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Correlates of healthy fruit and vegetable diet in students in low, middle and high income countries

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Abstract
Objectives The aim of this study was to assess the prevalence of fruits and vegetable consumption and associated factors among university students from 26 low, middle and high income countries.
Methods Using anonymous questionnaires, data were collected in a cross-sectional survey from 17,789 undergraduate university students (mean age 20.8, SD = 2.8) from 27 universities in 26 countries across Asia, Africa and the Americas.
Results Overall, 82.8 % of the university students consumed less than the recommended five servings of fruits and/or vegetables. The mean fruit and vegetable consumption varied by country, ranging from ≤2.5 mean daily servings in Jamaica, Philippines and Barbados to ≥3.9 mean daily servings in Mauritius, Tunisia and Ivory Coast. In multivariate logistic regression analysis, sociodemographic factors, psychosocial factors, and behavioural factors (inadequate dietary behaviours, binge drinking and physical inactivity) were associated with low prevalence of fruit and vegetable intake.
Conclusions Findings stress the need for intervention programmes aiming at increased consumption of fruit and vegetables considering the identified sociodemographic, psychosocial and behavioural risk factors.

Keywords Fruits · Vegetables · Consumption · Risk factors · Young adults

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Introduction

About 2.8 % of deaths (mainly gastrointestinal cancer, ischaemic heart disease and stroke deaths) globally are attributable to low fruit and vegetable consumption (WHO 2014). The health benefits of fruits and vegetables based on epidemiology studies led to the recommended intake of at least 400 g of fruit and vegetables per day (WHO 2003). Increasing individual fruit and vegetable consumption by up to 600 g per day (the baseline of choice) could reduce the total worldwide burden of disease by 1.8 % (Lock et al. 2005). During the transition from adolescence to young adulthood, the intake of fruit and vegetables tends to decline (Larson et al. 2008).

Studies among young adults, university students, seem to have found a high prevalence of low fruit and vegetable consumption (<5 servings/day), e.g., in Belgium 91.2 % (Verhoeven 2013), Brazil 85.2 % (Ramalho et al. 2012), Chile 94.8 % (Mardones et al. 2009), Germany 95 % (Keller et al. 2008), Saudi Arabia 73.6 % (Elsoadaa et al. 2013), and UK 70 % (Dodd et al. 2010).

Various reviews have identified, among others, sociodemographic, psychosocial and behavioural factors

related to low prevalence of fruit and vegetable consumption (e.g., Pearson et al. 2009; Rusmussen et al. 2006). In terms of sociodemographic factors, male university students tended to more likely have a high low prevalence of fruit and vegetable intake than female students (Elsoadaa et al. 2013; Neumark-Sztainer et al. 1996; Perera and Madhujith 2012; Verhoeven 2013), and a number of studies found an association between lower socioeconomic status and low prevalence of fruit and/or vegetable consumption (Doku et al. 2013; Elsoadaa et al. 2013; Pearson et al. 2009; Perera and Madhujith 2012; Ramalho et al. 2012). Beech et al. (1999) found cultural differences, i.e., African-American adolescents reported a lower mean consumption (2.2 servings) than white adolescents (2.7 servings). McAloney et al. (2014) found among UK young people that compared to white youth, Bangladeshi and Pakistani youth significantly less likely reached fruit and vegetable recommendations. A few studies (Papadaki et al. 2007; El Ansari et al. 2012) seemed to have found that university students living on the campus or off campus on their own were more likely to eat insufficient fruit and vegetables than students living with their parents.

Regarding psychosocial factors, mental distress and depression symptoms (Lytle et al. 2003; Rusmussen et al. 2006; Peltzer and Pengpid 2010), lack of social support or family connectedness (Neumark-Sztainer et al. 1996; Rasmussen et al. 2006), confidence, self-efficacy (Verhoeven 2013), lack of spirituality (Lytle et al. 2003), and poor academic achievement (Neumark-Sztainer et al. 1996) were found to be associated with insufficient fruit and vegetable intake. Behavioural factors associated with inadequate fruit and vegetable intake may include dietary behaviour, including dieting (Neumark-Sztainer et al. 1996), skipping or irregular breakfast (Pedersen et al. 2012; Lazzeri et al. 2013), irregular snack consumption (Lazzeri et al. 2013), lack of dietary fibre (Bertsias et al. 2005), low potassium (Bertsias et al. 2005), saturated and trans fatty acids and cholesterol (Bertsias et al. 2005), substance use, including tobacco use (Keller et al. 2008; Neumark-Sztainer et al. 1996) and alcohol use (Neumark-Sztainer et al. 1996), and low physical activity (Peltzer and Pengpid 2012; Ramalho et al. 2012).

Few studies have investigated the determinants of fruit consumption and vegetable consumption separately (e.g., Moore et al. 2014; Yen and Tan 2012), which largely found similar results to the studies with combined fruit and vegetable consumption. There is a lack of studies on fruit and vegetable consumption among young adults including university students across many low, middle and high income countries from Africa, Asia, and the Americas using the same methodology. Hence, the aim of this study was to assess the prevalence of fruit and vegetable consumption and associated factors among university students from 26 low, middle and high income countries, classified according to the World Bank (2013) classification of the world's economies.

