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A Pilot Study of Type 2 Diabetes among Female Jamaican Maroons from a Genetic Isolate: Physical Characteristics and Prevalence

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Abstract

The purpose of this study was to analyze type 2 diabetes (T2D) among adult female Jamaican Maroons, comparing those with and without type 2 diabetes (T2D). A health survey was conducted with a self-selected sample of female heads of household (n=116). Comparisons used analysis of variance/covariance (ANOVA/ANCOVA), cross tabulations, and logistic regression and resampling with listwise deletion of missing values (n=86). T2D women were significantly older than non-T2D women (71.7 years vs. 57.0 years, $p < 0.01$). Hip circumference (cm), BMI, fat mass (FM) (kg), and percent body fat were significantly lower in T2D women compared to non-T2D women. Obesity was significantly more frequent in non-T2D women (OR = 0.16, $p < 0.05$). Notably, waist:hip ratio was higher among T2D women compared to non-T2D individuals (0.95 vs. 0.88, $p < 0.04$). Mean systolic blood pressure among T2D women (152.8 mmHg) was significantly ($p < 0.04$) higher than non-T2D females (134.7 mmHg). The estimated prevalence of T2D among Maroon females (16/116) was 13.79% (95% CI: 8.67% - 21.24%), which is similar to non-Maroon Jamaican populations. Stepwise multivariate logistic regression showed that women self-reporting T2D tended to have: a higher waist circumference (OR=1.22, $p < 0.01$), decreased FM(OR=0.71, $p < 0.001$), higher systolic pressure (OR=1.06, $p < 0.007$), lower diastolic pressure (OR=0.90, $p < 0.02$), and a first-degree relative with T2D (OR = 9.11, $p < 0.03$). This is the first report on T2D in Jamaican Maroons. Abdominal (central) obesity, body composition, and systolic hypertension were associated with T2D. Central fat distribution predicted T2D rather than overweight or obesity *per se*. The prevalence of T2D in this small sample of women from a genetic isolate in the Blue Mountains of Jamaica was significantly lower compared to admixed urban Jamaicans.

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Introduction

The number of adults living with type-2 diabetes (T2D) worldwide is estimated at about 422 million, with the heaviest burden in low-income and middle-income countries [1,2]. The Caribbean has experienced rapid economic growth and an attendant increase in the number of T2D cases in the past 40 years; approximately 14% of adult mortality (> 18 years) in the region in the past decade was associated with T2D, not including T2D-related cardiovascular or renal failure causes of death [3,4].

Jamaica has experienced increased rates of T2D as the prevalence of risk factors, such as sedentary lifestyle, high energy carbohydrate diet, overweight and obesity, increased in the population [5]. The prevalence of T2D among adults in the National Survey of Jamaica (1995) was 17.9% (95% CI: 16.3% - 19.6%), and was higher in urban Kingston, 29.5% (95% CI: 26.7% - 32.6%)[5,6]. One of the challenges in analyzing T2D risk factors is the genetic heterogeneity of the Jamaican population. Many Jamaicans trace their descent to the forced migration of West African populations during the interval of slave trade. Of relevance to the Jamaican population, genomic analysis of West Africans has shown the possible presence of T2D susceptibility genes [7].

T2D has not been studied in the Maroons, an isolated population in Jamaica that has the the highest proportion of the West African genome (>95%) in the country. The Maroons are descendants of former African slaves who escaped British colonial plantations in the mid-1600s through late 1700s and established isolated independent settlements that have been recognized by the British since 1739 [8]. Maroons currently reside in small autonomous communities in the Jamaican Blue Mountains. A survey of Jamaican Maroons indicated that 97.5% of the genome was of West African origin [9]. Maroon communities have been closed to outsiders since the 1600s, suggesting that patterns of phenotypic and genotypic variation in Maroons, a small isolate, may be informative for analysis of human adaptation and complex diseases [10].

The aim of the present, exploratory study is to analyze the prevalence and physical characteristics predictive of T2D in several Maroon communities (Moore Town, Jamaica), providing the first data on T2D in Jamaican Maroons.

Materials and Methods

The study was approved by the Institutional Review Board of the University of West Indies, School of Medicine in January, 2016. Subjects provided informed consent.

