Diabetes in the Caribbean: Trouble in Paradise

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ABSTRACT

Background: Many developing countries, including countries of the English-speaking Caribbean, are undergoing an epidemiologic transition and experiencing rapid increases in the prevalence of diabetes.

Objectives: This article examines the epidemiology of diabetes, the types of diabetes, the etiologic factors and complications of diabetes, and the public health burden associated with diabetes in the Caribbean.

Methods: An extensive PubMed literature search was conducted for the period 1951 to 2008 using the search terms *diabetes, glucose intolerance, Caribbean, Jamaica, Barbados, Trinidad, Bahamas, Guyana,* and the names of all the other English-speaking Caribbean countries.

Results: Four hundred articles were identified in the literature search. Of these, 131 original articles were selected for inclusion in this review. Prevalence rates for diabetes ranged from 11% to 18% of the population in several countries. The prevalence of atypical diabetes (ketosis-prone diabetes) may be declining because of increases in the proportions of the population with type 2 diabetes mellitus. Ecologic studies show an east-to-west gradient from West Africa to the Caribbean for obesity and obesity-related diseases. The steep increase in the prevalence of obesity and the increase in sedentarism in Caribbean societies are the main risk factors driving the diabetes epidemic. The roles of early-life origins (specifically, in infants with low birth weight and rapid catch-up growth and/or macrosomic infants) and genetic factors await further clarification in this population. Diabetic foot, nephropathy, and stroke are common complications.

Conclusions: In the English-speaking Caribbean, diabetes is a major public health burden that threatens the gross domestic product of these developing island nations. Macroeconomic initiatives are needed to start the combat against diabetes. (*Insulin*. 2009;4:94–105) © 2009 Excerpta Medica Inc.

Key words: diabetes, Caribbean, African, Indian, obesity, complications.

INTRODUCTION

The Caribbean refers to a large geopolitical region of the Americas situated on the Caribbean Plate and consists of the Caribbean Sea, its islands, and the surrounding coasts. The region consists of hundreds of islands and islets enclosing the Caribbean Sea, stretching ~2500 miles, but the islands are no more than 160 miles wide at any point. The presence of European colonial powers in the region for hundreds of years has made the Caribbean a melting pot of ethnic groups, languages, and social customs. This article focuses on the English-speaking (Anglophone) nations and thus covers Anguilla, Antigua and Barbuda, the Bahamas, Barbados, Belize, the British Virgin Islands, the Cayman Islands, Dominica, Grenada, Guyana, Jamaica, Montserrat, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Surinam, Trinidad and Tobago, the Turks and Caicos Islands, and the US Virgin Islands. The total population of the Anglophone nations is ~14.5 million, and the per-capita income (2005 US $, World Bank) ranges widely, from $1010 to $10,920. Tourism is a major source of income for many Caribbean nations.

Caribbean people have moderate geographic mobility. Hence, several million people live outside of the region, mostly in the United States, Canada, and the United Kingdom. Although the ancestry of the ethnic groups in the region is varied (eg, African, Caucasian, Indian, Chinese, Middle Eastern), most individuals in the Anglophone Caribbean have West African ancestry as a remnant of the African slave trade and therefore identify themselves as black. Still, there was some intermingling of the races, and genetic admixture studies showed rates of 10% to 15% for non-African ancestry.[1]

Like many developing nations, Caribbean countries are undergoing significant demographic changes. As such, these countries have a double burden of infectious/communicable diseases (eg, HIV/AIDS) and chronic, noncommunicable diseases (especially diabetes), and these diseases are assuming epidemic proportions.[2] Few reviews of diabetes in this population have been conducted; however, this article summarizes the available information on the epidemiology of diabetes, the types of diabetes, the etiologic factors and complications of diabetes, and the public health burden associated with diabetes in the Caribbean.

METHODS

An extensive PubMed literature search was conducted for the period 1951 to 2008 using the search terms *diabetes*, *glu-*

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cose intolerance, *Caribbean*, *Jamaica*, *Barbados*, *Trinidad*, *Bahamas*, *Guyana*, and the names of all the other English-speaking Caribbean countries. Original articles were selected, and their reported data and bibliographies were examined. Other data sources were also used, including the Disease Control Priorities in Developing Countries and the International Diabetes Federation Web sites and personal communications with regional researchers for unpublished observations. A formal meta-analysis was not performed because of substantial heterogeneity between the studies, but this review summarizes the original reported data.

RESULTS

Four hundred articles were identified in the literature search. After review of the articles, 131 original articles were selected for inclusion in this review.

