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Short communication

Trends in the prevalence of metabolic syndrome and its components in the United States 2007–2014

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ABSTRACT

Background: Recent trends in the prevalence of metabolic syndrome (MetS) and its components among U.S. adults are not known.
Methods: We performed an updated analysis using the National Health and Nutrition Examination Survey 2007–2014 data to investigate the latest trends of prevalence of MetS and its components. MetS was defined based on the modified National Cholesterol Education Program-Adult Treatment Panel III criteria. Multiple regression models were used to assess linear trends over the years, after adjusting for sex, age, and race/ethnicity, as appropriate. Sampling weights were considered to account for complex sampling design, and all estimates were adjusted by age by a direct method.
Results: During 2007–2014, the age-adjusted weighted prevalence (±standard error) of MetS among U.S. adults was 34.3 ± 0.8%. In age-stratified analysis, 54.9 ± 1.7% of elderly population aged 60 and over had MetS. When evaluating trends from 2007 to 2014, the prevalence of MetS remained stable in all sex, age, and race/ethnicity groups (*P*-trends > 0.100 for all). Among the components of MetS, the prevalence of hypertriglyceridemia and fasting hyperglycemia decreased (*P*-trend <0.050). However, the prevalence of abdominal obesity significantly increased, especially in women (*P*-trend = 0.009). The prevalence of elevated blood pressure and low high-density lipoprotein cholesterol level remained stable.
Conclusions: The prevalence of MetS remained stable during 2007–2014. However, it was still prevalent in the U.S., especially among the elderly population. The prevalence of abdominal obesity continued to increase in women for which more efforts should be made.

1. Introduction

Metabolic syndrome (MetS) is a constellation of risk factors that increase cardiovascular disease and mortality [1,2]. Along with the modern epidemics of cardiometabolic risk factors, it has become a major public health challenge around the world [3]. Understanding prevalence and trends of MetS and its components is important not only to estimate public health burden but also to establish appropriate strategies. Previous reports using data from the National Health and Nutrition Examination Survey (NHANES) demonstrated that the prevalence of MetS among U.S. adults increased by >35% from 1988–1994 to 2007–2012 [4]. When evaluating detailed trends of the prevalence of MetS, it had first increased [5] and then stabilized since 2007 [6]. However, more recent prevalence and trends after 2012 are unknown, and latest studies did not evaluate individual components of MetS [4,6]. Therefore, we performed an updated analysis using the NHANES data to investigate recent trends in the prevalence of MetS and its components among U.S. adults in 2007–2014.

2. Methods

The NHANES is a nationwide survey to assess the health and nutritional status of the non-institutionalized civilian population in the U.S. [7]. It is conducted by the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention. It became a continuous program in 1999, and data has since been released in two-year cycles. Each year, the survey examines a nationally representative sample of approximately 5000 people selected from across the country using a stratified, multistage probability sampling design. The NHANES was approved by NCHS Research Ethics Review Board, and all participants provided written informed consent prior to inclusion in the study.

In this cross-sectional study, we used data from NHANES 2007–2014. The response rates during 2007–2014 were between 68.5% and 77.3%. Among the fasting (≥8 h and <24 h) subsample of NHANES participants, our study included 8698 non-pregnant adults aged ≥20 years who had completed examinations with reports on blood pressure, waist circumference, and lipid profile.

Blood pressure was measured based on standardized protocol. The average of three blood pressure measurements was used in this study. Waist circumference was measured from a horizontal line just above the uppermost lateral border of the ilium, and recorded to the nearest 0.1 cm. Venous blood samples were drawn in the morning session, from which

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triglyceride (TG) and high-density lipoprotein cholesterol (HDL-C) levels were directly measured. During the interview survey, questionnaires were used to evaluate medication use, smoking status, and history of atherosclerotic cardiovascular disease, including coronary heart disease, angina, myocardial infarction, and stroke.

