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A cross-sectional study of Jamaican adolescents' risk for type 2 diabetes and cardiovascular diseases

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A cross-sectional study of Jamaican adolescents' risk for type 2 diabetes and cardiovascular diseases

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ABSTRACT

Objectives: To compare obese versus non-obese Jamaican adolescents' risk for type 2 diabetes (T2D) and cardiovascular diseases (CVDs); and to explore a suitable and economical method of screening for these risk factors in the school settings.

Design: A descriptive cross-sectional study of adolescents' risk for T2D and CVD. All the participants were examined at their respective schools.

Setting: Jamaica, West Indies.

Population: 276 Jamaican adolescents aged 14–19 years, randomly selected from grades 9 to 12 from 10 high schools on the island and included both boys and girls. All ethnicities on the island were represented.

Main outcome measures: High fasting blood glucose, total cholesterol, glycated haemoglobin (HbA1c), blood pressure, body mass index (BMI), waist circumference, waist-to-hip ratio, family history of obesity, T2D and CVDs, low physical activity, and presence of Acanthosis Nigricans. All blood measures were analysed using the finger prick procedure.

Results: Waist circumference, waist-to-hip ratio, Acanthosis Nigricans, total cholesterol, family history of T2D and blood pressure were the strongest predictors of BMI ($p=0.001$). Over one-third of the participants were overweight. Jamaican adolescent females had a significantly higher number of risk factors and were less physically active than males ($p<0.05$). Over 80% of participants reported ≥3 risk factors for T2D and CVD. Participants with BMI ≥25 reported five or more risk factors. One-third of the overweight participants were classified with metabolic syndrome.

Conclusions: Jamaican adolescents are at risk of T2D and CVD. Family history of disease and anthropometric measures identified more participants at risk than did the blood measures. Jamaican adolescent females reported more risk factors for T2D and CVD as compared to males. Collection of this type of data was feasible within the school settings. All data were collected in 1 day per school. Intervention measures are needed to educate Jamaican adolescents to reduce overweight and subsequently the risk factors.

ARTICLE SUMMARY

Article focus

- What is the prevalence of risk factors for developing type 2 diabetes (T2D) and cardiovascular disease (CVD) among Jamaican adolescents?
- Is the screening of adolescents for risk factors of T2D and CVD in a school setting economical and feasible?

Key messages

- Jamaican adolescents are at risk for T2D and CVD. One-third of the sample had more than three risk factors.
- Overweight and obese Jamaican adolescents reported higher numbers of risk factors for T2D and CVD than their non-obese counterparts.
- Gender and place of residence were positively correlated with the risk factors for T2D and CVD. Girls had higher numbers of risk factors than boys. More urban versus rural adolescents had greater numbers of risk factors.

Strengths and limitations of this study

- A wide cross-section of adolescents was examined. Participants came from rural and urban areas, both genders, a variety of socioeconomic status, and all ethnicities were represented.
- The first study of its kind to examine Jamaican adolescents for 12 risk factors in one setting.
- The study provides information to facilitate government intervention for the prevention of chronic diseases within the schools, similar to the methods used in the past for immunisation and prevention of infectious diseases.
- A limitation to the study was that the family histories of T2D, CVD and obesity were self-reported.
- Blood measures were taken using finger pricks instead of standard laboratory procedures. However, this study explores an economical method of screening and provides one which is suitable for adolescents in a school setting.

INTRODUCTION

Obesity and related risk factors of type 2 diabetes (T2D) and cardiovascular diseases (CVDs) are of major public health concern,[1 2] especially in resource-limited countries where the healthcare costs of chronic diseases are

increasing. The prevalence of T2D in Jamaican youth has increased and currently affects over 10 000 individuals.[3] Risk factors for CVDs such as obesity, hypertension, hyperlipidaemia, family history of T2D, and race/ethnicity are common among adolescents.[4 5]

Adolescents in developing countries are consuming more high-fat, energy-dense foods and engaging in decreased physical activity, which mimic the lifestyle of developed nations.[6] Owing to travel, exposure to media and the open market economy, Jamaican adolescents are exposed to different foods and lifestyle factors. As a result, Jamaican adolescents are expected to share similarities in T2D and CVD risk factors with adolescents in the developed countries.