Prevalence/Incidence of Diabetes

Several country-specific population surveys have been conducted in the Caribbean since the 1950s. Hugh-Jones[3] published some of the first descriptions of diabetes in the Caribbean, where he noted that type 2 diabetes mellitus (DM) was more common than type 1 DM in Jamaica. However, he described a third type of diabetes, which he called "insulin resistance in youth" or type-J diabetes ("J" representing "Jamaica").[3]

The Hugh-Jones report[3] was mostly a single-institution review, but sequential population studies[4–7] were conducted in Jamaica over the next 40 years. Even though the diagnostic criteria were different in each study, a secular increase in prevalence was noted. However, although the age-specific rates of diabetes in middle-aged persons (55–64 years) increased from 14.5% in 1972 to 21.8% in 1999,[5,7] it is not clear whether the increase is statistically significant. Most of the increase in prevalence has been attributed to lifestyle factors, specifically obesity.[2] An increase in the prevalence of diabetes from 1.3% in the 1950s to >12% in the 1990s was also reported in Trinidad.[8] The increase was particularly notable in Indo-Trinidadians. Similar data existed for Barbados, which was noted to be the country with the highest prevalence in Latin America and the Caribbean in the 1970s.[9] **Table I** provides data on the prevalence of diabetes among adults in the English-speaking Caribbean.[6–8,10–14]

The disease burden is high; ~1 of every 6 to 9 persons has diabetes. These data are most likely an underrepresentation of the true picture, because the less stringent 1985 World Health Organization criteria for the diagnosis of diabetes were used.[12] In addition, the studies were mostly conducted in the late 1980s and 1990s, and further secular increases have probably occurred. Many smaller countries do not have local data; however, because these island nations have similar populations and lifestyles, these data have been extrapolated to these countries. Regardless, one can reasonably say that all the islands are involved in the emerging pandemic of diabetes. Indeed, some evidence suggests that more recent prevalence rates for diabetes could be >20% in urban areas.[15]

Incidence rates of diabetes are also high. In Trinidad, where ~40% of the population are of Indian ancestry and ~40% are of African ancestry, the incidence of diabetes was significantly higher in Indian men than in Afro-Trinidadian men (24 vs 13 per 1000 person-years).[16] This was also true for Indo-Trinidadian women (23 per 1000 person-years) and Afro-Trinidadian women (14 per 1000 person-years).[16] In Jamaicans, who are predominantly of African ancestry, the rates are 15 and 20 per 100 person-years for men and women, respectively.[17] Based on the high incidence rates, it has been predicted that the prevalence of diabetes in the Caribbean will increase by 148% over the period 2000 to 2030.[18]

Type 1 DM is not common in the Caribbean. The incidence rates are 4 to 5 per 100,000 person-years in black populations of the Eastern Caribbean,[19] with a peak in St. Croix (10.1 per 100,000 person-years).[20] As expected, the prevalence is dependent on age. Among persons with diabetes emerging before age 25 years, ~60% will have type 1 DM.[21] Of these, ~50% will have type 1A diabetes (ie, autoantibody positive; mostly antiglutamic acid decarboxylase 65 [anti-GAD65] and islet-cell antibody-2 [IA-2] antibodies) and ~50% will have type 1B diabetes (ie, antibody negative).

Etiologic Factors for Type 2 DM

Lifestyle Factors (Obesity and Physical Activity)

The Caribbean is undergoing rapid epidemiologic and nutritional transition.[22] Half a century ago, the most common causes of mortality were infections. However, over the past 3 decades, communicable diseases have accounted for only 5% to 10% of the total mortality, whereas chronic, noncommunicable diseases have assumed prominence. Hence, atherosclerotic complications (ie, coronary artery disease and stroke) are now the leading causes of mortality, and diabetes is the third reported cause in several countries.

The Caribbean is undergoing rapid epidemiologic and nutritional transition.

The prevalence of obesity is increasing in the Caribbean as part of the global pandemic. It is estimated that the population attributable risk for diabetes is 66% for body mass index (BMI) and 80% for waist-hip ratio, highlighting the pathophysiologic role of obesity.[7] The International Collaborative Study on Hypertension in Blacks (ICSHIB) utilized an ecologic design to determine the prevalence of chronic, noncommunicable diseases in the African diaspora. Anthropometry, glycemia, and blood pressure were measured using standardized protocols concurrently in the different countries.[23] Using each population as a unit of analysis, the prevalence of obesity rose across the east-to-west geographic gradient from West Africa (ie, Nigeria and

Table I. Prevalence of diabetes mellitus among adult populations in the English-speaking Caribbean over the past 2 decades.*

Country, Reference, Year	Study Sample/ Age, y	Diagnostic Method/ Criteria	Crude Prevalence Rates, % (95% CI)			Adjusted Prevalence Rates, % (95% CI)†		
			Male	Female	Both	Male	Female	Both
Barbados, Foster et al,[10] 1993	464 Urbanites, 40–79	Fasting blood glucose ≥7.8 mmol/L	15.0	18.0	17.0	15.9 (10.6–22.9)	16.9 (12.5–22.3)	16.4 (13.1–20.5)
Barbados, Hennis et al,[11] 2002	4709 Persons, 40–84	History of diabetes or A1C >10.0%	16.5 (14.9–18.3)	21.5 (19.9–23.2)	19.4 (18.2–20.6)	–	–	18.0 (16.8–19.1)
Jamaica, Ragoobirsingh et al,[6] 1995	2109 Persons, >15	Modified OGTT/ WHO 1985	–	–	17.9	–	–	11.1 (9.7–12.3)‡
Jamaica, Wilks et al,[7] 1999	1303 Urbanites, 25–74	OGTT/WHO 1985	9.8 (7.2–12.4)	15.7 (13.1–18.3)	13.4 (11.5–15.2)	9.5 (7.0–12.0)	15.7 (13.2–18.3)	12.6 (10.8–14.4)§
Trinidad, Miller et al,[8] 1989	2491 Persons, 35–69	Modified OGTT/ WHO 1985	11.9	14.9	13.2	11.6 (9.8–13.3)	13.9 (11.8–16.1)	12.7 (11.4–14.1)§