Methods

Sample and procedure

This cross-sectional study was carried out with a network of collaborators in participating countries (see "Acknowledgments"). The anonymous, self-administered questionnaire used for data collection was developed in English, then translated and back-translated into languages (Arabic, Bahasa, Chinese, French, Lao, Russian, Spanish, Thai, Turkish) of the participating countries. The study was initiated through personal academic contacts of the principal investigators. These collaborators arranged for data to be collected from intended 400 male and 400 female undergraduate university students aged 16–30 years by trained research assistants in 2013 in 1 or 2 universities in their respective countries. The universities involved were located in the capital cities or other major cities in the participating countries. Research assistants working in the participating universities asked classes of undergraduate students to complete the questionnaire at the end of a teaching class. In each study country, undergraduate students were surveyed in classrooms selected through a stratified random sample procedure. A university department formed a cluster and was used as a primary sampling unit. One department was randomly selected from each faculty. For each selected department, undergraduate courses offered by the department were randomly ordered. We included no incentive for participation, and there were no penalties for refusing to complete the survey. The students who completed the survey varied in the number of years for which they had attended the university. A variety of majors were involved, including education, humanities and arts, social sciences, business and law, science, engineering, manufacturing and construction, agriculture, health and welfare and services. Written informed consent was obtained from participating students, and the study was conducted in 2013. Participation rates were in most countries over 90 %. Ethics approvals were obtained from all participating institutions.

The sample size was calculated by using Epi-Info Version 7.1 (CDC). For population survey, the expected frequency of 50 %, Design effect 1, Confidence limited 5 %, Cluster 1, Population size approximately about 20,000 students per 1 university. For 99 % Confidence Interval, required minimum sample size of 644. This study wants to see behaviours in male and female students; thus

the sample size is split into two groups of 322 each. To prevent loss or uncompleted data, the sample size is increased to 800 (400 male, 400 female).

Measures

Fruit and vegetable consumption was assessed with two questions, "How many servings of fruit do you eat on a typical day?" and "How many servings of vegetables do you eat on a typical day?" (One standard serving = 80 g) (Hall et al. 2009). Cronbach alpha for this fruit and vegetable measure was 0.74. Insufficient fruit and vegetable consumption was defined as less than five servings of fruits and/or vegetables a day (Hall et al. 2009), and adequate fruit consumption 2 or more servings a day and adequate vegetable consumption 3 or more servings a day (CDC 2013).

Sociodemographic factor questions included age, gender, living arrangement, and socioeconomic background was assessed by rating their family background as wealthy (within the highest 25 % in "country", in terms of wealth), quite well off (within the 50–75 % range for their country), not very well off (within the 25–50 % range from "country"), or quite poor (within the lowest 25 % in their country, in terms of wealth). (Wardle and Steptoe 1991). We subsequently divided the students into poorer (not very well off and quite poor) and wealthier (wealthy, quite well off) categories.

Psychosocial factor variables

Centers for epidemiologic studies depression scale (CES-D)

We assessed depressive symptoms using the 10-item version of the CES-D (Andresen et al. 1994). Scoring is classified from 0 to 9 as having a mild level of depressive symptoms, 10–14 as moderate depressive symptoms, and ≥15 representing severe depressive symptoms (Andresen et al. 1994). The Cronbach α reliability coefficient of this 10-item scale was 0.78 in this study.

Non-organised religious activity

Non-organised religious activity was assessed with one item of the Duke University Religion Index (DUREL; Koenig et al. 1997).

Social support

Three items were drawn from the Social Support Questionnaire to assess perceived social support (Brock et al. 1996). Cronbach's alpha for this sample was 0.95.

Academic performance

Academic performance was assessed with the question, 'how would you rate your academic performance?' Response options ranged from 1 = excellent to 5 = not satisfactory. Results were reverse coded with a higher score indicating better academic performance, ranging from 1 to 5.

Behavioural factors

Additional dietary variables included: (a) trying to avoid eating foods that contain fat and cholesterol (yes, no); (b) trying to eat foods that are high in fibre (yes, no); (c) frequency of having breakfast (1 = almost every day to 3 = rarely or never); (d) frequency of having meals in a day; (e) frequency of having between-meal snacks in a day, (f) adding salt to meals (1 = usually to 4 = never); (g) eat a meal that includes meat (beef, pork, lamb, etc.) (1 = at least once a day to 5 = never); and (h) dieting to lose weight (yes, no) (Wardle and Steptoe 1991).

Tobacco use was assessed with the question: Do you currently use one or more of the following tobacco products (cigarettes, snuff, chewing tobacco, cigars, etc.)? Response options were "yes" or "no" (WHO 1998).

Binge drinking was assessed with one item, "How often do you have (for men) five or more and (for women) four or more drinks on one occasion?" Response options ranged from 1 = never to 5 = daily or almost daily (Babor et al. 2001).

Physical activity was assessed using the short version of the self-administered International Physical Activity Questionnaire (IPAQ) (IPAQ-S7S). The IPAQ aims to determine the time spent being physically active in the last 7 days by assessing the frequency and duration of walking, moderate-intensity and vigorous-intensity activity performed for at least 10 min duration per session (Craig et al. 2003). We categorise the population into two levels of physical activity: "low" and "moderate" or "high". Categories are based on standard scoring criteria http://www.ipaq.ki.se website, where the "moderate" category usually indicates meeting physical activity guidelines of 30 min of moderate intense activity 5 days a week, 20 min of vigorous activity 3 days a week, or a combination (International Physical Activity Questionnaire 2014).

Data analysis

Data analysis was performed using STATA software version 11.0 (Stata Corporation, College Station, Texas, USA). The proportion of sociodemographic, psychosocial and behavioural factors, and the prevalence of fruit and vegetable consumption was calculated as a percentage. We

used univariate logistic regression, followed by multivariate logistic regression with forced entry to obtain adjusted odds ratios (AOR) and associated 95 % confidence intervals to assess the association between sociodemographic, psychosocial and behavioural variables, and prevalence of inadequate fruit and vegetable intake. All variables statistically significant at the $p < 0.05$ level in bivariate analyses were included in the multivariate model. $p < 0.05$ was considered significant. In addition, multivariate conditional logistic regression was used to separately assess the association between sociodemographic, psychosocial and behavioural variables, and prevalence of adequate fruit (2 or more servings) and adequate vegetable (3 or more servings) intake, respectively. Variance inflation factor (VIF) and tolerance values for each model indicate multicollinearity was not a concern in any of the multivariate analyses. The country was entered as the primary sampling unit for survey analysis in STATA in order to achieve accurate CIs, given the clustered nature of the data.

