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The Waist Circumference of Risk in Black South African Men Is Lower Than in Men of European Ancestry

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Abstract

Background: Central obesity measured by waist circumference is a cardiovascular disease (CVD) risk factor; however, the waist circumference of risk in populations of African descent has not been identified. The International Diabetes Federation currently suggests that cutoffs established in men of European descent be applied to sub-Saharan men—a waist circumference ≥94 cm.

Subjects and Methods: Participants were 203 South African black men with type 2 diabetes mellitus (T2DM). They were divided into quartiles of waist circumference (>88 cm, 88–94 cm, 95–103 cm, >103 cm). Cardiovascular risk factors, including insulin resistance (IR), measured by modified homeostasis model assessement of IR (HOMA-IR), and the triglycerides-to-high-density lipoprotein cholesterol (TG-to-HDL-C) ratio, were compared across quartiles.

Results: Age, duration of diabetes, glycosylated hemoglobin (HbA1c), blood pressure, urinary albumin excretion, and smoking were similar across waist circumference quartiles. Overall, for both lipids and measures of IR, there was variation across waist circumference quartiles, but no significant differences between quartiles 2 and 3. Therefore, data from these two quartiles were pooled. Between the first and second + third (88–103 cm) quartiles, there were significant differences in HDL-C (1.30 ± 0.43, 1.10 ± 0.43 mmol/L, $P = 0.003$), TG (medians 1.10, 1.60 mmol/L $P < 0.001$), low-density lipoprotein cholesterol (LDL-C; 2.40 ± 0.93, 2.85 ± 1.03 mmol/L, $P = 0.01$), non-HDL-C (3.05 ± 1.18, 3.70 ± 1.16 mmol/L, $P = 0.002$), HOMA-IR (medians 0.90, 2.10, $P < 0.001$), and TG-to-HDL-C ratio (medians 0.89, 1.17, $P < 0.001$). Additional comparisons were made between men with waist circumference <90 cm and 90–93 cm. Values for each lipid and for IR parameters were more favorable in the <90-cm group (all $P < 0.05$).

Conclusions: For black South African diabetic men, CVD risk substantially increased with waist circumference >90 cm. The waist circumference cut point of >94 cm has the potential to misclassify many black South African diabetic men at risk for CVD.

Introduction

Obesity is common in some sub-Saharan African populations[1–3] and traditional cardiovascular risk factors, including type 2 diabetes mellitus (T2DM), are becoming prevalent in both urban and rural settings in Southern Africa.[4–6] Coronary heart disease (CHD), however, remains relatively rare in this region,[7–9] although recent evidence suggests an increase.[10–12] Central obesity, defined clinically by waist circumference, is an important risk factor for cardiovascular disease (CVD) in all populations, including those of sub-Saharan Africa origin,[13,14] in which it is also associated with traditional cardiovascular risk factors and with insulin resistance.[13,15,16] Some of the increased risk can be attributed to the clustering of interrelated factors of the metabolic syndrome, which is associated with an expanded waist circumference and insulin resistance.[16–18] However, the waist measurements that define increased health risks differ among races. The International Diabetes Federation (IDF) has suggested ≥94 cm and ≥80 cm, respectively, for men and women of African descent, as for subjects of European extraction,[17] while the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) guidelines for the metabolic syndrome recommend using a waist

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circumference of ≥102 cm and ≥88 cm for men and women, respectively, without regard to race, to define central obesity.[19] The latter values are associated with greatly increased health risks in populations of European extraction.[20] A recent joint international statement on metabolic syndrome recommended the use of population- and country-specific cut points to define an enlarged waist circumference.[21] The waist circumference that might be associated with increased health risk in sub-Saharan African men has not been defined.

