Review: Metabolic Syndrome in Black South African Women

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The prevalence of metabolic syndrome is increasing in African populations, and is particularly high in Black South African women (42%) vs women in the United Kingdom (23%) and the United States of America (36%). This population group is also known to have the highest prevalence of obesity in the sub-Saharan African region (42%), and consequently, a high risk of non-communicable diseases. In this article, we discuss factors (abdominal subcutaneous fat, visceral fat, lean mass, adiponectin, leptin, vitamin D, smoking and menopausal status) that have been investigated for their possible association with metabolic syndrome in African women, and discuss some recommendations for management of the syndrome. In particular, the infrastructural development of HIV/AIDS clinics in South Africa provides an ideal integrated platform to cater to the treatment needs of patients with multiple chronic morbidities. *Ethn Dis*. 2017(27): 189-200; doi:10.18865/ed.27.2.189

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Introduction

A large proportion of South African women of African ethnicity live in urban areas and have a high prevalence of obesity and related cardiometabolic diseases.[1,2] This has resulted in an increasing presence of metabolic syndrome (MetS) in Black South African women,[2-4] comparable to results found through studies of other African women,[2,5] and higher than most developing Asian countries and developed European countries (Table 1).[6] Most African countries have a higher prevalence of MetS in women than men (Table 1). When compared with rural Black African populations, an estimated 13.6% more women present with MetS in the urban setting,[3] which may be due to the higher prevalence of obesity associated with the urban environment.[7-9]

Most of the studies conducted in sub-Saharan Africa on the epidemiology and etiology of MetS have occurred in South Africa, and this country, like the rest of Africa is progressing through a nutrition transition with rising levels of obesity and non-communicable diseases (NCD).[35] Therefore, the purpose of this qualitative systematic review was to describe the epidemiology of MetS across Africa and to review data from South Africa on the demographic, behavioral and physiological factors that contribute to the development of MetS as these may be applicable to other African countries. The higher prevalence of obesity and MetS in African women and the greater number of studies in females than males are the principal reasons for focussing on MetS in women.

Epidemiology of Metabolic Syndrome

The data in Tables 1-4 compare the prevalence of MetS in males and females across studies conducted in different countries. The studies from non-African countries were chosen based on the use of recognized criteria for diagnosing MetS, the reporting of prevalence data in both males and females and large representative samples from rural and/or urban populations. The studies from African nations were chosen using similar criteria, but due to the small number of studies, the sample size was reduced to ≥100 participants and prevalence data for MetS had to be present for females. It should be noted that the aim of Tables 1-4 is to display an overview of the

prevalence of MetS in various populations, with a key emphasis on African and South African studies. Data from the United States show ethnic differences in MetS prevalence with South Asians having a higher prevalence compared with the other groups,[10,11] which is confirmed by data from the United Kingdom (Table 1).[12] In India[21] and Bangladesh[20] the prevalence of MetS is similarly high, especially in females (Table 2), while in South Asians living in South Africa the prevalence is higher in males compared with females (Table 4).[34] In European countries the prevalence of MetS differs little between sex (Table 1), while in Australia a large population study showed a much higher prevalence in males than females (Table 1),[15] a pattern also observed from studies in South Korea[17] and Turkey (Table 2).[22] A meta-analysis of 35 studies from mainland China, including both rural and urban populations, showed a higher prevalence of MetS in females than males.[18] A study from 7 cities across South America showed a similar prevalence of MetS in males and females, with the total prevalence levels varying from 14% in Ecuador to 27% in Mexico.[22] Data from African studies show a range of prevalence levels that are comparable with data from the developed world, particularly for urban-dwelling South African women (Table 3). The prevalence of MetS is consistently higher in African females when compared with males, with the exception of one study from Nigeria (Table 3).[27] In comparison, data from developed nations show similar prevalence levels between males and females of European ancestry or higher levels in males. These data are comparable to obesity trends in developed, compared with African, nations where in the latter countries, obesity is far more prevalent in females than males,[36,37] a trend that is not seen in the former countries.[38] The very high prevalence of MetS in type 2 diabetic patients is confirmed by the studies of Kenge et al[26] and Kalk and Joffe.[32] It should be noted that when comparing the prevalence of MetS across studies, some of the differences observed may be due to the different age ranges used in each study and also the different diagnostic criteria used for MetS.