Previous research revealed high body mass indices (BMIs) among Jamaican adolescents and adults.[7–10] However, the relationship of BMI to T2D and expression of CVDs has not been adequately studied in the Jamaican adolescent population. Previous studies of Jamaican adolescents[8] and adults[9] examined the association of metabolic syndrome with socioeconomic status (SES). While several studies have reported a prevalence of high BMI and central adiposity, two well-recognised risk factors for T2D and CVDs,[7–10] the majority of the research on obesity and its relation to T2D has been conducted among Jamaican adults rather than adolescents.[7 10 11]

Research on Jamaican adolescents is needed to assess the risk for T2D and CVDs in this country with scarce public health resources. Over half of the deaths in the Caribbean region during the late 1990 s were related to diabetes, cancer and CVDs.[12 13] Jamaica is in critical need of government-initiated primary prevention programmes that target adolescents, who may be at risk for these preventable chronic diseases. The study aimed to determine whether Jamaican adolescents were at risk for T2D and CVD, as seen in other adolescent populations.

The research questions of this study were:

1. Are Jamaican adolescents at risk for T2D and CVD?
2. Do risk factors for T2D and CVD differ by BMI categories?
3. Do risk factors for T2D and CVD differ by demographic and environmental variables?

METHODS

Five of the 14 parishes on the island were selected, and from these, 300 Jamaican adolescents aged 14–19 years from grades 9 to 12 were randomly selected from 10 high schools. Two schools per parish were randomly selected by drawing the names from a pool of all listed schools in that parish. Selections included one traditional school (offering more academic participants and typically serving middle/upper class families) and a non-traditional school offering more vocational education and typically serving students of lower SES per parish. Within each chosen school, a total of 30 students from grades 9 to 12 were randomly selected. Owing to missing data and the failure of some students to appear on the data collection day, the final sample numbered 276 students (144 boys and 164 girls).

Calculation of sample size

For a multiple linear regression with six predictor risk factors of T2D and CVD, a sample size of 300 was sufficient to yield 99% power to detect an R^2 of 0.10 using an F test with $p<0.05$.[14] The basis of choice for desired power value was based on studies addressing obesity among youth and risk factors for both T2D and CVD.[1 5]

Procedure

This study was approved by the Florida International University Institutional Review Board, the Division of Standards and Regulations Ministry of Health and Environmental Control, and the Ministry of Education and Youth, Jamaica. Written permission was obtained and a contact person (nurse or guidance counsellor) in each school was recruited to organise students on data-collection days. Parental written consent and students' assent were obtained. Participants were screened to determine whether they were on medications known to alter blood pressure (BP), glucose or lipid metabolism, and whether they had known eating disorders. No students fit these criteria.

Students reported for the assessment at 7:30 in each school. All participants reported compliance with fasting instructions. Weights, heights, waist circumference (WC) and BP were measured. Blood was tested by finger pricks for fasting blood glucose (FBG), total cholesterol (TC) and glycated haemoglobin (HbA1c). After completion of all anthropometric measures and blood tests, the students were served breakfast to avoid hypoglycaemic episodes. Next, the participants were examined for physical signs of Acanthosis Nigricans (AN). They then completed demographic and physical activity questionnaires and silhouettes for assessing the family history of obesity. The participants were given a small stipend for their participation. All assessments were completed within 3 h for each school and all data were collected in October 2007.

Anthropometric measures

Heights and weights were taken and used to calculate BMI as weight (kg) divided by height^2 (m^2).[15] BMIs were classified based on Cole *et al*'s[15 16] classifications. Waist and hip measurements were taken using standard procedures[17] and classified as risk versus no risk.