Results

Sample characteristics

The total sample included 17789 undergraduate university students (mean age 20.8, SD = 2. 8) from 26 countries. Overall, 82.8 % of the university students consumed less than the recommended five servings of fruits and/or vegetables. The mean fruit and vegetable consumption varied by country, ranging from ≤2.5 mean daily servings in Jamaica, Philippines and Barbados to ≥3.9 mean daily servings in Mauritius, Tunisia and Ivory Coast (see Table 1).

Table 2 describes the sample's independent and dependent variables. Overall, 34.5 % reported adequate fruits consumption (2 or more servings/day) and 18.8 % had adequate vegetables consumption (3 or more servings/day). Analysing differences in fruit and vegetable consumption by region, university students from study countries in the Caribbean and South America and Southeast Asia had significantly poorer fruit and vegetable consumption together and fruit consumption alone than students from any of the other study regions (see Table 2).

Associations with low prevalence of fruit and vegetable consumption

In multivariate logistic regression analysis, sociodemographic factors (younger age, living away from parents, having a poorer family background, and coming from a lower income country), psychosocial factors (low non-organised religious activity and high social support), and behavioural factors (not dieting to lose weight, lower meal and snack frequency, eating red meat at least once a day, usually adding salt to meals, not avoiding fat and cholesterol, not trying to eat fibre, binge drinking and physical inactivity) were associated with low prevalence of fruit and vegetable intake (see Table 3).

Associations with prevalence of adequate fruits and adequate vegetables consumption

In multivariate conditional logistic regression analysis, sociodemographic factors (living with parents or relatives, having a wealthier family background, and coming from a higher income country), psychosocial factors (non-organised religious activity), and behavioural factors (dieting to lose weight, higher meal and snack frequency, not skipping breakfast, not eating red meat at least once a day, avoiding fat and cholesterol, trying to eat fibre, not currently using tobacco and not binge drinking) were associated with adequate fruits consumption. Further, in multivariate conditional logistic regression analysis, sociodemographic factors (older age, being male, and living with parents or relatives), psychosocial factors (non-organised religious activity), and behavioural factors (higher meal and snack frequency, not eating red meat at least once a day, avoiding fat and cholesterol, trying to eat fibre, not currently using tobacco and moderate or high physical activity were found to be associated with adequate vegetables consumption (see Table 4).

Discussion

Using the same methodology for assessing fruit and vegetable consumption and comprehensive other measures, this study surveyed a large sample of university students in 26 low, middle and high income countries across Africa, Asia and the Americas. This study found, across the different study countries in mainly low and middle income countries, a high prevalence of inadequate fruit and vegetable consumption which is largely comparable with previous studies among university students in middle and high income countries (Dodd et al. 2010; Elsoadaa et al. 2013; Keller et al. 2008; Mardones et al. 2009; Ramalho et al. 2012). Considering the enormous health benefits of fruit and vegetable consumption (Lock et al. 2005), interventions in support of increasing fruit and vegetable intake are urgently needed.

There was significant country variation in the prevalence of inadequate and mean fruit and vegetable consumption ranging from low rates in Jamaica, Philippines and Barbados to high rates in Mauritius, Tunisia and Ivory Coast. In comparison with nationally representative adult data

Table 1 Sample and fruit and vegetable consumption by country in 26 countries, 2013

	N	Mean daily servings of			<1 or more servings of fruits (%)	<1 or more servings of vegetables (%)	Prevalence of <5 servings of fruit and vegetables % (95 % CI)
		Fruits *M* (SD)	Vegetables *M* (SD)	Fruits and vegetable *M* (SD)			
All	17,789	1.39 (1.1)	1.66 (1.2)	3.04 (1.9)	14.3	10.3	82.8 (82.2–83.4)
Caribbean and South America							
Barbados[f,b]	370	1.1 (1.0)	1.4 (0.9)	2.5 (1.7)	26.9	18.1	90.3 (87.2–93.3)
Grenada[e,b]	418	1.3 (1.0)	1.5 (1.1)	2.8 (1.9)	16.6	11.9	85.6 (82.3–89.0)
Jamaica[e,a]	681	1.0 (0.9)	1.1 (1.0)	2.1 (1.7)	35.1	21.6	92.4 (90.4–94.4)
Colombia[e,b]	727	1.2 (1.0)	1.4 (1.0)	2.6 (1.7)	19.6	11.6	89.5 (87.4–91.6)
Venezuela[e,b]	551	1.2 (1.0)	1.4 (1.0)	2.6 (1.7)	19.8	11.1	87.5 (84.7–90.2)
Sub-Saharan Africa							
Cameroon[d,a]	626	1.6 (1.2)	1.6 (1.2)	3.2 (2.0)	5.9	6.9	84.7 (81.8–87.5)
Ivory Coast[d,a]	745	1.3 (0.9)	2.6 (1.6)	3.9 (2.0)	14.6	9.5	64.4 (61.0–67.9)
Madagascar[c,a]	741	1.5 (1.1)	1.7 (1.0)	3.2 (1.7)	10.4	3.6	81.0 (78.1–83.8)
Mauritius[e,b]	458	1.6 (1.1)	2.5 (1.4)	4.1 (2.1)	11.3	2.5	66.4 (62.0–70.7)
Namibia[e,a]	456	1.4 (1.1)	1.5 (1.2)	2.9 (2.0)	13.7	12.3	84.2 (80.9–87.6)
Nigeria[d,a]	424	1.4 (1.1)	1.3 (0.9)	2.7 (1.9)	13.6	15.4	89.2 (86.2–92.1)
South Africa[e,a]	588	1.5 (1.2)	1.6 (1.4)	3.1 (2.2)	12.7	14.5	78.9 (75.6–82.2)
North Africa, Near East and Central Asia							
Egypt[d,b]	712	1.8 (1.2)	1.7 (1.2)	3.5 (2.1)	3.9	4.6	77.1 (74.0–80.2)
Tunisia[e,b]	797	1.8 (1.2)	2.2 (1.6)	4.0 (2.2)	4.7	8.8	66.1 (62.8–69.4)
Turkey[e,b]	782	1.4 (1.0)	1.5 (1.0)	2.9 (1.7)	9.8	9.8	84.3 (81.7–86.8)
Russia[e,b]	789	1.5 (1.1)	1.5 (1.1)	3.0 (2.0)	14.9	13.3	82.5 (79.9–85.2)
Kyrgyzstan[c,b]	832	1.5 (1.1)	1.6 (1.1)	3.1 (1.9)	5.5	7.1	86.5 (84.2–88.9)
South Asia and China							
Bangladesh[c,a]	636	1.4 (1.1)	1.9 (1.2)	3.3 (1.9)	22.8	11.4	76.1 (72.8–79.4)
India[d,a]	788	1.4 (1.2)	1.7 (1.3)	3.1 (2.1)	22.7	22.2	80.1 (77.3–82.9)
Pakistan[d,a]	804	1.4 (1.1)	1.4 (1.1)	2.9 (1.7)	18.0	13.3	85.6 (83.1–88.0)
China[e,a]	1,074	1.2 (0.8)	1.7 (0.9)	2.9 (1.4)	17.2	4.1	89.4 (87.5–91.2)
Southeast Asia							
Indonesia[d,b]	737	1.4 (0.9)	1.6 (1.0)	3.0 (1.6)	8.3	4.9	84.9 (82.4–87.5)
Laos[d,a]	794	1.2 (0.7)	1.5 (1.0)	2.7 (1.6)	9.2	8.5	90.4 (88.4–92.5)
Philippines[d,a]	775	1.1 (0.9)	1.3 (1.1)	2.4 (1.6)	21.5	18.2	91.1 (89.1–93.1)
Singapore[f,b]	876	1.3 (1.0)	1.7 (1.1)	3.0 (1.7)	16.2	6.7	86.6 (84.4–88.9)
Thailand[e,b]	523	1.6 (1.1)	2.0 (1.1)	3.6 (1.9)	4.0	2.3	73.0 (69.2–76.8)