In South Africa, overweight and obesity are substantially more prevalent in white than in black African men.[1] Furthermore, we have recently observed among African men with type 2 diabetes mellitus (T2DM) that the frequency of obesity [assessed as body mass index (BMI) or waist measurements] and the prevalence of the metabolic syndrome (defined according to both the IDF and NCEP ATP III criteria) were substantially lower than in a white diabetic cohort; the last observation was at least partly explained by smaller waist measurements in the Africans.[22] Together these findings suggest that the definition of metabolically important central obesity, which might predict a higher incidence of CVD, and possibly also diabetes, may differ in these two populations. Our goal, therefore, was to evaluate the association between waist circumference, CVD risk factors, and insulin resistance in black South African men with T2DM, a population expected to be at much higher risk for CVD than men without diabetes.[23]

Subjects and Methods

A total of 203 T2DM black African men, age at diagnosis of diabetes ≥30 years, mean age 50.0 (8.2) [standard deviation (SD)] (range 30–77) years, consecutively attending the Diabetes Clinic at the Johannesburg Hospital between 1994 and 2002, were evaluated. Except for one subject from Liberia, all participants were born in South Africa. The men were unskilled workers, manual laborers, domestic servants, unemployed, or retired; most had low levels of education (~50% with no secondary schooling) and literacy levels were low. Two of the diabetic men were blind. All participants had detectable levels of fasting C-peptide (concentrations ≥200 pmol/L). The men were weighed in light indoor clothes; waist circumference was measured by trained nurses midway between the eleventh rib and the pelvic brim, in the horizontal plane, at the end of quiet expiration. Hypertension was defined as a blood pressure >130/85 or the use of antihypertensive medication, which included thiazide diuretics and angiotensin-converting enzyme (ACE) inhibitors, with the addition of calcium channel and α-adrenergic blocking agents as required. No participant was receiving lipid-modifying agents at the time of evaluation. Diabetes was controlled by diet and as clinically indicated with the addition of metformin, a sulfonylurea, and/or insulin (most commonly a biphasic preparation given twice daily in combination with oral agents); thiazolidinediones were not used.

Blood was obtained (nonfasting in the majority) for the measurement of glucose, glycosylated hemoglobin (HbA1c), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), triglycerides (TG), and C-peptide, as previously described.[9] Low-density lipoprotein cholesterol (LDL-C) was calculated from the Freidewald equation.[24] CHD risk was evaluated by the Framingham method.[25] Insulin resistance was estimated by homeostasis model assessement of insulin resistance (HOMA-IR) using C-peptide concentrations,[26] and by the TG-to-HDL-C ratio, which correlates significantly with IR estimated by the HOMA-IR method in diabetic Africans.[27] Urinary albumin excretion was assessed as the urinary albumin-to-creatinine ratio.[28]

The subjects were initially analyzed by quartiles of waist circumference (Q1–Q4); every variable in Q2 and Q3 was similar, and therefore their data were pooled; this group was designated Q[2+3]. The data for Q1, Q[2+3], and Q4 were compared using the Kruskal–Wallis analysis of variance (ANOVA). Other tests used in the statistical analyses included the *t*-test, Mann–Whitney U-test, the chi-squared and Fisher exact tests, and linear regression analysis. Differences among groups were considered significant at a P value <0.05.

Patient data were obtained from routine hospital records of first admission to the clinic. All subjects provided verbal consent to be weighed and measured. The Committee for Research on Human Subjects of the University of the Witwatersrand approved the study and consented to the analysis on anonamized data.

Results

Patient characteristics and conventional CVD risk factors for the total group and in each waist quartile are shown in Table 1: 66.1% were overweight or obese, 43.4% overweight (BMI 25–29.9), and 22.7% obese (BMI >30). The waist measurements in successive quartiles were ≤87 cm, 88–94 cm, 95–103 cm, and >103 cm. Age and duration of diabetes were similar in the quartiles. The frequency of insulin prescription differed among the groups and was lowest in the most overweight subjects (33.3%). There were significant differences between the quartile groupings for CVD risk factors—the prevalence of hypertension and levels of TC, LDL-C, HDL-C, and TG. The levels of HbA1c, glucose and urinary albumin excretion, and the prevalence of smoking were similar. There were notable differences in several of the variables between Q1 and Q2. In Q1, higher HDL-C ($P<0.001$) concentrations, and lower levels of LDL-C ($P=0.01$), TG ($P<0.001$), non-HDL-C ($P=0.003$), TC-to-HDL-C ratio ($P<0.001$), and both measures of IR ($P<0.001$) (Table 2). A similar pattern was seen when Q1 was compared with Q[2+3] for concentrations of HDL-C ($P=0.003$), TG ($P<0.001$), and LDL-C ($P=0.010$) (Table 1), and the TC-to-HDL-C ratio ($P<0.001$) and non-HDL-C levels ($P=0.002$) and the estimates of insulin resistance ($P<0.001$ for both) (Table 2). Between Q[2+3] and Q4 there was a step up in the prevalence of hypertension ($P=0.006$), in the levels of TG ($P=0.027$), TC ($P=0.01$), LDL-C ($P=0.001$), and in the measures of insulin resistance [for HOMA-IR ($P=0.004$) and the TG-to-HDL-C ratio ($P=0.029$)] and in non-HDL-C levels ($P=0.002$) and the TC-to-HDL-C ratio ($P=0.027$).

