Components of the Metabolic Syndrome Differ Between Young and Old Adults in the US Population

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Prevalence of the metabolic syndrome (MetS) is high in the United States and is associated with increased risk of cardiovascular disease and diabetes. The authors examined whether the prevalence of the MetS and its components differs across age groups. Data were analyzed from 4 National Health and Nutrition Examination Surveys between the years 1999 and 2006. Prevalence of MetS as defined by the Third Report of the Adult Treatment Panel criteria and prevalence of associated cardiac risk factors were determined in 41,474 participants aged 18 years and older without a history of cardiovascular disease (CVD). All estimates were weighted. Prevalence of MetS among asymptomatic adults without CVD was 20.5% and remained stable for the total population during survey periods. Prevalence of MetS increased with age: 6.6% in young adults (age 18–29 years) and 34.6% in older adults (70 and older). Components of MetS differed between young and old adults. Young adults had lower levels of high-density lipoprotein cholesterol, less glucose intolerance, and less hypertension. This study provides an estimate of MetS prevalence in asymptomatic adults in the United States during an 8-year period revealing that MetS affects a large number of Americans. Components of MetS differ between young and old adults and may have important implications in their clinical management. *J Clin Hypertens (Greenwich).* 2012; 14:502–506. ©2012 Wiley Periodicals, Inc.

The metabolic syndrome (MetS) is a clinical syndrome characterized by multiple and inter-related metabolic risk factors in the same patient. Its presence identifies individuals at increased risk for cardiovascular disease (CVD) events and death.[1–3]

Published evaluations from representative national surveys in adolescents and adults up to the year 2000 have determined a high prevalence of this syndrome in the US population and noted a significant increase from 1988 to 2000.[4–6] The specific components of the MetS were also shown to increase during this period, with significant increases in abdominal obesity, serum triglyceride levels, and high blood pressure.[7]

It is unknown, however, whether the prevalence of MetS, its components, and variations in prevalence across various age groups in the US population has changed since 2000. Understanding the current age distribution of the different MetS components may help tailor public health programs and initiatives as well as shed some light on the pathophysiology and natural history of the MetS. The purpose of this study, therefore, was to determine the prevalence of the MetS and its components across various age groups in the US population since 1999.

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MATERIALS AND METHODS

The prevalence of the MetS and its components across various age groups was determined using data from 4 National Health and Nutrition Examination Surveys (NHANES) between the years 1999 and 2006. NHANES surveys are designed to assess the health and nutritional status of adults and children in the United States through both participant interviews and physical examinations. The NHANES are a stratified multistage probability sample of a US civilian noninstitutionalized population and are conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention.

The prevalence of MetS and associated cardiac risk factors was determined in 41,474 participants, aged 18 years and older, with no prior history of CVD. Individuals were identified as having the MetS according to the Third Report of the National Cholesterol Education Program Adult Treatment Panel III (NCEP/ATP III). The MetS was present if individuals had $\geq$3 of the following traits: abdominal obesity (waist circumference >102 cm in men and >88 cm in women), serum triglycerides $\geq$150 mg/dL, high-density lipoprotein (HDL) levels $\leq$40 mg/dL in men and $\leq$50 mg/dL in women, blood pressure $\geq$130/85 mm Hg, and a fasting blood glucose $\geq$100 mg/dL.[8,9] Participants currently using antihypertensive or antidiabetic medications were classified as having hypertension or diabetes, respectively.

Individuals were classified as asymptomatic if they answered "no" to all of the following questions in the NHANES examination questionnaire: Has a doctor told you that you have had a myocardial infarction? Has a doctor told you that you have had a stroke?

Has a doctor told you that you have coronary heart disease? Has a doctor told you that you have had angina?

Statistical analysis was performed using SPSS 15.0 software (SPSS, IBM, Armonk, NY). All estimates were weighted; the sample weights account for the unequal probabilities of selection from the complex NHANES sampling and the oversampling of selected population subgroups. Missing values were assumed to be missing at random.

RESULTS

The prevalence of the MetS among asymptomatic adults without CVD or diabetes was 20.5% and remained stable for the total population during the 4 survey periods. In the total population, the prevalence of the MetS was 20.3% in men and 21.0% in women. The prevalence of the MetS increased with age from 6.6% in young adults (aged 18–29 years) to 34.6% in older adults (70 years and older) (Table I).