[a] Gross enrollment ratio, tertiary education: 4–28 % (World Bank 2014)

[b] Gross enrollment ratio, tertiary education: 30–78 %

[c] Low income country

[d] Lower middle income country

[e] Upper middle income country

[f] High income country (Source: World Bank, New Country Classifications, 2013)

from the World Health Survey (WHS) using the same measure for fruit and vegetable assessment in 13 countries, our findings seem to be similar in two countries, Namibia 84.2 vs. 87.7 % in the WHS and Russian Federation 82.5 vs. 81.1 %; lower inadequate fruit and vegetable consumption in 6 countries, China 89.4 vs. 95.7 % in the WHS, Ivory Coast 64.4 vs. 70.9 %, Tunisia 66.1 vs. 94.4 %, Turkey 84.3 vs. 91.0 %, Mauritius 66.4 vs. 89.5 % and Pakistan 85.6 vs. 99.3 %, and higher inadequate fruit and vegetable consumption in 5 countries, Bangladesh 76.1 vs. 47 % in the WHS, India 80.1 vs. 74.2 %, Laos 90.4 vs. 80.4 %, South Africa 78.9 vs. 69.5 % and Philippines 91.1

Table 2 Independent variables and dependent variables in 26 countries, 2013

	Sample		<5 servings of fruit and vegetables	2 or more servings of fruits	3 or more servings of vegetables
	N or *M*	% or SD	% or *M* (SD)	% or *M* (SD)	% or *M* (SD)
Sociodemographic factors					
All					
Age in years			82.8	34.5	18.8
17–19	6,024	35.0	84.3	34.2	16.9
20–21	5,974	34.7	83.0	35.3	19.2
22 or more	5,194	30.2	81.4	33.0	20.5
Gender					
Female	10,399	58.7	83.3	34.9	18.5
Male	7,330	41.3	82.2	33.8	19.3
Living arrangement					
With parents/relatives	9,055	51.2	80.8	36.9	21.0
On campus/off campus (on their own)	8,629	48.8	85.1	31.9	16.5
Family economic background					
Quite poor/not very well off	8,121	46.2	84.5	29.6	19.3
Wealthy/quite well off	9,457	53.8	81.5	38.7	18.3
Country income					
Low income/lower middle income	8,614	51.6	82.5	33.8	18.6
Upper middle income/high income	9,175	48.4	83.1	35.2	19.1
Gross enrolment ratio, tertiary education[a]					
4–17 %	5,814	32.7	81.3	34.7	20.6
25–35 %	5,564	31.3	83.3	34.9	18.5
40–78 %	6,411	36.0	83.9	33.8	17.5
Region					
Caribbean and South America	2,832	15.9	89.3*	26.8*	12.3*
Sub-Saharan Africa	4,038	22.7	77.8	37.8	25.3
North Africa, Near East, Central Asia	3,912	22.0	79.4	41.8	19.1
South Asia and China	3,302	18.6	83.7	34.3	18.1
Southeast Asia	3,705	20.8	86.1*	29.0*	17.1
Psychosocial factors					
Depression symptoms (moderate or severe)	6,717	37.8	82.9	33.7	18.7
Non-organised religious activity					
Low	5,276	29.7	86.4	29.3	16.2
Medium	6,418	36.1	81.6	35.8	19.9
High	6,095	34.3	80.9	37.5	19.9
Social support					
High	7,458	42.7	83.9	34.2	18.4
Low	10,006	57.3	82.3	34.3	18.8
Academic performance (range 1–5)	3.0	0.9	3.0 (1.0)	4.1 (1.0)	3.9 (1.0)
Behavioural factors					
Dieting to lose weight	2,686	15.5	79.2	41.5	20.0
Daily meal frequency	2.7	0.7	2.6 (0.7)	2.7 (0.8)	2.8 (0.7)
Daily snacks frequency	1.5	0.9	1.5 (0.9)	1.7 (0.9)	1.6 (0.9)
Skips breakfast	8,047	45.3	84.9	30.7	17.2
Eats red meat at least once a day	8,136	46.0	85.1	31.2	16.9
Usually adds salt to meals	7,055	39.8	83.7	35.4	17.9
Avoids fat and cholesterol	6,821	38.8	79.6	39.3	21.8
Trying to eat fibre	6,863	39.4	78.7	39.5	23.4