Waist circumference correlated significantly with the nonfasting HOMA-IR calculation ($r=0.400$, $P<0.01$), TG concentrations ($r=0.217$, $P<0.01$), the TG-to-HDL-C ratio ($r=0.229$, $P<0.01$), and LDL-C ($r=0.291$, $P<0.01$). HOMA-IR and the TG-to-HDL-C ratio were also significantly related ($r=0.286$, $P<0.01$). The 10-year Framingham risk score increased progressively as waist circumference increased, with significant differences between Q1 and Q[2+3] ($P=0.014$), and between Q[2+3] and Q4 ($P=0.004$).

Some 50% of subjects ($n=102$) had a waist circumference <94 cm, and the second quartile in this analysis overlapped

Table 1. Clinical and Laboratory Variables in the Quartiles of Waist Circumference [Expressed as the Mean (SD), Median (IQR), or Percentages] in African Men with Type 2 Diabetes

Quartile	*All* (n = *203*)	*Q1* (n = *54*)	*Q2* (n = *48*)	*Q3* (n = *53*)	*Q[2 + 3]* (n = *101*)	*Q4* (n = *48*)	P[a]
Waist (cm)	95.3 (11.7)	82.8 (3.8)	91.0 (1.79)	98.6 (2.5)	94.8 (4.4)	111.7 (6.4)	
BMI	27.4 (4.9)	23.3 (2.4)	26.1 (2.3)	27.5 (2.6)	26.8 (2.5)	33.2 (5.3)	< 0.001
Age (years)	50.0 (8.2)	48.2 (8.2)	48.1 (7.9)	51.4 (7.2)	49.9 (7.7)	52.3 (9.0)	0.06
Duration diabetes (years)	3.0 (1.0,6.0)	3.0 (1.0,6.0)	2.0 (1.0,6.0)	2.0 (0.8,6.0)	3.0 (0.9,6.0)	4.0 (1.6,6.0)	0.31
Insulin Rx (%)	45.8	64.8	51.0	32.0	41.6	33.3	0.003
Smokers (%)	50.5	56.0	56.3	46.2	51.0	43.5	0.43
BP ≥ 130/85 (%)	59.1	48.1	54.2	57.7	56.4	79.1	0.005
HbA1c (%)	8.9 (3.11)	9.12 (3.11)	9.17 (3.31)	8.91 (3.20)	9.04 (3.24)	8.70 (3.14)	0.6
TC (mmol/L)	4.81 (1.25)	4.34 (1.26)	4.84 (1.28)	4.77 (1.13)	4.81 (1.20)	5.35 (1.15)	0.001
LDL-C (mmol/L)	2.87 (1.06)	2.40 (0.93)	2.87 (1.04)	2.82 (1.02)	2.85 (1.03)	3.44 (1.02)	< 0.001
HDL-C (mmol/L)	1.14 (0.37)	1.30 (0.43)	1.05 (0.27)	1.14 (0.45)	1.10 (0.37)	1.06 (026)	0.003
TG (mmol/l)	1.54 (1.1,2.5)	1.10 (0.8, 1.5)	1.80 (1.3,2.5)	1.55 (1.2,2.2)	1.60 (1.2, 2.4)	2,15 (1.5,2.8)	< 0.001
Urine ACR (mmol/mg)	2.1 (1.0, 6.0)	2.2 (1.0, 5.1)	2.2 (1.1, 5.2)	1.9 (0.8, 6.5)	2.0 (0.1, 2.0)	2.7 (1.0, 6.6)	0.80

[a]*P* value for comparisons between Q1, Q[2 + 3], and Q4.