Blood measures

Testing of FBG and TC was performed by workers of the Mobile Unit of the Heart Foundation of Jamaica. Workers of the Diabetes Association of Jamaica conducted the HbA1c tests. Students were pricked twice to obtain sufficient blood samples for all the three tests. FBG was classified based on the most current American Diabetes Association (ADA) criteria.[18] TC was coded using the current National Cholesterol Education Program (NCEP) guidelines for children.[19] The

International Diabetes Federation guidelines of <6.5% were used as the cut-off point for normal levels of HbA1c.[20]

BP was measured twice for each participant; participants rested for 5 min prior to each measurement. An average of two readings was used in the analysis. Participants who plotted below the 90th centile, within the 90–95th centile, and above the 95th centile for height, age and gender were classified as normal, prehypertensive and hypertensive, respectively. Adult values of 140/90 mm Hg were used for participants 17–19 years of age.[19]

The self-administered Physical Activity Questionnaire for Children (PAQ-C) assessed general physical activity levels during the school-year.[21] The instrument consisted of nine items that assessed activity levels at different times of the day including school and out of school activities. Items were scored on a scale of 1–5, where 1 is inactive (non-participation in that particular activity), 2 is low activity level (activity is performed 1–2 times), 3 is moderately active (activity is performed 3–4 times), 4 is active (activity is performed 5–6 times) and 5 is very active (activity is performed >7 times) in the past week. The nine items were summed and then averaged to determine the weekly activity level of adolescents. For the current study, physical activity levels were classified as 0, low (activity performed 0–2 times/week) and 1, physically active (activity performed >2 times/week).

Family history of obesity was determined by students' selections from nine body silhouettes which they considered matched their parents.[22] Presence of AN was determined by the detection of a dark line around the neck.[22] All instruments were pilot tested in a high school that was similar to, but not part of, the sample schools. Instruments for measuring physical activity, family history of obesity and AN were used, and reliability was determined in previous studies.[21–23] The demographic questionnaire was developed by the researcher and tested and validated before being administered. Family histories of T2D and CVDs were obtained from participants.

Statistics

Data were analysed using SPSS V.15.0 for Windows statistical software (SPSS Inc, Chicago, Illinois, USA). χ^2 Analyses were performed to determine the proportion of participants with known risk factors of T2D and CVD who were overweight or obese. Spearman's correlations were performed between participants' and parents' BMIs to determine the relation to family history of obesity. Logistic regressions were used to predict the risk factors by BMI status, race/ethnicity, gender, place of residence and income. Descriptive statistics such as means, SDs, frequencies and percentages for demographic characteristics of the population were determined. Statistical significance was set at $p<0.05$. Holm's sequential Bonferroni method was used to correct for type I error in the logistic regressions.

RESULTS

A total of 276 students participated. Of the 24 non-participants, 4 did not return the parental consent forms, 17 were absent on the day of data collection and 3 were removed from the data set due to incomplete data. Table 1 shows the percentages, means and SDs for all 12 risk factors examined.

Overweight (14.5%) and obese (21%) participants accounted for over one-third of the sample and were considered at risk for T2D and CVDs. Figure 1 shows the percentages of boys and girls in each BMI category.

The majority of the sample was classified as having normal BP. Over 44% had physical signs of AN as observed on the neck region. Participation in physical activities on an average of 1–2 times/week classified 38% of participants at risk for low physical activity (table 1). A higher percentage of participants had parents with T2D than with CVD. About two-third of the sample (65.6%) reported family histories of overweight and obesity. Spearman's correlation showed a weak but significant association between the family histories of obesity and participants' BMI ($r=0.19$, $p<0.001$). Weak positive correlations were found between BMIs of mothers and children ($r=0.15$, $p<0.05$), and between BMIs of fathers and children ($r=0.19$, $p<0.001$). Children were more likely to be underweight than their parents (figure 2). However, children surpassed their parents in the obese category.

Comparison of the risk factors by BMI classification

The total number of risk factors ranged from 0 to 10, with a mean of 3.78±2.32. Fourteen participants reported zero risk factors for T2D and CVD and 40 reported only one risk factor. Figure 3 shows the number of risk factors based on BMI status. A high percentage (83%) of adolescents had three or more risk factors regardless of their BMI status.

