

Socio-economic and behavioural determinants of fruit and vegetable intake in Moroccan women

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Abstract

Objective: To estimate daily fruit and vegetable intakes and to investigate socio-economic and behavioural differences in fruit and vegetable consumption among urban Moroccan women.

Design: A cross-sectional survey. Fruit and vegetable intake was measured with a single 24 h recall.

Settings: A representative population-based survey conducted in the area of Rabat-Salé.

Subjects: Women (*n* 894) of child-bearing age (20–49 years).

Results: Mean fruit and vegetable intake was 331 g/d (155 g/d for fruit and 176 g/d for vegetables). Only one-third (32.1%) of women consumed ≥ 400 g/d and half the sample (50.6%) were considered as low consumers, i.e. < 280 g/d. Women of higher economic status ate significantly more fruit ($P < 0.05$) and more fruit and vegetables combined ($P < 0.05$). Women ate significantly less vegetables if they ate out of home more often or skipped at least one main meal (breakfast, lunch or dinner) or ate more processed foods ($P < 0.05$, $P < 0.01$ and $P < 0.001$, respectively). Fruit and vegetable diversity was not associated with any of the factors investigated.

Conclusions: In this population, fruit and vegetable intakes are driven by different determinants. Indeed, while vegetable consumption was related only to behavioural determinants, fruit consumption was influenced only by economic status. Therefore, programmes promoting fruit and vegetable intake would be more effective if they account for these specific determinants in their design.

Keywords
Fruit and vegetables
Consumption
Determinants
Morocco
Women

Morocco is undergoing a rapid nutrition transition, characterised by increasing obesity and a high prevalence of diet-related chronic diseases, such as type 2 diabetes, CVD and cancer^(1–4). According to one study, which investigated the burden of diseases attributable to low intake of fruit and vegetables and its association with different health outcomes, it was estimated that worldwide over 1.7 million deaths (2.8%) were attributable to low fruit and vegetable intake, placing it among the top ten risks factors for mortality in middle- and high-income countries (the seventh and the eighth cause, respectively)⁽⁵⁾. More recently, the Global Burden of Disease study 2010 reported that in North African and Middle East countries, low consumption of fruit was the sixth overall leading cause of morbidity and the fourth behavioural factor contributing to morbidity⁽⁶⁾. The low consumption of vegetables was the

sixteenth overall leading cause of morbidity. Therefore, it is crucial to focus on fruit and vegetable intake, as they have a potential preventive effect on weight gain and chronic disease development⁽⁷⁾.

Based on evidence that fruit and vegetables have a protective effect on diet-related chronic diseases, the WHO has recommended eating at least 400 g of fruit and vegetables daily⁽⁸⁾. But the health benefits of fruit and vegetables are not only a question of quantity, but also a question of diversity^(9,10). Indeed, at present, no studies have clearly identified the mechanisms for the benefits of eating fruit and vegetables, nor which fruit or vegetables are most effective⁽¹¹⁾. Therefore, it is recommended to eat a wide variety of fruit and vegetables of different colours including red, green, yellow, white, purple and orange⁽¹²⁾.

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To be able to promote consumption of fruit and vegetables, it is important to investigate what kinds of factors may influence their intake, in order to identify potential levers to increase their intake in populations.

Food choices are not only influenced by hunger or other physiological factors. On the contrary, they are influenced by a wide range of determinants acting at different levels. Systematic reviews have identified several factors influencing fruit and vegetable intake, such as: biological determinants (e.g. gender and age); economic determinants (e.g. income and cost); physical determinants (e.g. time, cooking skills, accessibility and living area); and social determinants (e.g. marital status, having children, education, family, peers and culture)^(13–16).

Most of the studies investigating the relationship between fruit and vegetable consumption and age concluded that the amount of fruit and vegetables consumed increases with age^(17–22). The influence of income/education on fruit and vegetable consumption has also been widely described in the literature and studies tend to conclude that people with higher income, socio-economic status or education are more likely to consume more fruit and vegetables^(23–29). The household composition has also been demonstrated to influence the level of fruit and vegetable consumption, i.e. married couples are more likely to consume more fruit and vegetables^(13,14,30,31), but this relationship is less evident once they have children^(14,32,33).