SD, standard deviation; IQR, interquartile range; BMI, body mass index; BP, blood pressure; HbA1c, glycosylated hemoglobin; TC, total cholesterol; LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; TG, triglycerides; ACR, albumin-to-creatinine ratio.

with two conventional cut points used to define central obesity—94 cm and 90 cm for subjects of European and south Asian origins, respectively. The upper range of the third quartile, 103 cm, was very close to the defining level for high-risk central obesity (> 102 cm).[20] Therefore, the data were reanalyzed in categories separated according to waist cut points of < 90 cm ($n = 65$) and 90–93 cm ($n = 37$). There were significant differences between these groups for TG ($P = 0.001$), HDL-C ($P = 0.034$), LDL-C ($P = 0.016$), non-HDL-C ($P < 0.003$), the TG-to-HDL-C ratio ($P < 0.001$), and HOMA-IR ($P < 0.001$); the prevalences of hypertension and of smoking were similar.

Discussion

All subjects in this population of African diabetic men were C-peptide–positive and diabetes was, on average, of short duration (median duration 3 years); nearly half were treated with insulin, and glycemic control at the time of study was poor. There was a wide range of BMI and waist circumference. Two thirds were overweight or obese, with a mean BMI substantially higher than in the adult male African population of South Africa of the same age range (~ 24 kg/m^2) of whom only about 24% were overweight or obese.[1] The group characteristics were similar to diabetic populations from Nigeria[29] and from primary health facilities in urban Soweto, South Africa.[30]

Patients in the first waist quartile Q1 were lean by both BMI and waist criteria, all had readily detectable C-peptide concentrations, and one third did not require insulin. Apart from the high rate of hypertension, the average conventional cardiovascular risk factor profile was good in comparison with higher risk white diabetic populations.[9]

In comparison with those with higher waist circumference, patients in waist quartile one (Q1 < 88 cm), were characterized by the lowest cardiovascular risk profile—a lower prevalence of hypertension, the highest HDL-C and lowest LDL-C and TG concentrations, and lower values of both the measures of insulin resistance. They also had the lowest Framingham risk (Tables 1 and 2). The prevalence of hypertension, dyslipidemia, and insulin resistance were progressively greater at higher waist circumferences.

Because the second waist quartile overlapped with the two conventionally used waist cut points used to define "low

Table 2. Estimates of Derived Lipid Risk Assessments, the Framingham CVD Risk, Glucose, and C-Peptide Concentrations, and Estimates of Insulin Resistance in Each Waist Quartile Among Type 2 Diabetic African Men

Quartile	*Q1*	*Q2*	*Q3*	*Q[2 + 3]*	*Q4*	P[a]	*All*
Non-HDL-C (mmol/L)	3.05 (1.18)	3.81 (1.28)	3.59 (1.04)	3.70[b] (1.16)	4.32 (1.09)	< 0.001	3.68 (1.23)
TC-to-HDL-C	3.63 (1.47)	4.87 (1.65)	4.57 (1.59)	4.71[b] (1.62)	5.33 (1.46)	< 0.001	4.58 (1.66)
Glucose (mmol/L)	8.21 (4.28)	9.58 (4.37)	8.55 (3.50)	9.07 (3.84)	9.50 (3.84)	0.11	8.95 (1.70)
C-peptide (nmol/L)	1.40 (0.8, 2.7)	2.50 (2.0,4.3)	2.90 (1.9,4.0)	2.70[c] (2.0, 4,1)	3.20 (2.7, 4.4)	< 0.001	2.70 (1.50,3.90)
HOMA-IR[d]	0.90 (0.5, 2.1)	2.05 (1.4, 3.4)	2.20 (1.5, 3.2)	2.10[c] (1.5, 3.2)	2.55 (2.1, 3.9)	< 0.001	2.10 (1.10, 3.03)
TG-to-HDL-C (mmol/mmol)	0.89 (0.6, 1.3)	1.75 (1.2, 2.4)	1.64 (1.0, 2.3)	1.71[c] (1.1, 2.4)	2.11 (1.4, 3.4)	< 0.001	1.50 (0.92, 2.49)

[a]*P* value for comparisons between Q1, Q[2 + 3], and Q4.

