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ORIGINAL RESEARCH

Cardiovascular Risk Surveillance to Develop a Nationwide Health Promotion Strategy

The Grenada Heart Project

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OBJECTIVE The Grenada Heart Project aims to study the clinical, biological, and psychosocial determinants of the cardiovascular health in Grenada in order to develop and implement a nationwide cardiovascular health promotion program.

METHODS We recruited 2,827 adults randomly selected from the national electronic voter list. The main outcome measures were self-reported cardiovascular disease and behavioral risk factors, anthropometric measures, blood pressure, point-of-care testing for glucose and lipids, and ankle-brachial index. Risk factors were also compared with the U.S. National Health and Nutritional Survey data.

RESULTS Prevalence of cardiovascular disease risk factors were: overweight and obesity—57.7% of the population, physical inactivity—23.4%, diabetes—13.3%, hypertension—29.7%, hypercholesterolemia—8.6%, and smoking—7%. Subjects who were physically active had a significantly lower 10-year Framingham risk score ($p < 0.001$). Compared with the U.S. National Health and Nutrition Survey data, Grenadian women had higher rates of adiposity, diabetes, hypertension, and elevated low-density lipoprotein cholesterol, whereas Grenadian men had a higher rate of diabetes, a similar rate of hypertension, and lower rates of the other risk factors. Prevalence of peripheral arterial disease was 7.6%; stroke and coronary heart disease were equally prevalent at ~2%.

CONCLUSIONS This randomly selected adult sample in Grenada reveals prevalence rates of obesity, hypertension, and diabetes significantly exceeding those seen in the United States. The contrasting, paradoxically low levels of prevalent cardiovascular disease support the concept that Grenada is experiencing an obesity-related "risk transition." These data form the basis for the implementation of a pilot intervention program based on the Institute of Medicine recommendations and may serve as a model for other low- and middle-income countries.

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Cardiovascular disease (CVD) is the leading cause of mortality worldwide, with over 80% of CVD deaths estimated to occur in low- and middle-income countries (LMICs) [1]. A recent Institute of Medicine report stressed the need for more evidence to guide prevention and control of CVD in LMICs [2].

The Grenada Heart Project is the result of a series of discussions between the principal investigator of this study and a panel of ambassadors to the United Nations representing countries that were concerned by the looming CVD epidemic and were looking for a model applicable to countries with nonextensive resources. CVD risk factors, such as hypertension and diabetes, were perceived as significant and common health problems in Grenada, a middle-income country in the Caribbean [3]. This may have been due to the recent Westernization of diet and lifestyle, as well as declining physical activity due to increases in the use of motorized vehicles and the availability of sedentary entertainment. However, systematic population-wide surveillance relating to chronic diseases and their risk factors was lacking in Grenada and many other LMICs. The Grenada Heart Project was launched to study systematically the clinical, biological, and psychosocial determinants of the cardiovascular health of a nationally representative adult cohort of Grenada in order to inform the implementation of a nationwide intervention program. The long-term goal of the Grenada Heart Project is to use this national health survey to design novel community-based interventions to prevent the proliferation of CVD in this country and to serve as a model for other LMICs. In this report, the cardiovascular risk profile of the adult population of the main island of Grenada is described, as well as implications for nationwide prevention programs.

METHODS

Setting. Grenada is an independent country in the Caribbean Sea; it is made up of the main island of Grenada and 2 other islands and covers a landmass of 133 m^2 (roughly twice the size of Washington, DC, USA). It has a population of approximately 104,487 people, mainly of African descent. About one-third of the population is below 15 years of age, and about 20% of the adult population is above 65 years of age. Life expectancy at birth is 75 years; cardiovascular and respiratory diseases represent the main causes of death [4]. Over 90% of the adult population lives on the main island. The average per-capita income in 2010 was $5,500, categorizing the nation as upper-middle income; however, roughly one-third of Grenadians live below the poverty line, highlighting the economic disparities in this small nation [5]. The main island of Grenada is divided into 6 administratively distinct parishes.

Subjects. Between July 2008 and November 2009, individuals were randomly selected from polling division-level voters' lists of the main island of Grenada, yielding a nationally representative sample of adults aged 18 years or older. The size of the sample was proportionate to parish population, with the exception of the largest parish, St. George, which was relatively under-sampled due to insufficient resources. Each selected person was invited to come in a fasting state to a local clinic, where the survey was completed.