Fruit and vegetable consumption may also be related to certain behaviours such as out-of-home eating or skipping meals. Indeed, several studies conducted in adults living in high-income countries reported inverse associations between out-of-home eating frequency and fruit and vegetable intake^(34–37).

The aims of the present study were to characterise fruit and vegetable consumption in terms of quantity, quality and variety (all estimates of diversity), and to investigate determinants of fruit and vegetable consumption such as socio-economic and behavioural determinants, in urban Moroccan women living in a context of high prevalence of overweight and obesity.

Experimental methods

The study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Ethical and Deontological Consultative Committee of the Institute of Research for Development (July 2009) and by the Moroccan Ministry of Health (letter n°623, March 2009). After being thoroughly informed of the purpose and procedures of the survey, written or verbal informed consent was obtained from all participants. Verbal consent was witnessed and formally recorded. Women did not receive any incentive for their participation.

The questionnaires were administered in Arabic by trained interviewers.

Participants and settings

The target population was non-pregnant women of child-bearing age (20–49 years) living in the urban area of Rabat-Salé. Within this area, a three-stage random cluster sample was used. Forty-five clusters of about fifty households were randomly selected among census enumeration areas by the Ministry of Statistics and Planning. In each cluster, addresses were numbered. Then in each cluster a starting point, based on the address list, was randomly selected. From this starting point, investigators proceeded to adjacent households until twenty eligible households, i.e. with at least one non-pregnant woman aged 20–49 years, were selected. If several women were eligible in a household, one woman was randomly selected to participate.

Measures

Fruit and vegetable consumption

A single 24 h recall was administered to each participant by trained interviewers using the multi-pass method⁽³⁸⁾ (see online supplementary material). In this procedure, participants initially reported the time of eating, as well as all foods and beverages consumed during the last 24 h. At that stage, information about quantity and other details was not reported. After reviewing the list of food items for completeness, a second interview was undertaken with the participant to record details of recipes cooked and quantities of all food items consumed on the recall day (using diverse methods: photographs of food portion size^(39,40), household measures, known weight or prices). Lastly, specific information for fruit and vegetables was extracted from the recall. A Fruit and Vegetable Diversity Score (FVDS) was calculated by summing the number of different fruit and vegetables consumed over the last 24 h without any minimum quantity.

Socio-economic factors

Data on age, marital status, parity, educational level, employment and living area were collected.

An economic index was computed from six variables concerning housing (number of persons per room, presence of toilets, source of drinking water, kitchen and bathroom at home) and eleven variables concerning equipment at home (fridge, washing machine, dishwasher, satellite dish, Internet access, television, heating, air conditioning, telephone, car, computer) using correspondence analysis⁽⁴¹⁾. Then households were classified into tertiles, corresponding to low, medium and high economic level.

Behavioural factors

The behavioural factors investigated were: (i) the number of out-of-home eating occasions during the last week (including eating at other people's houses); (ii) usual

consumption of the three possible main daily meals (breakfast, lunch and dinner); (iii) eating from a shared bowl; and (iv) the number of processed foods consumed during the previous day. The processed foods taken into account were biscuits, cooked meats, cream cheeses, yoghurts and soft drinks.

Anthropometry

Weight was measured using BodyUp digital scales accurate to 100 g (Tefal™, France), which were verified daily. Height was measured using a portable stadiometer (Seca® 214) to the nearest millimetre (Seca®, Germany). All anthropometric measurements were performed by the interviewers. BMI was assessed from measured weight and height, and women were classified into four groups based on the WHO classification⁽⁴²⁾.

Data entry and data management

A data entry file was set up with EpiData entry, version 3.1⁽⁴³⁾. Data from questionnaires were entered twice, into two separate files, by the same operator and then compared for errors. Errors were corrected and the comparison between the two files was performed until differences no longer existed between them.

Data analysis

All statistical analyses were performed with the Stata statistical software package version SE 11.2⁽⁴⁴⁾. Summary statistics were used to describe the characteristics of the sample. Associations between socio-economic characteristics, behavioural factors and fruit and vegetable consumption were tested using linear regression analysis.

All analyses took into account both sampling design and sampling weight and were adjusted for all of the socio-economic variables and energy. $P < 0.05$ was considered as significant.

