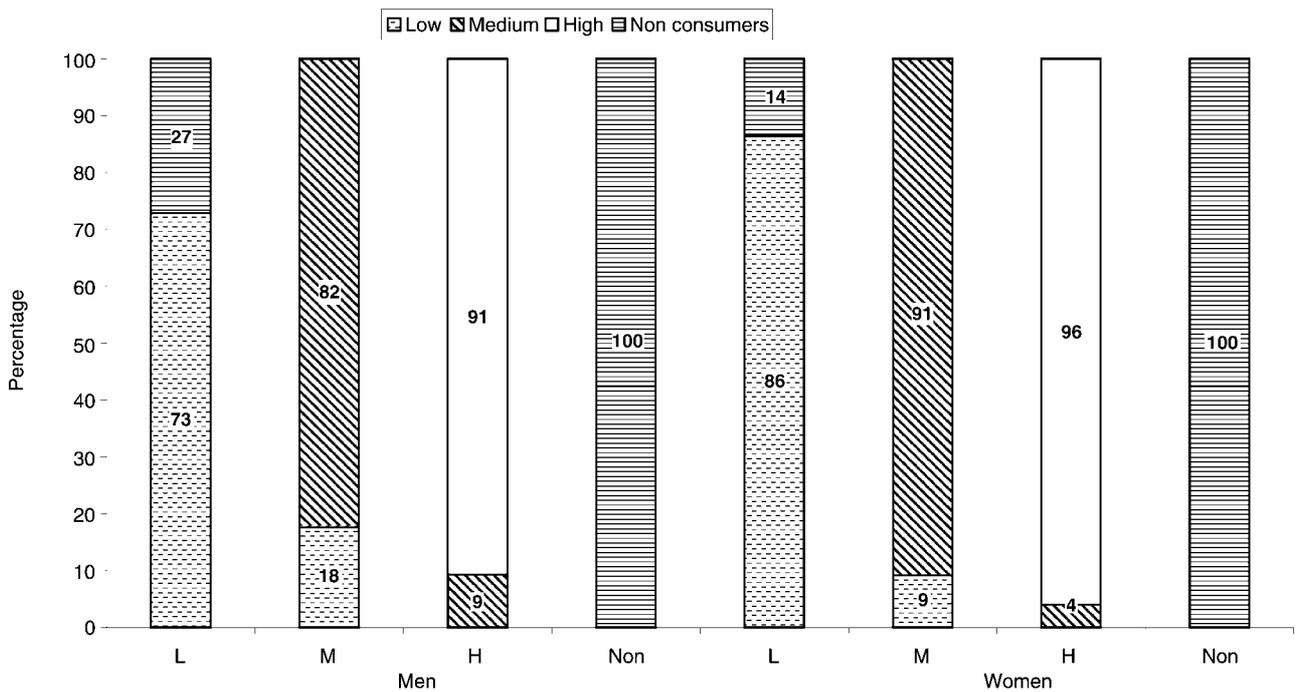


Fig. 2 Percentage of individuals misclassified as low, medium, high and non-consumers of fruit if composite foods are excluded from estimates of intake

