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RESEARCH PAPER

Determinants of inadequate fruit and vegetable consumption amongst Portuguese adults

A. Oliveira,*†‡ B. Maia*† & C. Lopes*†‡

*Institute of Public Health, University of Porto, Porto, Portugal
†Department of Clinical Epidemiology, Predictive Medicine and Public Health, University of Porto Medical School, Porto, Portugal
‡Cardiovascular Research & Development Unit, University of Porto Medical School, Porto, Portugal

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Correspondence
A. Oliveira, Rua Doutor Plácido da Costa 4200-450, Porto, Portugal.
Tel.: +351 22 0426640
Fax: +351 222061821
E-mail: acmatos@med.up.pt

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Abstract

Background: A low consumption of fruit and vegetables (F&V) represents a high burden on health. The present study evaluates sociodemographic, lifestyle and anthropometric determinants of an inadequate consumption of F&V (<5 servings per day).
Methods: Participants were randomly selected within the adult Porto population (n = 2485). Those with normal cognitive function and information on key variables were analysed (n = 2362). Diet was assessed by a validated food frequency questionnaire. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated by logistic regression, after sex stratification and controlling for age, education, marital status, smoking, regular physical exercise and total energy intake.
Results: Older women and men had 37% and 67%, respectively, lower odds of inadequate F&V consumption (≥65 versus <40 years: OR = 0.63, 95% CI = 0.42–0.94; OR = 0.33, 95% CI = 0.20–0.56). More educated subjects (>12 versus <5 years) and those engaged in regular physical exercise had approximately 50% lower probability of F&V inadequacy compared to non-practitioners, and this was similar in both sexes. On the other hand, female and male current smokers had 1.86- and 2.05-fold higher probabilities of having inadequate F&V consumption. Individuals consuming excessive alcohol (women: ≥15 g day^{-1}; men: ≥30 g day^{-1}) presented a two- and four-fold higher probability of having inadequate F&V consumption compared to nondrinkers (OR = 1.95, 95% CI = 1.38–2.77 in women; OR = 4.40, 95% CI = 2.70–7.18 in men).
Conclusions: In both sexes, an inadequate consumption of F&V was more frequently found in younger, less educated and less physically active subjects with smoking and drinking habits. Strategies aiming to increase F&V consumption should consider these target groups that present a clustering of unhealthy lifestyles.

Introduction

Awareness of the health benefits of fruit and vegetables (F&V) consumption, particularly with respect to cardiovascular risk (Bazzano, 2005; He *et al.*, 2006, 2007; Boeing *et al.*, 2012; Slavin & Lloyd, 2012), has led to several action plans to promote their consumption [World Health Organization (WHO), 2004; Pomerleau *et al.*, 2005a,b; Wolfenden *et al.*, 2012]. In several countries, a '5 a Day' national campaign has been launched to promote the daily consumption of at least five servings of F&V (Pomerleau *et al.*, 2005a,b), in accordance with the

WHO recommendation of a daily consumption of at least 400 g of F&V (excluding potatoes and other starchy tubers) (World Health Organization, 2003).

F&V consumption varies considerably among countries, partially as a reflection not only of differences in the assessment methods used to estimate dietary intake, but also economic, social and behavioural backgrounds. Pomerleau *et al.* (2004) estimated the consumption of F&V from 26 national population-based surveys and showed that mean intakes were generally lower than current recommendations, with large variations among subregions (highest in Europe A: WHO designation for European countries with very low child and adult mortality; lowest in America B: WHO designation for American countries with low child and adult mortality). A cross-sectional analysis from the European Prospective Investigation into Cancer and Nutrition (EPIC) (Agudo *et al.*, 2002), using 24-h diet recalls, showed that centres from Southern countries had the highest consumption of F&V in both sexes, and that differences in F&V mean intake by centre were not explained by lifestyle factors associated with F&V intake, suggesting that other determinants could be responsible for the observed differences.