Results

Of the women who were randomly selected to participate in the study, fifty-six refused (5.9% refusal rate). Eight hundred and ninety-five women were interviewed within forty-five clusters. One woman was excluded from the overall analysis because no food consumption data had been recorded for her and thirty-nine women considered as outliers (energy intake outside the allowable range of 2092–14 644 kJ/d (500–3500 kcal/d)) were excluded from the analyses that investigated the relationship between socio-economic and behavioural determinants and fruit and vegetable consumption.

Population characteristics

Over two-thirds of the respondents were married (66.1%; 95% CI 61.6, 70.7%) and had at least one child (70.0%; 95% CI 59.8, 80.1%; Table 1). About two-fifths of the

women had never attended school (41.3%; 95% CI 34.6, 48.1%) and the majority of women were unemployed (80.1%; 95% CI 76.0, 84.3%). Slightly less than two-thirds of the sample (65.0%; 95% CI 50.2, 79.0%) lived in the *medina* (traditional living area in Morocco; Table 1). Two-thirds of the respondents were either overweight or obese (overweight: 33.7%; 95% CI 30.3, 37.1%, obese: 32.4%; 95% CI 28.5, 36.4%).

One-third of women ate out of home at least once during the previous week (33.7%; 95% CI 26.5, 40.8%), another third usually skipped one of the three main daily meals (30.2%; 95% CI 24.0, 36.5%) and most of them usually ate from a common dish (86.6%; 95% CI 82.4, 90.7%), i.e. from a shared bowl. Almost two-thirds of the women did not eat any processed foods during the last 24 h (59.1%; 95% CI 54.0, 64.9%; Table 1).

Fruit and vegetable intake

During the previous 24 h, nearly two-thirds of the respondents ate fresh fruit (60.3%; 95% CI 54.6, 66.0%), but much fewer (13.0%; 95% CI 10.2, 15.8%) ate dried fruit; nearly all women ate vegetables (94.2%; 95% CI 92.8, 95.6%) and slightly more than a quarter ate beans or pulses (28.0%; 95% CI 23.7, 32.3%). Only a small proportion of women (2.6%; 95% CI 1.5, 3.7%) did not eat fruit or vegetables during the previous day.

The mean fruit and vegetable intake was 331 (95% CI 306, 357) g/d. The mean fruit intake was 155 (95% CI 136, 175) g/d and the mean vegetable intake was 176 (95% CI 164, 189) g/d. Slightly less than one-third of the women (32.1%; 95% CI 28.0, 36.2%) met the WHO recommendations, i.e. ate ≥ 400 g of fruit and vegetables daily. Half of the sample (50.6%; 95% CI 45.3, 55.9%) were low consumers, i.e. consumed < 280 g/d.

The weight of a mean fruit portion size was 155 (95% CI 144, 166) g and the weight of a mean dried fruit portion size was 31 (95% CI 24, 39) g. The weight of a mean vegetable portion size was 39 (95% CI, 37, 41) g and the mean weight of a portion size of beans or pulses was 126 (95% CI 113, 139) g.

Regarding diversity in the previous day, women ate slightly less than five different fruits and vegetables (4.77; 95% CI 4.52, 5.04). They ate roughly one fruit (1.08; 95% CI 0.97, 1.18) and more than three different kinds of vegetables (3.70; 95% CI 3.49, 3.91).

Socio-economic and behavioural determinants of fruit and vegetable intake

The mean daily intake of fruit and vegetables combined was not associated with any of the socio-economic determinants investigated, except for economic status (Table 2). Indeed, women with a higher economic status ate significantly more fruit and vegetables (296 g/d for women belonging to the low economic group *v.* 390 g/d for women belonging to the high economic group, $P = 0.049$). The same finding was reported for fruit. Thus,

Table 1 Characteristics of the study participants: Moroccan women of child-bearing age (20–49 years) from the urban area of Rabat-Salé (*n* 894)