All subjects provided informed consent, and ethics clearance was provided by the Institutional Review Boards of Mount Sinai School of Medicine and St. George's University.

Survey methods. The survey consisted of a questionnaire, limited physical examination, ankle-brachial index measurement, point-of-care laboratory testing, portable electrocardiography, and peripheral phlebotomy. A modified World Health Organization (WHO) STEPwise approach to Surveillance (STEPS) questionnaire, which included questions regarding demographics, socioeconomic status, history of heart disease, stroke, diabetes, hypertension, physical activity, smoking, alcohol consumption, and diet, was used [6]. A few questions were added that were designed to increase understanding of the environmental and social influences that may affect patterns of dietary and physical activity behavior. Anthropometric measurements included height measured by a stadiometer, weight measured with a balance beam scale, and waist and hip circumference measured to the nearest 0.2 cm using a steel measuring tape (standard 4-ounce or 118.3-ml tension). Blood pressure was recorded with the subject in a sitting position, resting quietly for 5 min with legs uncrossed. The right arm was used for the measurement. An appropriate cuff type was selected according to the arm circumference. A calibrated Omron digital automatic blood pressure monitor (Omron Healthcare, Kyoto, Japan) was used. Three blood pressure readings were taken at approximately 1-min intervals and the mean of the 3 readings were used. Both systolic and diastolic pressures were recorded. A pulse was also recorded at each reading. Ankle-brachial index was

calculated after measuring systolic blood pressure in the right and left brachial, posterior tibial, and dorsalis pedis arteries with a Doppler instrument. The higher of the brachial values was used as the denominator, and the higher of the lower limb pressures on each side was used as the ipsilateral numerator.

Survey participants were requested to fast for 8–12 h prior to screening for glucose and cholesterol. This was verified by asking the participant if they had fasted prior to testing. If the person had not fasted, she/he was invited to return at another time for biochemical testing. Personnel trained in the use of universal precautions in the collection of human body fluids carried out all laboratory procedures. The LDX Analyzer (Cholestech, Hayward, California, USA) was used to conduct point-of-care testing of glucose, total cholesterol, triglycerides, and high-density lipoprotein cholesterol. Low-density lipoprotein (LDL) cholesterol was calculated using the Friedewald formula. A 12-lead electrocardiogram was obtained using GE-CardioSoft program (GE Healthcare, Waukesha, Wisconsin, USA), printed, and electronically stored on a secure hard drive. The automated reading provided by the machine was used for point-of-care information given to the participant. A venous blood sample was obtained via the antecubital, processed, and stored locally in −80 °C freezers. The stored blood was eventually shipped to the Centers for Disease Control's labs to be tested for renal function; glycosylated hemoglobin; and inflammatory, thrombotic, and genetic markers. The electrocardiogram and peripheral blood analyses are ongoing and are not presented in this report.

Statistical methods. National estimates of the prevalence of CVD and mean values and percentages of CVD risk factors were obtained by weighting sample data to population estimates by age group, sex, and parish (unpublished data, Statistics Division of Ministry of Finance, Grenada). The age groups used were 18–29, 30–39, 40–49, 50–59, 60–69, and ⩾70 years. Medical histories of coronary heart disease (CHD), rheumatic heart disease, atrial fibrillation, heart failure, and stroke were self-reported on the questionnaire. This history was obtained in the local language by Grenadian personnel trained by a team of healthcare providers from Grenada and New York. CHD was defined as being aware of or being told by a healthcare professional of having heart attack, angina, or chest pain. Peripheral artery disease was defined as an abnormal ankle-brachial index ⩽0.9. Diabetes was defined as either: (1) self-reported use of a prescription antidiabetic medication or insulin in the last 2 weeks; or (2) fasting blood glucose >126 mg/dl [7]. Hypertension was defined as systolic blood pressure ⩾140 mm Hg or diastolic blood pressure ⩾90 mm Hg or taking blood pressure–lowering medication in the last 2 weeks [8]. Hypercholesterolemia was defined as total cholesterol ⩾240 mg/dl [9]. Smoking was defined, through self-report, as using any type of tobacco (including cigars, pipes, chewed) at least daily. Current cigarette smoking was defined as currently smoking at least 1 cigarette (manufactured or otherwise) per day. Body mass index (BMI) was defined as weight in kilograms divided by the square of height in meters; "overweight" was defined as BMI ⩾25 to <30 kg/m^2 and "obese" as BMI ⩾30 kg/m. Physical inactivity was defined as less than 150 min of moderate-equivalent activity per week [10].