A survey was conducted in Moore Town, Jamaica, between March and May of 2016. A sample of 116 female heads of households, resident in Moore Town, Jamaica, was interviewed and measured between March and May 2016. In addition to general medical history,

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the interview included specific questions regarding whether or not the interviewee had been diagnosed with T2D by a physician and whether or not she had any diabetic co-morbidities. Questions also considered family history with special emphasis on identifying relatives of the interviewee who had T2D.

Four body dimensions were measured by a single individual experienced anthropometrist (TF): weight (kg), height (cm), and waist and hip circumferences (cm). Waist circumference was measured to the nearest 0.1 cm around the trunk just above the iliac crest, taking care to not compress the skin [11]. Hip circumference was measured around the widest portion of the buttocks [12]. Intra-observer measurement error was 0.34 cm for both waist and hip circumferences. Replicate measurements were not available for height and weight. The body mass index (kg/m^2, BMI) and waist-to-hip ratio (waist, cm/hip, cm) were calculated. Overweight was defined as BMI > 25 and < 30, and obesity was set at > 30, according to International Obesity Task Force (IOTF) guidelines.

Fat free mass (FFM) was estimated with bioelectrical impedance analysis (BIA) using a single-frequency (50 kHz) impedance analyzer (model BIA 101Q; RJL Systems, Clinton Township, MI). Equations developed for Jamaicans were used: fat free mass (FFM) =13.7 +(0.25*weight kg) + 0.38*((height cm**2)/resistance) - 6.2*1[13]. Fat mass (FM) was derived as weight (kg) – FFM (kg). Percentage body fat was calculated as FM (kg)/weight (kg). Anthropometrics were similarly chosen for their predictive value in incident T2D according to a prior investigation in Jamaica [14].

Systolic and diastolic blood pressures were measured three times with a mercury sphygmomanometer to within 2 mmHg, and the average was taken; heart rate was measured three times, and the average taken. Elevated systolic blood pressure was a reading of > 140 mmHg while elevated diastolic was a reading ≥90 mmHg. Heart rate was measured at the radial artery on the wrist and timed using a stop watch.

Of the initial sample of 116 women, complete biometric data were available for 86 subjects, including 10 with T2D and 76 non-T2D women. Six T2D and 21 non-T2D subjects were excluded for missing anthropometric, blood pressures or BIA data. Listwise deletion for missing values resulted in 86 cases (76 non-T2D and 10 T2D) for evaluation.

Analysis of variance (ANOVA) and ANCOVA controlling for age was used to test differences between T2D and non-T2D subjects. Backward selection Wald χ^2 logistic regression analysis was used to develop a model of predictors of T2D status. Given the relatively small samples, bootstrapping analysis (n=1000 re-samples) was used to compute robust significance and variance estimates for the ANOVAs, contingency table analyses and logistic regression. All significance tests were two-tailed. The bootstrapped significances of the analyses were Bonferroni adjusted and statistically significant at $p < 0.05$ or lower when indicated significant. Analyses were performed using SPSS v24 (IBM SPSS, Chicago, Ill) and EpiTools (www.epitools.ausvet.com.au).

Results

The characteristics of the women are summarized in Table 1. T2D and non-T2D women differed significantly in age, 71.7 and 57.0 years, respectively ($p < 0.01$). Height, weight, BMI, waist circumference, and waist-hip ratio did not differ significantly between women with and without T2D. On the other hand, hip circumference was significantly higher ($p < 0.05$) in non-T2D women (104.9 cm) compared with T2D (97.2 cm). Estimated FFM did not differ significantly between T2D and non-T2D women ($p < 0.48$), while FM and percentage body fat were significantly lower in T2D women than in non-T2D women ($p < 0.13$). Systolic blood pressure tended to be higher but not diastolic blood pressure among T2D women compared with non-T2D. Neither difference was significant.

Frequency of family history of T2D in a first-degree relative was not different between women with and without T2D ($p < 0.75$). The prevalence of overweight, obesity and overweight + obesity also did not differ between the two groups. Elevated systolic blood pressure was slightly more frequent in T2D compared to non-T2D women, but not significantly ($p < 0.59$). Elevated diastolic blood pressure was not increased in frequency in T2D compared to non-T2D individuals ($p < 0.43$) (Table 2). Bootstrapping had no appreciable effect on results of the univariate comparisons.