Women are usually more concerned about diet and more often classify foods according to the nutrient content than men (Fagerli & Wandel, 1999). As a result, women tend to consume more F&V than men (Baker & Wardle, 2003; Friel *et al.*, 2005; Azagba & Sharaf, 2011; Esteghamati *et al.*, 2012). Furthermore, in a systematic review on environmental determinants of F&V consumption among adults, married individuals and those with lower household incomes had a consistently lower consumption of these foods (Kamphuis *et al.*, 2006). Smoking and physical inactivity was also shown to be inversely associated with F&V intake (Agudo *et al.*, 2002; Estaquio *et al.*, 2008). Moreover, it is possible that a high intake of F&V may simply be a proxy for behavioural patterns with an important impact on disease risk (Serdula *et al.*, 1996; Agudo *et al.*, 2002).

Although some studies have already studied the determinants of F&V consumption, few studies, in population-based samples, have controlled the effects for a large number of confounding factors. In Portugal, little is known about the frequency, distribution and determinants of an inadequate F&V consumption among adults, although such knowledge is essential for the planning of food policies, for the developing of nutritional education programmes and for planning future scientific investigation.

The present study aimed to evaluate sociodemographic, lifestyle and anthropometric determinants of an inadequate F&V consumption (<5 servings per day) among Portuguese adults, based on a population-based study (the EPIPorto study).

Materials and methods

Study population

The EPIPorto study is a large prospective study in the Northwest Portugal assembled to evaluate health determinants. Participants were recruited from the non-institutionalised inhabitants of Porto aged ≥18 years, by random digit dialling. The sample unit was the household, followed by a simple randomisation process by which a single participant was selected. At time of recruitment, 97% of households had a telephone number. Refusals were not replaced and the participation rate was 70% (Ramos *et al.*, 2004).

The baseline participant's evaluation was performed between 1999 and 2003 (n = 2485). A rapid evaluation of the participant's cognitive function was conducted using the Mini-Mental State Examination (Folstein *et al.*, 1975; Anthony *et al.*, 1982) in those aged ≥65 years to screen (and exclude) individuals with cognitive impairment, where the answers to the study questionnaire might be less valid (participants were excluded if they scored <24 points).

For the purpose of the present study, 74 participants were excluded based on their cognitive function, and 49 were excluded because did not present information for key variables. A total of 2362 subjects, 1455 (61.6%) women and 907 (38.4%) men, aged 18–92 years were included in the cross-sectional analyses.

Compared with women, men were significantly more educated [9.2 (4.8) versus 8.4 (5.3) years; $P < 0.001$] and more frequently blue-collar workers (66.0 versus 50.8%; $P < 0.001$), married (80.9 versus 60.8%; $P < 0.001$), current smokers (34.7 versus 17.7%; $P < 0.001$) and regular physical exercise practitioners (41.1 versus 31.5%; $P < 0.001$). Total daily energy and alcohol intake was significantly higher in men than in women [10638 (2328) versus 8618 (2759) kJ day^{-1}; $P < 0.001$ and 32.6 (33.2) versus 6.8 (11.9) g day^{-1}; $P < 0.001$, respectively].

The Ethic Committee of the São João University Hospital, Porto approved the study protocol. Procedures were developed to guarantee data confidentiality and protection, and every participant provided their written informed consent.

Dietary intake assessment

Diet over the previous year was assessed using an 82-item semi-quantitative food frequency questionnaire. Each participant was asked about the mean frequency of consumption (nine categories ranging from 'never or less than once a month' to '6 or more times a day'), the mean portion consumed (lower, equal or higher than the mean portion size) and the seasonal variation of consumption.

A photograph album was used to help with the decision of the mean portion size consumed. Any foods that were not included in the food list but eaten regularly (at least once a week) were listed in an opened section.

The questionnaire has 16 items related to fruits (three items were excluded: canned fruits, nuts and olive oils) and 17 items related to vegetables (including legumes and vegetable soup) (Table 1). Fruit intake was exclusive of jams/jellies, whereas vegetable intake was exclusive of potatoes and other starchy tubers. One cup of fruit juice and one plate of vegetable soup corresponded to one serving of fruits and vegetables, respectively.

The food frequency questionnaire had been previously validated by comparison with four 7-day food records (each one in a different season of the year), among 146 subjects of the Porto population (Lopes, 2000). The Spearman correlation coefficients adjusted for sex, age, education and total energy intake were 0.66 for fibre, 0.56 for vitamin C, 0.45 for vitamin E and 0.49 for carotenoids. The reproducibility of the questionnaire was also tested, applying it to a subsample of 150 individuals, 1 year after the first evaluation. The adjusted Spearman correlation coefficients obtained were 0.42, 0.48, 0.38 and 0.45, for fibre, vitamin C, vitamin E and carotenoids, respectively. In an additional analysis, we tested the correlations between F&V obtained from the food frequency questionnaire and food records. The Spearman correlation coefficients were 0.46 for fruits, 0.49 for vegetables and 0.49 for F&V together.