Men younger than 50 had a higher prevalence of MetS than did women. After 50 years of age, the prevalence of MetS was higher in women (Table I). In adults aged 18 to 29 years, the MetS was more prevalent in non-Hispanic whites, while in persons 70 and older, the MetS was more prevalent in Mexican Americans and other Hispanics. Mexican Americans and other Hispanics were the ethnic group with the greatest age-associated increase in MetS prevalence when comparing young adults with older adults. Non-Hispanic blacks were the ethnic group with the smallest age-associated increase in MetS prevalence.

The prevalence of the components of the MetS varied in our study. Abdominal obesity defined by waist circumference was the most common feature, followed by hypertension, hypertriglyceridemia, low HDL, and glucose intolerance in decreasing order of prevalence.

The prevalence of specific components of the MetS differed between young and older adults. Compared with older adults, young adults had a higher prevalence of low HDL and a lower prevalence of hypertension, hypertriglyceridemia, and glucose intolerance. Obesity was very prevalent in all persons with the MetS (Table II and Table III). Seventy-six percent of young individuals with the MetS had both abdominal obesity and low HDL cholesterol levels, compared with 41% of older adults with MetS (P=.001). A total of 85% of older individuals with the MetS had both hypertension and abdominal obesity, compared with only 42% of younger adults with the MetS (P=.001) (Table IV).

TABLE I. Metabolic Syndrome in Asymptomatic Patients by Age, Sex, Race/Ethnicity

Age range, y	Percentage	Sex and Race/Ethnicity	Percentage
18–29	6.6%	Male	8.0%
		Female	5.3%
		NH black	5.0%
		NH white	7.7%
		MA/other Hispanic	6.3%
30–39	12.4%	Male	13.1%
		Female	11.8%
		NH black	11.1%
		NH white	13.0%
		MA/other Hispanic	12.4%
Age 40–49	20.9%	Male	22.4%
		Female	19.4%
		NH black	20.2%
		NH white	19.7%
		MA/other Hispanic	22.7%
Age 50–69	32.2%	Male	30.5%
		Female	33.7%
		NH black	26.3%
		NH white	35.3%
		MA/other Hispanic	30.1%
Age ≥70	34.6%	Male	31.6%
		Female	36.4%
		NH black	24.0%
		NH white	34.6%
		MA/other Hispanic	36.5%
Total	20.5%	Male	20.3%
		Female	21.0%
		NH black	15.8%
		NH white	21.8%
		MA/other Hispanic	21.0%

Abbreviations: MA/other Hispanic, Mexican American/other Hispanic; NH black, non-Hispanic black; NH white, non-Hispanic white.

TABLE II. MetS Components in Asymptomatic Patients With MetS by Age Group

	Age, y, %					
	Total	18–29	30–39	40–49	50–69	≥70
TRI	66.0	63.3	61.4	57.7	68.5	74.7
HDL	64.9	87.3	82.5	75.7	57.4	47.6
HTN	80.2	52.2	65.2	74.6	86.1	94.7
ABD	91.4	85.5	90.4	92.7	92.3	90.4
GLU	39.3	30.3	34.9	40.9	40.4	41.5

Abbreviations: ABD, abdominal obesity; GLU, glucose intolerance; HDL, low high-density lipoprotein cholesterol; HTN, hypertension; MetS, metabolic syndrome; TRI, elevated triglycerides.

DISCUSSION

This study provides a nationally representative estimate of MetS prevalence in asymptomatic adults during an 8-year period and reveals that the MetS continues to affect a large number of Americans and its prevalence and its components differ across age groups. Previous evaluations of the NHANES data up to the year 2000 found an increasing prevalence of the MetS that correlated with an increasing prevalence of its individual components.[6] In comparison, our study demonstrates a stable prevalence of the MetS in asymptomatic adults during an 8-year period from 1999 to 2006. This difference in prevalence over time

TABLE III. MetS Components in Asymptomatic Individuals With MetS by Age Group

	Age 18–29, %	Age ≥70, %	*P* Value
HTN	52.2	94.7	.001
Low HDL	82.3	47.6	.001
High TG	63.3	74.7	.028
Abdominal obesity	85.5	90.4	.970
Glucose intolerance	30.3	41.5	.001

Abbreviations: HDL, high-density lipoprotein; HTN, hypertension; MetS, metabolic syndrome; TG, triglycerides.