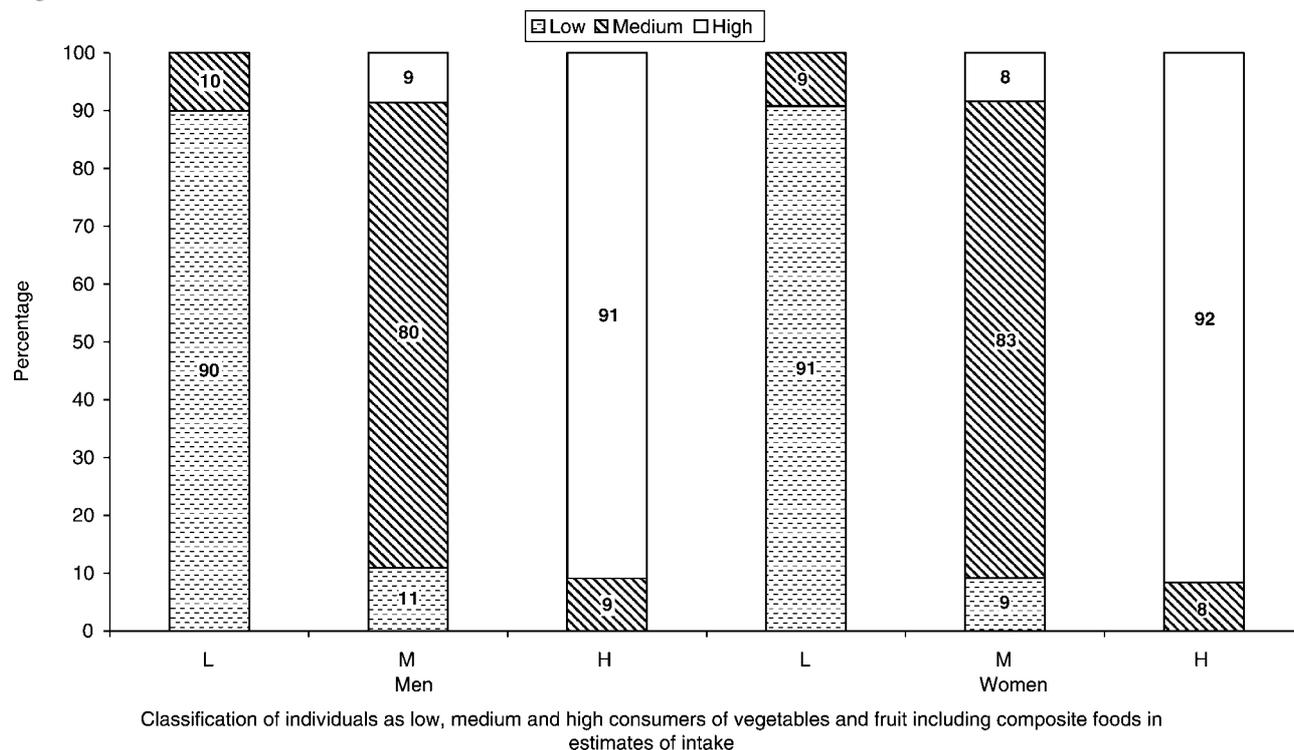


Fig. 3 Percentage of individuals misclassified as low, medium and high consumers of vegetables and fruit if composite foods are excluded from estimates of intake

Table 8 Percentage of individuals in different population groups complying with current dietary recommendations for vegetables and fruit, including and excluding vegetables and fruit from composite foods (CF)

	Percentage of individuals					
	3 servings of vegetables per day		≥ 2 servings of fruit per day		≥ 5 servings of vegetables and fruit per day†	
	Including CF	Excluding CF	Including CF	Excluding CF	Including CF	Excluding CF
Men						
18–35 years	9.0	3.2	26.9	26.9	17.4	13.0
36–50 years	11.9	5.5	34.3	33.1	25.4	15.7
51–64 years	9.8	5.2	32.4	30.1	21.4	16.8
Total	10.3	4.5	31.0	29.9	21.3	15.0
Women						
18–35 years	4.1	1.1	26.4	26.4	12.6	7.4
36–50 years	7.0	3.1	34.6	31.5	19.9	14.3
51–64 years	6.8	1.9	40.1	39.5	27.2	19.1
Total	5.9	2.1	32.8	31.4	18.8	12.8
Social class						
Professional, managerial & technical	9.3	3.3	41.9	40.6	27.1	18.2
Non-manual & skilled manual	5.9	1.6	29.6	28.9	16.6	11.1
Semi-skilled & unskilled manual	9.2	4.6	23.8	22.2	15.7	11.5
Unskilled	5.1	3.2	20.4	18.5	12.5	9.7
Education level attained						
Primary	5.9	2.1	20.8	19.7	13.5	11.1
Intermediate	7.4	4.6	22.3	21.3	14.5	9.9
Secondary	8.6	4.7	36.1	34.5	21.6	16.1
Tertiary	9.6	2.7	41.3	40.0	26.2	16.8
Smoking habits						
Current smoker	23.6	24.4	18.1	17.9	14.8	15.3
Ex-smoker	35.5	40.0	29.5	29.7	30.3	29.6
Non-smoker	40.9	35.6	52.4	52.4	55.0	55.0

1 serving = 80 g.

