Published in final edited form as:

Diabetes Metab Syndr. 2007 September ; 1(3): 151–157. doi:10.1016/j.dsx.2007.05.003.

Metabolic Syndrome Prevalence in an Urban African American Population

Fadia T. Shaya, Ph.D., M.P.H.^{1,2}, Anna Gu, M.A.¹, and Elijah Saunders, M.D.³

¹ The Department of Pharmaceutical Health Services Research, University of Maryland, School of Pharmacy, Baltimore, MD

² The Department of Epidemiology and Preventive Medicine, University of Maryland, School of Medicine, Baltimore, MD

³ Division of Hypertension, University of Maryland Medical System, Baltimore, MD

Abstract

Background—The metabolic syndrome (MeS) is a clustering of a group of metabolic risk factors in one person that predisposes to higher risk of cardiovascular disease (CVD) and type II diabetes. The metabolic syndrome has become increasingly common in the United States. With the increase in CVD morbidity and mortality among US adult populations, particularly African Americans, it becomes urgent to monitor and control metabolic syndrome in an effort to inform effective CVD prevention programs. We sought to assess the prevalence of and predictors of MeS syndrome in an urban, high risk, predominantly African American hypertensive population.

Methods—The study is part of the NHLBI U01 grant “Baltimore Partnership Programs to Reduce Cardiovascular Disparities”. A sample of 150 earlier enrolled patients was selected. Risk factors for metabolic syndrome were assessed at baseline, and include risk factors of abdominal obesity (BMI = 30), high triglycerides (triglycerides = 150 mg/dL), low HDL cholesterol (HDL < 40 mg/dL in men, or HDL < 50 mg/dL in women), elevated blood pressure (BP = 130/85 mmHg), and elevated fasting glucose (blood glucose = 100 mg/dL) – per ATP III criteria. We assessed the prevalence of MeS in general and across subgroups, and predictors of MeS were assessed using logistic regression.

Findings—The prevalence of MeS in this group of patients was 40%. Significant predictors of MeS include presence of diabetes ($P = 0.03$; OR = 3.03, 95% CI: 1.07–8.54), younger than 64 ($P = 0.04$; OR = 2.38, 95% CI: 1.02–5.56), and female gender ($P = 0.02$; OR = 2.63; OR = 1.18–5.88). The effect of self-perceived health status remain marginally significant ($P = 0.13$).

Address for reprints: Fadia T. Shaya, Ph.D., M.P.H., Department of Pharmaceutical Health Services Research, University of Maryland, 220 Arch Street, Room 01-204 Baltimore, MD 21201; 410-706-5392, fax 410-706-5394; fshaya@rx.umaryland.edu.

AUTHOR'S CONTRIBUTIONS

All authors participated in the study concept and design, data collection, statistical analysis, interpretation of data, and writing of the manuscript.

AUTHORS' CONFLICT OF INTEREST STATEMENT

None of the authors has any conflicts of interest with regard to this study or manuscript.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Interpretation—In this patient sample, the prevalence of MeS is higher than estimates based on the US general population. Our findings of factors associated with MeS are consistent with existing studies, with the exception of age factor, suggesting the impact of higher treatment rate and better medication compliance among elderly patients.

INTRODUCTION

Cardiovascular disease (CVD) is the most rampant health care problem for adults in the U.S. and arguable the world [1,2]. The frequency of CVD and diabetes mellitus (DM) being diagnosed concurrently in the same patient has increased at an alarming rate. Further research into etiology and risk factors has uncovered obesity as a strong risk factor for CVD in general and diabetes in particular, and may actually be the common link between them. The co-occurrence of all three conditions, cardiovascular disease, diabetes mellitus, and obesity, is increasingly referred to as the Metabolic Syndrome (MeS). This combination is particularly dangerous as studies have shown that DM patients have a similar risk of CVD mortality from CVD than non-diabetic patients with at least one previous episode of myocardial infarction and that hyperglycemia is a multiplier of cardiovascular risk [1]. A recent report from the Third National Health and Nutrition Examination Survey (NHANES) estimated that between 22%–24% of the U.S. adult population has MeS indicating that this is a serious public health concern [2]. Worldwide, estimates of MeS prevalence ranges greatly due to differing diagnostic standards, population selected, and study time. The vast majority of studies were conducted in population sample aged 20 and upward. Estimates of prevalence among men vary from 8% in India to 24% in USA; and from 7% in France to 43% in Iran for women [3, 4, 5].

