Association of Waist Circumference With Risk of Hypertension and Type 2 Diabetes in Nigerians, Jamaicans, and African-Americans

IKE S. OKOSUN, PHD
RICHARD S. COOPER, MD
CHARLES N. ROTIMI, PHD
BABATUNDE OSOTIMEHIN, MD
TERRENCE FORRESTER, MD

OBJECTIVE — Prior studies have supported that waist circumference correlates better with visceral adipose tissue and is a better predictor of cardiovascular disease than are BMI and waist-to-hip ratio. In this study, we reexamine the role of waist size on the risk of hypertension and type 2 diabetes in African-origin populations from three contrasting environments.

RESEARCH DESIGN AND METHODS — A cross-sectional survey was conducted of 5,042 men and women 25–74 years of age from Nigeria, Jamaica, and the U.S. The relationship between waist, blood pressure, and fasting blood glucose was assessed using multiple linear regression analyses. Logistic regression analyses using sex-specific empirical waist cut-points were used to determine the risks of hypertension and type 2 diabetes.

RESULTS — Waist circumference was positively correlated with blood pressure and fasting blood glucose ($P < 0.05$). Increasing waist quartiles were significantly associated with higher risks of hypertension in the three populations, as estimated from age-adjusted odds ratios obtained from sex-specific logistic regression models. A highly elevated risk of type 2 diabetes—10-fold for Jamaican men and 23-fold for African-American women—was observed in the comparison of lowest to highest quartiles of waist circumference

CONCLUSIONS — Substantial reduction in hypertension and diabetes in men and women is achievable if the waist size is decreased in these populations. Intervention programs designed to reduce waist circumference through lifestyle modification, including exercise and diet, may have significant public health significance in reducing the incidence of hypertension and adult-onset diabetes in these populations.

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In recent years, considerable attention has been given to the role of adiposity in the development of chronic diseases, leading to speculations that some forms of fat distribution may be more important in the causation of cardiovascular diseases than others (1,2). Evidence for the strong relationship between cardiovascular diseases and adiposity has often been based on the anthropometric indices of BMI and waist-to-hip ratio (WHR). BMI is a height-independent measure of weight often used as a measure of whole body size and the degree of fatness within populations. The use of BMI is controversial, however, in part because its correlation with fatness is not consistent across populations (3). WHR measures central fat deposition but is a poor measure of visceral fat mass, particularly in lean individuals (4). Waist circumference is an aggregate measurement of the actual amount of total and abdominal fat accumulation and is a crucial correlate of the complexities found among obese and overweight patients (5,6). Unlike the BMI, waist circumference is not profoundly influenced by height (7) and is therefore a better predictor of some cardiovascular diseases (8,9). Waist circumference has also been shown to be more correlated with levels of abdominal visceral adipose tissue (9–13).

Only a few studies examined the association of waist circumference with hypertension and diabetes in populations of the African diaspora (14,15). Investigating Africans in the diaspora makes it possible to dilute the potential confounding factors of social class and race that occurs often in black–white comparisons and to understand the range of interactions that occur in widely contrasting environments. This study examines the association of abdominal fat distribution (defined by waist circumference) with hypertension and type 2 diabetes.

RESEARCH DESIGN AND METHODS

Survey procedures
Data from Ibadan, Nigeria, and local surveys in Spanish Town, Jamaica, and the U.S. Third National Health and Nutrition Examination Survey (NHANES III) were used in this investigation. The Nigerian and Jamaican data were part of the International Collaborative Study of Hypertension in Blacks (ICSHIB). Detailed methods of the sampling and anthropometric measurement techniques are described extensively elsewhere (16–18). Briefly, ICSHIB was conducted between 1994 and 1996 in Nigeria, Cameroon, Jamaica, St. Lucia, Bar-