Table 1 List of food items accounting for the weekly mean consumption of fruit and vegetables in women and men

Fruits			Vegetables		
Food item	Servings/week	%*	Food item	Servings/week	%*
Women					
Apple, pear	5.24	32.4	Vegetable soup	6.67	27.7
Orange, tangerine	2.76	17.1	Lettuce, watercress	2.54	10.6
Banana	1.68	10.4	Tomato	2.25	9.3
Kiwi	1.31	8.1	Carrot	2.11	8.8
Peach, plum	0.84	5.2	Bean, chick pea	1.78	7.4
Grape	0.79	4.9	Onion	1.63	6.8
Melon, watermelon	0.74	4.6	Turnip	1.20	5.0
Persimmon	0.60	3.7	Peas, broad bean	1.01	4.2
Strawberry	0.58	3.6	White, savoy cabbage	1.00	4.2
Fruit juice	0.55	3.4	Bunch cabbage	0.91	3.8
Cherries	0.52	3.2	Broccoli	0.73	3.0
Figs, loquat, apricot	0.36	2.2	Cauliflower, brussels sprouts	0.52	2.2
Tropical fruit	0.20	1.2	Green beans	0.48	2.0
			Spring greens, spinaches	0.41	1.7
			Green pepper	0.33	1.4
			Portuguese cabbage	0.29	1.2
			Cucumber	0.21	0.9
Men					
Apple, pear	5.09	35.0	Vegetable soup	6.81	30.3
Orange, tangerine	2.45	16.8	Lettuce, watercress	2.49	11.1
Banana	2.06	14.1	Tomato	2.16	9.6
Kiwi	0.85	5.9	Onion	1.82	8.1
Grape	0.73	5.0	Bean, chick pea	1.78	7.9
Melon, watermelon	0.66	4.6	Carrot	1.67	7.5
Peach, plum	0.57	3.9	White, savoy cabbage	0.99	4.4
Strawberry	0.54	3.7	Peas, broad bean	0.93	4.1
Cherries	0.45	3.1	Bunch cabbage	0.80	3.6
Persimmon	0.37	2.5	Turnip	0.77	3.4
Fruit juice	0.34	2.3	Broccoli	0.46	2.0
Tropical fruit	0.22	1.5	Cauliflower, brussels sprouts	0.35	1.6
Figs, loquat, apricot	0.22	1.5	Green beans	0.34	1.5
			Spring greens, spinaches	0.33	1.5
			Green pepper	0.30	1.3
			Portuguese cabbage	0.28	1.3
			Cucumber	0.17	0.8

*Percentages were calculated by dividing the number of servings/week of each item by the total weekly amount of fruit or vegetables intake.

Detailed information on development, structure, validity and reproducibility of the questionnaire have been reported elsewhere (Lopes, 2000; Lopes *et al.*, 2007).

To estimate the daily number of servings of F&V, the reported frequency of consumption for each item was multiplied by the respective portion consumed (in grams) and by the seasonality factor (0.25 was considered the mean seasonality of 3 months). For the present analyses, consumption of F&V was stratified into two serving groups, according to the WHO recommended daily number of servings of F&V (<5 servings per day and ≥5 servings per day).

The contribution (as a percentage) of each F&V item for the mean weekly consumption of F&V was calculated by dividing the number of servings/week of each item by the total weekly amount of fruit or vegetables intake.

Food and beverage consumptions were converted into total energy and alcohol intake with the software FOOD PROCESSOR PLUS (ESHA Research Inc, Salem, Oregon, 1997) which has been adapted to Portuguese foods and drinks. Total energy intake (kJ per day) was divided into sex-specific tertile. Moderate drinking was defined as alcohol intake ≤15 g day^{-1} in women and ≤30 g day^{-1} in men (Lichtenstein *et al.*, 2006), whereas excessive drinking was considered to be above those thresholds.