Table 2 continued

	Sample		<5 servings of fruit and vegetables	2 or more servings of fruits	3 or more servings of vegetables
	N or *M*	% or SD	% or *M* (SD)	% or *M* (SD)	% or *M* (SD)
Current tobacco use	2,154	12.9	83.8	31.4	17.1
Binge drinking (at least once/month)	2,169	12.2	84.9	29.6	16.6
Physical activity					
Low	8,116	45.6	83.6	34.4	18.1
Moderate/high	9,673	54.4	81.1	34.5	19.5

* $P < 0.001$

[a] World Bank (2014) Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown

Table 3 Associations with prevalence of low fruit and vegetable consumption in 26 countries, 2,013

	UOR (95 % CI)	AOR (95 % CI)
Sociodemographic factors		
Age in years		
17–19	1.00	1.00
20–21	0.91 (0.83–1.00)	0.94 (0.84–1.04)
22 or more	0.82 (0.74–0.90)***	0.83 (0.74–0.93)***
Gender		
Female	1.00	–
Male	0.93 (0.85–1.00)	
Living arrangement		
With parents/relatives	1.00	1.00
On campus/off campus (on their own)	1.36 (1.25–1.47)***	1.26 (1.15–1.39)***
Family economic background		
Quite poor/not very well off	1.00	1.00
Wealthy/quite well off	0.81 (0.75–0.87)***	0.77 (0.70–0.85)***
Country income		
Low income/Lower middle income	1.00	1.00
Upper middle income/High income	0.86 (0.79–0.93)***	0.82 (0.74–0.91)***
Psychosocial factors		
Depression symptoms (moderate or severe)	1.01 (0.94–1.10)	–
Non-organised religious activity		
Low	1.00	1.00
Medium	0.70 (0.63–0.77)***	0.78 (0.69–0.87)***
High	0.66 (0.60–0.74)***	0.78 (0.69–0.88)***
Social support		
High	1.00	1.00
Low	0.90 (0.83–0.97)**	0.87 (0.79–0.95)**
Academic performance	0.95 (0.92–0.99)*	0.96 (0.92–1.01)
Behavioural factors		
Dieting to lose weight (base = no)	0.75 (0.67–0.83***	0.88 (0.78–0.99)*
Daily meal frequency	0.75 (0.71–0.79)***	0.76 (0.71–0.81)***
Daily snacks frequency	0.79 (0.76–0.83)***	0.81 (0.77–0.85)***
Skips breakfast	1.32 (1.21–1.42)***	1.07 (0.97–1.18)
Eats red meat at least once a day	1.35 (1.25–1.46)***	1.44 (1.31–1.58)***
Usually adds salt to meals	1.11 (1.03–1.20)***	1.14 (1.03–1.25)**

Table 3 continued

	UOR (95 % CI)	AOR (95 % CI)
Avoids fat and cholesterol	0.70 (0.64–0.75)***	0.80 (0.73–0.89)***
Trying to eat fibre	0.63 (0.58–0.68)***	0.76 (0.68–0.83)***
Current tobacco use (base = none)	1.08 (0.96–1.23)	–
Binge drinking (at least once/month)	1.19 (1.05–1.35)**	1.18 (1.01–1.37)*
Physical activity		
Low	1.00	1.00
Moderate/high	0.84 (0.78–0.91)***	0.74 (0.68–0.81)***

UOR unadjusted odds ratio, *AOR* adjusted odds ratio, *CI* confidence interval

*** $P < 0.001$; ** $P < 0.01$; * $P < 0.05$

Table 4 Associations with prevalence of adequate fruit and adequate vegetable consumption in 26 countries, 2,013

Variable	2 or more servings of fruits AOR (95 % CI)	3 or more servings of vegetables AOR (95 % CI)
Sociodemographic factors		
Age in years		
17–19	–	1.00
20–21		1.14 (1.03–1.26)*
22 or more		1.20 (1.08–1.34)***
Gender		
Female	–	1.00
Male		1.14 (1.04–1.25)**
Living arrangement		
With parents/relatives	1.00	1.00
On campus/Off campus (on their own)	0.85 (0.80–0.92)***	0.81 (0.74–0.88)***
Family economic background		
Quite poor/not very well off	1.00	–
Wealthy/quite well off	1.57 (1.46–1.70)***	
Country income		
Low income/Lower middle income	1.00	1.00
Upper middle income/High income	1.10 (1.02–1.19)*	1.08 (0.99–1.19)
Psychosocial factors		
Depression symptoms (moderate or severe)		
Non-organised religious activity		
Low	1.00	1.00
Medium	1.17 (1.07–1.28)***	1.17 (1.05–1.30)**
High	1.19 (1.08–1.30)***	1.16 (1.03–1.29)*
Social support		
High	–	–
Low		
Academic performance	1.09 (1.05–1.13)***	–
Behavioural factors		
Dieting to lose weight (base = no)	1.22 (1.12–1.37)***	–
Daily meal frequency	1.20 (1.13–1.26)***	1.30 (1.22–1.38)***
Daily snacks frequency	1.32 (1.27–1.37)***	1.12 (1.07–1.18)*
Skips breakfast	0.85 (0.79–0.92)***	–
Eats red meat at least once a day	0.75 (0.69–0.80)***	0.81 (0.74–0.89)***
Usually adds salt to meals	–	–