Results of the stepwise variable selection in multivariable logistic regression indicated five significant predictors of T2D (Table 3). Waist circumference was associated with an increased frequency of T2D (OR = 1.22, 95% CI: 1.02-1.44). FM was a negative predictor of T2D (OR = 0.71, 95% CI: 0.54-0.91). Systolic blood pressure is a positive predictor of T2D (OR = 1.06, 95% CI:1.02-1.11). Diastolic blood pressure is a negative predictor of T2D (OR = 0.90, 95% CI: 0.82-0.99). Finally, family history of a first degree relative increase is associated with a 9.11-fold increase (OR = 9.11, 95% CI: 1.11-75.10) in T2D likelihood (Table 3).

Discussion

Comparison of Maroons with related populations reveals a potentially interesting pattern (Table 4). The age-adjusted prevalence of T2D in the sample of Blue Mountain Jamaican Maroon women was 13.79% (95% CI: 7.52 – 20.07%). The prevalence of T2D in five Jamaican communities in the late 1950s and early 1960s was significantly lower than 13.79%, at 1.3% [14], whereas the estimated prevalence of T2D among Maroons was not significantly different from rural Jamaicans in 1972 (8.1%) [15], or the National Jamaican Health Survey of 1995 (17.9%) [16]. In contrast to the preceding, the prevalence of T2D in a national survey in 2008 (29.5%) [17], which included admixed Jamaicans resident in Kingston, was significantly higher than that observed among Maroons.

Body weight and BMI differed between the two groups, but not in the direction expected; the values tended to be lower among T2D women compared to non-T2D subjects. In addition to weighing less, variation in the distribution of adiposity between T2D and non-T2D women is different. Women with T2D had significantly elevated central adiposity. Prior investigation of anthropometrics that predicted T2D in Jamaicans found increased BMI, waist circumference, waist:hip ratio, and waist:height ratio. This finding agrees with recent literature that shows central obesity is closely correlated with T2D in women worldwide [18-20]. The waist:hip ratio was significantly greater among women with T2D compared to women without T2D, consistent with prior studies [21]. However, it is unusual to observe elevated waist:hip ratio in conjunction with lower weight, BMI, and FM. This implies that fat distribution differs between T2D and non-T2D women, with T2D women exhibiting a greater degree of central adiposity compared to non-T2D women. Whether or not central adipose tissue was subcutaneous or visceral cannot be determined in this study because skinfolds are not available.

	T2D (n=10)*		non-T2D (n=76)**			Age-adjusted T2D		Age-adjusted non-T2D		
	Mean	SE	Mean	SE	p§	Mean	SE	Mean	SE	p§§
Age (yrs.)	71.7	3.5	57.0	1.9	0.01	--	--	--	--	--
Height (cm)	158.0	1.4	159.2	0.8	0.61	160.5	3.5	158.9	0.7	0.46
Weight (kg)	64.6	2.9	74.5	1.7	0.03	67.9	4.4	73.9	1.6	0.21
Waist circumference (cm)	88.9	3.6	92.1	1.3	0.31	89.3	3.8	92.8	1.3	0.38
Hip circumference (cm)	94.4	3.6	105.3	1.4	0.01	97.2	3.8	104.9	1.3	0.058
Waist: Hip ratio	0.95	0.04	0.88	0.01	0.04	92.6	2.8	88.7	1.0	0.20
BMI (kg/m^2)	25.1	1.3	29.3	0.6	0.02	26.3	1.6	29.2	0.6	0.11
Body composition										
FFM (kg)	40.4	1.0	44.1	0.8	0.1	42.3	1.9	43.8	0.7	0.48
FM (kg)	24.5	2.3	30.4	1.1	0.02	25.6	2.8	30.1	1.0	0.13
FM (%)	36.6%	2.0	40.0%	0.6	0.02	36.9	1.8	39.9	0.6	0.12
Systolic blood pressure§§§	152.8	12.3	134.7	2.7	0.04	144.7	7.9	135.7	2.8	0.29
Diastolic blood pressure§§§	79.7	4.9	81.2	1.5	0.75	78.7	7.9	81.3	1.5	0.57
Heart rate (beats / min.)	77.4	4.3	76.3	1.4	0.99	77.0	4.1	76.2	1.4	0.85

Table 1: Descriptive statistics (age-adjusted means and standard errors) for age and anthropometric, body composition and physiologic variables.