A1C = glycosylated hemoglobin; OGTT = oral glucose tolerance test; WHO 1985 = World Health Organization 1985 diagnostic criteria for diabetes.[12]
*Modified from Barceló and Rajpathak.[13]
†Age and sex adjusted by the direct method, using the standardized world population[14]; 95% CI based on Poisson distribution.
‡Standardized by age.
§95% CI based on normal distribution.

Cameroon) to the Caribbean (ie, Jamaica, St. Lucia, and Barbados) and then to African Americans in the United States.[24–26] Notably, there is a gradient in the per-capita gross national product that parallels the geographic gradient in obesity, which supports a nutritional transition as the cause. Women bore a disproportionate burden of obesity in the ICSHIB study; approximately one third of Caribbean women were obese, and another third were overweight.[24] The prevalence in men was about one third that of the women.

The ICSHIB study also showed that the risk of diabetes is closely correlated to the BMI (**Figure 1**) and the amount of intra-abdominal fat (as measured by the waist circumference) across the east-to-west gradient.[27] Although in general the risk of diabetes increases with BMI, this was not true for Indo-Trinidadian men.[16] A sexual dimorphism was noted in the prevalence of diabetes, with higher rates reported for women, but much of the variance was associated with the higher prevalence of obesity in women. Clinical prediction models for diabetes in the Caribbean often used obesity as a predictor of diabetes, whether as BMI (>30 kg/m^2) or central obesity (waist circumference >94 cm in men and >80 cm in women).[28] However, waist circumference is not superior to BMI (at least in Jamaicans) as a predictor of diabetes.[17] More worrisome, the rate of adjusted annual weight increase was significantly greater in Jamaicans (1.37 kg/year) than in their American (0.52 kg/year) and Nigerian (0.31 kg/year) counterparts (all, $P < 0.05$).[29] Presumably, this steep increase in weight gain was the result of rapid cultural changes in a transitional society, and it does not bode well for incident diabetes rates.

Anecdotally, physical activity appears to be declining with increasing mechanization, use of motor vehicles, and sedentarism, but data are sparse. The levels of physical activity in Barbadian young people appeared to be comparable to those of American youth,[30] and the latter are well known to be low. There was also a sexual dimorphism in physical activity, with lower levels of activity generally reported for women. The importance of this finding was underscored in urban Jamaica, where severe or energetic physical activity was uncommon in men and nonexistent in women.[15] The protective effect of physical activity in Caribbean persons was similar to that in other populations; after adjusting for body composition, a 1-unit increase in physical activity level significantly reduced the odds of having diabetes in a cross-sectional analysis (odds ratio [OR], 0.05; 95% CI, 0.004–0.66).[15] That is, expending 590 to 670 kJ (about 20 minutes of brisk walking) daily was associated with a 20-fold reduction in the risk of diabetes.

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With the epidemic rates of obesity and diabetes, one can expect that many women will be at risk for gestational dia-