Estimates for risk factor means and percentages in Grenada were compared with the U.S. National Health and Nutrition Examination (NHANES) 2005–2006 [11] by standardizing the latter, by age and sex, to the national population of Grenada using the same age groups as already stated [12]. For smoking, only the NHANES question on cigarette smoking for 20-year-olds and above was used in the comparisons, assuming that the rates for 18- and 19-year-olds were similar to that of the 20- to 29-year-olds. Physical inactivity was not compared between the Grenadian and U.S. populations, due to differences in how activity was measured.

Wald tests were used to compare the sexes within Grenada and between Grenada and NHANES. Simple linear (for continuous variables) and logistic (for binary variables) regression was used to analyze risk factor trends. The relationship of CVD risk factors to education was evaluated, after controlling for age and sex. Analyses were carried out using the survey routines in Stata version 11 (Stata Corp., College Station, Texas, USA), and a p value of less than 0.05 was considered significant.

RESULTS

A total of 4,682 individuals were invited to participate in the survey, of whom 2,827 (60%) agreed to participate and completed the study questionnaire. Fifty-eight percent of the sample was women and 59% was 40 years of age or more (Table 1). Blood

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Table 1. Number (%) of participants in the survey for the Grenada Heart Project, by age group and sex

Age (years)	Men	Women
18–29	311 (25.9)	364 (22.4)
30–39	182 (15.2)	296 (18.2)
40–49	297 (24.7)	341 (21.0)
50–59	214 (17.8)	265 (16.3)
60–69	79 (6.6)	181 (11.1)
70+	118 (9.8)	179 (11.0)
Total	1,201	1,626

pressure was measured in all but 5 individuals, and cholesterol was measured in 2,779 (98%). Among nonparticipants, for whom there was a reason for nonparticipation, 40% declined to participate, 23% changed address, 26% had migrated, and 10% had died; 44% of the nonparticipants were women.

Adiposity. The most prevalent CVD risk factor in adult Grenadians was excess adiposity. The overall prevalence of obesity was 27% greater among women than in men ($p < 0.0001$). It was estimated that 57.7% were overweight or obese, with greater prevalence in women than in men ($p < 0.0001$). Mean BMI and waist circumference were similarly higher in women than in men ($p < 0.0001$). In both Grenadian men and women, the percentage overweight or obese was estimated to rise with age to 50–59 years, after which it declined (Fig. 1). Similar patterns by age were seen for mean BMI and waist circumference. After age standardization, the prevalence of overweight and obesity was less among Grenadian men than among U.S. men, but greater among Grenadian women than among U.S. women ($p < 0.0001$) (Table 2). A similar trend was observed for mean BMI. Waist circumference was lower in Grenadian men than in U.S. men; there was no significant difference in waist circumference observed between Grenadian and U.S. women.

Physical inactivity. The prevalence of physical inactivity was 23.4% and was more common among women than among men ($p < 0.0001$). Physical inactivity tended to increase with age for men. Among women, physical inactivity was relatively high up to age 60 (~28%) and increased notably above age 60. Subjects who performed greater than 150 min per week of moderate intensity activity had a remarkably lower 10-year risk for CHD by Framingham risk level (overall: 11.4% vs. 7.7%, $p < 0.001$). The relationship between physical activity and CHD risk was significantly different between men and women (interaction p value <0.001). Subjects who were physically active at work or during leisure time had a significantly lower Framingham risk score than those who were not (none 14.3%, work only 9.1% [$p = 0.004$], leisure only 8.8% [$p = 0.005$]). This difference was even wider for those who were physically active both at work and during leisure time, with a notable halving of their 10-year CHD risk (both 7.2% [$p < 0.001$]).

