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Fast-food and sweetened beverage consumption: association with overweight and high waist circumference in adolescents

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Abstract

Objective: Overweight and obesity have increased to epidemic proportions among adolescents and are associated with chronic non-communicable diseases and excess mortality in adulthood. The association of overweight/obesity with poor dietary habits has not been studied in adolescents in middle-income developing countries. The present study aimed to estimate the prevalence of overweight, obesity and high waist circumference (WC) in 15–19-year-old Jamaican adolescents and to investigate the association with fast-food and sweetened beverage consumption.

Design: The study enrolled 1317 (598 male, 719 female) adolescents aged 15–19 years using multistage, nationally representative sampling. Age-specific prevalence calculation used internal *Z*-score lines connecting with the WHO adult cut-off points. Logistic regression was used to examine the association of overweight or high WC with fast-food and sweetened beverage consumption, adjusting for potential confounders.

Results: The overall prevalence of overweight, obesity and high WC was approximately 15%, 6% and 10%, respectively. Prevalence estimated using internal *Z*-scores was similar to that using the International Obesity Taskforce cut-off points. Obesity (8·0% in females, 3·3% in males) and high WC (16·2% in females, 1·7% in males) were significantly more prevalent in females when using internal *Z*-score cut-offs. High WC was associated with the absence of fruit consumption ($P = 0{\cdot}043$) and overweight with high sweetened beverage consumption ($P = 0{\cdot}018$).

Conclusion: Overweight occurs frequently among Jamaican 15–19-year-olds and is associated with increased consumption of sweetened beverages. High WC is more prevalent among females and is related to low consumption of fruits and vegetables. Measures to reduce the consumption of sweetened beverages and increase fruit intake may reduce the prevalence of excess body fat among adolescents.

Keywords
Obesity
Diet
Overweight
Adolescents

Overweight and obesity have increased to epidemic proportions globally[1–6] and are associated with higher prevalence of chronic non-communicable diseases and excess mortality[7–13]. Among Jamaican adults, the prevalence of overweight and obesity increased from 26·5% in 1995[14] to 36·8% in 2000[15]. This is consistent with the ongoing epidemiological transition in middle-income countries. Major contributors to this phenomenon include decreased physical activity, sedentary behaviours, poor dietary patterns and increased food security[13,16]. It has been reported that the prevalence of overweight/obesity is 19·3% among Jamaican schoolchildren aged 11–12 years[17]. Another study estimated the crude prevalence of obesity among 15–19-year-old Jamaicans to be 4% in 2000[18].

The eating habits of youths have changed significantly over the past decades[19,20], with increases in the consumption of fast foods, sweetened beverages and pastries and lower intakes of fruits and vegetables[21–24]. Diet quality has diminished with fast-food consumption[25]. In some countries, the fast-food restaurant – rather than the home – has become the most common place for meal consumption for reasons of convenience, cost and availability[19,23]. Physical activity levels have decreased[23] and sedentary behaviours such as television viewing and playing video/computer games[20,26] have increased. Some epidemiological studies have shown an effect of sweetened beverages or fast-food consumption on BMI and waist circumference (WC)[26–28]. Some adolescent

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surveys have found a significant positive relationship between soft drink consumption and overweight (boys only) and obesity[23,29], whereas others have not[19–22]. The Westernized type of diet has become increasingly common among adolescents in developing countries and may be implicated in the emerging regional obesity epidemic. The association between overweight/obesity and poor dietary habits has not been studied in adolescents in middle-income developing countries.

More research is needed on the dietary factors contributing to the growing rate of adolescent overweight and obesity in Jamaica and the Caribbean. The age group 10–24 years, representing about 30 % of the Jamaican population[30], has traditionally been the healthiest and least demanding on the health-care system. However, at the present time there is clearly a need for health services to adapt to the increased demands from health-care problems among youths. Obesity in adolescence tracks into adulthood[2,31] and is associated with increased incidence of type 2 diabetes mellitus in youth[10,26,32]. It is important to document the burden of adolescent obesity and identify risk factors which are amenable to intervention.

In the current paper we present sex-specific prevalence estimates of overweight, obesity and high WC in a nationally representative sample of Jamaican adolescents aged 15–19 years. We explore the associations of fast-food consumption and other aspects of dietary pattern with overweight/obesity and with high WC.

Subjects and methods

General study information

The Jamaica Youth Risk and Resiliency Behaviour Survey 2006[33] enrolled a nationally representative sample of 15–19-year-old adolescents. The objective of the survey was to derive reliable estimates on adolescent health including markers of chronic non-communicable disease risk. Selected participants were visited at home in 2006 by trained interviewers who administered a questionnaire on dietary habits, physical activity, general health/well-being and lifestyle and completed anthropometric and blood pressure measurements. Quality control was assured by duplicate measurements on 10 % of all participants.

Sampling and sample size

A sample of 1185 participants was required to estimate an assumed prevalence of obesity of about 4 %, allowing for a 2 % error at the 95 % confidence level. Based on an expected refusal rate of 10 %, the adjusted sample size was 1320. The 2003 national demographic statistics estimated that there were 250 352 adolescents in the age group 15–19 years, representing approximately 10 % of the Jamaican population[30]. Participants were enrolled via a multistage sampling design. Jamaican enumeration districts were used as primary sampling units (PSU). Fifteen participants were systematically selected from each of the eighty-eight randomly selected PSU. PSU consisted of up to three enumeration districts (ED) and in cases where the expected number of adolescents (10 % of district population) was lower than fifteen, an additional and or adjacent ED was used. The overall refusal rate was 0·2 % and 1317 subjects (598 males, 719 females) provided data for analysis.