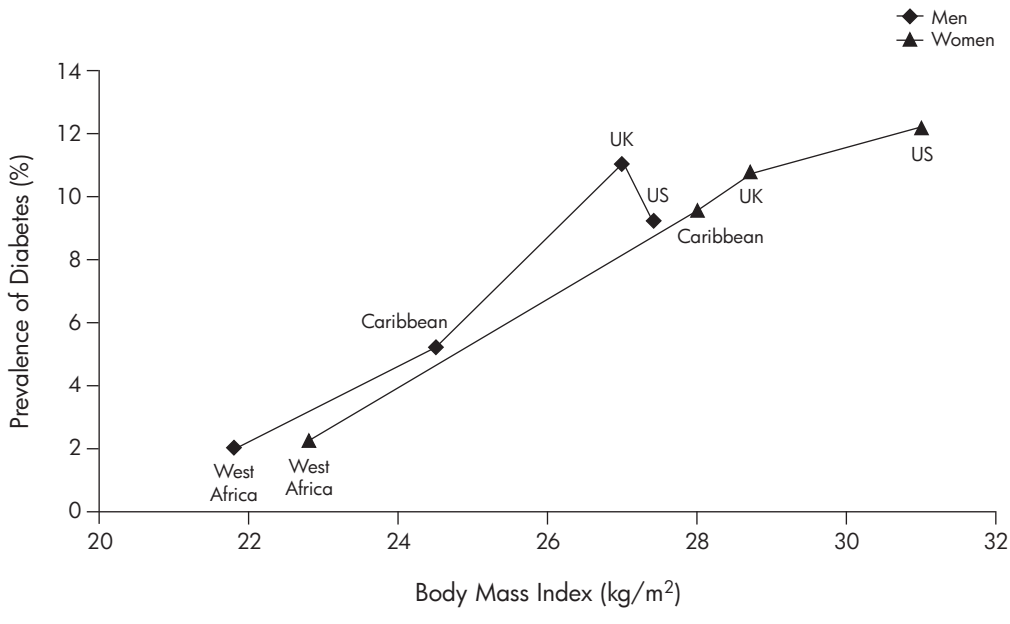

Figure 1. Prevalence of diabetes in the African diaspora, based on body mass index.[27] UK = United Kingdom; US = United States.

betes or enter pregnancy with type 2 DM. In Jamaica, ~13% of urban women of child-bearing age have diabetes.[7] Jamaican women with a family history of early-onset, autosomal-dominant type 2 DM have a 9-fold increased risk of gestational diabetes compared with women with no family history.[31] Women with prior gestational diabetes are well known to be at high risk for type 2 DM. Therefore, among Trinidadian women with prior gestational diabetes, >60% develop diabetes within 6 years.[32]

Genetic Factors

Whether genetic factors play a major role in diabetes is a hotly debated topic, even among Caribbean populations.[33] However, a family history of diabetes in any grandparent, parent, or sibling has been associated with a 2- to 4-fold increased risk of diabetes.[7,11] Although a family history of diabetes is a summary statement for multiple possible causative genetic factors, data are limited with regard to specific genetic factors in persons of Caribbean origin. The β-cell expressed transcription factor, TCF7L2, which is involved in β-cell dysfunction, was noted to be associated with glucose intolerance in 385 African-Caribbean persons living in the United Kingdom.[34] In another study involving ~1000 Jamaicans, TCF7L2 was associated with decreased β-cell function, but the PC-1 (ENPP1) K121Q polymorphism, which is involved in insulin resistance, was not (C. McKenzie, personal communication, July 2008). Although variants in peroxisomal proliferative activated receptor-γ, KCNJ11 (involved in the adenosine triphosphate–sensitive potassium channel in the β-cell), and the obesity-associated gene, FTO, have been implicated in candidate gene approaches and genome-wide scans,[35] these have not been properly evaluated in Caribbean populations to date. The Trp64Arg mutation of the β_3-adrenergic receptor has also been implicated in the development of hyperglycemia and obesity in Caribbean women, but not in Caribbean men.[36]

Early-Life Origins

Observational studies by Barker and Osmond[37] in the 1980s found an association between British individuals with low birth weight and increased rates of coronary heart disease later in life. This finding stimulated the concept that intrauterine health can influence health in adulthood (ie, the concept of developmental origins of chronic diseases). Birth weight can be considered a crude marker or summation of intrauterine growth, which, in turn, is determined by genetic factors, placental sufficiency, maternal body composition, and maternal nutrition. Hence, children with low birth weight are more likely to experience growth restraint, whether due to intrauterine nutritional restriction or a genetic predisposition to low birth weight.[38]

Similar associations of low birth weight have been made for the development of diabetes.[39,40] However, the association between birth weight and type 2 DM is convex (ie, the prevalence of diabetes is increased in individuals at both extremes of birth weight). The mechanisms underlying this relationship are not clear. β-Cell function[41,42] and/or insulin sensitivity[41–43] in childhood and adulthood may be decreased at the extremes of birth weight. Other pathophysiologic mechanisms involved in low–birth-weight individuals may include hypothalamic-pituitary-adrenal axis activation, visceral adiposity accumulation, changes in bioavailable insulin-growth factors, and/or altered appetite. Children who are large for their gestational age are more likely to be the offspring of glucose-intolerant mothers and thus experience intrauterine hyperglycemia, which per se may induce insulin resistance and type 2 DM later in life.

Children with low birth weight are more likely to experience growth restraint, whether due to intrauterine nutritional restriction or a genetic predisposition to low birth weight; similar associations of low birth weight have been made for the development of diabetes.

In Jamaican children, shortness at birth and increased current weight are independent predictors of insulin resistance, as measured by 2-hour insulin levels (**Figure 2**)[44] and increased glycosylated hemoglobin (A1C) levels (**Figure 3**).[45] Insulin resistance, as measured by the homeostasis assessment model, is more pronounced in the offspring of larger mothers and in children with faster postnatal growth (ie, catch-up growth) (T.E. Forrester, M.S. Boyne, C. Osmond, et al, unpublished data, 2008). The implication of these observations is important in developing countries, where there are substantial numbers of low–birth-weight babies and obese mothers. If these children undergo rapid catch-up growth starting in infancy, there may be an increased risk of diabetes later in life. Hence, when this second generation of women conceive, their offspring may be exposed to a hyperglycemic intrauterine environment (and thus be born macrosomic) or experience placental insufficiency (and thus be born small for their gestational age). Both conditions would increase the risk of glucose intolerance in the third generation.