From the Department of Preventive Medicine and Epidemiology (I.S.O., R.S.C., C.N.R.), Loyola University Stritch School of Medicine, Maywood, Illinois; University College Hospital (B.O.), Ibadan, Nigeria; and the Tropical Metabolism Research Unit (T.F), University of the West Indies, Mona, Jamaica.
Address correspondence and reprint requests to Dr. Ike S. Okosun, Department of Preventive Medicine and Epidemiology, Loyola University Stritch School of Medicine, 2160 S. First Ave., Maywood, IL 60153. E-mail: iokosun@wpo.it.luc.edu.
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Abbreviations: BP, blood pressure; dBP, diastolic blood pressure; FBG, fasting blood glucose; ICSHIB, International Collaborative Study of Hypertension in Blacks; NHANES III, Third National Health and Nutrition Examination Survey; OR, odds ratio; sBP, systolic blood pressure; WHR, waist-to-hip ratio.
A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Table 1—*Characteristics of the study populations*

	Nigeria		Jamaica		U.S.	
	Men	Women	Men	Women	Men	Women
n	875	1,056	510	776	844	983
Age (years)	41.5 ± 12.3	40.0 ± 11.3	46.8 ± 14.2	45.9 ± 13.2	45.9 ± 14.1	44.4 ± 13.3
Height (cm)	163.8 ± 9.5	157.8 ± 7.4	171.8 ± 7.1	160.8 ± 6.4	177.0 ± 6.7	163.0 ± 6.6
Weight (kg)	61.7 ± 10.8	58.0 ± 12.4	72.0 ± 14.4	74.4 ± 16.3	82.3 ± 17.5	78.3 ± 19.6
Hip (cm)	88.7 ± 9.7	92.6 ± 11.3	95.7 ± 8.1	104.4 ± 12.8	99.3 ± 10.0	107.2 ± 14.0
Waist (cm)	77.7 ± 9.2	75.7 ± 10.2	80.9 ± 11.7	83.4 ± 12.6	93.1 ± 13.6	95.0 ± 16.0
BMI (kg/m²)	22.5 ± 4.4	22.9 ± 5.2	23.8 ± 4.2	28.0 ± 6.5	26.5 ± 5.0	29.4 ± 6.9
WHR	0.88 ± 0.05	0.82 ± 0.07	0.84 ± 0.07	0.80 ± 0.06	0.93 ± 0.07	0.89 ± 0.08
dBP (mmHg)	71.6 ± 13.8	69.5 ± 14.0	70.0 ± 15.1	0.69.3 ± 14.7	78.4 ± 12.0	73.2 ± 12.6
sBP (mmHg)	120.0 ± 19.1	116.5 ± 20.5	122.3 ± 21.3	121.3 ± 21.9	126.4 ± 18.8	121.3 ± 21.7
FBG (mg/dl)	—	—	98.5 ± 42.0	99.8 ± 45.0	107.1 ± 44.8	107.1 ± 48.9

Data are means ± SD. In Nigeria, FBG was not determined.

bados, and the U.S. (Maywood, IL) using the sampling technique of probability proportional to size to draw a random sample of adults between the ages of 25 and 74 from households.

In Nigeria, participants were sampled from rural and urban communities of Ibadan. Ibadan is the largest and most populous city in the southwestern region of Nigeria. A brief questionnaire regarding health habits, medical history, and current medication use was administered. Height and weight were measured with subjects in their stocking feet and light clothes. Fasting blood glucose was not determined in Nigeria. The Jamaican survey sample was conducted in Spanish Town, a working-class community 10 km west of Kingston. Anthropometric data, including height, weight, waist, hip, and blood pressure (BP) measurements, were obtained in Jamaica after an overnight fast. Fasting blood glucose (FBG) was assayed using oxidase glucose test.