Sociodemographic, lifestyle and anthropometric characteristics

Trained interviewers collected information using a standard questionnaire. Data were obtained on social (completed years of formal education and occupation), demographic (sex, age and marital status) and lifestyles' characteristics (smoking status and physical exercise).

The number of completed years of formal education was divided into four categories: <5, 5–9, 10–12 and >12 years. Occupation was divided into the categories: white-collar worker (non-manual jobs), blue-collar worker (manual jobs) and others (housewives and students). Marital status was recorded in four categories: single, married, divorced and widowed, whereas, for analysis, participants were considered as married or not. According to smoking status, participants were classified as a never smoker (a person who never smoked), a former smoker (a person that stopped smoking for the last 6 months) or a current smoker, including both daily (at least one cigarette per day) and occasional smokers (less than a cigarette per day). For the present study, physical exercise was assessed using the question 'How long do you practice any sports or physical activity?'. A regular practice of physical exercise was assumed as the practice for at least 30 min per week of any leisure-time physical activity with energy expenditure higher than 2.5 metabolic equivalents per hour (including walking, running and any sports activity) during the previous year. Participants were classified as practitioners (yes) or non-practitioners (no) of regular physical exercise.

Anthropometrics were obtained by trained personnel, according to standard procedures, with subjects in light clothing and barefoot. Body weight was measured to the nearest 100 g using a digital scale (SECA, Columbia, IN, USA) and height was measured to the nearest 0.1 cm using a wall stadiometer (SECA). Body mass index (BMI) was calculated by dividing body weight (kg) by height squared (m^2) (expressed as kg m^{-2}). BMI was classified as <25.0 kg m^{-2} (under and normal weight, grouped together as a result of the low sample size of being underweight), 25.0–29.9 kg m^{-2} (overweight) and ≥30.0 kg m^{-2} (obese) (World Health Organization, 2000).

Statistical analysis

Analyses were conducted separately for each sex. Continuous variables were compared using the Mann–Whitney *U*-test and proportions were compared using the chi-squared test.

Associations between the sociodemographic and lifestyle characteristics and an inadequate consumption of F&V (<5 servings per day) were summarised using odds ratios (ORs) and 95% confidence intervals (CIs), as estimated by unconditional logistic regression (≥5 servings per day used as a reference category). ORs were adjusted for age, education, marital status, smoking status, regular physical exercise and total energy intake. All variables were included in the models as dummy variables.

Analyses were performed using SPSS, version 20.0 (IBM Corp., Armonk, NY, USA).

Results

All women and almost all men (99.7%) consumed vegetables on a daily basis. The proportion of daily consumers of fruit was 99.5% in women and 99.8% in men.

Table 1 shows the mean contribution (as a percentage) of each food item for the mean weekly consumption of F&V. In both sexes, vegetable soup, lettuce/watercress and tomato represented almost 50% of the weekly mean consumption of vegetables (47.6% for women and 51.1% for men). Adding carrot, bean/chick pea and onion, almost three-quarters of the total weekly consumption was achieved (70.6% in women and 74.6% in men). Taking fruits into account, the items apple/pear and orange/tangerine represented approximately 50% of the weekly mean consumption (49.4% in women and 51.8% in men). Adding banana, kiwi and peach/plum in women, and grape

in men, approximately 75% of the total weekly consumption was reached (73.2% in women and 76.8% in men).

In both sexes, the daily mean (SD) consumption of vegetables was significantly higher than fruit [3.4 (1.8) versus 2.3 (1.3) servings/day; $P < 0.001$ in women; 3.2 (1.6) versus 2.1 (1.2) servings/day; $P < 0.001$ in men]. Women reported a significantly higher daily mean (SD) consumption of F&V compared to men [5.8 (2.4) versus 5.3 (2.2) servings per day; $P < 0.001$].

Tables 2 and 3 present the odds ratios of inadequate F&V intake (<5 servings per day) according to sociodemographic, lifestyle and anthropometric factors, in women and men, respectively. The proportion of consumers of <5 servings per day of F&V was significantly higher in men than in women (49.2 versus 42.2%; $P = 0.001$).