†Equivalent to ≥ 400 g day⁻¹ vegetable and fruit intake.

Table 9 Mean contribution of vegetables, fruit and potatoes from all sources (including composite foods (CF)) and from CF alone to mean daily nutrient intake

Nutrient	Mean contribution (%)					
	Vegetables		Fruit		Potatoes	
	All sources	CF	All sources	CF	All sources	CF
Protein	3.3	0.7	0.9	0.0	6.0	0.9
Fat	2.1	0.9	0.3	0.0	8.3	1.6
Carbohydrate	3.3	0.8	5.4	0.2	18.1	2.5
Energy	2.7	0.8	2.7	0.1	11.8	1.8
Total sugars	5.5	1.4	13.6	0.4	2.4	0.3
Starch	2.0	0.4	0.2	0.0	27.9	3.8
Fibre (Southgate)	16.9	3.4	5.5	0.3	20.5	2.9
Fibre (Englyst)	19.0	3.9	7.7	0.4	23.5	3.3
Potassium	6.7	2.1	2.2	0.2	25.4	3.5
Calcium	4.2	0.9	2.0	0.1	2.3	0.4
Magnesium	5.4	1.2	4.2	0.1	14.3	2.0
Phosphorus	4.4	1.0	1.4	0.0	7.4	1.0
Iron	7.5	1.5	2.0	0.1	10.3	1.3
Copper	3.8	1.4	11.3	0.2	16.9	2.2
Zinc	3.8	0.9	0.9	0.0	6.6	1.0
Retinol	0.2	0.1	0.0	0.0	1.6	0.5
Carotene	63.0	11.0	1.7	0.1	0.4	0.3
Total vitamin A	32.1	5.5	1.2	0.0	0.9	0.2
Vitamin D	0.0	0.0	0.0	0.0	2.0	0.4
Vitamin E	12.7	2.8	5.0	0.2	14.8	1.8
Thiamin	6.6	1.6	3.5	0.1	19.4	2.6
Riboflavin	2.8	0.8	1.9	0.1	2.4	0.4
Total niacin equivalents	7.5	0.7	1.4	0.0	6.6	0.9
Vitamin B ₆	5.4	1.7	4.2	0.1	26.5	3.6
Vitamin B ₁₂	0.0	0.0	0.0	0.0	0.1	0.1
Folate	10.6	3.3	5.0	0.1	18.5	2.5
Pantothenate	5.5	1.7	2.3	0.1	12.9	1.9
Biotin	3.9	1.0	3.6	0.1	2.1	0.3
Vitamin C	23.7	6.5	25.0	0.6	27.0	3.9

potatoes. Overall, potatoes contributed about 8% of total fat intake and over 70% of fat from potatoes came from chipped, fried and roasted potatoes.

Fruit contributed <3% to mean daily intakes of total energy and contributed about 14% of mean daily total sugar, 25% of vitamin C and 11% of copper (Table 9). Fruit juice and citrus fruits contributed most significantly to the intake of vitamin C from fruit.

The effect of excluding composite foods from estimates of intake on calculation of the contribution of vegetables, fruit and potatoes to each nutrient is reported in Table 9.

In Table 10, the intakes of fruit and vegetables obtained from this analysis are compared with intakes from other European countries. Mean intake of total vegetables (excluding potatoes) and fruit was much lower in Ireland than in Spain⁴⁶ and Italy⁴⁷ but comparable to that in other countries. Intake of potatoes was similar to that in the UK²² but higher than in other European countries for which data are reported^{20,21,42–47}.