NHANES III data were accessed via a CD-ROM provided by the National Center for Health Statistics. The sampling and measurement procedures have been described in detail elsewhere (19). Briefly, NHANES III is a multistage probability sample of the major U.S. population groups defined and examined in two phases between 1989 and 1995. Only groups identified as African-American were used in this investigation. The NHANES III data include medical information, anthropometric variables, and FBG value determined by the oxidase glucose test.

All anthropometric measurements in ICSHIB were made by trained staff with techniques comparable with those used in NHANES III. Measurements were taken at the natural waist or at the midpoint between the bottom of the rib cage and 2 cm above the top of the iliac crest. Two measurements of waist circumference were made for each subject. Hip measurements were taken at the point of maximum extension of the buttocks. Duplicate measurements were taken to nearest 0.1 cm and repeated if they differed by more than 0.50 cm. The average of the two or three readings was used for this analysis. Description of measurement precision between technicians and sites has been described elsewhere (16–18).

Statistical analysis

Analyses were restricted to individuals 25–74 years old for whom medical history, medication use, weight, height, and waist and hip measurements were available. Thus, 1,931 individuals in Nigeria, 1,286 in Jamaica, and 1,827 in the U.S. were eligible. Statistical analyses were performed using programs available in SPSS for Windows (20). Correlation analyses were performed to determine if waist circumference was linearly related to other measures of body composition, diastolic BP (dBP), systolic BP (sBP), and FBG. Multiple linear regression analyses were performed (with all variables forced into models) separately for dBP, sBP, and FBG to assess the independent contribution of waist circumference and site to variations in levels of risk. To avoid potential confounding that may be associated with BP and FBG, we adjusted for BMI, age, smoking, and alcohol use. We also adjusted for diabetes and hypertension status in analyses involving BP and FBG, respectively. Multiple logistic regression analyses with hypertension and diabetes as dependent variables were done for each site. An ecological regression analysis with geographical site in the model was also performed. Because there were no fasting glucose measurements in Nigeria, analyses did not include Nigeria when diabetes was the dependent variable. Waist circumference was converted into site- and sex-specific quartiles to determine the risks of diseases using the first quartile as the reference category. Analyses of linear trends were performed when appropriate.

To our knowledge, there are no established cutoff points for waist circumference in estimating risk for hypertension and type 2 diabetes. To assess the impact of waist circumference, we used an empirical cut-

Table 2—*Correlation of waist circumference with FBG, dBP, and sBP in Nigerian, Jamaican, and African-American subjects*

	Nigeria			Jamaica			U.S.		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
dBP (mmHg)	0.18	0.16	0.19	0.24	0.28	0.21	0.19	0.17	0.25
sBP (mmHg)	0.12	0.15	0.07	0.30	0.30	0.20	0.26	0.26	0.23
FBG (mg/dl)	—	—	—	0.15	0.14	0.16	0.24	0.24	0.25

In Nigeria, FBG was not determined. Each coefficient is significant at $P < 0.05$.

point of ≥94.00 cm for men and ≥80.00 cm for women (Lean et al. [21]) and mean values derived from Nigeria using empirical tertiles. Our justification for the cut-point is based on the study by Lean et al. (21). These investigators found an agreement between waist circumference (≥94.00 cm for men and ≥80.00 cm for women) and BMI (BMI ≥25 kg/m^2) with a specificity of 97.5% and a sensitivity of 96.0%. With only 2.0% misclassification, and using the above cut-points, these investigators also found that waist circumference identified subjects with high WHR (≥0.95 for men and ≥0.80 for women) with 97.5% specificity and 96.0% sensitivity. The above BMI cut-points are consistent with the World Health Organization's recommendation, and the WHR is within the range suggested by the U.S. Department of Agriculture for Americans. The World Health Organization specifies a normal BMI as within 20–25 kg/m^2 (22). U.S. Department of Agriculture recommends a WHR of 0.95 for men and 0.80 for women for determining risk of cardiovascular diseases (23).