Among women, in univariate analysis, an inadequate consumption of F&V showed an inverse association with age (50–64 versus <40 years: OR = 0.72, 95% CI = 0.54–0.97), education (>12 versus <5 years: OR = 0.69, 95% CI = 0.53–0.94), regular physical exercise (OR = 0.52, 95% CI = 0.41–0.66) and total energy intake (third versus

Table 2 Odds ratios of inadequate fruit and vegetables consumption (<5 servings per day) according to sociodemographic, lifestyle and anthropometric factors in women

	Women (n = 1455)		
	% <5 per day*	Crude OR (95% CI)	Adjusted OR (95% CI)†
Age (years)			
18–39	46.0	1	1
40–49	40.5	0.80 (0.58–1.09)	**0.68 (0.48–0.97)**
50–64	38.2	**0.72 (0.54–0.97)**	**0.57 (0.40–0.81)**
≥65	46.5	1.02 (0.74–1.40)	**0.63 (0.42–0.94)**
Education (years)			
0–4	46.9	1	1
5–9	38.5	**0.71 (0.53–0.94)**	**0.66 (0.48–0.91)**
10–12	42.2	0.83 (0.58–1.17)	0.74 (0.50–1.10)
>12	37.7	**0.69 (0.53–0.89)**	**0.57 (0.40–0.80)**
Occupation			
White-collar	37.9	1	1
Blue-collar	48.1	**1.52 (1.21–1.91)**	**1.56 (1.20–2.02)**
Other	43.3	1.25 (0.92–1.70)	1.28 (0.91–1.79)
Marital status			
Married	40.3	1	1
Not married	45.2	1.22 (0.99–1.51)	1.21 (0.96–1.53)
Smoking status			
Never smoker	40.5	1	1
Former smoker	35.3	0.80 (0.56–1.15)	0.94 (0.64–1.40)
Current smoker	53.3	**1.68 (1.28–2.21)**	**1.86 (1.35–2.56)**
Regular exercise			
No	47.1	1	1
Yes	31.6	**0.52 (0.41–0.66)**	**0.51 (0.40–0.66)**
Body mass index (kg m^{-2})			
<25.0	42.9	1	1
25.0–29.9	37.8	0.81 (0.63–1.03)	**0.73 (0.55–0.96)**
≥30.0	47.4	1.20 (0.92–1.56)	1.08 (0.79–1.48)
Energy intake (kJ day^{-1})			
First tertile (<7486)	58.8	1	1
Second tertile (7486–9240)	41.2	**0.49 (0.38–0.64)**	**0.50 (0.39–0.65)**
Third tertile (>9240)	26.6	**0.25 (0.19–0.33)**	**0.23 (0.18–0.31)**
Alcohol intake (g day^{-1})			
0.0	38.8	1	1
0.1–14.9	44.6	**1.27 (1.02–1.60)**	**1.32 (1.03–1.69)**
≥15.0	46.8	**1.39 (1.01–1.91)**	**1.95 (1.38–2.77)**

Significant associations (α = 5%) are shown in bold.
*n = 614 (42.2%).
†Odds ratio adjusted for age, education, marital status, smoking status, regular physical exercise and total energy intake.
CI, confidence interval; OR, odds ratio.

Table 3 Odds ratios of inadequate fruit and vegetables consumption (<5 servings per day) according to sociodemographic, lifestyle, and anthropometric factors in men