TABLE IV. MetS Components in Asymptomatic Patients With MetS

	Age 18–29, %	Age ≥70, %	*P* Value	All Age Groups, %
TRI	63.3	74.7	.028	66.0
Low HDL cholesterol	87.3	47.6	.001	64.9
HTN	52.3	94.7	.001	80.2
ABD	85.5	90.4	.970	91.4
GLU	30.3	41.5	.001	39.3
TRI+HDL	52.2	30.9	.001	37.7
TRI+HTN	21.7	69.6	.001	48.4
TRI+ABD	49.2	64.7	.084	57.3
TRI+GLU	20.7	30.5	.001	27.1
HDL+HTN	41.7	44.0	.10	48.3
HDL+ABD	75.7	41.3	.001	58.0
HDL+GLU	22.1	14.5	.050	19.7
HTN+ABD	41.7	85.4	.001	73.1
HTN+GLU	11.7	38.2	.001	28.1
ABD+GLU	19.7	34.2	.001	32.8
TRI+HDL+HTN	12.8	27.5	.001	23.4
TRI+HDL+ABD	41.1	24.7	.001	31.1
TRI+HDL+GLU	14.1	12.0	.871	14.3
TRI+HTN+ABD	11.7	60.0	.001	41.5
TRI+HTN+GLU	8.3	27.4	.001	18.0
TRI+ABD+GLU	10.0	23.4	.001	21.0
HDL+HTN+ABD	34.9	39.2	.017	43.9
HDL+HTN+GLU	5.7	12.8	.001	11.7
HDL+ABD+GLU	14.5	11.7	.168	15.4
HTN+ABD+GLU	5.6	31.3	.001	23.5

Abbreviations: ABD, abdominal obesity; GLU, high fasting glucose; HDL, high-density lipoprotein; HTN, hypertension; MetS, metabolic syndrome; TRI, hypertriglyceridemia. *P* values reflect comparison between 18- and 29-year age group and the 70-and-older age group.

may be due to different study populations. More likely, however, the stability in overall MetS prevalence seen during the 8-year period of our study represents improvements in the detection and the management of MetS components given the fact that several researchers have reported improvements in the management of important CV risk factors such as low-density lipoprotein cholesterol, hypertension, and diabetes.[10,11]

Similar to multiple other observations, we found that the prevalence of the MetS increases with age. This age-related increase in MetS prevalence is most notable when individual sexes are analyzed separately. Park and colleagues previously described an increasing MetS prevalence up to the sixth decade in men and through the seventh decade in women. Prevalence in the eighth decade of life declined for both sexes.[12] A similar pattern was recently reported in an evaluation of the NHANES data up to 2006.[7] Our data are not stratified beyond age 70 years.

Age as a Risk Factor in MetS

Age is the most important determinant of risk for cardiovascular events.[13] Our study demonstrated a higher prevalence of the MetS in older individuals and showed a larger number of the components of the syndrome cluster in older-age patients compared with younger patients. This is important because CVD risk increases in proportion to the number of MetS components that are present in a particular individual.[2] Historically, descriptions of the US prevalence of the MetS have also shown age-related changes. Ford and colleagues[4] (NHANES III, 1988–1994) demonstrated increasing prevalence of MetS with increasing age, showing a prevalence of 6.7% in patients aged 20 to 29 years compared with more than 43.5% in those aged 60 to 69 years. Our study adds to these findings, demonstrating similar findings in a significantly larger study sample. Moreover, our data suggest that although MetS prevalence continues to increase with age, the absolute magnitude of MetS prevalence in older adults is less compared with data from the late 1980s and early 1990s.[4]

Kraja and colleagues also reported age-related increases in the prevalence of the MetS in the 2458 participants of the Family Heart Study. The prevalence of MetS was almost 3 times higher in individuals 50 years and older compared with younger participants. The number of MetS components present in an individual was also higher in those aged 50 and older when compared with younger participants.[14]

The accumulation of risk factors over time coupled with hormonal changes (especially in women) and variations in the secretory function of the pancreatic β cells, which declines with time, could at least partially explain the influence of age on the development of insulin resistance and the increasing prevalence of the MetS.[7]

Sex Differences in MetS

Important sex differences have been described with respect to the prevalence and distribution of the components of the MetS.[7] Traditionally, the MetS has been more prevalent in men, but in the past decade the prevalence among women has increased. This may be explained by an increase in obesity in women over the same period.[7]

Earlier reports from NHANES III data showed that men aged 50 to 69 years had a higher MetS prevalence than did women.[4] Interestingly, we found that men younger than 50 had a higher prevalence of MetS than

did women, while the prevalence of MetS was higher in women older than 50 years. These findings warrant aggressive screening for the MetS, especially in women older than 50 years.

A greater frequency of cardiovascular events has been found in women with MetS compared with men. The sex differences described above could translate into a possible higher risk for CVD events in women with the MetS.[7] Our study assessed the prevalence of the MetS, but did not investigate cardiovascular events that may derive from the MetS.