Overweight and obesity

Body weight, without shoes and with light clothing, was recorded to the nearest 0·1 kg using a calibrated electronic platform scale (model 2204; Tanita, Kingston, Jamaica). Standing height was recorded to the nearest 0·1 cm using a Seca Leicester Portable Height Measure (model SE001; Proweight Ltd, Nottingham, UK). Subjects had to stand tall but relaxed with heels together but feet diverging slightly. To the extent possible, heels, buttocks, shoulders and back of the head were positioned against the vertical ruler. Subjects were asked to look straight ahead during the measurement. BMI was calculated as weight divided by the square of height (kg/m^2).

Two different definitions of overweight and obesity were used for determination of sex-specific prevalence. The first definition used cut-off values for overweight and obesity that were based on internal *Z*-score lines connecting with the WHO 'adult' $\geq 25\,kg/m^2$ (overweight) and $\geq 30\,kg/m^2$ (obesity) cut-offs at age 18 years (Fig. 1). This method works as follows. First, to obtain BMI *Z*-scores, the distribution of raw BMI values for each sex was modelled with the LMS method[34] using the LMS module of the Growth Analyser software package version 3·0 (Dutch Growth Foundation, Rotterdam, The Netherlands). The LMS method is a method of constructing reference centile curves developed by Cole and Green[34]. It summarizes changing distributions by three curves representing the median (M), coefficient of variation (S) and skewness (L) (Box–Cox power) using penalized likelihood. Given these distribution parameters *Z*-scores can be calculated for any observed (BMI) value. It is important to emphasize that this method of *Z*-score calculation does not use an external reference. The obtained BMI *Z*-scores are internal *Z*-scores, i.e. they indicate each BMI value's position within the distribution of sample values at the same age and sex. Second, for each sex we determined which *Z*-score corresponded to the adult 25 and $30\,kg/m^2$ cut-offs at age 18 years. These *Z*-score cut-offs were then applied to the BMI *Z*-scores of all children younger than 18 years to find cases of overweight and obesity among them. We applied this back-tracking method on the assumption that children's BMI during adolescence tends to track better along the reference lines (*Z*-score lines) of their own population than along an external reference[35]. Given the fact that there are population differences in maturation rate and body composition, this assumption may

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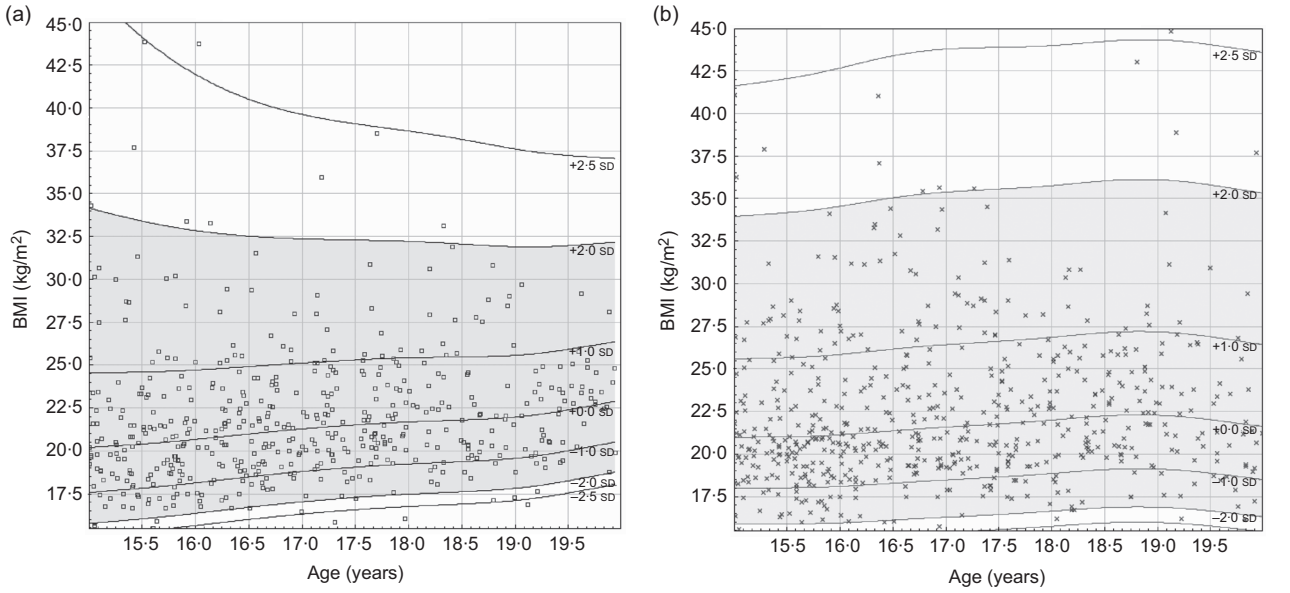

Fig. 1 Observed values and smoothed *Z*-score curves for BMI by age in males (a) and females (b): 15–19-year-old Jamaican adolescents, 2006