	Men (n = 907)		
	% <5 per day*	Crude OR (95% CI)	Adjusted OR (95% CI)†
Age (years)			
18–39	59.2	1	1
40–49	51.5	0.73 (0.49–1.11)	0.69 (0.43–1.11)
50–64	48.8	**0.66 (0.45–0.96)**	**0.58 (0.36–0.93)**
≥65	40.5	**0.47 (0.32–0.70)**	**0.33 (0.20–0.56)**
Education (years)			
0–4	49.3	1	1
5–9	53.3	1.17 (0.83–1.66)	0.97 (0.67–1.42)
10–12	46.5	0.90 (0.60–1.34)	0.66 (0.42–1.04)
>12	46.4	0.89 (0.63–1.26)	**0.51 (0.34–0.78)**
Occupation			
White–collar	48.1	1	1
Blue–collar	50.9	1.12 (0.84–1.49)	1.29 (0.95–1.76)
Other	55.6	1.35 (0.62–2.93)	0.94 (0.38–2.33)
Marital status			
Married	47.0	1	1
Not married	58.4	**1.58 (1.13–2.21)**	**1.60 (1.08–2.38)**
Smoking status			
Never smoker	42.8	1	1
Former smoker	43.9	1.05 (0.75–1.45)	1.18 (0.83–1.69)
Current smoker	60.0	**2.01 (1.44–2.80)**	**2.05 (1.43–2.94)**
Regular exercise			
No	54.9	1	1
Yes	41.0	**0.57 (0.44–0.75)**	**0.56 (0.42–0.75)**
Body mass index (kg m^{-2})			
<25.0	50.6	1	1
25.0–29.9	48.3	0.91 (0.69–1.22)	1.07 (0.78–1.47)
≥30.0	48.3	0.91 (0.62–1.35)	0.97 (0.63–1.48)
Energy intake (kJ day^{-1})			
First tertile (<9332)	61.6	1	1
Second tertile (9332–11564)	46.9	**0.55 (0.40–0.76)**	**0.43 (0.31–0.61)**
Third tertile (>11564)	39.1	**0.40 (0.29–0.56)**	**0.24 (0.17–0.35)**
Alcohol intake (g day^{-1})			
0.0	37.0	1	1
0.1–29.9	45.6	1.43 (0.95–2.16)	**1.71 (1.09–2.69)**
≥ 30.0	56.7	**2.23 (1.47–3.36)**	**4.40 (2.70–7.18)**

Significant associations (α = 5%) are shown in bold.
*n = 446 (49.2%).
†Odds ratio adjusted for age, education, marital status, smoking status, regular physical exercise and total energy intake.
CI, confidence interval; OR, odds ratio.

first tertile: OR = 0.25, 95% CI = 0.19–0.33), and a direct association with blue-collar occupation (blue-collar versus white-collar: OR = 1.52, 95% CI = 1.21–1.91), current smoking (current versus never smoker: OR = 1.68, 95% CI = 1.28–2.21) and alcohol intake (≥15 versus 0 g day^{-1}: OR = 1.39, 95% CI = 1.01–1.91). No significant associations were found with marital status (not married versus married: OR = 1.22, 95% CI = 0.99–1.51) and BMI (≥30 versus <25 kg m^{-2}: OR = 1.20, 95% CI = 0.92–1.56) (Table 2).

In men, univariate analysis showed an inverse association of inadequate F&V consumption with age (50–64 versus <40 years: OR = 0.66, 95% CI = 0.45–0.96; ≥65 versus <40 years: OR = 0.47, 95% CI = 0.32–0.70), regular physical exercise (OR = 0.57, 95% CI = 0.44–0.75) and total energy intake (third versus first tertile: OR = 0.40, 95% CI = 0.29–0.56), and a direct association with marital status (not married versus married: OR = 1.58, 95% CI = 1.13–2.21), current smoking (current versus never smoker: OR = 2.01, 95% CI = 1.44–2.80) and excessive

alcohol intake (≥30 versus 0 g day^{-1}: OR = 2.23, 95% CI = 1.47–3.36). Education (>12 versus <5 years: OR = 0.89, 95% CI = 0.63–1.26), occupation (blue-collar versus white-collar: OR = 1.12, 95% CI = 0.84–1.49) and BMI (≥30 versus <25 kg m^{-2}: OR = 0.91, 95% CI = 0.62–1.35) were not significantly associated with inadequate F&V consumption (Table 3).

In multivariate analysis (adjustment for age, education, marital status, smoking, regular physical exercise and total energy intake), older women and older men had 37% and 67%, respectively, lower odds of having inadequate F&V consumption compared to younger counterparts (≥65 versus <40 years: OR = 0.63, 95% CI = 0.42–0.94 in women; OR = 0.33, 95% CI = 0.20–0.56 in men). More educated subjects presented approximately 50% lower odds of having inadequate F&V consumption (>12 versus <5 years: OR = 0.57, 95% CI = 0.40–0.80 in women; OR = 0.51, 95% CI = 0.34–0.78 in men). Those engaged in regular physical exercise also had lower probability of F&V inadequacy compared to nonpractitioners (OR = 0.51, 95% CI = 0.40–0.66 in women; OR = 0.56, 95% CI = 0.42–0.75 in men). Women and men consuming more total energy intake showed a 75% lower probability of inadequate F&V consumption (third versus first tertile: OR = 0.23, 95% CI = 0.18–0.31 in women; OR = 0.24, 95% CI = 0.17–0.35 in men).