Diabetes. The overall prevalence of diabetes was 13.3%, and it was more common in women than in men, both overall (16% vs. 10%, $p < 0.0001$) and in all age groups. Its prevalence increased with age ($p < 0.0001$) up to age 60–69 years (Fig. 1). Mean fasting blood glucose was not significantly

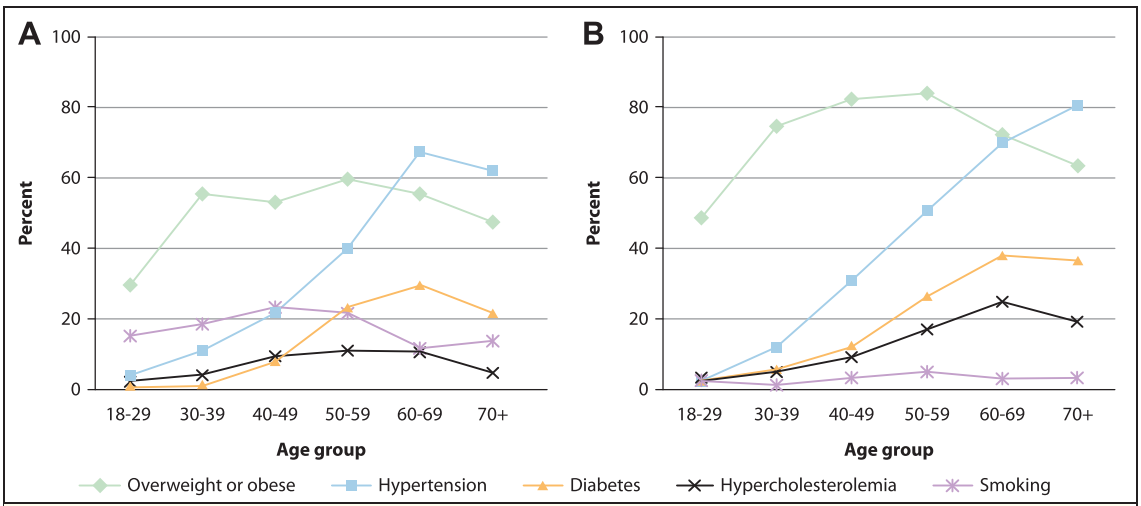

Figure 1. Prevalence of cardiovascular risk factors in adult Grenadian men (A) and women (B).

Table 2. Estimated mean levels (SE) or prevalence of major cardiovascular risk factors among adult Grenadian men and women, and in the U.S. NHANES survey 2005–2006 after age standardization to the adult population of Grenada. Based on complete sample *N* = 2,827

	Men			Women		
	Grenada	NHANES	*p* Value	Grenada	NHANES	*p* Value
Systolic BP, mm Hg	124.2 (0.51)	123.0 (0.35)	0.05	120.6 (0.46)	116.0 (0.34)	<0.0001
Diastolic BP, mm Hg	73.4 (0.36)	70.6 (0.31)	<0.0001	74.3 (0.28)	66.9 (0.26)	<0.0001
Hypertension, %	26.4 (1.22)	28.2 (1.02)	0.13	32.7 (0.92)	24.1 (0.79)	<0.0001
Total cholesterol, mg/dl	168.6 (1.20)	193.3 (1.06)	<0.0001	183.0 (1.19)	194.6 (1.01)	<0.0001
HDL cholesterol, mg/dl	46.7 (0.44)	48.2 (0.34)	0.006	49.2 (0.39)	58.8 (0.41)	<0.0001
LDL cholesterol, mg/dl	109.1 (1.21)	114.3 (1.42)	0.006	120.1 (1.24)	109.7 (1.28)	<0.0001
Hypercholesterolemia, %	6.3 (0.74)	12.4 (0.85)	<0.0001	10.8 (0.78)	14.8 (0.88)	0.0006
Body mass index, kg/m2	25.3 (0.15)	28.3 (0.15)	<0.0001	28.7 (0.17)	27.8 (0.18)	0.0001
Waist circumference, inches	35.2 (0.17)	39.3 (0.15)	<0.0001	36.4 (0.16)	36.1 (0.16)	0.15
Overweight or obese, %	47.2 (1.55)	70.4 (1.19)	<0.0001	68.1 (1.20)	58.4 (1.25)	<0.0001
Obese, %	14.8 (1.17)	31.3 (1.20)	<0.0001	38.9 (1.24)	33.4 (1.16)	<0.0001
Fasting blood glucose, mg/dl	99.5 (1.01)	102.9 (0.83)	0.01	100.1 (1.00)	97.4 (0.98)	0.05
Diabetes, %	10.4 (0.93)	7.9 (0.85)	0.008	16.0 (0.87)	8.1 (0.90)	<0.0001
Cigarette smoking, %	12.4 (1.09)	24.39 (1.15)	<0.0001	1.9 (0.37)	18.5 (1.02)	<0.0001