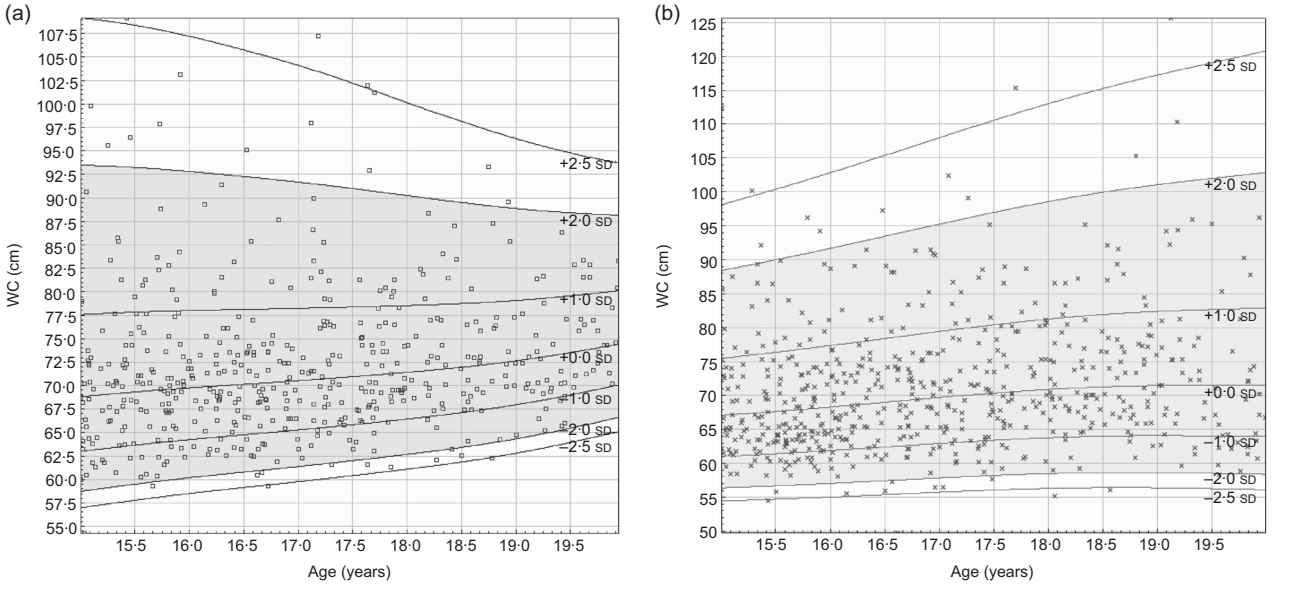

Fig. 2 Observed values and smoothed *Z*-score curves for waist circumference (WC) by age in males (a) and females (b): 15–19-year-old Jamaican adolescents, 2006

well be reasonable. Based on similar premises the use of internal references for scoring of BMI has been advocated before[35]. For participants aged 18 years and older the standard adult cut-offs were applied.

The second definition of overweight and obesity was based on the age/sex-specific BMI cut-off values proposed by the International Obesity Taskforce[36]. These international reference values were produced with the same back-tracking method as described above, the only difference being that a merged data set from different countries was used.

Waist circumference

WC was measured to the nearest 0·1 cm with a plastic tape measure using a standardization protocol observing waist as the midpoint between the lowest rib and iliac crest. The 'adult' cut-offs for high WC circumference, applied from age 18 years, were ≥93 cm for males and ≥81 cm for females[37]. For subjects younger than 18 years, the same method was used as described above for overweight and obesity, i.e. internal *Z*-score cut-offs corresponding to the 18-year values were applied (Fig. 2).

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Dietary pattern

We used a standard questionnaire that was validated for use in similar populations of adolescents[38]. Questions were asked pertaining to the dietary consumption pattern during a usual week, i.e. a week without social events modifying usual intake. Two questions were asked about dietary consumption: one on the usual weekly consumption pattern and the other about the frequency with which the particular food or food groups were consumed. For example, for fast-food consumption: (i) 'During a usual week, do you eat food at fast-food places such as Burger King, Juicy Patties, Tastee, Pizza Hut, Kentucky Fried Chicken?' These places are the main fast-food chains operating in Jamaica. Response categories for this first question were 'yes', 'no' and 'don't know'; and (ii) 'During a usual week, how many times do you eat food at places such as Burger King, Juicy Patties, Tastee, Pizza Hut, Kentucky Fried Chicken?' Response categories were '<1', '1', '2', '3', '4', '5 or more' and 'don't know'. A similarly structured set of questions was asked about usual week consumption of fruits, vegetables, pastries (buns, cakes, cookies, tarts, croissant, doughnuts, etc.) and sweetened beverages (sodas, lemonade, Kool Aid, box drinks and other sweetened beverages). Sweetened beverages consumption was categorized into bottle or glass per time and there was no differentiation between the types of sweetened beverages or the quantity and nature of sweetener used. We categorized days of alcohol consumption in the past year as more than once per week or not. Main method of protein source preparation was categorized as frying, steaming or stewing and baking.

Other variables

We calculated exact age at interview based on reported birth date and date of interview. Gender assignment was based on observation. To detect previously undiagnosed diabetes, we used fasting blood glucose measured with a portable machine (Accutrend GCT; Roche Diagnostics GmbH, Mannheim, Germany). Diabetes was defined as blood glucose $\geq 5{\cdot}6$ mmol/l[39,40]. Physical activity levels in the past week were assessed using the International Physical Activity Questionnaire short form[41] and classified as low, moderate or high. As a proxy for socio-economic status we used the proportion of household item possessions out of a predefined list of fifteen items.