To study the attributable risk of hypertension and type 2 diabetes to waist circumference, population attributable risk percent (PAR%) was estimated as follows.

$$PAR\% = \frac{(Prev_E)(OR-1)}{(Prev_E)(OR-1)+1}$$

On the basis of Lean et al. (21), $Prev_E$ is the exposed proportion (waist circumference ≥94.00 cm for men and ≥80.00 cm for women). OR is the odds ratio comparing men with a waist circumference <94.00 cm with those with one ≥94.00 cm, and women with a waist circumference <80.00 cm with those with one ≥80.00, adjusting for age in the logistic model. Using empirical waist tertile, $Prev_E$ is the exposed proportion (waist values ≥69.0, 76.0, and 88.1 cm in men and ≥66.1, 73.8, and 87.2 cm in women); and OR compares men with waist circumferences <69.0, 76.0, and 88.1 cm with those >69.0, 76.0, and 88.1 and women with waist values <66.1, 73.8, and 87.2 with those ≥66.1, 73.8, and 87.2 cm. A value of $P < 0.05$ indicated statistical significance.

Definitions and diagnostic criteria

On the basis of the American Diabetes Association criteria (24), type 2 diabetes was defined as either *1*) current diagnosis and use of insulin or hypoglycemic agent or *2*) FBG ≥126 mg/dl or a 2-h postload value of >200 mg/dl in the oral glucose tolerance test. The prevalence of hypertension was defined as sBP ≥140 or dBP ≥90 or current use of antihypertension medication (25). BMI was calculated as the measured weight in kilograms divided by height in meters squared (kg/m^2). WHR was calculated as waist divided by hip circumference measured in centimeters.

Table 3—*Site-specific multiple regression analysis for dBP, sBP, and FBG*

	dBP		sBP		FBG	
Variable	β	*P* value	β	*P* value	β	*P* value
Nigeria						
Waist	0.187	<0.001	0.082	0.181	—	—
BMI	0.097	0.289	0.124	0.313	—	—
Age	0.107	<0.001	0.555	<0.001	—	—
Diabetes	9.402	<0.001	20.958	<0.001	—	—
Sex	−2.021	0.003	−2.968	0.001	—	—
Smoking	1.930	0.018	−2.007	0.065	—	—
Alcohol use	−1.700	0.041	0.407	0.715	—	—
Hypertension	—	—	—	—	—	—
Constant	50.332	—	87.855	—	—	—
Jamaica						
Waist	0.193	<0.001	0.334	<0.001	0.972	<0.001
BMI	0.179	0.230	0.067	0.736	−1.378	<0.001
Age	0.220	<0.001	0.676	<0.001	0.404	<0.001
Diabetes	−0.923	0.431	2.668	0.086	—	—
Sex	2.241	0.032	2.153	0.119	−3.153	0.290
Smoking	−0.931	0.331	−0.482	0.706	−1.750	0.525
Alcohol use	−1.016	0.285	1.960	0.120	−1.593	0.559
Hypertension	—	—	—	—	8.276	<0.001
Constant	38.654	—	63.545	—	37.581	
U.S.						
Waist	0.241	<0.001	0.364	<0.001	1.067	<0.001
BMI	−0.191	0.282	−0.261	0.316	−1.003	0.122
Age	−0.034	0.341	0.502	<0.001	0.602	<0.001
Diabetes	−0.651	0.594	−0.586	0.741	—	—
Sex	6.723	<0.001	6.315	<0.001	−2.308	0.469
Smoking	−0.331	0.710	−1.409	0.277	11.068	0.001
Alcohol use	0.667	0.070	0.667	0.214	1.338	0.332
Hypertension	—	—	—	—	−2.953	0.419
Constant	55.419	—	70.933	—	6.994	—

In Nigeria, FBG was not determined.