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Criteria for Diagnosis of Metabolic Syndrome

Currently, the most widely used guideline used for the diagnosis of the MetS is the harmonized one that was proposed in 2009 by various organizations and that suggested synchronizing the various definitions.[39] Thus, rather than emphasising one particular component, three or more of the five components need to be present for a positive diagnosis, and region-specific cut-offs for central obesity were proposed (Table 5). The main concern with the harmonized definition is that the waist circumference cut points from White populations are recommended for sub-Saharan Africa due to the lack of African data. However, studies show that the current waist circumference cut point is not appropriate and should be higher in African women.[2,3] The aforementioned studies showed that triglyceride levels are low in African populations, and some have suggested that the triglyceride cut point for MetS should be increased in sub-Saharan African populations and African Americans.[40,41]

Data from studies conducted in various African regions demonstrate that some components of MetS are more prominent in African populations.[3,8,42] These studies showed that high waist circumference and low high density lipoprotein cholesterol (HDL) levels are the most prevalent components; this was further confirmed in a recent study of MetS in Black South African women.[43]

Socioeconomic Status

During the apartheid era, the Black majority were predominantly in the lower socioeconomic stratum and have historically been marginalized with limited access to education,

Table 1. Prevalence of metabolic syndrome in selected developed countries

Reference	Criteria used	Study design	N	Age,[a] years	Country	MetS prevalence	
						Male %	Female %
Aguilar et al[10]	Modified NCEP	NHANES, 2003-12; Cross-sectional	1,931	≥20	United States (MetS prevalence per ethnic group: African American, 33.0%; Hispanic, 35.0%; Non-Hispanic Whites, 33.0%)	30.3	35.6
Khan and Jackson[11]	Harmonized	Cross-sectional (urban)	1,403	20-68	United States (South Asian Americans)	47.0	54.0
Tillin et al[12]	Modified NCEP	Cross-sectional (urban)	4,860	40-69	United Kingdom		
					African Caribbeans	15.5[b]	23.4[b]
					Europeans	18.4[b]	14.4[b]
					South Asians	28.8[b]	31.8[b]
Villegas et al[13]	Modified NCEP	Cross-sectional (urban)	890	50-69	Ireland	21.8	21.5
Jeppesen et al[14]	Modified NCEP	Cross-sectional (urban)	2,493	41-72	Denmark	18.6	14.3
Cameron et al[15]	IDF	Cross-sectional (population-based)	6,072	50.5 ± 11.7	Australia	39.2	27.9
Bo et al[16]	Modified NCEP	Cross-sectional (urban)	1,877	45-64	Italy	24.1	23.1

a. Age range or mean age of participants as provided by the respective journal articles.
b. Age-adjusted MetS prevalence used.
NHANES, National Health and Nutrition Examination Survey; NCEP, National Cholesterol Education Program; IDF, International Diabetes Federation.

Table 2. Prevalence of metabolic syndrome in selected developing non-African countries