	<i>n</i>	Weighted %	95 % CI
Age (years)			
20–29	255	28.3	24.4, 32.3
30–39	313	31.6	27.6, 35.4
40–49	326	40.1	35.5, 44.8
Marital status			
Single	166	24.2	19.5, 28.9
Married	653	66.1	61.6, 70.7
Widowed	26	4.0	2.0, 6.1
Divorced	49	5.6	3.7, 7.5
Number of children			
None	219	30.0	25.5, 34.5
1 or 2	336	30.7	26.1, 35.3
≥3	339	39.3	33.7, 44.8
Education			
None	351	41.3	34.6, 48.1
Primary or partial secondary	409	43.8	38.8, 48.7
Secondary/university	134	14.9	10.5, 19.3
Employment			
Unemployed	726	80.1	76.0, 84.3
Employed	168	19.9	15.7, 24.0
Living area			
Modern	178	17.9	6.8, 29.5
Medina*	557	65.0	50.2, 79.0
Precarious†	159	17.1	5.8, 28.6
Number of weekly out-of-home eating occasions			
0	568	66.3	60.9, 71.7
1	141	16.6	13.2, 19.9
≥2	146	17.1	13.3, 20.9
Skipping at least one of the three main daily meals			
No	636	69.8	64.6, 74.9
Yes	258	30.2	24.0, 36.5
Usually eat from a shared bowl			
No	164	13.4	9.3, 17.6
Yes	730	86.6	82.4, 90.7
Number of processed foods consumed daily‡			
0	503	59.5	54.0, 64.9
1	216	24.4	20.9, 27.9
≥2	136	16.1	12.4, 19.9

*Traditional Moroccan living area.

†Precarious living area and shanty town.

‡Data based on 24 h recalls (*n* 855); processed foods are biscuits, meat products, processed cheese, yoghurts and soft drinks.

women with a higher economic status ate a significantly larger amount of fruit (117 g/d for women belonging to the low economic group *v.* 203 g/d for women belonging to the high economic group, $P=0.031$). The mean daily vegetable intake was not associated with any of the socio-economic determinants investigated.

The only socio-economic factor associated with FVDS was age (data not shown). Indeed, older women ate significantly more different types of fruit and vegetables compared with younger women (4.9 *v.* 4.7, $P=0.032$). Fruit Diversity Score (FDS) increased with age and economic status, i.e. older and wealthier women ate significantly more types of fruit (1.1 *v.* 1.0, $P=0.038$ and 1.35 *v.* 0.90, $P=0.022$; respectively). Vegetable Diversity Score (VDS) was not associated with any of the socio-economic factors investigated.

Mean daily fruit and vegetable intake was not associated with out-of-home eating frequency or with the fact that women ate from a common dish (Table 3). Women who

did not consume any processed food during the previous day tended to eat slightly more fruit and vegetables compared with those who ate two or more processed foods (334 g/d *v.* 323 g/d). However, this association was not significant. Women who usually skipped at least one of the three main daily meals ate significantly lower amounts of fruit and vegetables (305 g/d for women who skipped at least one meal *v.* 343 g/d for women did not skip any meal). Mean daily fruit intake was not associated with any of the behavioural determinants investigated. Mean daily vegetable intake was not associated with whether women usually ate from a shared bowl; however, women who ate out of home more frequently, as well as women who usually skipped at least one of the three main daily meals and women who ate more processed food ate significantly less vegetables (148 g/d *v.* 180 g/d, 152 g/d *v.* 187 g/d and 152 g/d *v.* 182 g/d, respectively).

FVDS, as well as FDS and VDS, were not associated with any of the behaviours investigated.

Table 2 Relationship between socio-economic factors and daily fruit and vegetable intake controlling for age, marital status, number of children, education, employment, economic status, living area and energy intake among Moroccan women of child-bearing age (20–49 years) from the urban area of Rabat-Salé (*n* 855)