Metabolic Factors

It is possible that other factors (eg, adipocytokines, oxidative stress) may be involved in the development of type 2 DM. Adiponectin is an adipocyte-derived hormone associated with insulin resistance, and hypoadiponectinemia has been associated with incident glucose intolerance in Jamaicans (OR, 0.93; 95% CI, 0.87–0.99).[46] In a cross-sectional study,[47] the mean (SD) adiponectin level was also lower in Trinidadian persons with type 2 DM than in nondiabetic controls (5.2 [0.5] vs 10.4 [1.4] μg/mL, respectively; $P < 0.01$). Heritability estimates of adiponectin suggest that genetic factors influence the interindividual variation in circulating adiponectin levels and therefore the risk of glucose intolerance.[48]

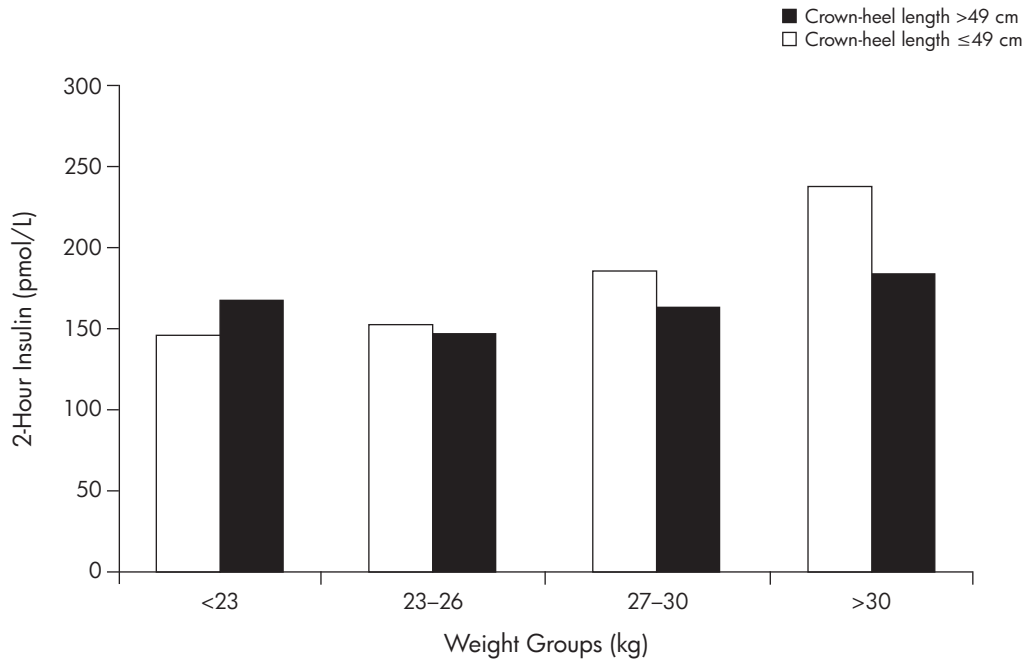

Figure 2. Effects of current weight and length at birth on 2-hour insulin concentration (geometric means) in 400 Jamaican children (mean age, 8.4 years).[44] (Trend of current weight with 2-hour insulin, $P = 0.001$; crown-heel length with 2-hour insulin, $P < 0.05$.)

Although oxidative stress (as measured by lipid peroxides)[49] and inflammatory markers (eg, sialic acid, highly sensitive C-reactive protein)[50] may be involved in diabetic complications in African-Caribbean persons, they may not be involved in the pathogenesis of type 2 DM.[51]

Etiologic Factors for Type 1 DM

The human T lymphotropic virus type 1 (HTLV-1) is endemic in the Caribbean, with a prevalence of 2% to 5%.[52] Consequently, it is interesting that one report[53] found a higher-than-expected seroprevalence of HTLV-1 in Jamaicans