Reference	Criteria used	Study design	N	Age,[a] years	Country	MetS prevalence	
						Male %	Female %
Kim[17]	Modified NCEP	Cross-sectional (urban)	11,810	≥45	South Korea	53.2	35.7
Li et al[18]	IDF	Meta-analysis of 35 papers (rural, urban)	226,653	≥15	China	19.2	27.0
Bhowmik et al[19]	IDF	Cross–sectional (rural)	2,293	≥20	Bangladesh	19.2[b]	27.5[b]
Deepa et al[20]	Modified NCEP	Cross-sectional (urban/rural)	1,123	>20	India	23.0	40.0
Ozsahin et al[21]	Modified NCEP	Cross–sectional (urban)	1,637	20–79	Adana, Turkey	23.7	39.1
Escobedo et al[22]	Modified NCEP	Cross-sectional (urban)	11,550	25-64	South America (Prevalence per country: Mexico, 27%; Venezuela, 26%; Chile, 21%; Columbia, 20%; Peru, 18%; Argentina, 17%; Ecuador, 14%)	20.0	22.0

a. Age range or mean age of participants as provided by the respective journal articles.
b. Age-adjusted MetS prevalence used.
NCEP, National Cholesterol Education Program; IDF, International Diabetes Federation.

Table 3. Prevalence of metabolic syndrome in African countries

Reference	Criteria used	Study design	N	Age,[a] years	Country	MetS prevalence	
						Male %	Female %
Akintunde et al[23]	IDF	Cross-sectional (urban)	140	55.1 ± 10.8	Osogbo, Nigeria	23.0	37.0
Tran et al[24]	IDF	Cross-sectional (urban)	1,935	≥24	Addis Ababa, Ethiopia	14.0	24.0
Assah et al[25]	Modified NCEP	Cross-sectional (urban/rural)	552	25-55	Cameroon	7.0[b]	25.0[b]
Kengne et al[26]	IDF	Cross-sectional (urban; type 2 diabetics)	308	55.8 ± 10.5	Cameroon	55.7[b]	72.1[b]
Adeoye et al[27]	IDF	Cross-sectional (urban)	256	42.0 ± 9.4	Nigeria	17.0	14.0
Labhardt et al[28]	IDF	Cross-sectional (rural)	1,026	≥25	Lesotho	9.8	22.9
Mogre et al[29]	IDF	Cross-sectional (urban)	200	≥30	Ghana	13.0	27.3

a. Age range or mean age of participants as provided by the respective journal articles.
b. Age-adjusted MetS prevalence used.
National Cholesterol Education Program; IDF, International Diabetes Federation.

Table 4. Prevalence of metabolic syndrome in South Africa

Reference	Criteria used	Study design	N	Age,[a] years	Country	MetS prevalence	
						Male %	Female %
Crowther and Norris[3]	Harmonized	Cross-sectional (urban)	1,251	18-84	Soweto, Johannesburg (Black South African)	–	42.1
Schutte and Olckers[30]	IDF	Cross-sectional (urban)	102	31.3 ± 8.6	Potchefstroom (Black South African)	–	24.8
Jennings et al[31]	IDF	Cross-sectional (urban)	225	27.0 ± 7.0	Cape Town (Black South African)	–	9.9
Motala et al[2]	Harmonized	Cross-sectional (rural)	947	>15	Kwa–Zulu Natal (Black South African)	11.6	30.2
Kalk and Joffe[32]	IDF	Cross-sectional (urban; type 2 diabetics)	500	>30	Johannesburg, South Africa		
					African	46.5	85.2
					White	74.1	86.6
Peer et al[4]	Harmonized	Cross-sectional (urban)	1,099	25-74	Cape Town (Black South African)	16.5	43.0
George et al[33]	Harmonized	Cross-sectional (urban)	724	18-70	Soweto, Johannesburg		
					Black South African	19.3	39.2
					Indian South African	55.8	37.4
Erasmus et al.[34]	IDF	Cross-sectional (urban)	563	50.9 ±9.1	Bellville, Cape Town (mixed ethnic background)	30.6	67.8

a. Age range or mean age of participants as provided by the respective journal articles.
IDF, International Diabetes Federation.

