ORIGINAL RESEARCH

Is Prevalence of Atherosclerotic Risk Factors Increasing Among Young Adults? It Depends on How You Ask

Michelle H. Leppert, MD, MBA; Sharon N. Poisson, MD, MAS; Stefan H. Sillau, PhD; Jonathan D. Campbell, PhD; P. Michael Ho, MD, PhD; James F. Burke, MD, MS

***Background*—**Incidence of cardiovascular disease in young adults is unabated. Increased prevalence of self-reported atherosclerotic risk factors may be driving this trend. The goal of this study was to examine whether the prevalence of atherosclerotic risk factors in young adults is increasing over time using both self-report and standard clinical criteria.

***Methods and Results*—**Data from young adults, aged 20 to 45 years, in the National Health and Nutrition Examination Survey from 1999/2000 to 2013/2014 were analyzed. Risk factor prevalence of hypertension, diabetes mellitus, and hyperlipidemia was measured using clinical criteria and self-report. Smoking was based on self-report only, and obesity was based clinically on body mass index and waist to height ratio. Prevalence by survey was adjusted for age, sex, and race/ethnicity. By clinical criteria, adjusted prevalence of any 3 risk factors (hypertension, diabetes mellitus, and hyperlipidemia) declined slightly from 21.8% to 18.9% (P for trend=0.05). However, by self-report, the adjusted prevalence of any 3 risk factors increased from 17.8% to 26.5% (P<0.01). Hypertension was unchanged by clinical criteria (P=0.32) but increased by self-report (P<0.08). Diabetes mellitus, by clinical diagnosis and self-report, remained unchanged (P=0.35 and P=0.29, respectively). Hyperlipidemia, by clinical criteria, declined over time (P<0.01), but increased by self-report (P<0.01). Smoking declined (P<0.01), and obesity increased by both body mass index (P<0.01) and waist/height ratio (P<0.01).

***Conclusions*—**The perception that young adult risk factors are increasing is consistent with increasing self-reported risk factors. However, evidence does not suggest that clinical risk factor prevalence overall has increased in young adults. **(*J Am Heart Assoc*. 2019;8:e010883. DOI: 10.1161/JAHA.118.010883.)**

Key Words: atherosclerosis • diabetes mellitus • hypercholesterolemia • hypertension

The incidence of cardiovascular disease, including stroke and acute myocardial infarction (AMI), in young adults continues to be unabated.[1,2] Stroke hospitalizations in older adults (≥65 years old) have decreased precipitously in the United States over the past decade (−28.5% in people aged 65–84 years, and −22.1% in those aged >85 years).[3] At the same time, stroke hospitalizations in young adults have increased (43.8% in people aged 25–44 years).[3] This same phenomenon has been reported in many western countries, including France, Denmark, and Sweden.[4–6] Similar trends have been observed for AMI in the United States. AMI hospitalizations in the Medicare population (>65 years old) have declined by 24% from 1999 to 2008, but AMI hospitalization rates have not declined in those <50 years old.[2,7] It is unclear why strokes and AMI have not declined in young adults, as they have in older adults.

Some researchers have attributed the growth in young adult cardiovascular diseases to an increased burden of atherosclerotic risk factors (ie, hypertension, hyperlipidemia, diabetes mellitus, obesity, and smoking). This theory is substantiated by 2 important findings. First, the proportion of young adults with first time stroke who have atherosclerotic risk factors at discharge has increased.[8] Second, a population-based stroke study found an increase in self-

From the Departments of Neurology (M.H.L., S.N.P., S.H.S.) and Clinical Pharmacy (J.D.C.), and Division of Cardiology (P.M.H.), University of Colorado Anschutz Medical Campus, Aurora, CO; Colorado Cardiovascular Outcomes Research Group, Denver, CO (M.H.L., P.M.H.); Cardiology Section, VA Eastern Colorado Health Care System, Denver, CO (P.M.H.); and Department of Neurology, University of Michigan Health System, Ann Arbor, MI (J.F.B.).