MeS is characterized by a cluster of metabolic factors including abdominal obesity, dyslipidemia, hypertension, insulin resistance, as well as both prothrombotic and proinflammatory states.[6] The Adult Treatment Panel III (ATP III) [3] defines MeS as a combination of at least three of the following five criteria (1) waist circumference (WC) = 102 cm in men and 88 cm in women; (2) serum triglyceride level (TAG) = 150 mg/dL; (3) high-density lipoprotein cholesterol (HDL) level = 40 mg/dL in men and = 50 mg/dL in women; (4) blood pressure (BP) = 130/85 mm Hg; and (5) fasting glucose level = 100 mg/dL (Table 1). The treatment goal is to control these risk factors in order to prevent deleterious cardiovascular events.

Each of the three mentioned co-morbid conditions contribute to the etiology of MeS in slightly different but related ways:

The role of obesity

Obesity as measured by waist circumference or BMI is the strongest risk factor for MeS, CVD, and DM. Differences in body fat distribution, particularly surrounding organs such as the heart, kidney, liver, and skeletal muscle in the truncal/abdominal region, will compromise their metabolic functions. Obesity reduces the amount of lipoprotein lipase (LpL) action which circulates lipids for clearance and thus interferes with TAG removal and may cause atherogenesis. Obesity also promotes hyperglycemia by overloading the body with excess fuel. Tissues become insulin resistant leading to abnormal changes in cellular

enzyme activities. Hyperglycemia also triggers hyperinsulinemia which causes increased activation of the sympathetic nervous system and hypothalamo-pituitary adrenal axis. In addition, the excess adipose tissue associated with obesity promotes the conversion of cortisone to cortisol. These conditions, if untreated, result in hypertension. Obesity also has an effect on thrombosis and inflammation by increasing the secretion of clotting proteins [7].

The role of cardiovascular disease

Hypertension (HTN), loosely defined as a blood pressure equal to or greater than 140/90 mm Hg, is the most significant CVD risk factor involved in MeS prognosis. HTN is directly caused by increased circulating blood volume, decreased arteriolar elasticity, and endothelial dysfunction which triggers a decrease in production of vasodilators such as nitric oxide (NO) and promotes the circulation of inflammatory cytokines [6]. Persistent hypertension is a primary risk factor for stroke, heart attack, heart failure, aneurysm, and end-organ damage.

The role of diabetes mellitus

DM is a disorder characterized by persistent hyperglycemia due to insulin resistance. Insulin is a pleiotropic hormone which signals a number of cellular processes such as glucoregulation, lipid metabolism, and protein synthesis in multiple tissues. In patients with DM, these actions of insulin are reduced. Consequently, there is an increase in free fatty acids which promote oxidative stress, endothelial dysfunction, vascular damage, and atheroma formation. The clinical results are high BP, HDL suppression, and high triglycerides (TAG) additionally, DM is associated with macrovascular (myocardial infarction, stroke) and microvascular (retinopathy, neuropathy, renal disease) problems which interfere with blood and nutrient delivery to multiple tissues throughout the body. DM is a crucial factor in MeS and is highly predictive of CVD risk. In 1999 the San Antonio Heart Study found that insulin resistant patients had a greater incidence of hypertension and dyslipidemia than non-insulin resistant patients [5]. Other epidemiological studies have established a similar relationship between hyperglycemia and CVD which implicates the importance of DM as a risk factor for cardiovascular mortality.

MeS has been documented across all racial groups in the U.S.[2] and in the rest of the world. [5]. However, MeS prevalence is greatest amongst Hispanics and blacks, particular in women. The most prevalent combination of risk factors in blacks is obesity/HTN, while in other ethnic groups (White, Hispanics and Asians) it is obesity/DM. The racial disparity is largely attributed to environmental, lifestyle and social factors which influence the incidence of obesity, CVD, and DM [9].