Table 4 continued

Variable	2 or more servings of fruits AOR (95 % CI)	3 or more servings of vegetables AOR (95 % CI)
Avoids fat and cholesterol	1.22 (1.13–1.33)***	1.21 (1.10–1.33)***
Trying to eat fibre	1.22 (1.13–1.32)***	1.40 (1.27–1.53)***
Current tobacco use (base = none)	0.86 (0.77–0.96)**	0.83 (0.72–0.96)**
Binge drinking (at least once/month)	0.82 (0.73–0.92)***	–
Physical activity		
Low	1.00	1.00
Moderate/High	1.07 (0.99–1.15)	1.23 (1.13–1.35)***

AOR adjusted odds ratio, *CI* confidence interval

*** $P < 0.001$; ** $P < 0.01$; * $P < 0.05$

vs. 76.0 %. From the different study regions, the highest insufficient fruit and vegetable intake was in the Caribbean and South American countries, which seems to concur with the lowest vegetable supply per capita in the South American region (47.8 kg/per capita per year, followed by Africa (52.1 kg), compared to other world regions, with the Asian region (116.2 kg/per capita per year) having the highest supply (Nandi and Bhattacjarjee 2005, WHO 2005). The low fruit and vegetable consumption may be attributed to the nutrition transition in these countries such that eating patterns have shifted from a traditional diet (cereal-based and low fat) to a more westernised diet high in animal meats, fats, sugar and refined foods and low in fibre, fruits and vegetables (Kanungsukkasem et al. 2009). Analysing fruit consumption separately, along with study countries in the Americas Southeast Asian countries had the lowest rates of fruit consumption, compared to the other study regions. This finding is confirmed in a study among school-going adolescents and adults in Southeast Asian countries (Kanungsukkasem et al. 2009; Peltzer and Pengpid 2012), and among adults in the Caribbean (Colón-López et al. 2013). Further, the differences by country in terms of fruit and vegetable consumption may also be related to cultural differences (Beech et al. 1999) and due to patterns of seasonal variability of fruit and vegetable consumption (Pomerleau et al. 2004).

Contrary to a number of studies (Elsoadaa et al. 2013; Neumark-Sztainer et al. 1996; Perera and Madhujith 2012; Verhoeven 2013), this study did not find a difference between male and female university students in terms of prevalence of inadequate fruit and vegetable intake. In agreement with several studies (Doku et al. 2013; Elsoadaa et al. 2013; Pearson et al. 2009; Perera and Madhujith 2012; Ramalho et al. 2012;), this study found a strong association between lower socioeconomic status and low prevalence of fruit and/or vegetable consumption. It is unclear if lack of economic resources, availability, knowledge and/or motivation leads to the low fruit and vegetable consumption (Neumark-Sztainer et al. 1996). One possibility is that fruit and vegetable prices are so high that they form a barrier to consumption in lower income consumers and lower income countries (Pollard et al. 2002). Moreover, the fact that lower intake of fruit and vegetables is linked to lower socioeconomic status at the individual level may mean that the prevalence of low consumption in this study is underestimated, since students often come from a more affluent background. An interesting study finding was that in agreement with some other studies (El Ansari et al. 2012; Papadaki et al. 2007) that university students living on the campus or off campus on their own were more likely to eat insufficient fruit and vegetables than students living with their parents. It is possible that students who stay with their parents engage still more in a traditional diet, while those stay on their own or on campus have a more westernised diet low in fruits and vegetables. This result may call for increased fruit and vegetable promotion in an assortment of places frequented by students.

Regarding psychosocial factors, this study found that low non-organised religious activity and high social support were associated with inadequate fruit and vegetable consumption. In relation to the first variable, low non-organised religious activity, this result has also been found previously (Lytle et al. 2003), while other studies (Neumark-Sztainer et al. 1996; Rasmussen et al. 2006) found the opposite result in relation to social support. The finding that higher non-organised religious activity increased significantly the odds of eating fruits and vegetables can be linked to students having more trait self-control, which was found in a previous study to be associated with higher fruit and vegetable consumption (Hankonen et al. 2014). Hankonen et al. (2014, p. 242) hypothesise that "Individuals high in trait self-control eat more healthily because they have higher self-efficacy, more positive taste expectations, stronger intentions and more plans, compared to those low in self-control." Poorer academic achievement was found

in bivariate analysis to be associated with inadequate fruit and vegetable intake, as found in a previous study (Neumark-Sztainer et al. 1996), while in contrast to previous studies (Lytle et al. 2003; Peltzer and Pengpid 2010; Rusmussen et al. 2006), this study did not find an association with mental distress or depression symptoms.

In this study, a number of dietary behaviours (not dieting to lose weight, lower meal and snack frequency, eating red meat at least once a day, usually adding salt to meals, not avoiding fat and cholesterol, not trying to eat fibre) were found to be associated with inadequate fruit and vegetables intake. Some of these findings confirm previous studies (Bertsias et al. 2005) in terms of lack of dietary fibre and intake of fatty acids and cholesterol, while Neumark-Sztainer et al. (1996) found dieting and our study not dieting to lose weight were associated with inadequate fruit and vegetable consumption. In bivariate analysis, skipping breakfast, as found in previous studies (Lazzeri et al. 2013; Pedersen et al. 2012), was associated also with insufficient fruit and vegetable intake. It appears that some of the hypothesis that study countries are undergoing a health transition where staples and side dishes are replaced by higher proportions of fats and animal meat and less fruits and vegetables (Shetty 2002) is confirmed in this study. This is evident by the association between frequent eating of red meat, not avoiding fat and cholesterol and inadequate fruit and vegetable intake found in this study. The study also confirms the previous findings (Keller et al. 2008; McClure et al. 2009; Neumark-Sztainer et al. 1996; Yen and Tan 2012) in identifying that tobacco users have lower odds of eating fruits and vegetables (when analysed separately). Health promotion programmes should target the tobacco users (Yen and Tan 2012).