For confidence interval = Estimate ± 1.96 SE (estimate and SE listed in the table).
BP, blood pressure; HDL, high-density lipoprotein; LDL, low-density lipoprotein; SE, standard error.

different between men and women in Grenada (99.5 mg/dl in men vs. 100.1 mg/dl in women, $p = 0.67$), but it demonstrated the same pattern by age as for diabetes. In both sexes, diabetes was more common in Grenada than in the United States ($p = 0.008$ for men; $p < 0.0001$ for women) (Table 2). Compared with the United States, mean glucose levels in Grenada were slightly lower for men and higher for women ($p = 0.01$ for men and 0.05 for women). Using our prevalence data, we estimate that 14,500 people most likely suffer from diabetes (5,700 men, 8,800 women) in Grenada.

Blood pressure. Overall prevalence of hypertension was 29.7% and was more common among women than among men (33% vs. 26%, $p = 0.0001$). The overall mean systolic blood pressure in Grenada was 122.4 mm Hg and was higher among men than women ($p < 0.0001$), which is likely explained by the greater percentage of women (86%), than men (75%), taking treatment for raised blood pressure (Fig. 1). Diastolic blood pressure was similar between the sexes ($p = 0.06$). Both systolic and diastolic pressures were significantly higher in Grenada than in the United States (Table 2), although hypertension was more prevalent in Grenada only for women ($p < 0.0001$). Mean systolic blood pressure increased with age in Grenada, whereas diastolic blood pressure increased up to the 60–69 year age group. Hypertension increased steadily with age in both sexes ($p < 0.0001$), except for a slight fall in men after age 60–69 years. Using our prevalence data, we estimate that 32,000 people most likely suffer from hypertension (14,000 men, 18,000 women) in Grenada.

Lipids. The overall prevalence of hypercholesterolemia was 8.6%. As with blood pressure and diabetes, all the lipid variables had higher average values in women than in men ($p < 0.0001$ for total cholesterol, high-density lipoprotein cholesterol, LDL cholesterol, and hypercholesterolemia). Among all Grenadian men, 6% had hypercholesterolemia, with a peak prevalence of 11% at age 50–59 years; in women, the overall prevalence was significantly higher than for men at 11%, with a peak of 25% at age 60–69 years (Fig. 1). Compared to U.S. men, Grenadian men had lower values for all lipid variables ($p = 0.006$ or below). Compared to U.S. women (Table 2), Grenadian women had higher values of LDL cholesterol, but lower values of other lipid variables ($p = 0.0006$ or below for all comparisons).

Tobacco use. The overall prevalence of cigarette smoking was 7%. In contrast to the other risk factors, smoking (of any medium) was more common among men in Grenada: 17.6% of men reported smoking, compared with 3% of women ($p < 0.0001$). Among men, smoking increased with ages up to the 40–49 year age group, peaked at 23%, and then declined. Among women, the prevalence of smoking never exceeded 5% in any age group, with no evidence of systematic differences by age (Fig. 1). Far fewer smoked in Grenada than in the United States:

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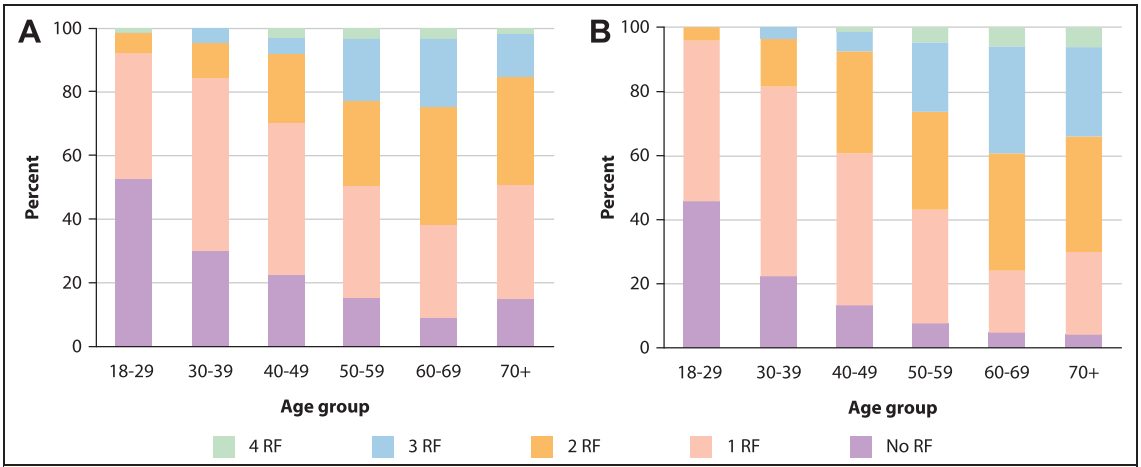