Effect of dietary pattern on overweight and high waist circumference

We used crude odds ratios and multiple logistic regression analysis to explore the association between dietary pattern and outcome variables. The internal *Z*-score cut-off method (see above) was used to define overweight and obesity. Children with obesity were excluded from the analyses of overweight. Levels of dietary variables significantly associated with overweight or high WC were simultaneously introduced in a multiple logistic regression model as dummy variables. In addition to including the dietary variables, the regression analysis also included the following covariates: age, gender, diabetes, socio-economic status and physical activity level. Conditional odds ratios and their 95 % confidence intervals were used to express the main effects of fast-food consumption. The statistical software packages STATA version 9·0 (Stata Corporation, College Station, TX, USA) and SPSS version 12·0 (SPSS Inc., Chicago, IL, USA) were used for all statistical calculations.

Ethical issues

Ethical approval was provided by the Ethics Committees of the Ministry of Health, Jamaica and of the University of the West Indies. Informed consent was obtained from each participant in the study (over age 17 years) or a parent or guardian. A confidentiality form was signed by each interviewer upon completion of training. Data were stored anonymously in an electronic database. Personal identifying information was kept in a separate restricted-access master file. Participants with serious untreated health problems were referred to the appropriate health services.

Results

Table 1 illustrates the mean BMI and WC by age and gender of Jamaican 15–19-year-old adolescents within the study. There were significant sex differences for mean BMI but not for WC. Figure 1 illustrates the age distribution of BMI by sex. Individual observed values are shown along with selected *Z*-score lines describing the distribution according to LMS model fitting. Median BMI increased with age and was higher in females than in males at all ages. The Spearman rank correlation between

Table 1 Mean BMI and waist circumference (WC) by age and sex in 15–19-year-old Jamaican adolescents, 2006

	BMI (kg/m^2)					WC (cm)				
	Males (*n* 585)		Females (*n* 701)			Males (*n* 585)		Females (*n* 701)		
Age (years)	Mean	SD	Mean	SD	*P* value	Mean	SD	Mean	SD	*P* value
15	21·4	5·1	22·1	5·2	0·207	71·1	9·1	69·0	9·3	0·033
16	21·5	3·6	22·5	5·1	0·052	70·9	6·3	70·5	9·2	0·666
17	22·0	3·4	22·7	4·8	0·174	72·8	8·2	71·9	10·2	0·448
18	23·3	5·1	22·8	3·8	0·460	73·5	7·1	73·4	9·2	0·898
19	22·4	2·6	23·4	6·0	0·203	73·1	5·5	74·3	13·8	0·524
Total	22·0	4·2	22·6	5·0	0·018	72·0	7·7	71·2	10·1	0·116

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BMI and age was positive and significant ($\rho = 0{\cdot}162$, $P < 0{\cdot}001$; sexes combined). Figure 2 illustrates the age distribution of WC by sex. In females there was a clear increase in WC with age. In males, the median increased with age but the +2 *Z*-score line did not. For older ages, variance increased in females but not in males. There was a small degree of positive skewness in the distribution of BMI and WC in the sample.

The overall prevalence estimates of overweight, obesity and high WC were of the order of 15 %, 6 % and 10 %, respectively (Table 2). Regardless of the definition used, overweight prevalence was higher in females than in males but this did not reach statistical significance. Using internal *Z*-score cut-offs, the prevalence of obesity and high WC was significantly higher in females than in males as judged by the non-overlapping confidence intervals.

Dietary consumption patterns of the 15–19-year-old Jamaican adolescents by sex are shown in Table 3. Table 4 presents the odds ratios of overweight and high WC associated with various levels of fast-food consumption and other aspects of the diet compared with their respective reference level. The crude odds for overweight were increased significantly in subjects who consumed fast food >3 times weekly (OR = 1·84, 95 % CI 1·07, 3·17) and in those who consumed >1 bottle of sweetened beverage daily (OR = 1·52, 95 % CI 1·07, 2·16). Pastry consumption was associated with decreased odds for overweight and high WC but this achieved significance only for high WC in the group who consumed pastries ≥4 times weekly (OR = 0·46, 95 % CI 0·24, 0·91). Vegetable and fruit consumption patterns were not significantly related to overweight. No significant relationship was demonstrated between fast-food or sweetened beverage consumption and high WC. Adolescents who never consumed fruits had significantly increased odds for high WC (OR = 1·75, 95 % CI 1·02, 3·01). Trend analyses exploring the dose–response effect of dietary pattern and overweight showed a significant linear relationship between fast-food and sweetened beverage consumption levels and the odds of overweight (results not shown).