	<i>n</i>	Fruit and vegetables (g/d)			Fruit (g/d)			Vegetables (g/d)		
		Mean	SE	<i>P</i> value	Mean	SE	<i>P</i> value	Mean	SE	<i>P</i> value
Age (years)										
20–29	243	328	20.1		151	16.6		177	9.8	
30–39	297	344	23.8	0.16	158	11.7	0.23	186	15.5	0.56
40–49	315	325	18.3		157	14.4		168	7.4	
Marital status										
Married	631	337	14.6	0.22	156	10.8	0.62	180	7.8	0.23
Unmarried	224	321	21.7		153	17.2		168	10.6	
Number of children										
None	208	346	25.0		167	18.5		179	14.7	
1 or 2	323	336	19.2	0.39	149	13.9	0.16	188	9.7	0.47
≥3	324	317	16.7		152	11.8		165	8.5	
Education										
None	340	283	15.0		124	11.6		160	7.4	
Primary or partial secondary	387	359	19.6	0.16	169	13.5	0.22	190	10.7	0.49
Secondary/university	128	389	24.4		205	20.6		184	13.6	
Employment										
Employed	160	350	27.1	0.99	165	17.4	0.80	185	20.7	0.80
Unemployed	695	327	15.0		153	10.8		174	6.9	
Economic status										
Low	285	296	21.4		117	12.6		180	12.6	
Medium	260	302	16.6	<0.05	142	11.7	<0.05	161	9.1	0.22
High	310	390	18.0		203	16.4		187	8.9	
Living area										
Modern	168	329	23.4		158	16.0		171	10.9	
Medina	538	340	16.6	0.62	161	12.9	0.58	179	7.9	0.83
Precarious	149	303	25.8		130	18.8		173	16.4	

Table 3 Relationship between behavioural factors and daily fruit and vegetable intake controlling for age, marital status, number of children, education, employment, economic status, living area and energy intake among Moroccan women of child-bearing age (20–49 years) from the urban area of Rabat-Salé (*n* 855)

	<i>n</i>	Fruit and vegetables (g/d)			Fruit (g/d)			Vegetables (g/d)		
		Mean	SE	<i>P</i> value	Mean	SE	<i>P</i> value	Mean	SE	<i>P</i> value
Out-of-home eating occasions (times/week)										
0	568	323	14.9		143	10.2		180	7.9	
1	141	385	28.0	0.11	193	23.4	0.43	191	16.0	<0.05
≥2	146	314	18.9		165	18.9		148	12.4	
Skipping at least one of the three main daily meals										
Yes	258	305	17.7	<0.05	153	13.8	0.46	152	8.4	<0.01
No	597	343	14.4		156	10.7		187	7.1	
Eating from a shared bowl*										
Yes	730	332	13.8	0.13	154	10.5	0.33	178	6.9	0.18
No	124	326	26.1		164	19.7		164	14.4	
Processed foods (number/d)										
0	503	334	16.2		152	11.1		182	9.2	
1	216	332	22.3	0.05	154	14.0	0.53	177	12.5	<0.001
≥2	136	323	28.9		171	22.7		152	11.7	

**n* 854 (one missing value).

Discussion

In terms of quantity and quality, fruit consumption was vastly different from vegetable consumption. Indeed, while almost all women ate vegetables on a daily basis, less than two-thirds of them ate fruit every day. Overall women ate only one portion of fruit per day with a mean portion size weighing 155 g, i.e. about twice the weight of

the reference portion size (80 g). In comparison, vegetable diversity was higher but the weight of the mean vegetable portion size was 39 g, i.e. about half the weight of the reference portion size. Therefore, contrary to other studies where one eating occasion was assimilated to be one portion^(45–47), in the present context, it is important to measure the exact quantity of fruit and vegetables consumed rather than just recording or recalling the frequency

of consumption, as one occasion was completely different from one portion.

The mean fruit and vegetable intake was relatively high (331 g/d); however, only one-third met the ≥ 400 g/d recommended by the WHO and half of the sample were considered as low consumers, indicating that in the present context the consumption of fruit and vegetables is still a public health issue. In comparison, in Brazil, a country also experiencing rapid nutrition transition and with higher economic development compared with Morocco, one in five adults meet the WHO daily recommendations (20.5 % of women)⁽⁴⁸⁾. In a high-income country, such as the USA, less than one-third of adults eat the recommended amount of fruit and vegetables (26.3 % eat ≥ 3 servings of vegetables and 32.5 % eat ≥ 2 servings of fruit per day)⁽²⁰⁾. It is worth noting that all these results are based on different dietary assessment methods and therefore are not comparable, strictly speaking.