Figure 2. Percentage of Grenadian men (A) and women (B) with 0, 1, 2, 3, and 4 risk factors by age group. The risk factors included are overweight/obesity, hypertension, diabetes, hypercholesterolemia, and smoking. RF, risk factor.

12% versus 24% for men and 2% versus 18% in women (both $p < 0.0001$) (Table 2).

Clustering of risk factors. Overall, 75% of the adult population surveyed had at least 1 of the 5 major binary risk factors: overweight or obese; hypertension; diabetes; hypercholesterolemia; and smoking. Percentages (to whole numbers) with 1, 2, 3, and 4 risk factors for the population were estimated at 43%, 20%, 10%, and 2%, respectively. Among Grenadian women, 79% had at least 1 of the 5 CVD risk factors compared with 71% among men ($p < 0.0001$). Percentages (to whole numbers) with 1, 2, 3, and 4 risk factors in women were estimated at 43%, 22%, 12%, and 2% and in men 42%, 19%, 8%, and 1%, respectively. No one in the sample had all 5 risk factors (Fig. 2).

In both sexes, the percentage of adults with 2 or 3 risk factors increased with age up to 70 years (Fig. 2). For women, in all age groups, the majority had at least 1 risk factor: even at age 18–29 years, only 46% were free of risk factors. At least 39% of women over age 40 had 2 or more risk factors. The percentage of women with 4 risk factors increased steadily with age, to a peak of 6% in the $\geqslant 70$ year group.

Relationship of CVD risk factors to educational level. Higher educational level was associated with lower systolic and diastolic blood pressure. Although there was a trend toward lower hypertension prevalence with higher educational level, this was not statistically significant. Educational level was also inversely associated with waist circumference, obesity, diabetes, and smoking. Although there was a trend toward lower cholesterol levels with increasing educational level, this was not statistically significant. Educational level was not associated with physical inactivity.

Prevalence of cardiovascular diseases. Despite the elevated prevalence of multiple cardiovascular risk factors, the estimated prevalence of all forms of self-reported CVD was low in adult Grenadians. Stroke and CHD were roughly equally prevalent (1.9% and 1.8%, respectively). There was a trend toward greater prevalence of CHD among women, although this difference was not statistically significant (Table 3). PAD was the most common form of CVD, with an overall prevalence of 7.6% and a trend toward higher prevalence in women (8.4% vs. 6.8%, $p = 0.18$). Prevalences were generally highest in the oldest age group, as expected, but there was no regular pattern of increasing prevalence with age. No subjects reported having had atrial fibrillation and only 5 reported a history of heart failure.

DISCUSSION

In this first systematic nationwide cardiovascular health survey in the Caribbean to report using a modified WHO STEPS survey instrument, we have found an early indication of major future

Table 3. Estimated prevalences (%) of cardiovascular disease in adult Grenadians, by sex group

	Men	Women	*p* Value[a]
Coronary artery disease	1.3 (0.5)	2.6 (0.4)	0.07
Rheumatic heart disease	0.8 (0.3)	0.8 (0.2)	0.92
Stroke	1.6 (0.4)	2.2 (0.4)	0.34
Peripheral arterial disease	6.8 (0.8)	8.4 (0.7)	0.18

Note: Results are self-reported except that peripheral artery disease was defined as ankle-brachial index $\leqslant 0.9$. Based on complete sample $N = 2,827$. Values in parentheses are standard errors.
[a] The *p* value for sex difference.

problems in chronic disease in the middle-income country of Grenada. The most common cardiovascular risk factor appears to be overweight and obesity, with a substantial proportion of the population being characterized as physically inactive, hypertensive, or diabetic. Paradoxically, however, we found that Grenada currently has low levels of prevalent self-reported CVD, in contrast with the generally high levels of risk factors. It appears that Grenada is experiencing the third stage of epidemiological transition (degenerative and man-made disease), wherein the risks of obesity and sedentary lifestyle come into play [13–15]. Whereas the increase in most risk factors with age is expected, the disproportionate excess of adiposity in the middle-age groups, coupled with the low prevalence of manifest CVD, supports the phenomenon of an obesity-related "risk transition" in Grenada. The health risk transition is a phenomenon of disproportionate increase in diseases related to obesity and "pathologically" increased consumption of food, alcohol, and tobacco, most often as a result of rapid Westernization and urbanization especially affecting young to middle-aged adults [16].