Logistic regression predicting the risk factors

Cross-tabulation of BMI with each of the individual risk factors of T2D and CVDs (table 2) and χ^2 analyses revealed significant results for WC, presence of AN, waist-to-hip ratio (WHR), TC, BP and family history of T2D. In all cases, overweight/obese participants, compared to their counterparts, were more likely to be at risk for T2D and CVDs.

Comparison of risk factors with demographic and environmental variables

Gender, ethnicity, place of residence and income were positively associated with nine risk factors for T2D and CVD (high FBG, TC, WC, WHR, and presence of AN, low PA, and family history of obesity, CVD and T2D) and with each individual risk factor. Logistic regression analyses (table 3) showed significance for all demographic variables and selected risk factors. Multiple linear regression analyses were performed on the significantly correlated demographic and environmental variables. Of

Table 1 Distribution of variables for Jamaican adolescents, 2007 (N = 276)

Variables	N (%)	Mean (SD)
Gender		NA
M	112 (40.6)	
F	164 (59.4)	
Ethnicity		NA
Blacks	215 (77.9)	
Non-Blacks	61 (22.1)	
Place of residence		NA
Urban	140 (50.7)	
Rural	136 (49.3)	
Age (years)		15.6 (1.2)
14–16	214 (77.5)	15.1 (0.8)
17–19	62 (22.5)	17.3 (0.5)
Waist circumference (cm)		79.06 (14.2)
No risk (<94 M, <80 F)	197 (71.4)	
Risk (≥94 M, ≥80 F)	79 (28.6)	
Waist-to-hip ratio		0.80 (0.06)
No risk (<0.85 F, <1.0 M)	255 (92.4)	
Risk (≥0.85 F, ≥1.0 M)	21 (7.6)	
Body mass index		23.76 (7.72)
Underweight (<18.5)	68 (24.6)	16.72 (1.30)
Normal weight (18.5–25)	110 (39.9)	20.90 (1.76)
Overweight (25– <30)	40 (14.5)	27.32 (1.38)
Obese (≥30)	58 (21.0)	32.33 (1.68)
Fasting blood glucose (mg/dL)		91.21 (10.5)
Normal (≤100)	234 (84.8)	
IFG (100–126)	39 (14.1)	
Diabetes (≥126)	3 (1.1)	
Total cholesterol (mg/dL)		143.0 (21.3)
Normal (≤170)	250 (90.6)	
Borderline (170–200)	23 (8.3)	
Above normal (≥200)	3 (1.1)	
HbA1c (%)		6.09 (1.3)
Normal (≤6.5)	202 (73.2)	
Above normal (>6.5)	74 (26.8)	
Blood pressure (mm Hg)		
Systolic		116.8 (16.23)
Diastolic		69.9 (10.9)
Normal*	205 (74.3)	
Prehypertensive†	24 (8.7)	
Hypertensive‡	47 (17.0)	
Family histories of T2D		NA
Yes	145 (52.5)	
No	131 (47.5)	
Family histories of CVDs		NA
Yes	82 (29.7)	
No	194 (70.3)	
Family history overweight		NA
Yes	181 (65.6)	
No	95 (34.4)	
Acanthosis nigricans		NA
Present	122 (44.2)	
Absent	154 (55.8)	
Physical activity		NA
Low (PA ≤2×/week)	107 (38.8)	
High (PA >2×/week)	169 (61.2)	

*<90th centile.
†90–95th centile.
‡>95th centile.
HbA1c, glycated haemoglobin; CVDs, cardiovascular diseases; F, female; IFG, impaired fasting glucose; M, male; NA, not applicable; PA, physical activity; T2D, type 2 diabetes.