NHANES reports that obesity, defined as a Body Mass Index (BMI) greater than 30, affects 49.7% of black women and 30.1% of white women in the U.S. Amongst men, obesity is estimated to be 28.1% in black men and 27.3% in white men [2]. The Center for Disease Control and Prevention (CDC) estimates obesity to be the next worldwide epidemic, even upstaging communicable diseases [10]. The alarming prevalence of obesity in the black community is attributed to diets high in fat and salt but low in calcium and fiber content. Similarly, the problem of hypertension can be traced back to poor nutrition, but is also thought to be due to the fact that blacks have a more salt sensitive renin response and lower

levels of vasodilator hormones [11] Additionally, blacks have less access to adequate medical coverage and are less aware of healthcare concerns than whites. The high rates of MeS in women can be attributed to lower rates of physical activity and poor diet.

It is believed that we are only seeing the tip of a new MeS epidemic [4], which should be addressed preemptively. Specifically, it is important for medical professionals to understand the major diagnostic criteria in order to help patients manage and mitigate their CVD risk. In our example in the present study, we examine the prevalence of MeS, and associated risk factors, in a subset of 150 hypertensive patients enrolled in a prospective study, the Baltimore Cardiovascular Partnership.

METHODS

Selection of Subjects

The Baltimore Cardiovascular Partnership (BCP) Hypertensive Training Program is conducted within the community partnership between the Bon Secours Baltimore Health System and the University of Maryland Baltimore, within grant number U01HL79151, funded by the National Heart, Lung, and Blood Institute. The objectives of the study are to determine how physicians and patients respond to their respective cardiovascular health education programs, in terms of improving knowledge and compliance with treatment guidelines. The target enrollment is 800 patients (at least 85% blacks and 50% women) with uncontrolled hypertension, defined as blood pressure (BP) = 140/90. and follow-up occurs every six months, for a minimum of 12 months and a maximum of 36 months. One-half of the patients are enrolled in the education program, and at each patient visit, the following data are collected by the research nurse: height, weight, blood glucose levels, BP, HDL cholesterol, TAG, and current medical conditions and current medications. Further, patients complete surveys to assess their knowledge of hypertension and their level of compliance to therapy. For the current study on the prevalence of MeS, we selected a sample of 150 enrolled patients. Proper human protection certificates were obtained (IRB number : nnnnnnnnnnn) and patients were asked to sign informed consent prior to enrollment in the study.

Data Analysis

Each patient was evaluated for MeS according to the four indices defined by ATP III (Triglycerides, HDL Cholesterol, Blood Pressure and Fasting Glucose, see Table 1). We assessed the number of patients with risk factors for metabolic syndrome across race and gender. We also compared the averages of above indices in general and in each subgroup with standards from ATP III and tested differences within gender groups using Chi-square tests. Finally, logistic regression models were built to test the effects of gender, race, age, smoking status, presence of diabetes, physical activity, and self-evaluated health status in hypertension on the likelihood of having MeS. All statistical analyses were conducted using SAS 9.1 (Statistical Analysis Software, Cary, North Carolina).

RESULTS

Patients in the study sample were predominantly African Americans (90.6%) and females (64.0%). Most patients are under 65 years of age (69.3%), do not perceive themselves to be in good health status (80.0%), and are physically inactive (84.0%). Besides, about 15% of the hypertensive patients have diabetes. (Table 2)

Results of the bivariate analysis of MeS prevalence and each predictor revealed that age, gender and the presence of diabetes showed a statistically significant correlation MeS. As shown in Table 3, MeS is more prevalent in female patients and those with diabetes, and the difference is statistically significant at $p < 0.05$. In our sample, we also found that patients younger than 65 were more likely to have MeS as compared to their older counterparts. Interesting, patients who perceive their health status to be good are less likely to have MeS, although it is only marginally significant ($p = 0.13$). (Table 3)

The results of the logistic regression analysis performed to examine the independence of the association between MeS and predicting factors are summarized in table 4. They are consistent with the findings from the bivariate analyses. Significant predictors of MeS include presence of diabetes ($p = 0.03$), younger age than 64 ($p = 0.04$), and female gender ($p = 0.02$). The effect of self-perceived health status remains marginally significant ($p = 0.13$).