Table 2 Sex-specific prevalence estimates of overweight, obesity and high waist circumference (WC) among 15–19-year-old Jamaican adolescents, 2006

		Overweight		Obesity		
		Internal *Z*-scores*	IOTF†	Internal *Z*-scores*	IOTF†	High WC*
Males	Prevalence (%)	12·5	12·8	3·3	5·0	1·7
	95 % CI	9·8, 15·2	10·1, 15·5	1·9, 4·7	3·2, 6·8	0·6, 2·8
	n	584	585	584	585	577
Females	Prevalence (%)	17·4	17·5	8·0	7·7	16·2
	95 % CI	14·6, 20·2	14·7, 20·3	6·0, 10·0	5·7, 9·7	13·4, 18·9
	n	700	701	700	701	692
Sexes combined	Prevalence (%)	15·2	15·4	5·8	6·5	9·6
	95 % CI	13·2, 17·2	13·4, 17·4	4·5, 7·1	5·1, 7·8	8·0, 11·2
	n	1284	1286	1284	1286	1269

*Based on a method that connects (for each sex) *Z*-score lines of the internal distribution to the adult cut-offs of ≥25 kg/m^2 for overweight, ≥30 kg/m^2 for obesity, ≥93 cm for WC in males and ≥81 cm for WC in females.
†International Obesity Taskforce cut-offs[36].

Table 3 Dietary consumption patterns by sex in 15–19-year-old Jamaican adolescents, 2006

Dietary consumption pattern	Males (%)	Females (%)	Total (%)
Usual week consumption of fruits			
<1 time/d	9·6	9·6	10·2
1 time/d	8·7	8·7	8·4
>1 time/d	81·7	81·1	81·4
Usual week consumption of vegetables			
<1 time/d	33·6	35·5	34·6
1 time/d	47·3	48·2	47·8
>1 time/d	19·1	16·3	17·6
Usual week consumption of fast food			
None	38·5	29·7	33·7
<3 times/week	54·2	60·9	57·9
>3 times/week	7·3	9·4	8·4
Usual week consumption of pastries			
None	15·4	15·1	15·2
<3 times/week	60·0	70·3	65·6
>3 times/week	24·7	14·6	19·2
Usual week consumption of sweetened beverages			
<1 bottle/d	33·9	33·8	33·8
1 bottle/d	18·0	19·6	18·8
>1 bottle/d	48·2	46·7	47·3

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Table 4 Crude odds ratios for the association of overweight or high waist circumference (WC) and levels of dietary pattern variables in non-obese 15–19-year-old Jamaican adolescents, 2006

	Overweight*			High WC*		
	No. in group	Crude OR	95 % CI	No. in group	Crude OR	95 % CI
Usual week consumption						
Fast food						
None	403	Reference group		428	Reference group	
1–3 times/week	696	1·19	0·84, 1·68	724	0·94	0·62, 1·41
≥4 times/week	99	1·84	1·07, 3·17	105	1·08	0·53, 2·17
Sweetened beverages						
<1 bottle/day	415	Reference group		435	Reference group	
1 bottle/d	223	1·04	0·59, 2·16	231	0·67	0·38, 1·20
>1 bottle/d	559	1·52	1·07, 2·16	589	0·92	0·61, 1·39
Pastries						
None	178	Reference group		191	Reference group	
1–3 times/week	782	0·70	0·47, 1·06	821	0·77	0·48, 1·25
≥4 times/week	231	0·64	0·38, 1·06	241	0·46	0·24, 0·91
Vegetables						
>1 time/d	204	Reference group		223	Reference group	
1 time/d	587	1·35	0·86, 2·13	608	0·79	0·48, 1·30
<1 time/d	407	1·11	0·68, 1·80	429	0·86	0·51, 1·45
Fruits						
≥1 time/d	977	Reference group		1024	Reference group	
<1 time/d	100	0·99	0·56, 1·73	101	1·22	0·63, 2·37
None	109	0·96	0·56, 1·65	121	1·75	1·02, 3·01
Usual number of alcoholic drinks						
≤1/week	1119	Reference group			Reference group	
>1/week	80	1·20	0·67, 2·06		0·59	0·23, 1·47
Main cooking method						
Steaming or stewing	457	Reference group		473	Reference group	
Frying	668	1·05	0·76, 1·46	702	0·75	0·50, 1·11
Baking	65	1·66	0·88, 3·12	74	1·64	0·93, 3·25

*Based on a method that connects (for each sex) *Z*-score lines of the internal distribution to the adult cut-offs of ≥25 kg/m^2 for overweight, ≥93 cm for WC in males and ≥81 cm for WC in females.

Table 5 Logistic regression of overweight and high waist circumference (WC) *v.* fast-food consumption, adjusting for other dietary pattern variables, age, sex, socio-economic status, diabetes and physical activity, among non-obese 15–19-year-old Jamaican adolescents, 2006

	Overweight†		High WC†	
Model variable*	Direction of association	*P* value	Direction of association	*P* value
Sex = male	−	0·008	−	<0·001
Sweetened beverage consumption >1 bottle/d	+	0·018	+	0·183
Pastries consumption	−	0·016	−	0·028
High physical activity	−	0·132	+	0·047
No fruit consumption	+	0·171	+	0·043

*Only variables with $P < 0·1$ are listed. Fast-food consumption variables were not significant.
†Based on a method that connects (for each sex) *Z*-score lines of the internal distribution to the adult cut-offs of ≥25 kg/m^2 for overweight, ≥93 cm for WC in males and ≥81 cm for WC in females.

The χ^2 test for trend also showed that there was an inverse association between increases in fruit consumption and high WC (results not shown).

No significant association was found between consumption of alcoholic drinks more than once weekly and overweight or high WC. When baking or frying was the main method of preparing protein in the household, the odds for overweight and high WC (baking only) were notably increased but this did not reach statistical significance.