MetS was defined based on the modified National Cholesterol Education Program-Adult Treatment Panel III criteria [1], as the presence of ≥3 of the following components: 1) waist circumference ≥ 102 cm in men and ≥88 cm in women; 2) TG level ≥ 150 mg/dL; 3) HDL-C level < 40 mg/dL in men and <50 mg/dL in women; 4) blood pressure ≥ 130/85 mm Hg or taking hypertension medications; and 5) fasting glucose level ≥ 100 mg/dL or taking diabetes medications. Since there was no information regarding indications for the use of cholesterol medications in NHANES, it was not considered in the diagnosis of MetS to avoid overestimation of its prevalence.

Using fasting subsample weights to account for complex sampling design, we examined the characteristics of study population and the prevalence of MetS and its components across the study years. Data were presented as median and interquartile range (IQR) or as proportion (%) ± standard error (SE). All estimates were adjusted by age using the direct method to the U.S. Census population in 2000. The analyses were repeated after being stratified by sex, age (20–39, 40–59, and ≥60), and race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and other). Multiple regression models were used to compare prevalence estimates and assess linear trends over the years, after adjusting for sex, age, and race/ethnicity, as appropriate. All statistical analyses were performed using STATA 12.1 (Stata Corp., USA).

3. Results

Table 1 demonstrates weighted characteristics of study population according to the years. Overall, median age was 46 years (IQR, 33–59) and 49.8 ± 0.6% were men.

During 2007–2014, the age-adjusted weighted prevalence (±SE) of MetS among U.S. adults was 34.3 ± 0.8% (35.3 ± 1.0% in men and 33.3 ± 1.0% in women). In age-stratified analysis, it was 19.3 ± 1.0%, 37.7 ± 1.1%, and 54.9 ± 1.7% among individuals aged 20–39 years, 40–59 years, and ≥60 years, respectively.

When evaluating trends from 2007 to 2014 (Fig. 1), the prevalence of MetS remained stable in overall population, and this trend was maintained in all sex, age, and race/ethnicity groups (*P*-trends > 0.1 for all). Furthermore, there was no statistically significant difference in the prevalence of MetS between 2007–2008 and 2013–2014 (36.6 ± 1.7% and 33.8 ± 1.6%, respectively; *P*-value = 0.195). Among the components of MetS, the prevalence of hypertriglyceridemia and fasting hyperglycemia decreased in both sexes (*P*-trends < 0.050). However, the prevalence of abdominal obesity significantly increased, especially in women (*P*-trend = 0.009). In 2013–2014, 68.3 ± 1.6% of women exhibited abdominal obesity. The prevalence of elevated blood pressure tended to increase in overall population with marginal significance (*P*-trend = 0.050), but this trend became nonsignificant in sex-stratified analysis (*P*-trend = 0.227 for men and 0.087 for women). Furthermore, there was no statistically significant difference in the prevalence of elevated blood pressure between 2007–2008 and 2013–2014 (*P*-value = 0.500 for men and 0.115 for women). Finally, the prevalence of low HDL-C level remained stable during the study period.

4. Discussion

The prevalence of MetS remained stable during 2007–2014 among U.S. adults. This result extends the previous finding [6] to 2014. Among the components of MetS, the prevalence of hypertriglyceridemia and fasting hyperglycemia decreased, and that of low HDL-C level remained stable in the U.S. Although the prevalence of elevated blood pressure seemed to increase in overall population, there was no statistical significance in the sex-stratified analysis. These stable or decreasing trends in the prevalence of several components of MetS might contribute to the stabilization of that of MetS. However, MetS was still prevalent in the U.S., and more than one third of U.S. adults had MetS. Especially, 54.9 ± 1.7% of elderly population aged 60 and over had MetS during the study period. This is a concerning finding since the U.S. will experience considerable growth in its older population [8]. Therefore, continued efforts should be made to monitor the prevalence of MetS and optimize treatment for its components.