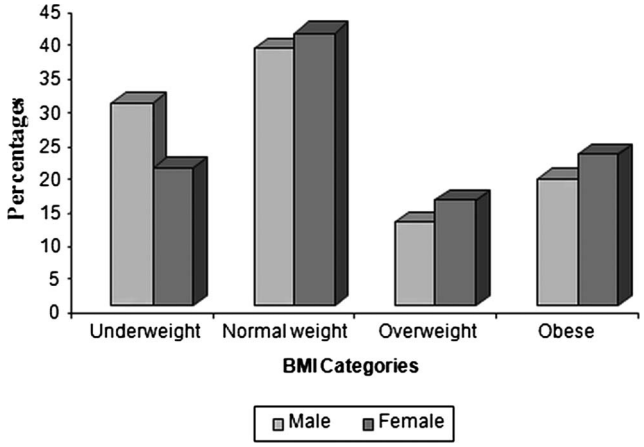

Figure 1 Comparison of actual body mass index (BMI) by gender of Jamaican adolescents. BMI was classified using Cole *et al*'s[15 16] classification for children aged 2–18 years based on age and sex. Higher percentages of girls were found in all BMI categories, except for underweight.

these four variables, only gender was significant for the total number of risk factors (p=0.010). Cross tabulation of gender and number of risk factors showed more girls (n=120, 73.2%), who had ≥3 risk factors, compared to boys (n=63, 52.3%), p<0.05.

DISCUSSION

Jamaican adolescents are at risk of developing T2D and CVDs. In studies of children/adolescents of primarily Caucasian cohorts, girls were more likely to have T2D, whereas boys were more at risk for CVDs.[24–26] In our study, girls had significantly more risk factors than did

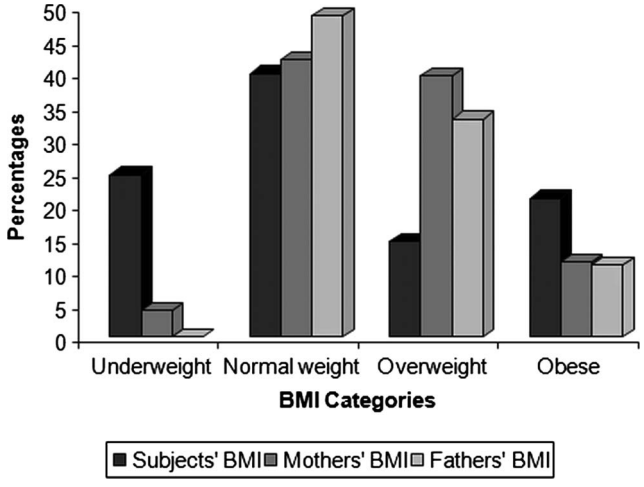

Figure 2 Comparison of adolescent participants' and parents' body mass index (BMI). Participants' BMIs were based on actual measures of weights and heights and classified using Cole *et al*'s[15 16] classification of BMI for children aged 2–18 years based on age and sex. Secondary BMI values from silhouettes were used to determine parents' BMI.

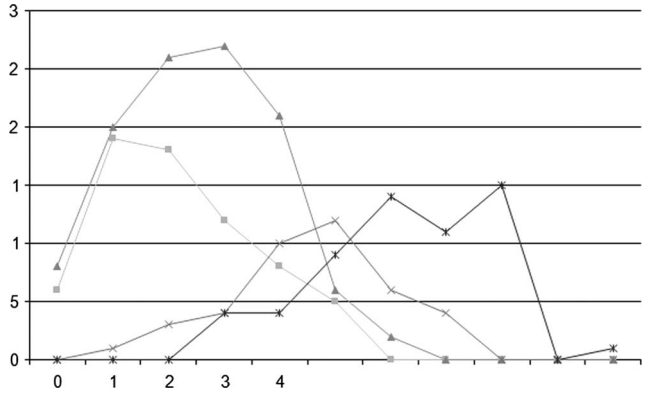

Figure 3 Relationship between body mass index (BMI) status and number of type 2 diabetes (T2D) and cardiovascular disease (CVD) risk factors (R=0.70, p<0.01) for BMI and total number of risk factors. Note: a count of all risk factors was made, and the number of risk factors was compared with the BMI levels. All participants at all BMI levels reported some risk factors. Underweight participants reported a family history of obesity, T2D and CVD, which are risk factors for the development of chronic diseases. Overweight and obese participants had greater numbers of risk factors.