RESULTS

Overall, there was a gradient for mean height, weight, hip and waist circumference, and BMI, increasing in the direction of Nigeria, Jamaica, and the U.S. (Table 1). Although men (except in Jamaica) tended to be heavier than women, women were found to have wider waists and hips compared with men within populations ($P < 0.05$). The largest relative difference between men and women in mean waist circumference was observed in Jamaica, with a difference of 2.5 cm.

The result of univariate analysis of the correlation of waist with BP and FBG is presented in Table 2. Waist circumference was statistically and positively correlated with sBP, dBP, and FBG among women and men ($P < 0.05$).

We performed separate multiple regression analyses on dBP, sBP, and FBG in association with other confounding variables known to influence each of the dependent variables, including BMI, age, history of diabetes and hypertension, sex, smoking, and alcohol use (Table 3). Waist circumference was independently and significantly associated with dBP and sBP when adjusted for BMI, age, diabetes, sex, smoking, and alcohol use in Nigeria, Jamaica, and the U.S. ($P < 0.01$). Waist circumference was also independently associated with BMI, age, hypertension, sex, smoking, and alcohol use in Jamaica and the U.S. ($P < 0.01$). Because age was sta-

Table 4—*Multiple regression analysis of site and other factors associated with BP, FBG, and BMI*

	dBP		sBP		FBG		Waist circumference	
Variable	β	*P* value	β	*P* value	β	*P* value	β	*P* value
Waist	0.203	<0.001	0.245	<0.001	1.027	<0.001	—	—
BMI	0.031	0.654	−0.034	0.710	−1.149	0.001	1.755	<0.001
Age	0.130	<0.001	0.609	<0.001	0.511	<0.001	0.115	<0.001
Diabetes	0.599	0.448	4.999	<0.001	3.376*	0.138	—	—
Sex	1.034	0.019	0.898	0.131	−4.523	0.032	0.660	<0.001
Smoking	0.008	0.987	−1.506	0.025	3.732	0.062	1.293	<0.001
Alcohol use	1.171	0.597	0.498	0.273	0.242	0.834	0.406	0.011
Jamaica	−2.876	<0.001	−1.413	0.053	—	—	1.481	<0.001
U.S.	0.263	0.764	−1.323	0.299	5.404	0.074	6.252	<0.001
Constant	48.264	—	74.939	—	21.156	—	6.252	—

*Value is for hypertension.

tistically and positively associated with dBP, sBP, and FBG, it was adjusted for in all regression models ($P < 0.05$).

The results of the regression models showed that waist circumference accounted for 5, 10, and 11% of the total variations in dBP and 14, 25, and 23% of variations in sBP in Nigeria, Jamaica, and the U.S., respectively. Waist also accounted for 7 and 12% of the total variation in FBG in Jamaica and U.S., respectively, adjusting for confounders. When ecological regression analysis was used, waist circumference accounted for 7, 20, and 29% of geographic variations in dBP, sBP, and FBG, respectively.

To determine whether the three groups have the same BP and FBG for a given waist circumference value, independent of other risk factors—including BMI, age, sex, smoking, alcohol intake, and diabetes and hypertension status—we used multiple linear regression models with BPs and fasting blood glucose as dependent variables (Table 4). Dummy variables were used to compare Nigerians with non-Nigerians (for BP) and Jamaicans with Americans (for FBG). Jamaica was negatively associated with dBP and sBP, independent of other risk factors. U.S. was independently associated with higher FBG values relative to Jamaica. Also, Jamaica and U.S. residence were independently associated with increased waist circumference.

We calculated site-specific trends in the risk of hypertension and diabetes from sex-specific ORs based on empirical waist cut-points (Tables 5 and 6). A consistent trend of increasing risk of hypertension with increasing waist circumference emerged for both men and women. The strongest association of increasing waist with hypertension was in the fourth quartiles compared with the first quartiles for both men and women in each population. Comparing the fourth quartiles to the first quartiles, there was about a two- to fivefold increased risk of hypertension in Nigerian, Jamaican, and U.S. men and women, as estimated from age-adjusted ORs obtained from sex-specific logistic regression models. As with hypertension, the risk of diabetes increased monotonically with an increase in waist circumference for both men and women (Table 6). Also, the increase in risk of diabetes was much greater for each subsequent quartile, with a 9-fold excess for men in Jamaica and a 23-fold excess risk in U.S. women for the fourth compared with the first quartiles of waist circumference.