Fast-food consumption at the different levels was not significantly associated with either overweight or high WC in the multiple logistic regression analysis (Table 5). High consumption of sweetened beverages remained associated with overweight ($P = 0·018$). Consuming more than one bottle of sweetened beverage daily increased the odds for overweight by 50 % (not shown; conditional OR = 1·52, 95 % CI 1·07, 2·16). Pastry consumption had a significant negative association with both overweight and high WC ($P = 0·016$ and $P = 0·028$, respectively). Absence of fruit consumption remained significantly associated with high WC ($P = 0·043$).

Discussion

The findings of the present study reveal that 15·2 % of Jamaican 15–19-year-old adolescents were overweight, 5·8 % were obese and 9·6 % had high WC. The prevalence

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of obesity and high WC was significantly higher in females than in males. Prevalence estimates of overweight and obesity were almost identical regardless of the definition used. There is a great level of comparability between our findings and other studies in adolescent health. For example, the prevalence of overweight is 17·4 % in North America (12–19 years)[42], 20·0 % in Europe, 10·0 % in Africa[4] and 17·0 % in Mexico (10–17 years)[43]. Our findings are consistent with the trend of higher prevalence of overweight and obesity among females seen in other developing countries[1,43,44], but contrast with an opposite trend in developed nations[4,23,45]. The prevalence of overweight and obesity among children and adolescents is increasing globally in both developed and developing countries[1,4,44–46].

The central tenet surrounding overweight and obesity is an imbalance where energy intake exceeds expenditure. Changes in dietary patterns in the past few decades, such as an increase in the consumption of energy-dense, high-fat and sugar-rich foods, and more sedentary lifestyles have been implicated in the pandemic of obesity[19,20,47] but the association between these dietary changes and the increase in obesity has not always been demonstrable in epidemiological studies[15].

Bivariate analysis showed that high consumption of fast foods (OR = 1·84) and sweetened beverages (OR = 1·52) was positively associated with overweight in both sexes. Only the association with high sweetened beverage consumption remained significant when confounders were adjusted for. It is possible that the association with high fast-food consumption became undetectable in multiple regression analysis due to a significant correlation ($P < 0·01$) between fast-food consumption and sweetened beverage consumption. One hypothesized mechanism explaining the contribution of sweetened beverages to the development of overweight is that liquid calories seem to be consumed over and above the usual diet. That is, persons do not take into account the liquid calories and continue to consume their usual total calories[21]. The result is the consumption of excess energy. Both in bivariate and multiple logistic regression analyses there was a counterintuitive negative association between the consumption of pastries and overweight and high WC. This finding is similar to those in a number of studies on adolescent health where pastry consumption was inversely associated to overweight/obesity[23,48,49], and may be explained by the fact that overweight and obese adolescents are more likely to under-report unhealthy food choices. In addition, bias may have resulted from the fact that we obtained information only on the frequency of food consumption, not portion sizes. The latter may have been greater in the overweight and obese adolescents.

Our findings show that fruit consumption less than once per day or none at all was significantly positively associated with high WC particularly in females. Our results support the growing body of evidence implicating increased consumption of fast food and sweetened beverages in the increased prevalence of overweight and obesity[24,49] and the possible protective effect of increased consumption of fruits and vegetables. Secondary analysis of data from the National Health and Nutrition Examination Survey 1999–2002 showed that 24·0 % of children were overweight or at risk for overweight and 10·7 % were clinically overweight. No significant association was found between overweight and increased fast-food and sweetened beverage consumption. However, there was a significant association with lower consumption of milk, fruits and vegetables and with higher total fat consumption[50]. Consumption of sweetened beverages (soft drinks, fruit flavoured drinks, tea and coffee), sweets (desserts, candy, etc.) and animal protein (beef, eggs, pork, poultry and seafood) was positively associated with overweight status[20]. Conversely, dietary patterns consistently containing whole grains, legumes, fruits and vegetables appeared distinctly advantageous in terms of mitigating increases in adiposity[24,51]. Clearly, as diet quality diminishes with increased consumption of energy-dense foods and beverages, healthful foods are being omitted, resulting in heightened prevalence of overweight and high WC among adolescents.

A large proportion of 15–19-year-old Jamaican adolescents are at increased health risk owing to overweight (15·2 %), obesity (5·8 %) and high WC (9·6 %). These data also indicate that dietary patterns limited in or devoid of fruits and vegetables, and with increased consumption of fast foods and sweetened beverages, are associated with overweight and obesity. Our results provide sufficient information to advocate an increase in consumption of fruits and vegetables and a decrease in consumption of fast food and sweetened beverages. The question, however, of just how these dietary patterns are implicated in the high prevalence of overweight and obesity seen in adolescents remains unclear and requires in-depth clinical trials and intervention studies as part of efforts to ameliorate the attendant risk and sequelae associated with overweight and obesity. The inconsistency of associations could be due to chance or bias resulting from misclassification, which is a common problem in nutritional epidemiology. Estimates of dietary intake in the present study were not measured quantitatively but are sufficient to classify dietary patterns of the participants. The significant trends demonstrated cannot be ignored as they may provide a substantial basis for intervention studies.