In general, this study confirms the co-occurrence of various unhealthy dietary behaviours with inadequate fruit and vegetable consumption. Further, alcohol use (binge drinking) and low physical activity were associated with inadequate fruit and vegetable intake, which conforms with other studies (Neumark-Sztainer et al. 1996; Peltzer and Pengpid 2012; Ramalho et al. 2012). The associations found suggest that intervention programmes may want to address a range of health-compromising behaviours in addition to programmes directed to nutritional intake (Neumark-Sztainer et al. 1996). Our study results imply the need for multifaceted programmes to educate and motivate students to make healthier dietary choices (Yen and Tan 2012) and interventions to increase public awareness on the need to change several behaviours including the increase in fruit and vegetable consumption, other dietary behaviours, physical activity, and tobacco use cessation. These intervention programmes may be targeted and tailored to those university students who have lower fruit and vegetable consumption (Yen and Tan 2012). Based on our study findings, these groups may include students who live in campus residences or on their own, the less wealthy, those who also have poor other dietary behaviours, tobacco users and the physically inactive. In addition, programmes that incorporate an increase of self-control and social support may be beneficial for the increase of fruit and vegetable consumption.

Study limitations

This study had several limitations. The study was cross-sectional, so causal conclusions cannot be drawn. The investigation was carried out with students from one or two universities in each country, and inclusion of other centres could have resulted in different results. University students are not representative of young adults in general, and the consumption of fruit and vegetables and its risk factors may be different in other sectors of the population. The assessment of correlates of fruit and vegetables could have included other factors such as sensory appeal, familiarity and habit, cost, availability and accessibility, time constraints, preferences, personal ideology, policy, guidelines, media and advertising, which have been found relevant in previous studies (Pomerleau et al. 2004; Rasmussen et al. 2006). In addition, some of the measures were brief and academic performance was only assessed by self-report, and future studies should include objective measures of obtaining academic records.

Conclusion

The study found, among a large sample of university students from 26 countries across Africa, Asia and America, a high prevalence of inadequate fruit and vegetable consumption indicating the need to improve fruit and vegetable intake in the young adult population. Having identified sociodemographic, psychosocial and behavioural such as dietary, substance use and physical inactivity risk factors, interventions may be tailored to include multiple health-compromising behaviours.

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Conflict of interest The authors declare that they have no competing interests.

References

Andresen EM, Malmgren JA, Carter WB, Patrick DL (1994) Screening for depression in well older adults: evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). Am J Prev Med 10(2):77–84

Babor TF, Higgins-Biddle JC, Saunders JB, Monteiro M (2001) AUDIT: The Alcohol Use Disorder Identification Test. World Health Organization, Geneva

Beech BM, Rice R, Myers L, Johnson C, Nicklas TA (1999) Knowledge, attitudes, and practices related to fruit and vegetable consumption of high school students. J Adolesc Health 24(4):244–250

Bertsias G, Linardakis M, Mammas I, Kafatos A (2005) Fruit and vegetables consumption in relation to health and diet of medical students in Crete, Greece. Int J Vitam Nutr Res 75(2):107–117

Brock D, Sarason I, Sarason B, Pierce G (1996) Simultaneous assessment of perceived global and relationship-specific support. J Soc Pers Relationships 13:143–152

CDC (2013) State indicator report on fruits and vegetables. Retrieved at http://www.cdc.gov/nutrition/downloads/state-indicator-report-fruits-vegetables-2013.pdf. Accessed 10 Oct 2014

Colón-López V, Banerjee G, Gertz AM, Ortiz AP, Calo W, Finney-Rutten LJ, Colón-Ramos U, Hesse BW, Tortolero G (2013) Behavioral correlates of fruit and vegetable intake in Puerto Rico: results from the Health Information National Trends Survey. P R Health Sci J 32:194–199

Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE et al (2003) International physical activity questionnaire: 12-Country reliability and validity. Med Sci Sports Exerc 35:1381–1395

Dodd LJ, Al-Nakeeb Y, Nevill A, Forshaw MJ (2010) Lifestyle risk factors of students: a cluster analytical approach. Prev Med 51(1):73–77

Doku D, Koivusilta L, Raisamo S, Rimpelä A (2013) Socio-economic differences in adolescents' breakfast eating, fruit and vegetable consumption and physical activity in Ghana. Public Health Nutr 16(5):864–872

El Ansari W, Stock C (2012) Mikolajczyk RT (2012) Relationships between food consumption and living arrangements among university students in four European countries–a cross-sectional study. Nutr J 11:28. doi:10.1186/1475-2891-11-28

Elsoadaa SS, Abdelhafez AM, Rabeh NM, Zahran SE, Osfor MMH (2013) Consumption of fruits and vegetables among UmmAl-Qura university students in Makkah, Saudi Arabia: a cross-sectional study. Life Sci J 10(4):223–231

Hall JN, Moore S, Harper SB, Lynch JW (2009) Global variability in fruit and vegetable consumption. Am J Prev Med 36(5):402–409

Hankonen N, Kinnunen M, Absetz P, Jallinoja P (2014) Why do people high in self-control eat more healthily? Social cognitions as mediators. Ann Behav Med 47:242–248

International Physical Activity Questionnaire (IPAQ). IPAQ Scoring Protocol. Available online: https://sites.google.com/site/theipaq/. Accessed on 5 April 2014

Kanungsukkasem U, Ng N, Van Minh H, Razzaque A, Ashraf A, Juvekar S, Masud Ahmed S, Huu Bich T (2009) Fruit and vegetable consumption in rural adults population in INDEPTH HDSS sites in Asia. Glob Health Action Sep 28;2. doi: 10.3402/gha.v2i0.1988

Keller S, Maddock JE, Hannöver W, Thyrian JR, Basler HD (2008) Multiple health risk behaviors in German first year university students. Prev Med 46(3):189–195