Discussion

The current analysis indicates that intakes of vegetables and fruit in Ireland are roughly similar to those in most Northern European countries but considerably lower than

in Spain and Italy. The differences in intakes are most striking for fruit, with consumption being almost three times higher in Spain than in Ireland. Potato consumption in Ireland is comparable with that in the UK but almost twice the intake reported in other European countries. There is evidence that potato consumption in Ireland has decreased over the last decade, with the contribution of potato to percentage of energy decreasing from 12–14%⁴² to 11–13% in the current analysis. Potatoes are generally not included with vegetables in dietary guidelines for vegetable consumption although the rationale for their exclusion is not clear. There is inconsistency and sometimes lack of clarity as to whether or not potatoes should be counted in meeting current recommendations^{2,18} for vegetables and fruit.

The main contributions made by vegetables to nutrient intakes were for fibre, carotene (and hence vitamin A), folate and vitamins C and E. Fruit contributed significantly only to sugar, copper and vitamin C. Although the health benefits of high vegetable and fruit consumption are evident, it has not yet been elucidated whether these benefits are associated with their content of essential nutrients or with other components (e.g. phytochemicals), or both. Potatoes made a significant contribution to a wide range of nutrients in the diet, accounting for over 10% of the population mean daily intakes of energy, carbohydrate, dietary fibre, potassium, magnesium, iron, copper, vitamins B₆, C and E, thiamin, folate and pantothenate. The exclusion of vegetables and fruit from composite foods from estimates of intakes results in underestimation of the contributions of vegetables and fruit to total nutrient intakes.

Bingham *et al.*⁴⁸ have previously concluded that a 7-day estimated food diary (as used in the current survey) can be used to measure habitual food intake. It is presumed therefore that the current estimates represent habitual individual intakes of vegetables and fruit. The current survey, as with all dietary surveys, had evidence of misreporting of energy intakes⁴⁹. Previous studies have indicated that estimates of vegetable and fruit intakes were not significantly different between misreporters and good reporters⁴⁹, and a recent study reported that vegetables and fruit were consumed with the same frequency in both misreporters and good reporters⁵⁰. The impact of misreporting on estimates of vegetable and fruit intake was assessed in the current analysis by using Goldberg's cut-off of EI/BMR <1.05⁴¹. Excluding the 20% of individuals who had EI/BMR <1.05 resulted in a small increase in the mean intake of 3.5% for total vegetables (excluding potatoes), 5.4% for fruit and 7.5% for potatoes. As these effects were relatively small and as previous studies have indicated that vegetables and fruit are unlikely to be misreported, the results presented in the current paper include these individuals.

Vegetables and fruits consumed as individual portions and as composite foods containing vegetables were

Table 10 Mean daily intakes of vegetables and fruit in Ireland, compared with other European countries

Country, study and reference	Method	Age (years)	Mean intake (g day ⁻¹)					
			Total vegetables (excluding potatoes)	Potatoes	Total fruit			
<i>Ireland</i>								
Irish Universities Nutrition Alliance, 2001 (this study)	7-day food record	18–64	Excluding composite foods					
			Men	112	Men	277	Men	126
			Women	96	Women	148	Women	134
			All	104	All	210	All	130
			Including composite foods					
			Men	149	Men	296	Men	133
Women	132	Women	163	Women	140			
All	140	All	227	All	136			
<i>Ireland</i>								
Lee and Cunningham, 1990 ⁴²	7-day diet history	18+	Men	119	Men	340	Men	93
			Women	89	Women	190	Women	128
<i>UK</i>								
Gregory <i>et al.</i> , 1990 ²²	7-day weighed record	16–64	All	152	All	221	All	72
<i>Belgium</i>								
De Hennauw and De Backer, 1999 ²⁰	24-hour estimated food record	25–74	Men	139			Men	207
			Women	172			Women	205
<i>France</i>								
Volatier and Verger, 1999 ²¹	7-day dietary history questionnaire	> 18	Men	93			Men	189
			Women	109			Women	184
<i>Denmark</i>								
Haraldsdóttir, 1999 ⁴³	7-day estimated food record	15–80	Men	128	Men	128	Men	152
			Women	103	Women	103	Women	179
<i>Finland</i>								
Anttolainen <i>et al.</i> , 1998 ⁴⁴	24-hour estimated food record	25–64	Men	119	Men	143	Men	173
			Women	122	Women	84	Women	214
<i>Holland</i>								
Zoo eet Netherland, 1998 ⁴⁵	2-day record	19–65+	Men	144	Men	147	Men	107
			Women	137	Women	107	Women	125
			All	123	All	114	All	105
<i>Spain</i>								
Agudo <i>et al.</i> , 1999 ⁴⁶	diet history (previous year)	29–69	Men	274			Men	348
			Women	244			Women	349
<i>Italy</i>								
Turrini <i>et al.</i> , 1999 ⁴⁷		18–60	All	433 g of vegetables and fruit per day				