§- MANOVA with bootstrapped p value (n=1000 resamples) with Bonferroni correction for multiple comparisons
§§ -MANOVA with MANCOVA age adjusted means/SEs with Bonferroni correction for multiple comparisons
§§§ -mmHg (mm of mercury)

	T2D (n=10)		non-T2D (n=76)					
Variable	n	%	n	%	OR	Lo	Hi	p*
First degree relative T2D	5	50.0	40	50.1	1.05	0.28	3.94	0.94**
Overweight	6	60.0	33	43.4	1.96	0.51	5.64	0.33
Obese	0	0	29	38.0	--	--	--	0.01**
OW + OB	7	63.4	64	81.0	0.41	0.41	1.58	0.24**
Elevated Systolic BP§	8	80.0	51	67.1	1.96	0.39	9.93	0.33
Elevated Diastolic BP§§	4	40.0	23	30.3	1.54	0.40	5.97	0.53**

Table 2: Comparison of T2D status by occurrence of T2D in first degree relatives, overweight, obesity, overweight + obesity, and blood pressures.

* Chi-square with boostrapping
**Fisher's Exact Probability Test with bootstrapping
§ - Blood pressure > 120 mmHG
§§ - Blood pressure > 90 mmHG

		95% CI		
Variable	OR	lo	hi	p§
Fat mass	0.71	0.54	0.91	0.002
Waist circumference	1.22	1.02	1.44	0.003
Systolic Blood Pressure	1.06	1.02	1.11	0.005
Diastolic Blood Pressure	0.90	0.82	0.99	0.02
First degree relative T2D	9.11	1.11	75.1	0.03

Table 3: Logistic regression of T2D status on anthropometrics, body composition, blood pressures, and family history of T2D in Maroons with T2D (n=10) and without T2D (n=76).

Nagelkerke $R^2 = 0.43$, Cox & Snell $R^2 = 0.22$

§ - Bootstrapped p value (n=1000 samples)

Body weight is significantly lower among T2D women. Body composition analysis indicates a trend for T2D women to have slightly (but not significantly) reduced FFM compared to non-T2D women ($p < 0.08$). T2D females have significantly less FM ($p < 0.03$) compared to non-T2D subjects. Reduced FFM among T2D compared to non-T2D women indicates absolutely but not relatively lower lean body mass, which is an important finding because lean tissues are associated with glucose metabolism. Importantly, weight was different between the two groups, indicating a difference in body composition that may be important to development of the T2D. Prior investigations have focused on percent body fat and FM in T2D individuals because of the association between T2D and obesity. Higher waist: hip ratio and decreased FFM and FM predict T2D. This suggests variation in relative lean and fat mass between T2D and non-T2D among Maroons should be further investigated.

	Type 2 Diabetes				
	N	Prevalence	95% CI	Year	Reference
Jamaica					
Five Communities§	4516	1.3%	0.1% to 1.6%	1957 1959 1960	[29]
Rural Jamaica	531	8.1%	6.1% to 10.8%	1972	[15]
National Survey	2109	17.9%	16.3% to 19.6%	1995	[16]
International Survey	820	8.1%	6.2% to 9.9%*	1996	[32]
Jamaica elderly (> 60)	1318	10.2%	8.5% to 11.8%*	1995	[33]
Spanish Town	1303	13.4%	11.5% to 15.2%	1999	[31]
Kingston Admixed§	900	29.5%	26.7% to 32.6%	2008	[5]

Table 4: Comparison of prevalence of T2D in Jamaica.
§ - Significantly different from Maroons T2D prevalence 2016
§§ - Not significantly different from Maroons T2D prevalence 2016
*95% CI was calculated, not reported in the original publication

Family history of T2D was not increased among women with T2D compared to non-T2D women ($p < 0.23$). No significant differences in frequency of overweight, obesity, and hypertension were found between the two groups (Table 2).

Apparent fat patterning among Maroon women in central adiposity parallels prior investigations [22-24]. Upper body adiposity is frequently associated with untoward complications of overweight and obesity, while lower body fat deposition (gluteal-femoral adiposity) is apparently protective from adverse effects of excess fatness [25]. In the present study, observed relative measures (percent body fat, BMI), absolute measures (weight, FFM, FM), and increased waist:hip ratio collectively suggest that central adiposity is a major risk factor for T2D. Significant findings in logistic regression analysis augment the univariate ANOVA findings, showing the importance of absolute differences between T2D and non-T2D in waist circumference, blood pressure (systolic and diastolic), and family history of a first degree relative with T2D. Diastolic blood pressure tends to be lower among T2D hypertensive individuals than among non-T2D hypertensives [26].