We assessed the impact of waist circumference using multiple logistic regression (Table 7) by comparing men with a waist circumference ≥94.00 cm with those <94.00 cm and women with waist ≥80.00 cm and those <80.00 cm. We also compared men and women of Jamaica and the U.S. with those of Nigeria (based on empirical waist cut-points derived from the Nigeria data). The results of these analyses show that a waist circumference ≥94.00 cm in men was associated with approximately a two- to fourfold increase in the risk of hypertension in Nigerian, Jamaican, and U.S. men ($P < 0.001$). Women with waist values ≥80.00 cm had a 58, 164, and 54% increased risk of hypertension in

Table 5—*Age-adjusted ORs for hypertension by sex-specific quartiles of waist circumference in Nigerian, Jamaican, and African-American subjects*

	Men		Women	
Site	Mean ± SD	OR (95% CI)	Mean ± SD	OR (95% CI)
Nigeria				
I	66.6 ± 3.0	1.00 (Reference)	66.0 ± 3.1	1.00 (Reference)
II	72.5 ± 1.4	1.21 (0.46–3.22)	72.4 ± 1.5	1.55 (0.91–2.50)
III	78.0 ± 2.0	1.74 (0.70–4.30)	78.1 ± 2.0	0.95 (0.55–2.66)
IV	89.8 ± 6.8	3.83 (1.61–9.14)	91.2 ± 7.7	1.87 (1.14–3.06)
Jamaica				
I	68.4 ± 2.5	1.00 (Reference)	67.9 ± 4.3	1.00 (Reference)
II	74.6 ± 2.1	1.81 (0.78–4.17)	78.7 ± 2.5	1.31 (0.74–2.33)
III	83.2 ± 2.8	2.33 (1.04–5.76)	87.2 ± 2.5	2.81 (1.62–4.88)
IV	97.4 ± 7.2	5.40 (2.48–11.77)	99.8 ± 7.5	3.55 (2.09–6.16)
U.S.				
I	76.9 ± 4.3	1.00 (Reference)	75.9 ± 5.5	1.00 (Reference)
II	87.9 ± 2.5	1.46 (0.87–2.44)	86.6 ± 2.7	1.90 (1.05–3.44)
III	96.3 ± 2.4	2.04 (1.23–3.36)	98.9 ± 3.3	2.18 (1.22–3.89)
IV	111.1 ± 9.4	2.35 (2.43–3.88)	116.4 ± 9.8	2.34 (1.31–4.14)

OR is from the logistic regression model. Hypertension is defined as sBP ≥140 or dBP ≥90 mmHg or current use of antihypertension medication.

Table 6—*Age-adjusted ORs for type 2 diabetes by sex-specific quartiles of waist circumference in Jamaican and African-American subjects*

	Men		Women	
Site	Mean ± SD	OR (95% CI)	Mean ± SD	OR (95% CI)
Jamaica				
I	68.4 ± 2.5	1.00 (Reference)	67.9 ± 4.3	1.00 (Reference)
II	74.6 ± 2.1	3.92 (1.25–12.32)	78.7 ± 2.5	1.13 (0.56–2.32)
III	83.2 ± 2.8	6.47 (2.10–19.92)	87.2 ± 2.5	2.17 (1.15–4.12)
IV	97.4 ± 7.2	10.79 (3.61–32.26)	99.8 ± 7.5	4.10 (2.24–7.51)
U.S.				
I	76.9 ± 4.3	1.00 (Reference)	75.9 ± 5.5	1.00 (Reference)
II	87.9 ± 2.5	1.65 (0.80–3.39)	86.6 ± 2.7	5.81 (1.96–17.20)
III	96.3 ± 2.4	2.47 (1.26–4.87)	98.9 ± 3.3	15.29 (5.41–43.21)
IV	111.1 ± 9.4	5.31 (2.75–10.28)	116.4 ± 9.8	20.12 (7.23–56.01)