Contrary to what was usually reported in other studies^(13,14,19,20,22), in the present context, the amount of fruit and vegetables eaten was not associated with age, marital status, parity, education or living area. For age, one of the possible reasons for not finding any association was that the population under investigation – women of child-bearing age – represented a relatively narrow age range. For marital status, the difference with other studies may be cultural, given that in Morocco, single people tend to stay living within families until they are married.

As reported in other studies^(19,23,25,27,28,49), women with a higher economic status ate more fruit and vegetables.

Similar to the amount of fruit and vegetables consumed, the determinants of fruit or vegetable consumption are completely different. Indeed, fruit consumption was positively associated only with economic status, whereas vegetable consumption was not influenced by any of the socio-economic factors investigated. Moreover, while fruit consumption was not associated with any behavioural determinants, vegetable consumption was independently and negatively related to out-of-home eating, skipping meals and eating processed foods. In other words, in the present context where fruit is more expensive than vegetables, fruit consumption was economically driven, whereas vegetables are part of the daily main traditional Moroccan dish called *tajine* that is made up of meat (more rarely of fish) and vegetables, and vegetable consumption was thus influenced more by behaviours characteristic of a modern dietary pattern.

There are some limitations associated with the present study. First, fruit and vegetable intake was based on data collected from a single 24 h recall. Therefore, the interpretation of results should be treated with caution, since a single 24 h recall gives no information on intra-individual variability in food intakes and so it is less likely to reflect true long-term individual intakes⁽⁵⁰⁾. Furthermore, the 24 h recall relies on the participant's memory, both for identifying food and beverages consumed and the evaluation

of portion sizes. Additionally, in the present study, the amount of food consumed was assessed mainly using photographs of food portion size presented in an individual plate, whereas Moroccan women traditionally eat from a shared dish. As a consequence, this may have introduced a bias in the reported amount of vegetables consumed.

Conclusions

In a context where diet-related chronic diseases are highly prevalent and half of urban Moroccan women are considered low consumers of fruit and vegetables, it is crucial to focus on their intake as part of a healthy diet. Fruit consumption and vegetable consumption among urban Moroccan women are driven by distinct determinants. Indeed, while vegetable consumption was related only to behavioural determinants, fruit consumption was influenced only by economic status. Therefore, programmes that promote fruit and vegetables intake should account for these differences to enhance their effectiveness. For instance, programmes that would aim to increase vegetable consumption might promote the Moroccan traditional diet that is naturally high in vegetables; while programmes that would aim to increase fruit consumption might include economic measures such as subsidies or vouchers to make fruit more affordable for the population.

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Supplementary material

To view supplementary material for this article, please visit <http://dx.doi.org/10.1017/S1368980014001761>