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References

1. Bener A (2006) Prevalence of obesity, overweight, and underweight in Qatari adolescents. *Food Nutr Bull* **27**, 39–45.
2. Deshmukh-Taskar P, Nicklas TA, Morales M, Yang SJ, Zakeri I & Berenson GS (2006) Tracking of overweight status from childhood to young adulthood: the Bogalusa Heart Study. *Eur J Clin Nutr* **60**, 48–57.
3. James PT (2004) Obesity: the worldwide epidemic. *Clin Dermatol* **22**, 276–280.
4. Kosti RI & Panagiotakos DB (2006) The epidemic of obesity in children and adolescents in the world. *Cent Eur J Public Health* **14**, 151–159.
5. Salazar-Martinez E, Allen B, Fernandez-Ortega C, Torres-Mejia G, Galal O & Lazcano-Ponce E (2006) Overweight and obesity status among adolescents from Mexico and Egypt. *Arch Med Res* **37**, 535–542.
6. Wang Y & Lobstein T (2006) Worldwide trends in childhood overweight and obesity. *Int J Pediatr Obes* **1**, 11–25.
7. Berenson GS, Srinivasan SR, Bao W, Newman III WP, Tracy RE & Wattigney WA (1998) Association between multiple cardiovascular risk factors and atherosclerosis in children and young adults. The Bogalusa Heart Study. *N Engl J Med* **338**, 1650–1656.
8. Freedman DS, Khan LK, Dietz WH, Srinivasan SR & Berenson GS (2001) Relationship of childhood obesity to coronary heart disease risk factors in adulthood: the Bogalusa Heart Study. *Pediatrics* **108**, 712–718.
9. Freedman DS, Dietz WH, Tang R, Mensah GA, Bond MG, Urbina EM, Srinivasan S & Berenson GS (2004) The relation of obesity throughout life to carotid intima-media thickness in adulthood: the Bogalusa Heart Study. *Int J Obes Relat Metab Disord* **28**, 159–166.
10. Fung TT, Rimm EB, Spiegelman D, Rifai N, Tofler GH, Willett WC & Hu HB (2001) Association between dietary patterns and plasma biomarkers of obesity and cardiovascular disease risk. *Am J Clin Nutr* **73**, 61–67.
11. Jafar TH, Chaturvedi N & Pappas G (2006) Prevalence of overweight and obesity and their association with hypertension and diabetes mellitus in an Indo-Asian population. *CMAJ* **175**, 1071–1077.
12. Okosun IS, Cooper RS, Rotimi CN, Osotimehin B & Forrester T (1998) Association of waist circumference with risk of hypertension and type 2 diabetes in Nigerians, Jamaicans, and African-Americans. *Diabetes Care* **21**, 1836–1842.
13. Wilks R, Bennett F, Forrester T & McFarlane-Anderson N (1998) Chronic diseases: the new epidemic. *West Indian Med J* **47**, Suppl. 4, 40–44.
14. Forrester T, Wilks R, Bennett F, McFarlane-Anderson N, McGee D, Cooper R & Fraser H (1996) Obesity in the Caribbean. *Ciba Found Symp* **201**, 17–26.
15. Jackson M, Walker S, Forrester T, Cruickshank JK & Wilks R (2003) Social and dietary determinants of body mass index of adult Jamaicans of African origin. *Eur J Clin Nutr* **57**, 621–627.
16. Gulliford MC (1996) Epidemiological transition in Trinidad and Tobago, West Indies 1953–1992. *Int J Epidemiol* **25**, 357–365.
17. Jackson M, Samms-Vaughan M & Ashley D (2002) Nutritional status of 11–12-year-old Jamaican children: coexistence of under- and overnutrition in early adolescence. *Public Health Nutr* **5**, 281–288.
18. Wilks R, Zohoori N, Ashley D & Figueroa P (2000) *The Jamaican Healthy Lifestyle Survey*. Kingston: Epidemiology Research Unit, University of the West Indies and Ministry of Health.
19. Rajeshwari R, Yang SJ, Nicklas TA & Berenson GS (2005) Secular trends in children's sweetened-beverage consumption (1973 to 1994): the Bogalusa Heart Study. *J Am Diet Assoc* **105**, 208–214.
20. Nicklas TA, Demory-Luce D, Yang SJ, Baranowski T, Zakeri I & Berenson G (2004) Children's food consumption patterns have changed over two decades (1973–1994): The Bogalusa Heart Study. *J Am Diet Assoc* **104**, 1127–1140.
21. Birch LL & Fisher JO (1998) Development of eating behaviors among children and adolescents. *Pediatrics* **101**, 539–549.
22. Carrera PM, Gao X & Tucker KL (2007) A study of dietary patterns in the Mexican-American population and their association with obesity. *J Am Diet Assoc* **107**, 1735–1742.
23. Janssen I, Katzmarzyk PT, Boyce WF, King MA & Pickett W (2004) Overweight and obesity in Canadian adolescents and their associations with dietary habits and physical activity patterns. *J Adolesc Health* **35**, 360–367.
24. Nicklas TA, Yang SJ, Baranowski T, Zakeri I & Berenson G (2003) Eating patterns and obesity in children. The Bogalusa Heart Study. *Am J Prev Med* **25**, 9–16.
25. Bowman SA, Gortmaker SL, Ebbeling CB, Pereira MA & Ludwig DS (2004) Effects of fast-food consumption on energy intake and diet quality among children in a national household survey. *Pediatrics* **113**, 112–118.
26. Bedogni G, Iughetti L, Ferrari M, Malavolti M, De Simone M, Fiori G, Battistini N & Bernasconi S (2002) Association of waist circumference and body mass index with fasting blood insulin in severely obese children: a cross-sectional study. *Diabetes Nutr Metab* **15**, 160–164.
27. Gibson S & Neate D (2007) Sugar intake, soft drink consumption and body weight among British children: further analysis of National Diet and Nutrition Survey data with adjustment for under-reporting and physical activity. *Int J Food Sci Nutr* **58**, 445–460.
28. Ritchie LD, Spector P, Stevens MJ, Schmidt MM, Schreiber GB, Striegel-Moore RH, Wang MC & Crawford PB (2007) Dietary patterns in adolescence are related to adiposity in young adulthood in black and white females. *J Nutr* **137**, 399–406.
29. Phillips SM, Bandini LG, Naumova EN, Cyr H, Colclough S, Dietz WH & Must A (2004) Energy-dense snack food intake in adolescence: longitudinal relationship to weight and fatness. *Obes Res* **12**, 461–472.
30. STATIN (2001) *Demographic Statistic*. Kingston: Statistical Institute of Jamaica.
31. Freedman DS, Khan LK, Serdula MK, Dietz WH, Srinivasan SR & Berenson GS (2005) The relation of childhood BMI to