health care, and the ability to earn a sustainable income.[44] However, even in the post-apartheid era, the majority of Black South Africans are still living in relatively poorer conditions compared with other population groups, with most not having completed high school.[36] Data on the impact of socioeconomic status (SES) on metabolic diseases in South African populations is complex. Some data show a positive association of SES asset index with body fat mass,[45] while in other studies, an inverse association with waist circumference and visceral fat was observed.[46] Increasing wealth is associated with elevated blood pressure and obesity.[47] However in a recent study on the etiology of MetS in mid-life urban South African females, no socioeconomic factors (education and employment) were associated with MetS risk.[47]

Metabolic and Anthropometric Factors

Visceral fat is the principal anthropometric variable that relates to all the cardiometabolic components of the syndrome,[31,48] but in South African studies it has been shown that the visceral depot is lower in African than White females even though the former group is more insulin resistant than the latter.[49-51] In a recent study of African women, waist circumference was left out of MetS criteria to uncover the principal determinants of the cardiometabolic components of the syndrome. Visceral fat was found not to correlate with any of the cardiometabolic components but trunk fat-free soft-tissue mass (FFSTM) and abdominal subcutaneous fat were found to positively and negatively modulate risk for the MetS, respectively.[43] No previous studies have shown that abdominal subcutaneous fat is a protective factor against MetS and this study demonstrated that this relationship was due to the negative correlation of this variable with fasting glucose levels. Previous studies have shown that subcutaneous abdominal fat is related to a lower risk for type 2 diabetes and that fasting glucose levels are lower in diabetic patients with higher subcutaneous abdominal fat levels.[52,53] It is possible that subcutaneous fat may protect against MetS by acting as a reservoir for systemic triglycerides,[54] thus preventing their deposition in visceral adipose tissue, skeletal muscle or liver, which then attenuates insulin resistance. The positive association of trunk FFSTM with MetS was a novel finding, and was due to the negative association of FFSTM with HDL levels, as has been observed in two previous studies.[55,56]

Data from studies conducted in various African regions demonstrate that some components of MetS are more prominent in African populations.[3,8,42]

The reason for the negative relationship between FFSTM and HDL levels is not fully understood. However, it has been hypothesized that the liver, which is a major component of the FFSTM measurement from DEXA, can accumulate lipid (hepatic steatosis), which in turn is negatively related to serum HDL levels.[57]

Adiponectin is an adipose specific

Table 5. Criteria used to identify MetS in a population/cohort by means of the harmonized guidelines[a]

Risk factors	Criteria	
Waist circumference, cm	Male	Female
Europid and sub-Saharan African	≥94	≥80
Asian, Ethnic Central and Southern American, and Japanese	≥90	≥80
Chinese	≥85	≥90
Triglycerides, mmol/L^{-1}	≥1.7 or specific management	
High–density lipoprotein cholesterol, mmol/L^{-1}	<1.0 males; <1.30 females	
Blood pressure, mm Hg	≥130 systolic and/or ≥85 diastolic or diagnosed hypertension	
Blood glucose, mmol/L^{-1}	≥5.6 or diagnosed diabetes	

a. The harmonized guidelines require the presence of 3 or more of the above 5 criteria for diagnosis of MetS.

secretory product that falls with increasing adiposity,[58] via an unknown mechanism. This adipokine is associated with a lower risk of diabetes,[59] hypertension,[60] and dyslipidemia[61] and may therefore be an important role player in the etiology of MetS. Low adiponectin levels were observed to be a strong determinant of MetS risk in African women via the strong negative correlations of serum adiponectin concentrations with triglyceride and glucose levels and a positive correlation with HDL levels.[43] In another study, higher concentrations of adiponectin were related to a lower BMI and higher insulin sensitivity in a combined sample of different South African population groups; however, Black patients were found to have lower levels of adiponectin compared with White patients.[62] Few data are available on the role of adiponectin in the etiology of MetS in developing countries,[63] but a recent study showed that low adiponectin levels were related to a higher risk of MetS independently of insulin resistance, suggesting that low adiponectin levels increase MetS risk independently of its effects on insulin resistance.[43]