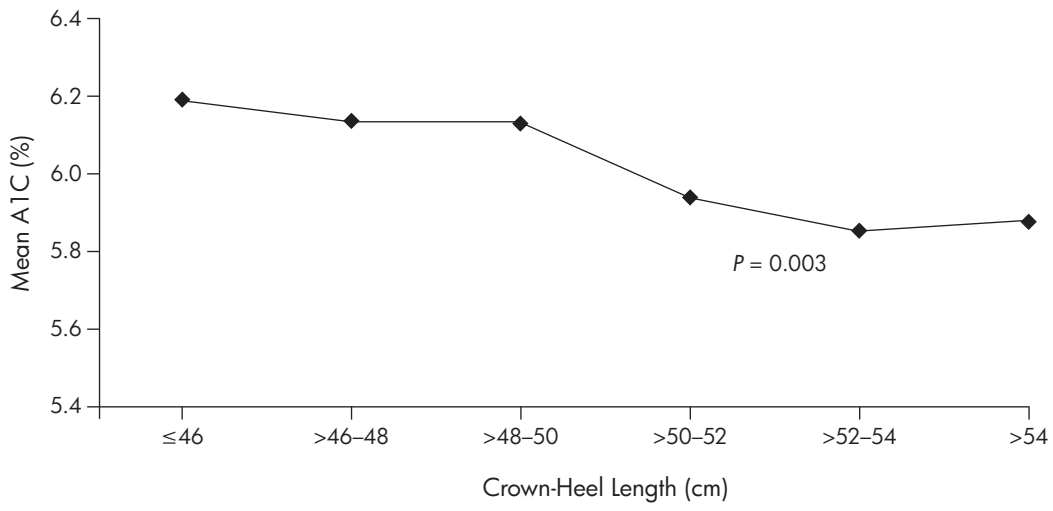

Figure 3. Association between glycosylated hemoglobin (A1C) level in 475 Jamaican children ≤10 years of age and their crown-heel length at birth (adjusted for age, sex, and current weight).[45]

with type 1 DM, but this initial finding awaits further study.

Polymorphisms in the HLA-DQ genes and the DRB1 gene (or a gene in linkage disequilibrium with it), which are uncommon among whites, were associated with altered risk of type 1 DM in African Jamaicans.[54] Notably, the DRB1*03-DQ2/DRB1*04-DQ8 genotype had the highest associated risk, but DRB1*0401-DQ8 and DRB1*0408-DQ8 were also considered potential risk factors.[54] The DRB1*1503-DQ6 and DRB1*03-DQA1*0401-DQB1*0402 haplotypes were associated with less risk of diabetes.

Type-J Diabetes

Since the first description of type-J diabetes,[3] similar forms of diabetes have been referred to as Flatbush diabetes, phasic insulin-dependent DM,[55] atypical diabetes, type 1b diabetes, and ketosis-prone diabetes. This type of diabetes is more common in nonwhite races, and marginal nutritional status may play a role in some persons. Anecdotally, the prevalence of type-J diabetes seems to have declined, although the decline could be associated with the nutritional transition in the Caribbean causing a preponderance of type 2 DM.

Since the first description of type-J diabetes, similar forms of diabetes have been referred to as Flatbush diabetes, phasic insulin-dependent diabetes, atypical diabetes, type 1b diabetes, and ketosis-prone diabetes.

In general, these individuals have periods in which they require insulin (as reflected by the presence of ketosis), especially during metabolic stresses such as infection.[56] At other times, good glycemic control can be obtained with only lifestyle changes and oral antidiabetes agents. Many persons have insulin resistance and/or malnutrition.[57] It appears that these persons have β-cells that are sensitive to catabolic conditions (when inflammation and lipolysis increase) and these lead to transient, but significant, β-cell dysfunction. The precise metabolic triggers (eg, glucotoxicity, cytokines, nonesterified fatty acids, adipokines) are not known. Undoubtedly, this classification of diabetes represents a heterogeneous collection of phenotypes with different degrees of autoimmunity (ie, the diabetes autoantibodies anti-GAD65 and anti–IA-2 antibodies) and impaired β-cell function.[56] In a study of 103 patients with diabetic ketoacidosis conducted in the United States,[58] ~50% of persons with ketosis-prone diabetes had no evidence of autoimmunity (A–) and had preserved β-cell function (β+), 22% were A–β–, 17% were A+β–, and 11% were A+β+. Comparative data are lacking in Caribbean persons, but in one study looking at diabetes in Caribbean youth,[21] who were not necessarily selected on the basis of having ketosis-prone diabetes, 30% were A–β+, 41% were A–β–, and 39% were A+β– or A+β+. As such, some persons who have less autoimmunity (ie, antibody negative but with preserved β-cell reserve) demonstrate a clinical course more in keeping with type 2 DM despite having periods of ketosis.[59] Persons who are autoantibody positive tend to eventually need insulin therapy, whereas persons with preserved β-cell reserve may have periods of insulin independence.[56]

Maturity-Onset Diabetes of Youth

Maturity-onset diabetes of youth is rare in most societies, and this is true in the Caribbean. Insulin promoter factor–1 mutations in familial early-onset diabetes have been described in Trinidadians.[60]

Complications

Ethnic Differences in Complications

Chronic hyperglycemia results in both macroangiopathy (ie, coronary heart disease, stroke, peripheral artery disease) and microangiopathy (ie, retinopathy, nephropathy, neuropathy). In general, myocardial infarctions are believed to be less prevalent in populations of African ancestry and African-Caribbean persons than in whites.[61,62] Conversely, rates of stroke[63] and renal failure[64] were increased in these populations. It is not clear why such disparities exist. Genetic factors,[61] the prevalence of other concomitant cardiovascular risk factors,[63] and the level of therapeutic control of these cardiovascular risk factors have been implicated. Few data are available on genetic factors that influence complications in diabetic Caribbean people. However, persons of African ancestry had higher systolic blood pressure but lower triglyceride and total cholesterol levels than did persons of other ancestries.[62] Hypertension occurred in 52% and 35% of Jamaican women and men with type 2 DM, respectively.[7] African-Caribbean persons also had less nocturnal dipping of blood pressure than Europeans (12% vs 17% day-to-night decrease in mean systolic blood pressure, respectively [$P < 0.05$], after adjustment for resting systolic pressure).[65] Tobacco use was also relatively low in diabetic persons.[7] Consequently, these differences could account for the higher rates of stroke and renal failure (which are correlated with blood pressure), and the less atherogenic lipid profile may reduce the risk of coronary artery disease.