Koenig HG, Parkerson GR Jr, Meador KG (1997) Religion index for psychiatric research. Am J Psychiatry 154:885–886

Larson NI, Neumark-Sztainer DR, Harnack LJ, Wall MM, Story MT, Eisenberg ME (2008) Fruit and vegetable intake correlates during the transition to young adulthood. Am J Prev Med 35(1):33–37

Lazzeri G, Pammolli A, Azzolini E, Simi R, Meoni V, de Wet DR, Giacchi MV (2013) Association between fruits and vegetables intake and frequency of breakfast and snacks consumption: a cross-sectional study. Nutr J 12:123. doi:10.1186/1475-2891-12-123

Lock K, Pomerleau J, Causer L, Altmann DR, McKee M (2005) The global burden of disease attributable to low consumption of fruit and vegetables: implications for the global strategy on diet. Bull World Health Organ 83(2):100–108

Lytle LA, Varnell S, Murray DM, Story M, Perry C, Birnbaum AS, Kubik MY (2003) Predicting adolescents' intake of fruits and vegetables. J Nutr Educ Behav 35(4):170–175

Mardones HMA, Olivares CS, Araneda FJ, Gómez FN (2009) Stages of change related to fruit and vegetables consumption, physical activity, and weight control in Chilean university students. Arch Latinoam Nutr 59(3):304–309

McAloney K, Graham H, Law C, Platt L, Wardle H, Hall J (2014) Fruit and vegetable consumption and sports participation among UK Youth. Int J Public Health 59(1):117–121

McClure JB, Divine G, Alexander G, Tolsma D, Rolnick SJ, Stopponi M, Richards J, Johnson CC (2009) A comparison of smokers' and nonsmokers' fruit and vegetable intake and relevant psychosocial factors. Behav Med 35:14–22

Moor I, Lampert T, Rathmann K, Kuntz B, Kolip P, Spallek J, Richter M (2014) Explaining educational inequalities in adolescent life satisfaction: do health behaviour and gender matter? Int J Public Health 59(2):309–317

Nandi BK, Bhattacjarjee L (2005) Why fruits and vegetables? Their contribution to improving nutrition in developing countries. Paper presented at the FAO Sub Regional Workshop on Quality and Safety of Fresh Fruits and Vegetables, 28 February to 4 March 2005

Neumark-Sztainer D, Story M, Resnick MD, Blum RW (1996) Correlates of inadequate fruit and vegetable consumption among adolescents. Prev Med 25:497–505

Papadaki A, Hondros G, Scott JA, Kapsokefalou M (2007) Eating habits of university students living at, or away from home in Greece. Appetite 49:169–176

Pearson N, Biddle SJ, Gorely T (2009) Family correlates of fruit and vegetable consumption in children and adolescents: a systematic review. Public Health Nutr 12(2):267–283

Pedersen TP, Meilstrup C, Holstein BE, Rasmussen M (2012) Fruit and vegetable intake is associated with frequency of breakfast, lunch and evening meal: cross-sectional study of 11-, 13-, and 15-year-olds. Int J Behav Nutr Phys Act 9:9. doi:10.1186/1479-5868-9-9

Peltzer K, Pengpid S (2010) Fruits and vegetables consumption and associated factors among in-school adolescents in seven African countries. Int J Public Health 55(6):669–678

Peltzer K, Pengpid S (2012) Fruits and vegetables consumption and associated factors among in-school adolescents in five Southeast Asian countries. Int J Environ Res Public Health 9(10):3575–3587

Perera T, Madhujith T (2012) The pattern of consumption of fruits and vegetables by undergraduate students: a case study. Tropical Agr Res 23(3):261–271

Pollard J, Kirk SF, Cade JE (2002) Factors affecting food choice in relation to fruit and vegetable intake: a review. Nutr Res Rev 15(2):373–387

Pomerleau J, Lock K, McKee M, Altmann DR (2004) The challenge of measuring global fruit and vegetable intake. J Nutr 134(5): 1175–1180

Ramalho AA, Dalamaria T, Souza OF (2012) Regular consumption of fruits and vegetables by university students in Rio Branco, Acre State, Brazil: prevalence and associated factors. Cad Saude Publica 28(7):1405–1413

Rasmussen M, Krolner R, Klepp KI, Lytle L, Brug J et al (2006) Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: quantitative studies. Int J Behav Nutr Phys Act 3:22

Shetty PS (2002) Nutrition transition in India. Public Health Nutr 5(1A):175–182

Verhoeven H (2013) Determinants of fruit and vegetable and fat intake in university students: a cross-sectional explanatory study. PhD Thesis, Free University of Brussels

Wardle J, Steptoe A (1991) The European Health and Behaviour Survey: rationale, methods and initial results from the UK. Soc Sci Med 33:925–936

World Bank (2014) Gross enrollment ratio, tertiary education, both sexes. Retrieved at http://data.worldbank.org/indicator/SE.TER.ENRR. Accessed 12 Nov 2014

World Bank (2013) New Country Classifications, 2013. http://data.worldbank.org/news/new-country-classifications

World Health Organization (WHO) (1998) Guidelines for controlling and monitoring the tobacco epidemic. WHO, Geneva

World Health Organization (WHO) (2003) Diet, nutrition and the prevention of chronic diseases: Report of a Joint WHO/FAO Expert Consultation. WHO, Geneva

World Health Organization (WHO) (2005) Patterns and determinants of fruit and vegetable consumption in sub-Saharan Africa: a multicountry comparison. WHO, Kobe

World Health Organization (WHO) (2014) Global Strategy on Diet, Physical Activity and Health. Retrieved at http://www.who.int/dietphysicalactivity/fruit/en/index2.html. Accessed 12 June 2014

Yen ST, Tan AK (2012) Who are eating and not eating fruits and vegetables in Malaysia? Int J Public Health 57(6):945–951