References

- Benjelloun S (2002) Nutrition transition in Morocco. *Public Health Nutr* **5**, 135–140.
- Tazi MA, Abir Khalil S, Chaouki N *et al.* (2003) Prevalence of mean cardiovascular risk factors in Morocco: results of national survey, 2000. *J Hypertens* **21**, 897–903.
- World Health Organization (2005) Facing the Facts. http://www.who.int/chp/chronic_disease_report/media/impact/morocco.pdf (accessed August 2014).
- El Rhazi K, Nejari C, Zidouh A *et al.* (2011) Prevalence of obesity and associated sociodemographic and lifestyle factors in Morocco. *Public Health Nutr* **14**, 160–167.
- World Health Organization (2009) *Global Health Risks. Mortality and Burden of Disease Attributable to Selected Major Risks*. Geneva: WHO.
- Lim SS, Vos T, Flaxman AD *et al.* (2012) A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet* **380**, 2224–2260.
- Mendis S & Alwan A (2011) *Prioritized Research Agenda for Prevention and Control of Non Communicable Diseases*. Geneva: WHO.
- World Health Organization (1990) *Diet, Nutrition, and the Prevention of Chronic Diseases. Report of a WHO Study Group meeting held in Geneva from 6–13 March 1989. WHO Technical Report Series no. 797*. Geneva: WHO.
- Thompson HJ, Heimendinger J, Diker A *et al.* (2006) Dietary botanical diversity affects the reduction of oxidative biomarkers in women due to high vegetable and fruit intake. *J Nutr* **136**, 2207–2212.
- Bhupathiraju SN & Tucker KL (2011) Greater variety in fruit and vegetable intake is associated with lower inflammation in Puerto Rican adults. *Am J Clin Nutr* **93**, 37–46.
- Padayatty S & Levine M (2008) Fruit and vegetables: think variety, go ahead, eat! *Am J Clin Nutr* **87**, 5–7.
- World Cancer Research Fund/American Institute for Cancer Research (2007) *Food, Nutrition, Physical Activity and the Prevention of Cancer: A Global Perspective*. Washington, DC: AICR.
- Pollard J, Kirk SF & Cade JE (2002) Factors affecting food choice in relation to fruit and vegetable intake: a review. *Nutr Res Rev* **15**, 373–387.
- Kamphuis CB, Giskes K, de Bruijn GJ *et al.* (2006) Environmental determinants of fruit and vegetable consumption among adults: a systematic review. *Br J Nutr* **96**, 620–635.
- Shaikh AR, Yaroch AL, Nebeling L *et al.* (2008) Psychosocial predictors of fruit and vegetable consumption in adults: a review of the literature. *Am J Prev Med* **34**, 535–543.
- Guillaumie L, Godin G & Vezina-Im LA (2010) Psychosocial determinants of fruit and vegetable intake in adult population: a systematic review. *Int J Behav Nutr Phys* **7**, 12.
- Johansson L & Andersen LF (1998) Who eats 5 a day? Intake of fruits and vegetables among Norwegians in relation to gender and lifestyle. *J Am Diet Assoc* **98**, 689–691.
- Agudo A & Pera G (1999) Vegetable and fruit consumption associated with anthropometric, dietary and lifestyle factors in Spain. EPIC Group of Spain. European Prospective Investigation into Cancer. *Public Health Nutr* **2**, 263–271.
- Estaquio C, Druesne-Pecollo N, Latino-Martel P *et al.* (2008) Socioeconomic differences in fruit and vegetable consumption among middle-aged French adults: adherence to the 5 a day recommendation. *J Am Diet Assoc* **108**, 2021–2030.
- Centers for Disease Control and Prevention (2010) State-specific trends in fruit and vegetable consumption among adults – United States, 2000–2009. *MMWR Morb Mortal Wkly Rep* **59**, 1125–1130.
- Godin G, Amireault S, Bélanger-Gravel A *et al.* (2010) Prediction of daily fruit and vegetable consumption among overweight and obese individuals. *Appetite* **54**, 480–484.
- Azagba S & Sharaf M (2011) Disparities in the frequency of fruit and vegetable consumption by socio-demographic and lifestyle characteristics in Canada. *Nutr J* **10**, 118.
- Ricciuto L, Tarasuk V & Yatchew A (2006) Socio-demographic influences on food purchasing among Canadian households. *Eur J Clin Nutr* **60**, 778–790.
- Lallukka T, Laaksonen M, Rahkonen O *et al.* (2007) Multiple socio-economic circumstances and healthy food habits. *Eur J Clin Nutr* **61**, 701–710.
- Elfhag K, Tholin S & Rasmussen F (2008) Consumption of fruit, vegetables, sweets and soft drinks are associated with psychological dimensions of eating behaviour in parents and their 12-year-old children. *Public Health Nutr* **11**, 914–923.
- Yeh MC, Ickes SB, Lowenstein LM *et al.* (2008) Understanding barriers and facilitators of fruit and vegetable consumption among a diverse multi-ethnic population in the USA. *Health Promot Int* **23**, 42–51.
- Hall JN, Moore S, Harper SB *et al.* (2009) Global variability in fruit and vegetable consumption. *Am J Prev Med* **36**, 402–409.
- Lallukka T, Pitkaniemi J, Rahkonen O *et al.* (2010) The association of income with fresh fruit and vegetable consumption at different levels of education. *Eur J Clin Nutr* **64**, 324–327.
- Paalanen L, Prattala R, Palosuo H *et al.* (2011) Socio-economic differences in the consumption of vegetables, fruit and berries in Russian and Finnish Karelia: 1992–2007. *Eur J Public Health* **21**, 35–42.
- Friel S, Newell J & Kelleher C (2005) Who eats four or more servings of fruit and vegetables per day? Multivariate classification tree analysis of data from the 1998 Survey of Lifestyle, Attitudes and Nutrition in the Republic of Ireland. *Public Health Nutr* **8**, 159–169.
- Kamphuis CB, van Lenthe FJ, Giskes K *et al.* (2007) Perceived environmental determinants of physical activity and fruit and vegetable consumption among high and low socioeconomic groups in the Netherlands. *Health Place* **13**, 493–503.
- Wandel M (1995) Dietary intake of fruits and vegetables in Norway: influence of life phase and socio-economic factors. *Int J Food Sci Nutr* **46**, 291–301.
- Devine CM, Wolfe WS, Frongillo EA *et al.* (1999) Life-course events and experiences: association with fruit and vegetable consumption in 3 ethnic groups. *J Am Diet Assoc* **99**, 309–314.
- Bowman SA & Vinyard BT (2004) Fast food consumption of US adults: impact on energy and nutrient intakes and overweight status. *J Am Coll Nutr* **23**, 163–168.
- Crawford D, Ball K, Mishra G *et al.* (2007) Which food-related behaviours are associated with healthier intakes of fruits and vegetables among women? *Public Health Nutr* **10**, 256–265.
- Beydoun MA, Powell LM & Wang Y (2009) Reduced away-from-home food expenditure and better nutrition knowledge and belief can improve quality of dietary intake among US adults. *Public Health Nutr* **12**, 369–381.
- Vandevijvere S, Lachat C, Kolsteren P *et al.* (2009) Eating out of home in Belgium: current situation and policy implications. *Br J Nutr* **102**, 921–928.