DISCUSSION

The Metabolic Syndrome has rapidly emerged to epidemic proportions in the U.S. over the last twenty years, and is starting to gain epidemic proportions worldwide. MeS is a particularly devastating condition, not only due to its large prevalence, but also because it is associated with obesity, cardiovascular disease and diabetes. These three conditions provoke equally dangerous metabolic abnormalities that are not compatible with normal life and increase a patient's risk of having a cardiac emergency. It is thought that the symptoms of MeS are not acquired independently of one another, but rather are related in a vicious cycle (i.e. obesity provokes DM which then provokes CVD, etc.). The coexistence of each condition in a patient has a multiplicative effect on morbidity and mortality rates. It has been estimated that one quarter of the American adult population suffers from MeS. Concurrently, as the incidence of childhood obesity increases [12], it is expected that further cases of pediatric MeS will be established.

The prevalence of MeS in our sample of urban patients, with hypertension and mostly African American, is 40%, which is higher than the 27% prevalence estimates from National Health and Examination Survey (NHANES) [13]. This higher prevalence may be due to the fact that patients in our sample are hypertensive at baseline. Our study also shows female gender and diabetes, but not race, to be strongly associated with MeS. These results are consistent with data from existing studies [8]. For example, data from NHANES exhibited a much higher age adjusted prevalence of MeS among women (29.0%) than among men (25.2%), while age-adjusted prevalence of MeS was 23.8% among non-Hispanic Whites and 21.6% among African Americans. Women are also more likely than men to be obese, and

the difference is more significant among African Americans [14]. Besides, studies have shown that the prevalence of sedentary lifestyles, high-fat, high-caloric diets and smoking are relatively high among African American women, and these lifestyle factors increase the risk of cardiovascular diseases and cardiac mortality rates [15, 16, 17, 18, 19].

This study also found a lower MeS prevalence among older patients, while most studies based on the general population yielded contradicting results [20, 21]. This apparent contradiction can be attributed to higher treatment rates and better compliance among elderly hypertensive populations. In the Framingham cohort for example, hypertension treatment rates increased from 55% in the group younger than 60 years of age to 73% in the group between 60 and 79 years age [22]. There is also compelling evidence supporting a better compliance rate among older patients [23,24].

One of the major strengths of this study relates to its sample selection. While MeS has raised worldwide attention and numerous studies have been conducted in a highly heterogeneous spectrum of populations, to our knowledge, there are few investigations focusing on hypertensive patients, especially African American hypertensive patients, a patient subgroup particularly vulnerable to cardiovascular diseases. Our study results have the potential to raise further concerns in policy makers and health care providers about the importance of promotion of cardiovascular health in African Americans. The high prevalence of MeS in patients under 65 years suggests the detrimental effects of issues such as noncompliance and undertreatment.

The data reported in this study also have some limitations; we were limited in statistical power by the relatively low number of non African-American patients, in investigating racial differences in MeS prevalence. We were also unable to assess waist circumference in patients, which is defined as a diagnostic standard in ATP III. Further, self-reported status in smoking and physical activity may not be as reliable as objective measures; however, they still remain valuable assessments in the absence of alternative approaches.

Further studies based on large sample sizes are needed to evaluate the effect of patient/physician intervention on the risk factors of MeS and its related outcomes. The data will be very critical to the definition and development of effective public health strategies for enhancing compliance to treatment and knowledge, awareness of healthy lifestyle in this high-risk population.

Acknowledgments

Funded by the National Heart, Lung and Blood Institute (U01HL79151)

FUNDING SOURCE: This study was sponsored by funding from the National Heart, Lung, and Blood Institute (NHLBI, U01HL79151)

References

1. Prospective Studies Collaboration. Age-specific relevance of usual blood pressure to vascular mortality: a meta-analysis of individual data for one million adults in 61 prospective studies. *The Lancet*. 2002; 360:1903–13.