adult adiposity: the Bogalusa Heart Study. *Pediatrics* **115**, 22–27.
32. Israeli E, Schochat T, Korzets Z, Tekes-Manova D, Bernheim J & Golan E (2006) Prehypertension and obesity in adolescents: a population study. *Am J Hypertens* **19**, 708–712.
33. Wilks R, Younger N, McFarlane S, Francis D, van den Broeck J (2007) Jamaica Youth Risk and Resiliency Behaviour Survey 2006. Community-based Survey on Risks and Resiliency Behaviours of 15–19 year olds, 2007. http://www.cpc.unc.edu/measure/publications/pdf/tr-07-64.pdf (accessed December 2007).
34. Cole TJ & Green PJ (1992) Smoothing reference centile curves: the LMS method and penalized likelihood. *Stat Med* **11**, 1305–1319.
35. Reilly JJ (2006) Obesity in childhood and adolescence: evidence based clinical and public health perspectives. *Postgrad Med J* **82**, 429–437.
36. Cole TJ, Bellizzi MC, Flegal KM & Dietz WH (2006) Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* **320**, 1240–1243.
37. Han TS, van Leer EM, Seidell JC & Lean ME (1995) Waist circumference action levels in the identification of cardiovascular risk factors: prevalence study in a random sample. *BMJ* **311**, 1401–1405.
38. Pan American Health Organization (1997) *The Caribbean Youth Survey 1997*. Washington, DC: Pan American Health Organization.
39. Genuth S, Alberti KG, Bennett P *et al.* (2003) Follow-up report on the diagnosis of diabetes mellitus. *Diabetes Care* **26**, 3160–3167.
40. World Health Organization (2006) *Definition and Diagnosis of Diabetes Mellitus and Intermediate Hyperglycaemia*. Geneva: WHO.
41. IPAQ Research Committee (2006) International Physical Activity Questionnaire (IPAQ) Short Form. http://www.ipaq.ki.se/scoring.pdf (accessed January 2006).
42. Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ & Flegal KM (2006) Prevalence of overweight and obesity in the United States, 1999–2004. *JAMA* **295**, 1549–1555.
43. Rio-Navarro BE, Velazquez-Monroy O, Sanchez-Castillo CP, Lara-Esqueda A, Berber A, Fanghanel G, Violante R, Tapia-Conyer R & James WP (2004) The high prevalence of overweight and obesity in Mexican children. *Obes Res* **12**, 215–223.
44. Bovet P, Chiolero A, Madeleine G, Gabriel A & Stettler N (2006) Marked increase in the prevalence of obesity in children of the Seychelles, a rapidly developing country, between 1998 and 2004. *Int J Pediatr Obes* **1**, 120–128.
45. Lien N, Kumar BN & Lien L (2007) Overweight among adolescents in Oslo. *Tidsskr Nor Laegeforen* **127**, 2254–2258.
46. Smith BJ, Phongsavan P, Havea D, Halavatau V & Chey T (2007) Body mass index, physical activity and dietary behaviours among adolescents in the Kingdom of Tonga. *Public Health Nutr* **10**, 137–144.
47. French SA, Story M & Jeffery RW (2001) Environmental influences on eating and physical activity. *Annu Rev Public Health* **22**, 309–335.
48. Flynn MA, McNeil DA, Maloff B, Mutasingwa D, Wu M, Ford C & Tough SC (2006) Reducing obesity and related chronic disease risk in children and youth: a synthesis of evidence with 'best practice' recommendations. *Obes Rev* **7**, Suppl. 1, 7–66.
49. Janssen I, Boyce WF, Simpson K & Pickett W (2006) Influence of individual- and area-level measures of socioeconomic status on obesity, unhealthy eating, and physical inactivity in Canadian adolescents. *Am J Clin Nutr* **83**, 139–145.
50. O'Connor TM, Yang SJ & Nicklas TA (2006) Beverage intake among preschool children and its effect on weight status. *Pediatrics* **118**, e1010–e1018.
51. Demory-Luce D, Morales M, Nicklas T, Baranowski T, Zakeri I & Berenson G (2004) Changes in food group consumption patterns from childhood to young adulthood: the Bogalusa Heart Study. *J Am Diet Assoc* **104**, 1684–1691.