boys and were less physically active. Our findings on clustering of the risk factors related to overweight were similar to previous research,[5 27 28] which found that overweight children and adolescents had at least one cardiovascular risk factor. Our participants, whether overweight or not, had three or more risk factors of T2D and CVD. The number of risk factors was higher than expected when compared to US-based studies.[5 28 29] Knowledge of the prevalence of overweight and the number of risk factors in this population is vital, since obesity during childhood and adolescence transcends into adulthood.[27 30] It is likely that the accompanying risk factors of hypertension, AN, hyperglycaemia and hyperlipidaemia will also be manifested in the adult years.

Differences in risk for T2D and CVD by BMI classification

The findings of high BMI and its association with risk factors for T2D and CVDs were in agreement with studies conducted in minority and Caucasian children.[1 2] There was evidence of a high prevalence of obesity indicators: BMI, WC and WHR, which are considered as risk factors for T2D and CVDs in US adolescents.[1 5 26] The prevalence rate of overweight among Jamaican adolescents was twice that of US adolescents (35% vs 17%)[26] and exceeded previous findings of Jamaican adolescents' overweight.[8 9 31] Higher BMI might have been related to outliers, which were not removed from our analyses due to the small sample size.

We found a high prevalence of underweight and overweight adolescents (24.6% and 35%), which supports the notion that over nutrition and under nutrition coexist in resource-poor countries.[28] This phenomenon, which is referred to as the obesity paradox, occurs when

Table 2 Cross tabulations and ORs of individual risk factors with BMI classifications of Jamaican adolescents, 2007 (N=276)

Risk factors	Underweight/normal (n=185), BMI <25 N (%)	Overweight/obese (n=91), BMI ≥25 N (%)	OR	95% CI	p Value
Fasting blood glucose (≥100 mg/dL)	23 (12.4)	19 (20.9)	1.86	0.9 to 3.6	0.076
Total cholesterol (≥170 mg/dL)	8 (4.3)	18 (19.8)	5.50	2.3 to 13.1	<0.001*
HbA1c (>6.5%)	43 (23.2)	31 (34.1)	1.71	0.9 to 2.9	0.062
Blood pressure (≥90th centile)	29 (15.7)	42 (46.2)	4.60	2.6 to 8.2	<0.001*
Waist circumference (≥94 cm male, ≥80 cm female)	7 (3.8)	75 (82.4)	119.20	47.1 to 30.1	<0.001*
Waist-to-hip ratio (≥1.0 male, ≥0.85 female)	5 (2.7)	16 (17.6)	7.70	2.7 to 21.7	<0.001*
Presence of Acanthosis Nigricans	41 (22.2)	81 (89.0)	28.45	13.5 to 59.8	<0.001*
Low physical activity (≤2×/week)	71 (38.4)	36 (39.6)	1.05	0.6 to 1.7	0.850
Family histories of T2D	82 (44.3)	63 (69.2)	2.83	1.7 to 4.8	<0.001*
Family histories of CVDs	55 (29.2)	27 (29.6)	0.99	0.6 to 1.7	0.554
Family histories of obesity	113 (61.1)	68 (74.7)	1.89	1.1 to 3.3	0.031*

*Significant using Holm's Sequential Bonferroni Method.
CVDs, cardiovascular diseases; BMI, body mass index; HbA1c, glycated haemoglobin; T2D, type 2 diabetes.

underweight and obesity are found in the same impoverished family.[32] We found significantly more overweight mothers compared with fathers, consistent with other studies on Jamaican adults.[7 30] Other literature suggested that the presence of more overweight mothers may be due to the more domestic lifestyles of women, especially because women are in charge of food preparation and have more access to food. Results on BMI, gender and age are similar to previous findings,[8] which reported that more Jamaican girls than boys aged 10–15 years tended to be overweight, and this trend continues into adulthood.[30]

Risk factors for T2D and CVD

We investigated whether low physical activity was related to risk factors associated with T2D and CVD, since inactivity has been associated with chronic diseases.[33] Despite the prevalence of high BMIs, the majority of participants were classified as being physically active, with boys being more active than girls. Similar gender differences on physical activity were supported by Ichinohe *et al*[30] who found that Jamaican adult women exercised less frequently than did adult men. In addition, it is part of the Jamaican culture to assign more household chores to the women, leaving them with less time for the kinds of physical activities measured by PAQ-C.