2. Ford ES, Giles WG, Dietz WH. Prevalence of the metabolic syndrome among US adults: findings from the Third National Health Examination Survey. *JAMA*. 2002; 287:356–59. [PubMed: 11790215]
3. Eckel RH, Grundy SM, Zimmet PZ. The metabolic syndrome. *Lancet*. 2005; 365:1415–28. [PubMed: 15836891]
4. Reynolds K, He J. Epidemiology of the Metabolic Syndrome. *Am J Med Sci*. 2005; 330(6):273–279. [PubMed: 16355011]
5. Cameron AJ, Shaw JE, Zimmet PZ. The metabolic syndrome: prevalence in worldwide populations. *Endocrinol Metab Clin N Am*. 2004; 33:351–375.
6. American Heart Association. Metabolic Syndrome. Accessed in July, 2006 <http://www.americanheart.org/presenter.jhtml?identifier=4756>
7. Stanner, S., editor. *Cardiovascular Disease: Diet, Nutrition, and Emerging Risk Factors*. Blackwell Publishing; Oxford: 2005.
8. Codario, R. *Type 2 Diabetes, Pre-Diabetes, and the Metabolic Syndrome: The Primary Care Guide to Diagnosis and Management*. Humana Press; Totowa, NJ: 2005.
9. Sowers JR, Ferdinand KC, Bakris GL, Douglas JG. Hypertension-related disease in African Americans. *Postgrad Med*. 2002; 112:24–32.
10. Center for Disease Control and Prevention. Overweight and Obesity. Accessed December 2006 <http://www.cdc.gov/nccdphp/dnpa/obesity/>
11. Saunders, E. *Cardiovascular Diseases in Blacks*. F. A. Davis Company; Philadelphia, PA: 1991.
12. Weiss R, Raz I. Focus on childhood fitness, not just fatness. *Lancet*. 2006; 368:261–262. [PubMed: 16860679]
13. Ford ES, Giles WH, Mokdad AH. Increasing prevalence of the metabolic syndrome among U.S. adults. *Diabetes Care*. 2004; 27:2444–9. [PubMed: 15451914]
14. Paeratakul S, Lovejoy JC, Ryan DH, Bray GA. The relation of gender, race and socioeconomic status to obesity and obesity comorbidities in a sample of US adults. *Inter J Obesity*. 2002; 26:1205–1210.
15. Okosun IS, Glodener M, Dever GE. Diagnosed diabetes and ethnic disparities in adverse health behaviors of American women. *J Nat Med Assoc*. 2003; 95(7):523–3.
16. Sanchez-Johnsen LA. Smoking cessation, obesity and weight concerns in black women: a call to action for culturally competent interventions. *J Nat Med Assoc*. 2005; 97(12):1630–8.
17. Granner ML, Abood DA, Black DR. Racial differences in eating disorder attitudes, cigarette, and alcohol use. *Am J Health Behav*. 2001; 25(2):83–99. [PubMed: 11297045]
18. Striegel-Moore RH, Dohm FA, Kraemer HC, Daniels S, Taylor CB, Crawford PB, et al. Eating disorders in white and black women. *Am J Psychiatry*. 2003; 160(7):1326–31. [PubMed: 12832249]
19. McTigue K, Larson JC, Valoski A, Burke G, Kotchen J, Lewis CE, et al. Mortality and cardiac and vascular outcomes in extremely obese women. *JAMA*. 2006; 296(1):79–86. [PubMed: 16820550]
20. Gu D, Reynolds K, Wu X, Chen J, Duan X, Reynolds RF, et al. Prevalence of the metabolic syndrome and overweight among adults in China. *Lancet*. 2005; 365:1398–405. [PubMed: 15836888]
21. Eckel RH, Grundy SM, Zimmet PZ. The metabolic syndrome. *Lancet*. 2005; 365:1415–28. [PubMed: 15836891]
22. Lloyd-Jones DM, Evans JC, Levy D. Hypertension in adults across the age spectrum: current outcomes and control in the community. *JAMA*. 2005; 294:466–472. [PubMed: 16046653]
23. Monane M, Bohn RL, Gurwitz JH, Glynn RJ, Levin R, Avorn J. The effects of initial drug choice and comorbidity on antihypertensive therapy compliance. *Am J Hypertens*. 1997; 10:697–704. [PubMed: 9234822]
24. Wannemacher AJ, Schepers GP, Townsend KA. Antihypertensive medication compliance in a Veterans Affairs Healthcare System. *Ann Pharmacother*. 2002; 36(6):986–91. [PubMed: 12022897]
25. Carson, JA, Burke, F., Hark, L., editors. *Cardiovascular Nutrition: Disease Management and Prevention*. American Diabetic Association; USA: 2004.