quantified mainly using a photographic food atlas²⁹, and the use of in-house or average portion size data from MAFF³⁰ was kept to a minimum. The disadvantage of using average portion sizes is that a single fixed weight is assigned to each food item and overuse leads to over-standardisation of portions, thus attenuating efforts to collect truly individual data. The vegetable and fruit components of composite foods were quantified using recipe information collected during the course of the survey; recipe information from *McCance & Widdowson's The Composition of Foods*, fifth edition and manufacturers' ingredient information was used when recipe information was not available.

Information on serving sizes for vegetables and fruit is very limited in the literature. Serving size has important implications when estimating intakes (e.g. in food-frequency questionnaires (FFQs)) and in aiding individuals when interpreting dietary advice regarding vegetable and fruit intakes. An average serving size of 80 g is commonly used for dietary guidance^{2,25}. This 80 g serving size is an interpretation of the World Health Organization's recommendation of 400 g day⁻¹ of vegetables and fruit as

5 servings (80 g) a day². Therefore its foundation was not based on any formal analysis of suitable data to estimate frequency of consumption and portion size correctly. In the absence of another definition of serving size, 80 g has been used to define serving size in this paper when estimating compliance with current recommendations of vegetable and fruit intake.

In this study, an average serving size of individually consumed vegetables was estimated to be 105 g (average portion consumed in composite foods was 75 g), while an average serving of individual fruit consumed was 169 g (average portion of fruit consumed in composite foods was 39 g). While the method used in this survey for quantification of vegetable and fruit intakes (primarily the photographic atlas) has limitations in its ability to define the distribution of serving size, it is clear that the use of 80 g as a reference value for average serving sizes is a sizeable underestimate for vegetables, and particularly for fruit, consumed as discrete portions.

While the 7-day food diary provided a sufficient level of recipe information to permit the disaggregation of vegetables and fruit consumed in composite foods, other

methods of dietary assessment (e.g. FFQs) present serious limitations when it comes to estimating the intake of vegetables and fruit from composite foods, as this level of disaggregation is not possible. There are no databases available that provide the content of individual foods in composite foods, so it was necessary to develop such a database in the course of this analysis. The development of such databases has important applications especially in the field of nutritional epidemiology, to allow more accurate assessment of vegetable and fruit intakes. Improved accuracy in estimating food intakes is crucial to improve the detection of real diet–disease relationships in populations.

Composite foods contributed on average 37 g day^{-1} of vegetables (26% of mean vegetable intake in the population), 6 g day^{-1} (4%) of fruit and 17 g day^{-1} (7%) of potatoes. The contribution of composite foods was most significant for the 'other vegetables' category (24 g day^{-1} or 33% of the total intake of 'other vegetables' in the population). The predominant vegetables in this category were mushrooms, onions and peppers. This indicates the importance of measuring vegetables that are consumed individually as small amounts in composite foods, but which contribute significantly to total vegetable intakes. These findings highlight the potential for underestimation of mean intakes of fruit and particularly vegetables in population groups if composite foods are excluded. Other investigators have also highlighted the importance of considering the contribution made by composite foods to fruit and vegetable intakes^{23–25,51}. Krebs-Smith *et al.*⁵¹ examined vegetable and fruit intakes in American adults, including vegetables and fruit disaggregated from composite foods, and found that 29% of vegetables and 11% of fruit came from composite foods, similar to the proportions found in the current analysis.