The adipokine leptin is positively associated with fat accumulation.[64] In a cross-sectional study of Black South Africans with known coronary artery disease, leptin concentrations were higher in women compared with men, and an association with MetS was demonstrated.[65] A number of other South African studies have shown evidence of the correlation of leptin with components of the MetS.[66,67] White women have lower leptin levels than Black BMI-matched African women,[68] indicating an ethnic variation in the production of this adipokine.[69] A positive association between leptin and blood pressure in Black South African women has been observed,[70,71] and leptin also correlates with total cholesterol levels.[72]

Vitamin D deficiency has been associated with cardiometabolic diseases; however, the evidence is inconsistent.[73,74] A recent Iranian study noted that vitamin D supplementation improves vitamin D status and lowers triglyceride levels in patients with MetS.[75] However, a study by George et al demonstrated that vitamin D status is not linked with MetS risk or its components in Black and Indian South Africans, but parathyroid hormone (PTH) is associated with an increased risk of MetS.[33] The association of PTH with MetS was due to its positive correlation with systolic and diastolic blood pressure and waist circumference.

There are many other biomarkers that have been shown to augment the risk of MetS, including inflammatory markers and indicators of oxidative stress.[76,77] The association of pro-inflammatory markers and MetS has been confirmed in adolescent Egyptians,[78] but this relationship and the link of other biomarkers with MetS needs to be confirmed in adult sub-Saharan African populations.

Physical Activity and Dietary Intake

There is little data on the relationship of physical activity and dietary intake with MetS in African populations; however, some studies have been conducted on the relationship of these factors with obesity and components of the MetS. Thus, data from South Africa show that women living in urban settings have higher sitting times than urban men and rural women,[79] and Black African women who met physical activity guidelines have a lower risk of insulin resistance and lower HDL levels compared with inactive women, despite total body weight of the sample having increased in the study period.[80] These studies highlight that physical activity is associated with positive health outcomes, and the reverse for sitting time. However, there is a paucity of such studies and more information needs to be generated on the physical activity patterns of women living in African nations.[81] A recent study has shown that higher intensity physical activity is associated with better insulin sensitivity in Black South African women.[45] This study also observed that walking for transport can result in lower risk of hypercholesterolemia, which is particularly important for women who are sedentary.

The prevalence of obesity is very high in urban, Black South African women and such data suggest that the country is in the advanced stages of a nutritional transition.[82] The emergence of cardiometabolic diseases in Black South Africans could be attributable to the adoption of lifestyle behaviors associated with this transition,[83] with those in the lower SES stratum consuming cheap, energy-dense foods, predominantly purchased from informal street food vendors.[84] Caloric intake of this type has been associated with fat accumulation in Black African women.[85]

In terms of dietary intake, there

are no studies that characterize food intake within African patients with MetS. However, studies have shown that urban Black South African women have sufficient dietary energy intake, but mostly from refined carbohydrates.[86] A diet high in carbohydrates is associated with atherogenic dyslipidaemia,[87] particularly a lowered HDL concentration and increasing serum triglyceride concentration.[88] Moreover, African populations do not consume sufficient fruits and vegetables,[89] and compared with rural Black African women, urban-dwelling women consume more total fat, saturated fat and sugar.[36]

Smoking and Alcohol Intake

A recent study showed that smoking is associated with high MetS risk in Black South African women.[43] The association of smoking with MetS was due to its effect on triglyceride levels, confirming the findings of Oh et al.[90] Tobacco consumption in South Africans is relatively high in Black males; however, women have a significantly lower prevalence of active smoking.[36] The consumption of smokeless tobacco (snuff) is comparatively more popular than cigarette smoking among Black South African women.[91] South African snuff has a lower concentration of tobacco-specific N-nitrosamines compared with the majority of products from other countries, but the amount of unionized nicotine in the products is high, allowing for faster absorption rates of nicotine.[92] The association of snuff with cardiometabolic diseases seems to be unclear, even though its consumption is associated with increased fat deposition in the visceral adipose depot of African women.[46] A study conducted in Sweden has shown a relationship between smokeless tobacco and MetS,[93] but this needs to be confirmed in the African context.