Ethnicity and MetS

In previous evaluations of the NHANES data up to 1994, Mexican Americans had the overall highest prevalence of MetS, followed by non-Hispanic whites and non-Hispanic blacks.[4] In those studies, MetS prevalence across age groups as a function of ethnicity was not reported. Our study provides data on changes in MetS prevalence across age groups as a function of ethnicity. In younger-aged adults, non-Hispanic whites comprised the ethnic group with the highest prevalence of MetS. In older adults, Mexican Americans and other Hispanics had the highest prevalence of MetS. Age-specific differences in MetS prevalence in various ethnic groups have significant public health implications and may allow targeting of at-risk populations based on age and ethnicity.

Component Distribution for the MetS Across Different Age Groups

The prevalence of individual components of the MetS is known to increase with age,[7] but age-related clustering of various MetS components in patients with MetS is much less understood and infrequently described in the literature.

This analysis shows that young adults with the MetS have a different distribution of MetS components compared with older adults. This presents two different "typical phenotypes" for patients with MetS at the two ends of the age spectrum. The most frequent presentation of an asymptomatic young adult with MetS was abdominal obesity and low HDL cholesterol in contrast to the oldest age group, in whom the triad of abdominal obesity, hypertension, and hypertriglyceridemia was most frequent. Abdominal obesity was a predominant factor in all age groups and did not demonstrate any significant changes in prevalence across the age groups evaluated. On the other hand, hypertriglyceridemia, hypertension, and hyperglycemia significantly increased in prevalence with increasing age.

Recently, Ervin[15] described the prevalence of the MetS components in relation to age and sex in adults 20 years and older from the NHANES database from 2003 to 2006; reporting significant differences in the prevalence of abdominal obesity, hypertriglyceridemia, hypertension, and hyperglycemia in 3 increasing age brackets. Low HDL cholesterol had no association with age for either sex.[15]

In contrast to the study by Ervin, in which no significant association between low HDL and age groups was found,[15] our data showed that the prevalence of low HDL cholesterol levels in persons with the MetS varied according to age. This could represent a selection bias as older individuals with low HDL become symptomatic, which would have excluded them from our analysis or could signify a true change in the prevalence of low HDL cholesterol with increasing age.

Our results demonstrate significant differences in the component distribution of risk factors present in asymptomatic individuals with the MetS. This has important implications for the evaluation and management of individual patients as well as for the understanding of the pathophysiology of the MetS. Our findings suggest that the MetS may express itself differently in young vs older adults or it may indicate that the MetS is a pathophysiologically different disease in young vs older persons.

In the majority of young adults, the diagnosis of MetS can be established without the presence of impaired fasting glucose or hypertension and a substantial proportion of these individuals have MetS based exclusively on the presence of abdominal obesity and dyslipidemia. Johnson and colleagues[16] reported similar findings in a younger cohort of individuals with MetS. In adolescents aged 12 to 19 years, hypertriglyceridemia (25.6%), low HDL cholesterol levels (19.3%), and abdominal obesity (19.1%) were the most common components of the MetS. The triad of abdominal obesity, hypertriglyceridemia, and low HDL cholesterol was the most frequently encountered constellation of MetS components in both men and women.[16] These findings are consistent with our own and suggest similar characteristics of the MetS composition in age groups younger than the ones evaluated in our analysis.

LIMITATIONS

We acknowledge a number of limitations to our study. First of all, it is a retrospective analysis. Secondly, we have assessed the prevalence of MetS and its components but have not evaluated the associated adverse outcomes related to the presence of MetS. Thirdly, we did not assess the impact of inflammatory markers on disease prevalence. Fourthly, we evaluated adults 18 and older and did not study the prevalence and component characteristics of asymptomatic adolescents with MetS younger than 18 years. Finally, our study focused on MetS prevalence and component distribution in asymptomatic individuals and did not assess prevalence trends in persons with a history of CVD. Future studies should compare symptomatic and asymptomatic populations with the MetS and determine whether significant differences in the composition of MetS characteristics exist between young and older adults.

CONCLUSIONS

This study provides a nationally representative estimate of MetS prevalence in asymptomatic adults in the

United States during an 8-year period revealing that the increase in MetS prevalence previously reported has now stabilized, although the condition continues to affect a large number of Americans. The prevalence of the MetS differs across age groups when stratified by sex and race, and the components of the MetS are different between young and older adults. Low HDL cholesterol and abdominal obesity are more prevalent in young adults with the MetS. Hypertension and abdominal obesity are more prevalent in older adults with the MetS. Differences in the prevalence of the MetS between young and old adults have important implications in the clinical management of these patients and the implementation of public health programs.

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