Low physical activity and related risks for chronic diseases in Jamaica are of concern to the Caribbean Community (CARICOM) and were discussed by the heads of Government at the 2007 CARICOM meeting in Port of Spain, Trinidad.[12] The current study provides preliminary data to support development of youth programmes that provide physical activities for both boys and girls.

This study was unprecedented in its examination of Jamaican adolescents for the presence of AN, which is easily determined by the dark line around the neck, axilla, knees and elbows.[34] Over 40% of our sample had AN on the neck area. There was no conclusive evidence that these participants had increased susceptibility to T2D, but the presence of AN may be a risk factor for T2D in later years. The ease and low cost of screening for AN may be helpful in identifying those at risk for T2D.

AN is associated with hyperinsulinaemia and high BMI, risk factors for T2D.[34 35] Hyperinsulinaemia results from insulin resistance (IR) and is associated with high BMI.[34 35] The one-time finger-prick method of testing FBG in this study did not allow for measurement of IR, which is commonly measured by the homeostatic model assessment (HOMA), using fasting plasma glucose and insulin concentrations to determine insulin sensitivity and secretion.[36] The examination of AN served as a suitable method of screening for the risk factor of T2D in a school setting.

Differences in risk for T2D and CVD by demographic and environmental variables

The association of ethnicity, gender, place of residence, income and number of risk factors for T2D and CVD was investigated based on earlier findings.[24 25] Rosenbloom *et al*[24] found that female adolescents were 1.7 times more likely to develop T2D than males. McKnight-Menci *et al*[25] found a higher prevalence of T2D among females than males. In this study, though, significance was found only for gender and physical activity after controlling for type I error. Boys were more physically active and girls had significantly more risk factors than boys.

Several studies have found greater numbers of risk factors for T2D and CVD among the lower income group as compared to the higher income group.[37 38] We found no significant relationship between income and the risk factors of T2D and CVD after controlling for type I error. Results from the current study suggest that

Table 3 Relationships among gender, ethnicity, place of residence, income and risk factors of T2D and CVD in Jamaican adolescents, 2007 (N=276)

Risk factors	Model p Value	Gender (male)†			Ethnicity (non-Black)†			Place of residence (urban)†			Household income (low)†		
		OR	95% CI	p Value	OR	95% CI	p Value	OR	95% CI	p Value	OR	95% CI	p Value
High FBG	0.332	2.01	1.03 to 3.93	*0.040*	0.86	0.37 to 2.0	0.729	0.81	0.42 to 1.6	0.555	0.92	0.53 to 2.21	0.829
High TC	0.036	0.61	0.25 to 1.5	0.281	0.36	0.07 to 1.45	0.141	1.2	0.52 to 2.78	0.674	3.7	1.06 to 12.8	*0.039*
High BMI	0.100	0.64	0.37 to 1.09	0.101	1.03	0.55 to 1.93	0.917	1.87	1.1 to 3.14	*0.018*	1.03	0.58 to 1.76	0.955
High WC	0.043	0.56	0.32 to 0.97	*0.041*	0.88	0.46 to 1.69	0.708	1.9	1.1 to 3.2	*0.021*	0.79	0.45 to 1.37	0.398
Presence of AN	0.080	0.53	0.32 to 0.87	*0.013*	0.66	0.36 to 1.21	0.175	0.88	0.54 to 1.44	0.618	0.04	0.56 to 1.59	0.817
Low PA	<0.001	0.36	0.21 to 0.62	*<0.001**	1.2	0.66 to 2.25	0.536	0.57	0.35 to 0.95	*0.032*	1.1	0.66 to 1.98	0.633
Family histories of T2D‡	0.007	0.70	0.43 to 1.1	0.163	2.09	1.13 to 3.9	*0.019*	1.2	0.78 to 2.08	0.329	0.60	0.35 to 1.02	0.057
Family histories of CVDs‡	0.003	0.53	0.30 to 0.94	*0.030*	1.68	0.90 to 3.1	0.100	0.77	0.45 to 1.3	0.342	0.51	0.29 to 0.88	*0.016*
Family histories of obesity‡	0.014	1.05	0.64 to 1.78	0.844	0.62	0.34 to 1.16	0.133	0.54	0.32 to 0.90	*0.019*	0.49	0.27 to 0.87	*0.014*