In contrast to the other components of MetS, we found a significant increasing trend in the prevalence of abdominal obesity among U.S. women during 2007–2014. It is an important public health issue, since abdominal obesity is independently associated with increased mortality [9], even in subjects with normal body mass index (BMI) [10]. Furthermore, waist circumference may better explain obesity-related health risk than BMI [11]. Considering its clinical significance and increasing

Table 1
Weighted[a] characteristics of study participants according to the study years.

	Year				Overall
	2007–2008	2009–2010	2011–2012	2013–2014	
Number in sample	2051	2370	2092	2185	8698
Age, median (IQR), year	46 (33–58)	46 (32–59)	47 (34–60)	47 (33–60)	46 (33–59)
Men, % (SE)	50.2 (1.3)	50.2 (1.1)	49.5 (1.4)	49.4 (1.1)	49.8 (0.6)
BMI, median (IQR), kg/m^2	27.4 (24.0–31.4)	27.8 (24.0–32.2)	27.7 (24.1–32.1)	27.9 (24.0–32.4)	27.7 (24.0–32.0)
Obesity[b], % (SE)	31.9 (1.6)	35.5 (1.3)	35.1 (1.8)	36.9 (1.1)	34.9 (0.7)
ASCVD[c], % (SE)	7.4 (0.9)	7.1 (0.4)	7.3 (0.7)	7.1 (0.8)	7.2 (0.4)
Antihypertensive medication[d], % (SE)	23.3 (0.9)	22.5 (1.6)	24.2 (1.4)	22.9 (1.3)	23.2 (0.7)
Antidiabetic medication[d], % (SE)	8.1 (0.8)	7.3 (0.6)	7.8 (1.0)	8.0 (0.8)	7.8 (0.4)
Lipid-lowering medication[d], % (SE)	15.6 (1.3)	15.6 (0.6)	17.7 (1.0)	17.8 (1.0)	16.7 (0.5)
Current smoking[e], % (SE)	21.9 (1.6)	19.6 (1.0)	20.4 (1.7)	19.2 (1.9)	20.3 (0.8)
Components of MetS, median (IQR)					
Systolic BP, mm Hg	118.0 (109.3–128.0)	117.3 (108.7–128.0)	119.3 (110.7–129.3)	118.0 (110.0–130.7)	118.7 (109.3–128.7)
Diastolic BP, mm Hg	70.0 (62.0–76.7)	68.7 (62.0–75.3)	71.3 (64.7–77.3)	69.3 (62.0–76.0)	70.0 (62.7–76.7)
Waist circumference, cm	96.8 (86.5–106.9)	97.0 (87.0–108.1)	97.2 (87.3–108.3)	98.1 (87.7–108.6)	97.3 (87.1–108.0)
Triglycerides, mg/dL[f]	111.0 (78.0–161.0)	103.0 (74.0–148.0)	105.0 (76.0–151.0)	93.0 (64.0–143.0)	103.0 (73.0–151.0)
HDL-C, mg/dL[f]	51.0 (42.0–62.0)	51.0 (42.0–63.0)	51.0 (43.0–61.0)	51.0 (43.0–62.0)	51.0 (43.0–62.0)
Fasting glucose, mg/dL[f]	100.0 (93.0–109.0)	98.0 (92.0–107.0)	99.0 (92.0–108.0)	98.0 (92.0–107.0)	99.0 (92.0–107.0)

IQR, interquartile range; SE, standard error; BMI, body mass index; ASCVD, atherosclerotic cardiovascular disease; MetS, metabolic syndrome; BP, blood pressure; HDL-C, high-density lipoprotein cholesterol.

[a] Using fasting subsample weights.
[b] Defined as BMI ≥ 30 kg/m^2.
[c] Self-reported diagnosis of atherosclerotic cardiovascular disease, including coronary heart disease, angina, heart attack, and stroke.
[d] Self-reported medication use.
[e] Determined based on self-reported claims of smoking cigarette "every day" or "some days".
[f] To convert the values to mmol/L, multiply by 0.02586.

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