On the other hand, direct associations were observed between inadequate F&V consumption and smoking; current smokers of both sexes had 1.86 and 2.05 higher odds of having inadequate F&V consumption (OR = 1.86, 95% CI = 1.35–2.56 in women; OR = 2.05, 95% CI = 1.43–2.94 in men). Women consuming more than 15 g of alcohol per day (~1 drink) and men consuming more than 30 g of alcohol per day presented two times and four times, respectively, more probability of having inadequate F&V consumption compared to nondrinkers (OR = 1.95, 95% CI: 1.38–2.77 in women; OR = 4.40, 95% CI = 2.70–7.18 in men).

According to the same model, female blue collar workers had 1.56 higher probability of F&V inadequacy compared to white-collar workers (OR = 1.56, 95% CI = 1.20–2.02), and not married men also presented a 1.60 higher probability of inadequate F&V consumption compared to married men (OR = 1.60, 95% CI = 1.08–2.38).

Discussion

The present study demonstrates that younger age, lower education, current smoking, physical inactivity and alcohol drinking were the main determinants of an inadequate F&V consumption, in both sexes. Minor differences were found according to sex: being a blue-collar worker in women and not being married in men was shown to increase the probability of having a consumption of F&V < 5 servings per day.

The results of the present study are in agreement with previous investigations that used different methods to assess food intake, in different population sets (Agudo & Pera, 1999; Casagrande *et al.*, 2007; Estaquio *et al.*, 2008).

In the Spanish cohort of the multicentre EPIC study (Agudo & Pera, 1999), using the diet history method, the consumption of ≥400 g day^{-1} of F&V (~5 servings per day), in men and women together, was directly associated with age, education, practice of physical exercise, BMI and energy intake, and was inversely associated with smoking and alcohol. In the NHANES 1999–2002 (Casagrande *et al.*, 2007), using 24-h recalls, adequate consumption of F&V, in men and women together, was directly associated with age, education and income. However, a study in Portugal, using data from the National Health Survey (Moreira & Padrao, 2006), reported that educational level was more strongly associated with food choices including F&V than income. Another recent study showed that F&V are directly related to income when income reaches high levels, and that these differences are mediated by education (Middaugh *et al.*, 2012).

In a French cohort study (Estaquio *et al.*, 2008), using 24-h recalls, in both sexes, consumers of ≥5 servings per day of F&V were significantly older, more educated, nonsmokers and less alcohol drinkers, as corroborated in the present study. The same study also reported a direct association with the practice of physical exercise in women, and no significant associations with occupation and marital status in both sexes. However, in the present study, the practice of regular physical exercise was significantly associated with more F&V intake in both sexes and being a blue-collar worker in women and not being married in men was directly associated with inadequate F&V consumption.

In the present population-based sample, the proportion of F&V consumers <5 servings per day was approximately 45%. This proportion is similar to that found in France (46%) (Estaquio *et al.*, 2008), higher than that observed in Spain (only 26% ate less than 400 g day^{-1}) (Agudo & Pera, 1999) and lower than that observed in USA (75%) (Blanck *et al.*, 2008) and Brazil (66%) (Mondini *et al.*, 2010). As reported previously (Pomerleau *et al.*, 2004), South European countries have a higher F&V intake, in agreement with a Mediterranean eating style. When comparing our results with the Spanish EPIC cohort (Agudo & Pera, 1999) using the diet history method, the mean consumption was higher for fruits than vegetables and, overall, higher in women than in men, as found in the present study.

A major problem when comparing results across populations is the inconsistency in food grouping. As in most studies, vegetables did not include tubers (potatoes) or cereals. This attempt to be comparable with other reports sometimes leads to inconsistencies from a botanical point of view. For example, tomatoes were classified as vegetables even they are botanically fruits, and vegetables included green beans and peas, although they are legumes.

In Portugal, a South European country, there is scarce available information available on food consumption. The last National Food Survey dates from 1980 and food balance sheets and household budget surveys only provide information about F&V availability. According to the National Heath Surveys (Marques-Vidal *et al.*, 2006), the percentage of subjects consuming F&V in the previous day (this short period represents a methodological limitation) has increased between 1987 and 1999, although no updated published individual data are available at the national level, increasing the interest in reporting our results, even at a regional level.