[b]Comparisons between Q1 and [Q2 + 3], $P \leq 0.002$.

[c]Comparisons between Q1 and [Q2 + 3], $P < 0.001$.

[d]HOMA-IR assessed using nonfasting glucose and C-peptide concentrations.

risk" in south Asian (≥90 cm) and European men (≥94 cm), we evaluated the effect of these measurements on risk factor profiles in our patients. Between the groups with waist circumferences <90 cm and those with waist circumferences of 90–93 cm, there were again highly significant differences in estimates of insulin resistance and lipid levels, but not in the frequency of hypertension. Taken together, these analyses suggest that in diabetic African men a lower waist circumference (i.e., ≥88 or ≥90 cm) than the one currently recommended by the IDF (≥94 cm)[17,21] might be more appropriate to define the waist circumference for "increased CVD risk" in this population, and perhaps in the general adult African male population.

There was a second significant step up in risk factors between waist groups Q[2+3] and Q4 (waist >103 cm). These included TG levels and both measures of insulin resistance, and more significantly LDL-C and non-HDL-C concentrations and the TC-to-HDL-C ratio, as well as in the prevalence of hypertension; HDL-C concentrations were, however, not different. These findings imply that the use of the waist cut point of ≥102 cm may be appropriate to define "very high health risk" for this African population, as in subjects of European extraction.[20]

Whereas abdominal obesity appears to be central to the diagnosis of the metabolic syndrome in sub-Saharan Africa,[16,31,32] some analyses have questioned the usefulness of HDL-C[29] and TG concentrations[33] in its definition in these populations, because their TG concentrations are uniformly lower in comparison with white subjects.[9] Nevertheless, TG levels do rise with increasing levels of obesity and insulin resistance in Africans, as in the present study.[32,34–36] Taken together, these observations from Africa support the quest for race- and perhaps region-specific TG cut points, lower than those used for white subjects, for risk assessment and the definition of the metabolic syndrome in populations of African descent.[33,37] In Africans, HDL-C concentrations appear to be relatively insensitive to the effects of obesity and perturbations of glucose homeostasis.[31,36] The present data, however, support the utility of HDL-C concentrations, but only in risk assessment in normal weight versus overweight and obese diabetic African men.

There are several limitations to our study. Our results apply to diabetic men; whether these findings are valid for nondiabetic African men is uncertain. Nevertheless, there was a wide spectrum of obesity among the patients, from lean to severe obesity, and the prevalence of hypertension and concentrations of cholesterol and TG in subjects with diabetes broadly reflect those of the nondiabetic population. Moreover, a recent cross-sectional population-based study found that a waist circumference >86 cm predicted the presence of at least two elements of the metabolic syndrome in rural African men in South Africa, an observation in accord with our data.[38]

Second, mainly nonfasting levels of C-peptide, glucose, and TG were available for evaluation. We have, however, found that HOMA-IR calculated from fasting and nonfasting C-peptide and glucose values in the same subjects are positively correlated,[27] and the modified HOMA-IR calculation we used demonstrated a strong correlation with waist circumference, as would be expected from the relationship between insulin resistance and waist circumference. Similarly, the nonfasting TG-to-HDL-C ratio, a surrogate measure for insulin resistance, also tracked the changes in waist circumference. The use of nonfasting TG concentration, about 15% higher than fasting levels, would have resulted in higher values of the TG-to-HDL-C ratio and exerted a small effect on the calculation of LDL-C levels. Finally, this was a cross-sectional study and therefore can only provide suggestive information on the long-term relationships between waist circumference and CVD risk in subjects without diabetes.

In summary, our data that CVD risk is related to waist circumference in diabetic men support the findings of the recent population-based study from Africa on the relationship between waist circumference and CHD. They also suggest that the waist circumference cut points currently recommended by the IDF to define increased health risk in African men living in sub-Saharan Africa are probably set too high. Prospective studies in these populations will be required to formally establish the relationships between waist circumference and health risk, including risk for T2DM.

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Author Disclosure Statement

No competing financial interests exist.

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