For a middle-income country such as Grenada with limited resources, responding adequately to the "double burden" of rising chronic diseases while still combating communicable diseases and malnutrition could lead to a dangerous downward spiral toward worsening health. This phenomenon has been illustrated in a large study in Thailand, where the transition of much of Thailand from a predominantly rural and agricultural country to an increasingly urban country with an industrial and service economy had a profound impact on social conditions and other health determinants related to food, alcohol, and drug consumption [16,17].

Although the transition in risk factors is "almost complete" in Grenada, the corresponding transition in CV morbidity/mortality may not be fully established, opening a window of opportunity for prevention (control of risk factors to reduce future disease burden). In addition, the disproportionate burden of nearly every CVD risk factor in women and the inverse relation of CVD risk factors to educational level are important elements to guide the design of future interventions.

The results summarized in this paper form the foundation for the intervention phase of the Grenada Heart Project. We have leveraged our community and government resources to pursue an intervention phase that involves 2 broad approaches: community-based initiatives and governmental programs, with a special focus on physical activity, obesity, diabetes, and hypertension. The community-based initiative will study the effectiveness of community-based motivational peer support to improve lifestyle-related risk factors using a cluster-randomized trial. With respect to the governmental programs, we will work in collaboration with the government of Grenada to implement the 12 Institute of Medicine recommendations to promote cardiovascular health across the nation [2]. We have engaged the Ministry of Health to introduce new, intersectoral, population-wide efforts. These include new evidence-based policies to affect dietary patterns favorably such as restrictions on salt intake, saturated fatty acids in cooking oils, and sugary drinks; encouragement for private-sector alliances dealing in organic produce; and laws to curb tobacco smoking. Finally, in continuing collaboration with the Ministry of Health, St. George's University, and the American Heart Association, the Grenada Heart Project will attempt to maximize the impact of these interventions through health education campaigns.

By forming a strong collaboration with key partners including government, academia, civil society, and the private sector, we hope to create a powerful example of nationwide cardiovascular health promotion to attenuate the transition from risk factors to cardiovascular events, which can serve as a model for other LMICs.

Our study has the advantage of using a large, random sample drawn from the entire resident adult community of the main island of Grenada. The survey was conducted by a dedicated local survey team who traveled across the island, with assistance from investigators in New York. Our study must, however, be interpreted in light of the following potential limitations. First, the response rate was only modest, and this may have led to systematic bias. However, the age structure of our sample was similar to that of the country of Grenada (Table 1), and any potential bias due to differences in age and sex structure between the sample and population was minimized as a result of the weighted analyses we performed. Second, some parts of the island were under-sampled, although the effects of this were also addressed in the weighted analyses according to age, sex, and parish. Third, the self-reported nature of disease histories may underestimate the true prevalence of cardiovascular disease, due to possible lack of health education and use of healthcare resources.

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The survival rate after incident CVD, which may be relatively low in Grenada, may have also led to an underestimate of the true burden of CVD. Fourth, we were unable to reliably identify urban dwellers as a separate group, which might have given additional insight into the epidemiological processes in action.

CONCLUSIONS

Cardiovascular diseases represent an increasing problem in LMICs, such as Grenada, undergoing a rapid transition in their risk profiles. Only the tip of the iceberg is known, given the inherent difficulty in tracking the emergence of new patterns of disease and related morbidity and mortality in countries where both healthcare resources and research capabilities are suboptimal. Furthermore, the situation is aggravated by the superimposition of obesity and physical inactivity as "recent" risk factors on other previously established ones. Unless urgent measures are taken to curb the proliferation of CVD risk factors over the next few decades, LMICs are likely to experience exponential rise in CVD burden, and we will continue to suffer losses in the gains we have made in high-income countries in the reduction of CVD mortality. The Grenada Heart Project thus aims to serve as a model demonstration project for the implementation of the Institute of Medicine recommendations to promote cardiovascular health among LMICs.

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