Macrovascular Disease

The leading cause of death in Caribbean populations is cardiovascular disease. Hyperglycemia-induced macrovascular complications are affected by race. Indo-Trinidadians have a population attributable mortality that is 2.9 to 6.9 times higher than that reported for other racial groups,[61,66] and most of this is related to diabetes-induced cardiovascular disease. According to the Disease Control Priorities Project in developing countries,[67] age-adjusted death rates due to diabetes per 100,000 population in 1998 were 67.9, 53.4, and

105.1 for Barbados, Jamaica, and Trinidad, respectively. In Barbados, diabetes accounted for an excess mortality of 42%, and a 9% increase in all-cause mortality occurred for each 1% increase in A1C level (death rate ratio, 1.09; 95% CI, 1.04–1.15).[11] However, few data regarding specific macrovascular complications and the associated mortality rates are available from other Caribbean countries.

Amputations

Amputation rates for diabetic feet are troublesomely high. The most detailed data came from Barbados, where the 1-year incidence of lower-extremity amputations was 936 per 100,000 population (557 per 100,000 for minor amputations and 379 per 100,000 for major amputations).[68] Independent risk factors for amputations were poor footwear (OR, 2.7; 95% CI, 1.20–5.97), elevated A1C (OR, 1.4 per 1% increase; 95% CI, 1.26–1.57), the presence of peripheral neuropathy ($P < 0.001$), and the presence of peripheral vascular disease ($P = 0.01$).[68] It is also possible that hemorrheologic factors, such as increased plasma viscosity and fibrinogen, may play a role in the development of diabetic foot.[69]

Hemorrheologic factors, such as increased plasma viscosity and fibrinogen, may play a role in the development of diabetic foot.

Retinopathy

Few data regarding retinopathy are available from the Caribbean apart from the Barbados Eye Study,[70] which found that the prevalence of retinopathy was ~29%. Most persons had mild disease, whereas ~8% had moderate changes and 1% had severe retinopathy. Clinically significant macular edema was found in 9% of persons with diabetes. In the same cohort, after 4 years, the incidence was 32% in those with known diabetes at baseline and 21% in persons with newly diagnosed diabetes.[71] Clinically significant macular edema developed in 5% of those individuals. The 9-year incidence of retinopathy increased to 40% (9% for moderate and 3% for severe/proliferative disease), and the incidence of macular edema was ~9%.[72] Increased systolic blood pressure was a risk factor; over a period of 9 years, the relative risk (RR) was 1.3 (95% CI, 1.1–1.4) for every 10-mm Hg increase, and the use of antihypertensive agents lowered the risk by 50%.[73] The risk of retinopathy increased by 30% with each 1% increase in A1C level (RR, 1.3; 95% CI, 1.2–1.5).[73] Maculopathy was seen in 48% of Jamaicans with type 2 DM 2 decades ago,[74] but no recent data are available. The burdens of glaucoma and cataracts are also high,[11] which clearly implicate the roles of retinopathy screening and proper control of glycemia and blood pressure in prevention.

Nephropathy

The Caribbean Renal Registry reported that diabetes accounted for ~28% of the cases of end-stage renal disease in Jamaica, the Bahamas, Barbados, and Trinidad.[75] Tortola had the highest rate (46%), possibly because of the small numbers in the registry.[75] In many countries, nonwhite persons with diabetes have higher rates of nephropathy. Some investigators have postulated that the increased oxidative stress in African-Caribbean persons may be involved in increased renal damage.[49] Nephropathy may also be more common in ketosis-prone diabetes.[76]

Hyperglycemic Crises

The actual prevalence of hyperglycemic crises in the general diabetic population in the Caribbean is not known. However, ~60% of persons admitted with diabetic ketoacidosis had type 2 DM.[77] Hyperglycemic crises also were associated with mortality rates of 7% for ketoacidosis, 20% for hyperosmolar hyperglycemia, and 25% for mixed ketoacidosis/hyperosmolar syndrome.[77]

Other Complications

Few (or no) data are available regarding other, less traditional complications of diabetes (eg, depression, erectile dysfunction, osteopenia, vascular dementia, reduced lung function) in the Caribbean.