T2D is often associated with obesity. Approximately 90% of diabetics are overweight or obese [27]. However, in a genetic isolate from the Valley of Oaxaca, southern Mexico where the prevalence of T2D is estimated at 20%, overweight was moderate (males 46%, females 47%) but obesity was low (5% males, 14% females) [28]. Differential fat deposition to the trunk in T2D rather than general overweight and appendicular obesity is apparently a risk factor in the Zapotecs from Oaxaca[28], similar to the Maroons in the present investigation. These findings differ from trends observed in other studies of body composition and diabetes. Among female Maroons, the non-T2D individuals were heavier with higher FM and FFM. The Maroon diet does not contain energy-dense foods high in carbohydrates or saturated fats (Table 5). The natural history of T2D among Maroons in genetic and environmental isolation, with a restricted diet, may be different than in urban, admixed populations in the context of the nutritional transition.

Comparison of Maroons to related populations reveals an interesting pattern. The main finding of the present study is that the prevalence of T2D in the Blue Mountain Jamaican Maroons is 13.79% (95% CI: 7.85 – 20.75%). The prevalence of T2D in five Jamaican communities in the late 1950s and early 1960s was 1.3% [29], which is significantly lower than Maroons in 2016 (Table 4). Prevalence of T2D among Maroons is not significantly different from rural Jamaicans (8.1%), or the National Jamaican Health Survey (17.9%) (Table 4). In contrast, the prevalence of T2D in a national survey (29.5%) [5] that included Kingston admixed Jamaicans was significantly higher than that among the Maroons (13.79%, ages 22.6 to 91.8 years).

A major limitation is reliance on self-reported T2D as no diabetes testing was done in this survey. This kind of bias is likely to

Breakfast	N	%	Lunch	N	%	Dinner	N	%
Tea	28	24.1%	Rice	11	9.5%	Chicken	42	36.2%
Bread§§	26	22.4%	Bread§§	7	6.0%	Rice	42	36.2%
Sugar§	18	15.5%	Milk§	6	5.2%	Wheat§§	23	19.8%
Milk§	16	14.0%	Chicken	6	5.2%	Fish	13	11.2%
Banana	13	11.2%	Banana	6	5.2%	Banana	11	9.5%
Wheat§§	12	10.3%	Biscuit	5	4.3%	Beef	6	5.2%
Eggs	11	9.5%	Cake	5	4.3%	Bread§§	3	2.6%
Chicken	10	8.6%	Corn*	4	3.4%	Corn*	3	2.6%
Plantain	10	8.6%	Cheese	4	3.4%	Milk§	3	2.6%
Corn*	8	6.9%	Wheat§§	4	3.4%	Plantain	3	2

Table 5: Dietary 24 hour recall by female head of household.
§ - added to tea of coffee, §§ - wheat flour products, * - corn meal products

favor the null hypothesis (i.e., no differences between the two groups) and underestimate T2D effects. In addition, prior studies that used biochemical diagnostics have found an under ascertainment of T2D >50% [30]. Additional limitations of the present study center on small sample size, sampling only females and measuring only heads of household. Bootstrapping (resampling) produced robust estimates of variance because of possible bias of small sample size. Other limitations include the absence of T2D testing; the present study used self-report of a physician telling the subject that she had "sugar in the blood," which is local vernacular for a diabetes diagnosis. Notably, the US National Health and Nutritional Examination Survey (NHANES) uses self-reported T2D status. In a larger study, a full battery of nutritional anthropometry along with body composition and testing (HbA1c, whole and fractions of cholesterol, triglycerides, creatinine) should be done.

In summary, Maroon women with T2D have increased waist: hip ratio, slightly lower FFM, and elevated systolic blood pressure. However, overweight and obesity do not seem strongly associated with T2D, although this may be a chance finding due to small sample sizes. The female Maroon population on average exhibits signs of metabolic syndrome (increased blood pressure, high heart rate, high rates of overweight and obesity, large waist circumference, high waist: hip ratio).

Competing Interests

None of the authors have any competing financial interests or conflicts of interest in relation to this work.

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