*PA and gender considered significant after controlling for type I error.
†Represents reference groups for the variable.
‡Represents a positive family history of disease.
AN, Acanthosis Nigricans; BMI, body mass index; CVDs, cardiovascular diseases; FBG, fasting blood glucose; PA, physical activity; TC, total cholesterol; T2D, type 2 diabetes; WC, waist circumference.
Note: Owing to limitation of space in table 3, the reference values for each variable were omitted; however, they were all identified previously in table 1.
Numbers in italics represent significance at the 0.05 level.

Jamaican adolescents may be at risk for T2D and CVD irrespective of household income.

With the increase in cases of diabetes in Jamaican adults and the rising cost of treating diabetes and its complications, early detection of risk factors is needed. Family history of disease and anthropometric measures identified more participants at risk than did the blood measures. Therefore, prevalence studies are needed to identify anthropometric anomalies and serve as a first step in the prevention of the onset of chronic diseases.

Strengths and limitations

The study was unprecedented in its examination of Jamaican adolescents with multiple risk factors for T2D and CVDs. Prior to this study, little emphasis was given to the early detection of risk factors for T2D in Jamaican adolescents. Testing for the presence of AN was a novel part of the study and was new to the agencies and study population involved.

A more precise instrument for measuring physical activity is needed. PAQ-C did not measure the amount of time or energy expended on each activity. Our findings on the prevalence of overweight and obesity of parents were determined by a surrogate measure and not by actual measures of heights and weights, which might have affected our results. However, our findings of higher BMI in girls compared with boys are consistent with other studies on Jamaican adults.

Recommendations

Our study has presented a framework for future studies on nutrition-related chronic diseases among Jamaican adolescents. Research evidence warrants interventions for this group. As part of the current preventive approach in healthcare, we recommend screening of schoolchildren for risk factors of T2D and CVD annually within the school system. School nurses can be trained to conduct this type of screening. Immediate referral, follow-up testing and monitoring of students found to be at risk are essential actions for chronic disease prevention. Identification of these risk factors can help in planning early interventions to improve the long-term outcomes of these chronic diseases. Monitoring of body weight is achievable at no extra cost to the schools. School nurses can be trained to recognise the physical signs of AN, a procedure which is inexpensive and non-invasive. On the basis of these findings, the authors recommend reintroducing and re-emphasising physical education to all grades in high schools, while paying particular attention to motivating the highest risk groups and girls, in an effort to prevent adolescent obesity.

CONCLUSION

Similar to other ethnic minority groups in US-based studies, Jamaican adolescents tended to have a cluster of risk factors for T2D and CVD. High BMI, high WC, high WHR and presence of AN were among the strongest

predictors of T2D and CVD. Prevalence of overweight/obesity among our sample was twice that of adolescents in the USA. Jamaican adolescents are at risk for T2D and CVD regardless of their BMI, race/ethnicity, gender, income levels and whether they reside in rural or urban communities. Preventive measures such as nutrition education and intervention to reduce weight and increase physical activity are needed. This study shows that primary prevention programmes for overweight and obesity should be implemented in the school setting, targeting school children and adolescents to prevent chronic diseases such as T2D and CVD in later life.

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