Clinical Management

Some efforts have been made to standardize the clinical care of persons with diabetes. The Caribbean Health Research Council (CHRC), in partnership with the Pan American Health Organization (PAHO), produced clinical guidelines for managing diabetes in the Caribbean primary care setting in 2006.[78] The metabolic target goals were similar to those in the International Diabetes Federation guidelines,[79] although the 2 sets of guidelines differed in the goals for low-density lipoprotein cholesterol. The CHRC/PAHO targets are presented in **Table II**.[78]

The CHRC/PAHO guidelines emphasize the use of metformin as pharmacotherapy, especially in overweight/obese persons, but otherwise allow the use of any antidiabetes medication (sulfonylureas, thiazolidinediones, meglitinides, α-glucosidase inhibitors, and insulins). Nutritional intervention is also highly recommended, but the Caribbean region suffers from a lack of trained nutritionists and dietetic professionals. Previously, in response to this need, PAHO and the Caribbean Food and Nutrition Institute produced a manual on the nutritional management of obesity, diabetes, and hypertension.[80] In addition to these regional guidelines, some countries (eg, Jamaica) have also produced national guidelines.[81]

Public Health Burden/Interventions

Although diabetes care in the Caribbean is improving,[82] it remains suboptimal. In various surveys, ≥50% of persons had inadequate glycemic control (A1C >7.0%) in Jamaica[83] and Trinidad.[84] Also, in Jamaica, the type of health care fa-

Table II. The Caribbean Health Research Council/Pan American Health Organization targets for managing diabetes in the Caribbean primary care setting.[78]

Glycosylated hemoglobin	<6.5%
Blood pressure	≤130/80 mm Hg
Total cholesterol	<5.2 mmol/L
High-density lipoprotein cholesterol	>1.0 mmol/L
Low-density lipoprotein cholesterol	<1.8 mmol/L
Triglycerides	<1.7 mmol/L
Body mass index	18.5–25.0 kg/m^2
Waist circumference	<80 cm in women and <94 cm in men

cility (ie, private sector, public clinic, specialty clinic) did not influence the level of glycemia.[83] In Jamaica, laypersons in communities were trained in diabetes prevention and care as an alternative to traditional point-of-care for diabetes intervention.[85] Initial data suggested that, with repeated training, these lay diabetes facilitators were independently associated with a reduction in A1C of 0.5%.[86] Efforts to use locally available foodstuffs with lower glycemic indices have resulted in small, but significant, improvements in glycemia and atherogenic profiles.[87,88] Some countries are considering mobile therapeutic clinics for better accessibility, especially in inner-city and rural areas. Clearly, more work needs to be done.

By one conservative estimate, diabetes cost the Anglophone Caribbean US $218.1 million in direct costs, US $812.4 million in indirect costs, and US $687 million per capita in direct costs, along with 5555 diabetes-related deaths in 2000.[89] For many countries with modest gross domestic product per capita and with the anticipated increased rates of diabetes, one can easily project that diabetes could bankrupt some island nations in the future. As a consequence, the governments of the region proposed that the "The health of the region is the wealth of the region" in the 2001 Nassau Declaration.[90] In 2007, regional leaders reaffirmed their commitment in the Declaration of the Port of Spain to begin public health initiatives focused against diabetes and other obesity-related diseases.[91] At a regional level, and for many countries, this is a relatively novel concept, because most public health initiatives in the past were directed against infectious/communicable diseases, which traditionally caused most of the public health burden.

It is obvious that a coordinated macroeconomic, multisectoral approach is needed. Various culturally sensitive incentives to promote healthy, balanced nutrition; opportunities to incorporate leisure-time physical activities; and increasing activity during routine daily living are needed. Some countries (eg, Antigua) have adopted socialized, government-subsidized approaches by providing antidiabetes medications and glucose-monitoring supplies. However, as in any epidemic, proper surveillance is needed to gauge the effect of any intervention. Public health initiatives are urgently needed in this region.

CONCLUSIONS

The Anglophone Caribbean is caught in the throes of the obesity and diabetes pandemics. Although atypical diabetes is prevalent in this region, type 2 DM is the major public health burden, with prevalence rates that are higher than those reported in many developed countries. This burden is compounded by staggering projected incidence rates for obesity and, thus, diabetes. Macrovascular and microvascular complications already are common; therefore, it will be hard for these developing nations to survive the loss of productive manpower, direct costs, and indirect costs associated with diabetes. Consequently, primary prevention measures (lifestyle interventions), active diabetes screening, and surveillance will be needed for the 21st century. Because the origins of diabetes may also start from early life, more research is needed to define these mechanisms, as well as to implement suitable public health measures. These intervention strategies should probably be directed toward women of child-bearing age, as well as children. This would result in a radical viewpoint that intervention for diabetes (and other chronic, noncommunicable diseases) needs to occur throughout the life span. However, the precise nature of such interventions is undefined at present. In persons with diabetes, greater attention will be needed to systematically improve concurrent risk factors (ie, blood pressure, lipids, use of antiplatelet agents) and reduce glycemia. Sex-specific measures may be needed because women carry a disproportionate burden of obesity and diabetes.

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