OR is from the logistic regression model. Type 2 diabetes is defined as FBG ≥126, 2-h blood glucose ≥200 mg/dl, or use of insulin or hypoglycemic agent.

Nigeria, Jamaica, and the U.S., respectively. Having waist circumference above the cut-points proposed by Lean et al. (21) and the Nigerian tertile means was associated with a higher risk of diabetes in Jamaicans and African-Americans.

To avoid bias, we repeated all analyses excluding individuals with medical conditions that might influence BP and FBG, such as prevalent hypertension, diabetes, coronary heart disease, or use of antihypertensive medications. Similar results of the independent association between waist circumference, BP, and FBG were observed (data not shown).

CONCLUSIONS

— Although obesity, hypertension, and type 2 diabetes are known factors in the insulin resistance syndrome (5–7), their independent and collective roles are not understood. In an attempt to elucidate the role of obesity, numerous investigations have sought to define the best anthropometric determinants of obesity and how obesity relates to hypertension and diabetes. Despite these efforts, the best anthropometric methods for obesity have not been fully determined. Traditionally, BMI and WHR are the most cited indices in literature because they approximate adiposity and fat distribution (26–29). Opinions vary as to whether or not waist circumference is as good a predictor as other anthropometric parameters. The best argument in favor of waist as predictor for these diseases is that it is a cumulative measurement of the absolute amounts of total and abnormal fat distribution, which is more relevant to cardiovascular diseases than total body fat. Analysis of the influence of waist on cardiovascular diseases by Chan et al. (26) shows that one achieves a better discrimination of risks with waist measurement than with WHR or BMI.

In a recent study, Wei et al. (9) investigated the predictive power of waist circumference, BMI, WHR and other anthropometric indices for type 2 diabetes in Mexican Americans. They used receiver operating characteristics (ROC) and log-likelihood ratio tests to compare the predictive powers of these indices for type 2 diabetes, adjusting for known confounders. They found that although BMI, WHR, and waist were independent predictors for type 2 diabetes, waist was the strongest and most consistent with all modelled simultaneously. Thus the researchers concluded that abdominal fat localization often indicated by waist measure was more important than total amounts of body fat or subcutaneous adipose tissue in predicting type 2 diabetes.

As was reported by others, we observed a positive association between weight, BMI, waist, hip, and WHR and increased risk of high BP. Similar association of increased

Table 7—*Age-adjusted ORs and population attributable risk (PAR%) associated with hypertension and type 2 diabetes by empirical waist circumference cut-points*