BMI = Body Mass Index
SBP = Systolic Blood Pressure
DBP = Diastolic Blood Pressure
HDL = High-density Lipoprotein Cholesterol
TAG = Triglyceride

Figure 1.
Prevalence of Risk Factors in ALL BCP Patients

Table 1Diagnostic Criteria for Metabolic Syndrome²⁵

Risk Factor	WHO (World Health Organization) Criteria	ATP (Adult Treatment Panel) III Criteria
Abdominal Obesity/Body Mass Index (BMI)	BMI ≥30	Waist Circumference > 102 cm in men Waist Circumference > 88 cm in women
Triglycerides (TAG)	TAG ≥ 150 mg/dL	TAG ≥150 mg/dL
HDL Cholesterol	HDL = 35 mg/dL in men HDL = 39 mg/dL in women	HDL < 40 mg/dL in men HDL <50 mg/dL in women
Blood Pressure	BP = 160/90 mm	BP = 130/85 mm
Fasting Glucose	Impaired glucose tolerance	Glucose = 100 mg/dL

BMI = Body Mass Index

SBP = Systolic Blood Pressure

DBP = Diastolic Blood Pressure

HDL = High-density Lipoprotein Cholesterol

TAG = Triglyceride

Table 2

Baseline characteristics of the sample

Variable	Frequency	Percent
Age	104	30.7
<65	46	69.3
65+		
Race	135	90.0
African American	15	10.0
Other	96	64.0
Gender	54	36.0
Female		
Male		
Diabetes	22	14.7
Yes	128	85.3
No		
Self-perceived health	30	20.0
Good	120	80.0
Not-so-good		
Exercise	24	16.0
Yes	126	84.0
No		

Table 3

Number of Patients with Risk Factors for Metabolic Syndrome Present in Individual Groups

Characteristics	MeS (%) (N = 60)	MeS free (%) (N = 90)	P value
Age Under 65 65+	47 (78.3) 13 (21.7)	57 (63.3) 33 (36.7)	0.05
Race African American Other	53 (88.3) 7 (11.7)	82 (91.1) 8 (8.9)	0.58
Gender Female Male	44 (73.3) 16 (26.7)	52 (57.8) 38 (42.2)	0.05
Diabetes Yes No	14 (23.3) 46 (76.7)	8 (8.9) 82 (91.1)	0.01
Self-perceived health Good Not-so-good	8 (13.3) 52 (86.7)	22 (24.4) 68 (75.6)	0.09
Exercise Yes No	11 (18.3) 49 (81.7)	13 (14.4) 77 (85.6)	0.52
Smoking Yes No	10 (14.4) 50 (85.6)	17 (18.9) 73 (81.1)	0.73

Table 4

Predictors of receiving the metabolic syndrome, results from logistic regression

Parameter	DF	Estimate	OR Point Est.	95% CI	Pr > Chisq
Intercept	1	0.54			
African American	1	-0.44	0.65	0.20-2.07	0.4636
Self-perceived health	1	-0.73	0.48	0.19-1.23	0.1282
Smoking	1	-0.16	0.85	0.32-2.24	0.7416
Male	1	-0.96	0.38	0.17-0.85	0.0173
Senile	1	-0.85	0.42	0.18-0.98	0.044
Diabetes	1	1.11	3.03	1.07-8.54	0.0361
Exercise	1	0.05	1.04	0.38-2.86	0.9288

DF= Degree of freedom

OR= Odds Ratio

CI=Confidence Interval