38. Dennis B, Ernst N, Hjortland M *et al.* (1980) The NHLBI nutrition data system. *J Am Diet Assoc* **77**, 642–647.
39. Herberg S, Deheeger M, Preziosi P *et al.* (2002) *SU.VI.MAX: Portions Alimentaires Manuel Photos Pour L'estimation des Quantités*. Paris: Polytechnica.
40. Centre d'Information et de Recherche sur les Intolérances et l'Hygiène Alimentaire (2008) *Aliments et préparations typiques de la population marocaine. Outil pour estimer la consommation alimentaire*. Bruxelles: Editions du CIRHA.
41. Traissac P & Martin-Prevel Y (2012) Alternatives to principal components analysis to derive asset-based indices to measure socio-economic position in low- and middle-income countries: the case for multiple correspondence analysis. *Int J Epidemiol* **41**, 1207–1208.
42. World Health Organization (1995) *Physical Status: The Use and Interpretation of Anthropometry. Report of a WHO Expert Committee. WHO Technical Report Series* no. 854. Geneva: WHO.
43. Lauritsen JM & Bruus M (2004) *EpiData version 3.1. A Comprehensive Tool for Validated Entry and Documentation of Data*. Odense, Denmark: The EpiData Association.
44. Stata Corporation (2011) *Stata Statistical Software, Release SE11.2*. College Station, TX: Stata Corporation.
45. Yarnell JW, Fehily AM, Milbank JE *et al.* (1983) A short dietary questionnaire for use in an epidemiological survey: comparison with weighed dietary records. *Hum Nutr Appl Nutr* **37**, 103–112.
46. Behavioral Risk Factor Surveillance System BRFSS (1998) Survey data, National Center for Chronic Disease Prevention and Health Promotion Centers for Disease Control and Prevention, US Department of Health and Human Services. <http://www.cdc.gov/brfss/questionnaires.htm> (accessed June 2012).
47. Thompson B, Demark-Wahnefried W, Taylor G *et al.* (1999) Baseline fruit and vegetable intake among adults in seven 5A Day study centers located in diverse geographic areas. *J Am Diet Assoc* **99**, 1241–1248.
48. Ministério da Saude (2010) *Vigitel Brazil 2010: protection and risk factors for chronic diseases by telephone inquiry*. <http://bvsms.saude.gov.br/php/index.php> (accessed May 2012).
49. Ball KCD & Mishra G (2006) Socio-economic inequalities in women's fruit and vegetable intakes: a multilevel study of individual, social and environmental mediators. *Public Health Nutr* **9**, 623–630.
50. Willett WC (1998) *Nutritional Epidemiology*, 2nd ed. New York: Oxford University Press.