In relation to individuals, composite foods contributed on average 27% (P95 68%) of their total vegetable intake, 12% (P95 100%) of fruit intake and 9% (P95 46%) of potato intake. There was a considerable variation between individuals in the mean daily intake of vegetables and fruit from composite foods. For example, for mean daily vegetable intake (excluding potatoes) P5 and P95 were 0 and 106 g, respectively, while for fruit intakes P5 and P95 were 0 and 27 g, respectively. Therefore estimates excluding vegetables and fruit from composite foods would result in the misclassification of individuals into thirds of intake. For example, an examination of thirds of intake of vegetables in this analysis revealed that, when vegetables from composite foods were excluded, 25% of men and 26% of women were misclassified as being in the lowest third of intake, and 21% and 23% of men and women, respectively, were misclassified as being in the highest third of intake for vegetables. Similarly, when fruit from composite foods was excluded, 27% of men and 14% of women were misclassified as non-consumers and 9% of

men and 4% of women were misclassified as being in the highest third of intake for fruit.

Excluding composite foods from estimates of intake of vegetables introduces an unequal bias to estimates of intake in different population groups. Intakes of vegetables from composite foods were similar between men and women and between different age groups. However, significant differences in intakes of vegetables from composite foods across categories of social class and education level attained may introduce bias in the estimates of intake in these population groups when composite foods are excluded. This is particularly apparent in those individuals with tertiary education and professional, managerial and technical workers who are consuming more vegetables from composite foods. It is important therefore to pay particular attention to composite foods when estimating vegetable intakes in these groups. Health promotion strategies could also be developed to increase vegetable consumption through the promotion of vegetable-containing composite foods in certain population groups.

Excluding composite foods from the estimation of intakes can also underestimate the level of compliance with dietary guidelines as well as exposure to food chemicals such as pesticides, of which vegetables and fruit would be an important source. This study shows that compliance with guidelines for intake of vegetables and fruit is low. Only 20% of Irish adults achieved the recommendation for an intake of $\geq 400 \text{ g}$ (5 or more 80 g servings) of vegetables and fruit per day¹⁹. When fruit and vegetables from composite foods were excluded, less than 15% of men and 13% of women achieved this recommendation. When evaluated against US guidelines¹⁷ only 10% (5% excluding composite foods) of men and ~6% (2% excluding composite foods) of women achieved the American recommendations of 3 servings of vegetables a day. When composite foods were included in estimates of fruit intakes, 31% of men and ~33% of women achieved recommendations for 2 servings of fruit per day. Compliance with current recommendations for fruit was largely unaffected when composite foods were excluded from estimates of intakes because of the small contribution that composite foods made to total fruit intakes.

The current analysis found a significant pattern of decreasing compliance with recommendations for vegetable and fruit intake in men and women with decreasing level of educational attainment and social class, when composite foods were both included and excluded. Current smokers also had a significantly lower level of compliance compared with non-smokers. Previous investigators have reported lower intakes of vegetables and fruit in people with a low level of education⁵², in low socio-economic groups^{53,54} and in those who smoke⁵⁵. This trend of decreasing vegetable and fruit consumption with decreasing level of educational attainment and social class

indicates that the cost to the consumer of purchasing vegetables and fruit may be an important barrier to increasing vegetable and fruit consumption in Ireland. Other factors such as lack of knowledge or understanding of dietary guidelines for achieving health may also be important.

Conclusion

Intakes of vegetables and fruit are low compared with current dietary recommendations, particularly in those of lower levels of educational attainment and social class. Composite foods are an important source of vegetables (less importantly of fruit) and should be included when estimating vegetable intakes. Failure to do so may result in bias in estimates of intake and of compliance with dietary guidelines for population groups, as well as misclassification of individuals by level of intake.

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