Data from the Third National Health and Nutrition Examination Survey showed that alcohol consumption lowers MetS risk in all ethnic groups, but the association is particularly strong in White patients and those who consume a low-moderate amount of alcoholic drinks per month.[94] In contrast, Park et al showed that alcohol consumption increases the risk of MetS in male patients, but decreases the risk in women who are heavy consumers of alcohol.[95] Alcohol consumption seems to be associated with lower triglyceride levels, high HDL, and lower waist circumference.[94] The link between alcohol intake and MetS needs to be analyzed in African women; however, the longitudinal association of a higher alcohol intake with a smaller change in waist circumference over a 10-year period in Black South African women suggests that there may be a link with other components of the MetS.[96]

Sleep and the Menopause Transition

Sleep duration is another behavioral factor that may contribute to the risk of MetS in African females, but has received far less attention than diet or physical activity. We know that shorter sleep duration (<7 hours per night) is associated with weight gain.[97] A recent study has analyzed the relationship of night time sleep duration and day time napping with BMI, waist and blood pressure in Black South African males and females.[98] This study demonstrated that in women aged >40 years, there was a significant negative relationship between sleep duration and BMI, while irrespective of age, sleep duration was positively associated with blood pressure, which is a novel finding. In men, day time napping was associated with lower blood pressure and lower waist circumference and BMI. A Korean study showed that both shorter and longer sleep duration (>9 hours per night) are associated with MetS and its components;[99] however this has not been confirmed in African populations.

The link between menopausal status and MetS is controversial. Compared with pre-menopausal Ghanian women, post-menopausal women have a significantly higher prevalence of MetS and its components.[100] In comparison, a South African cross-sectional study has shown that menopause was not associated with MetS or with any significant change in BMI, but was linked to a fall in lean mass and bone mineral density.[46] The latter study notably used the more robust STRAW +10 criteria to define the menopause transition in African women.

Management of Metabolic Syndrome

The primary health care system in South Africa is currently being transformed. The HIV/AIDS epidemic has

led to the development of clinic infrastructure that could be expanded for use in treating NCDs.[101] In addition, anti-retroviral therapy is associated with an increase in metabolic diseases in African women,[102,103] thus making an integrated system of health care a logical approach in the management of patients with multiple morbidities. Data on the prevalence of MetS in HIV-positive Black South African women is limited; however, a study in the Eastern Cape region of South Africa observed a 27% prevalence of MetS in infected African patients using antiretroviral medication.[104] Finally, a cohesive effort from public and private institutions is needed to address the increasing prevalence of NCDs in the country, particularly in those communities where current interventions are ineffective in preventing and managing the problem.

Conclusions and Implications

In the context of a global health focus on NCDs, this review has shown that the high prevalence of MetS in Black South African women is influenced by multiple inter-related factors. This represents a major challenge to the transitioning primary health care system in South Africa. A more holistic approach to management of the disease needs to be developed in the midst of persistent social disparities. Community health care workers represent a valuable element of this approach, particularly as the disease can be influenced by patient behavior. Given the background of the population and the resource limitations of the country, cost-effective interventions can help policy makers ensure sustainable management of MetS and related disorders. It is therefore of vital importance that more intervention studies for MetS are performed based on current knowledge to allow the development of effective management policies and programs for Black South Africans.

Conflict of Interest

No conflicts of interest to report.

Author Contributions

Research concept and design: Gradidge, Crowther; Data analysis and interpretation: Gradidge, Crowther; Manuscript draft: Gradidge, Crowther; Statistical expertise: Crowther; Acquisition of funding: Gradidge; Administrative: Gradidge; Supervision: Crowther

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