In the present study, F&V inadequacy clustered with a range of unhealthy lifestyles, such as physical inactivity, smoking and drinking habits. At least to some extent, it would be expected that diet and other health behaviours might cluster together because health consciousness (e.g. to eat more F&V) could affect several factors at the same time. Even recommendations join together diet and lifestyles (Lichtenstein *et al.*, 2006), aiming to promote healthy dietary lifestyles as a whole. Thus, preventive strategies to promote F&V intake should consider comprehensive approaches because F&V low consumers are likely to present other unhealthy lifestyles.

According to several studies and WHO reports (World Health Organization, 2003, 2004; Bazzano, 2005), the relationship between F&V and other risk factors is important from both an aetiological perspective and also for the prevention of disease. However, in the last decade, more integrative strategies aiming to study the cumulative effect of several foods and nutrients through the definition of dietary patterns have been proposed. According to such strategies, diet is considered as a complex mixture of components that interact (Hu, 2002; Schulze & Hoffmann, 2006). Probably, this strategy should be applied not only to dietary factors, but also to other lifestyle and biological factors. Nonetheless, overall, F&V are considered as a surrogate measure of healthy behaviours, and to understand their determinants in different population sets gives the potential for prevention.

One of the advantages of the present study was the possibility of taking into account several potential confounders simultaneously; thus, we might have isolated the effect of some factors for F&V inadequacy. Nonetheless, we cannot exclude some residual confounding. Additionally, it has the advantage of being a population-based study, with participants being randomly recruited from the community, and under rigorous procedures of data collection by trained interviewers.

Some limitations of the present study are also worthy of note. This is a cross-sectional study and the temporal sequence of the sociodemographic and lifestyle characteristics with the consumption of F&V cannot necessarily be determined. However, for variables with a lower probability of changing over time according to exposure, such as age, education and occupation, the associations found might not be affected by reverse causality. On the other hand, the non-observed associations between BMI and F&V consumption could be a result of the cross-sectional nature of the study.

One potential misclassification bias of the present study relates to the accuracy of assessing F&V consumption. In the present study, diet over the previous year was assessed using a validated semi-quantitative food frequency questionnaire. This method is simple, inexpensive and easy to administer in large epidemiological studies (Willett, 1998); however, the estimate's quality depends of the number of items included. Kristal *et al.* (2000) showed that, compared with 4-day food records, long food frequency questionnaires overestimate fruit consumption by 40% and short questionnaires underestimate F&V consumption by 19% and 16%, respectively. The food frequency questionnaire used in the present study was not specifically validated for the assessment of F&V consumption. However, the validation of nutrients considered as markers of F&V consumption, such as fibre, carotenoids and vitamin C, showed satisfactory correlation coefficients compared to four 7-day food records: 0.67, 0.49 and 0.55, respectively (Lopes, 2000).

Food frequency questionnaires are retrospective methods of assessing dietary intake, and are thus prone to recall bias. To minimise this as much as possible, data collection in the present study was conducted by trained personnel in face-to-face interviews, using a photograph album to help with the selection of portion sizes. Additionally, as already discussed, our food-frequency questionnaire has shown good reproducibility and validity in this specific population compared to a prospective method.

The possibility for a tendency to overestimation as a result of social desirability bias cannot be discarded. Self-reporting of F&V intake is susceptible to substantial social approval bias, independently of age, education level, ethnicity, self-perceived health status and time since last medical check-up (Miller *et al.*, 2008).

Conclusions

In both sexes, a lower consumption of F&V (defined as <5 servings per day) was found in younger, less educated and less physically active subjects with smoking and drinking habits. Strategies to increase F&V consumption should consider these target groups that present a clustering of unhealthy lifestyles.

Conflict of interests, source of funding and authorship

The authors declare that there are no conflicts of interest.

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AO participated in the acquisition and interpretation of data and was involved in drafting the manuscript. BM was involved in the analysis and interpretation of data and in drafting the manuscript. CL conceived and designed the study, revised the manuscript, and gave final approval concerning the version to be published. All authors critically reviewed the manuscript and approved the final version submitted for publication.

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