		Men			Women	
Site		OR (95% CI)	PAR%		OR (95% CI)	PAR%
Hypertension						
	Prev$_E$[1]			Prev$_E$[2]		
Nigeria	6.3	4.23 (2.06–8.68)	16.9	23.3	1.58 (1.07–2.33)	11.9
Jamaica	16.3	2.78 (1.63–4.74)	22.5	59.3	2.64 (1.77–3.92)	49.3
U.S.	43.2	1.77 (1.28–2.44)	25.0	78.7	1.54 (0.97–2.47)	29.8
Jamaica	Prev$_E$[3]			Prev$_E$[3]		
I	85.6	1.26 (0.76–2.16)	20.0	96.5	1.62 (0.37–7.17)	33.4
II	70.5	1.64 (1.07–2.51)	31.1	64.3	3.02 (1.67–5.45)	56.5
III	34.7	1.96 (1.36–2.83)	25.0	27.3	2.44 (1.51–3.96)	28.2
U.S.						
I	92.5	1.00 (0.53–1.89)	—	95.5	1.08 (0.48–2.45)	7.1
II	83.9	1.85 (1.10–3.08)	41.6	89.7	2.84 (1.44–5.61)	62.3
III	61.3	1.90 (1.33–2.70)	35.5	62.3	2.09 (1.48–2.94)	40.4
Type 2 diabetes						
	Prev$_E$[1]			Prev$_E$[2]		
Jamaica	16.3	2.09 (1.38–3.16)	10.0	59.3	3.38 (1.84–6.21)	58.5
U.S.	43.2	3.90 (2.67–5.72)	55.6	78.7	1.63 (0.94–2.81)	33.1
Jamaica	Prev$_E$[3]			Prev$_E$[3]		
I	85.6	3.62 (1.64–7.96)	69.2	96.5	0.99 (0.22–4.41)	—
II	70.5	3.01 (1.80–5.02)	58.6	64.3	5.28 (2.22–12.56)	73.4
III	34.7	2.72 (1.87–3.97)	59.7	27.3	2.62 (1.48–4.61)	30.7
U.S.						
I	92.5	0.80 (0.44–1.47)	—	95.5	0.57 (0.26–1.29)	—
II	83.9	2.16 (1.21–3.84)	49.3	89.7	1.10 (0.57–2.14)	8.2
III	61.3	4.97 (3.08–8.03)	71.0	62.3	2.05 (1.31–3.22)	39.3

OR is from the logistic regression model. Prev$_E$[1], exposed proportion (waist circumference ≥94.00 cm); Prev$_E$[2], exposed proportion (waist circumference ≥80.00 cm); Prev$_E$[3], exposed proportion (mean of 69.0, 76.0, and 88.1 cm in men and 66.1, 73.8, and 87.2 cm in women, respectively, derived from Nigerian mean waist tertiles). Hypertension is defined as sBP ≥140 or dBP ≥90 mmHg or current use of antihypertension medication. Type 2 diabetes is defined as FBG ≥126, 2-h blood glucose ≥200 mg/dl, or use of insulin or hypoglycemic agent.

risk of type 2 diabetes was observed in Jamaica and the U.S. These findings are consistent with recently published data (25–33).

A gradient in the direction of Nigeria, Jamaica, and U.S. for risk factors (waist circumference, weight, BMI, hip, WHR) and prevalence of hypertension and type 2 diabetes was observed in this study. This gradient has implications in developing a framework for understanding the environmental and genetic determinants of hypertension and diabetes among African-Americans, of whom significant numbers are known to have originated from Sub-Sahara Africa. The observed high risk of diabetes in U.S. women compared with Jamaican women was driven by the higher variability of waist circumference among U.S. women. The result of this study shows that Jamaican and U.S. black men and women have a higher waist circumference at any level of BMI compared with Nigerian men and women. This suggests that lifestyle (probably affluence) did modify the relationship between BMI and waist circumference.

Our study demonstrates that waist circumference is significantly and independently associated with increased risk of hypertension and diabetes in men and women of three African populations in widely contrasting environments. In an ecological analysis, waist accounted for a remarkable variation in dBP, sBP, and FBG. The attributable risk estimates suggest that risk of developing hypertension and diabetes could be reduced substantially by reducing waist size to <94.00 cm for men and <80.00 cm for women in these populations.

In conclusion, we have demonstrated that waist circumference is highly associated with hypertension and diabetes in the three populations of the African diaspora currently living in vastly different environmental settings. We also showed by assessing the impact of waist size that a substantial decrease in hypertension and type 2 diabetes incidence is possible by developing public health strategies designed to reduce waist circumference across sites. Studies are needed to investigate waist circumference as a marker of the insulin resistance syndrome. Such studies will lend some insight into the clustering of hypertension, central obesity, and diabetes often seen among ethnic groups such as those of African descent.

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