Accompanying Tables S1 through S6 and Figure S1 are available at https://www.ahajournals.org/doi/suppl/10.1161/JAHA.118.010883

Correspondence to: Michelle H. Leppert, MD, MBA, Department of Neurology, School of Medicine, University of Colorado Anschutz Medical Campus, Mail Stop L950, 12401 E 17th Ave, Aurora, CO 80016. E-mail: michelle.leppert@ucdenver.edu

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Clinical Perspective

What Is New?

- The prevalence of atherosclerotic risk factors among young adults in the United States has remained stable, according to the National Health and Nutrition Examination Survey from 1999 to 2014, as measured by standardized clinical criteria.
- There has been a disproportional increase in self-reported risk factors among young adults over the same time period.

What Are the Clinical Implications?

- The increasing burden of cardiovascular disease in young adults may not be attributable to increased prevalence of atherosclerotic risk factors.
- Studies that depend on self-report may not be reliable in predicting risk factor trends over time in the young adult population.

reported atherosclerotic risk factors among young adults.[9] However, the reliability of self-reporting of atherosclerotic risk factors has not been well characterized, which would be important in determining whether the prevalence is actually increasing. Furthermore, the change in prevalence of atherosclerotic risk factors in young adults over time is not well defined. In this study, we sought to evaluate whether young adult atherosclerotic risk factor prevalence is increasing by using both self-report and standard clinical criteria over time.

Methods

Study Population

We examined 8 consecutive surveys by the National Health and Nutrition Examination Survey (NHANES) from 1999/2000 to 2013/2014. The NHANES is a series of stratified, multistage probability surveys designed to be representative of the US noninstitutionalized, civilian population. Since 1999, NHANES has continuously collected data in 2-year cycles via in-home interviews and visits to the mobile examination center. All participants provided written informed consent, and the National Center for Health Statistics Review Board, governing human subject research, approved the NHANES protocol. Institutional Review Board approval was exempt at the University of Colorado Anschutz Medical Center (Aurora, CO) because these data are deidentified and publicly available. The authors declare that all supporting data are available within the article and its online supplementary files. For comparability between the clinical criteria and self-report groups, we only included participants who completed both the survey and physical examination. Because survey questions about cholesterol were not answered until the age of 20 years, this study included young adults between the ages of 20 and 45 years. Women who were pregnant at the time of the examination were excluded. Race and ethnicity were self-reported. For the purposes of this study, race/ethnicity are classified as non-Hispanic white, non-Hispanic black, Mexican American, and other, including multiracial.

Risk Factor Diagnosis

Hypertension

Blood pressure is taken after resting quietly in the sitting position for 5 minutes, and 3 consecutive blood pressure measurements are obtained. If a blood pressure measurement is interrupted or incomplete, a fourth attempt may be made. Clinical hypertension is defined by meeting any of the following 3 conditions: (1) mean systolic blood pressure ≥140 mm Hg, (2) mean diastolic blood pressure ≥90 mm Hg, or (3) answering yes to the question "Are you now taking medication to lower your blood pressure?"

Hypertension by self-report is defined by answering yes to any of 3 questions: (1) "Were you told on ≥2 different visits that you had hypertension, also called high blood pressure?", (2) "Because of your blood pressure, have you ever been told to take prescribed medicine?", or (3) "Are you now taking medication to lower your blood pressure?"

Hyperlipidemia

Venous samples were collected from participants, stored frozen, and shipped to a laboratory, according to a standardized protocol. Despite changes in laboratory methods during survey years, standardization of serum lipid was performed according to the criteria of the Centers for Disease Control and Prevention's lipid standardization program. According to the most recent 2013 guidelines on treatment of cholesterol, statin therapy is typically reserved for those with a 10-year cardiovascular event risk of at least 7.5% or more.[10] Given the low risk of cardiovascular disease in the young and the fact that the Atherosclerotic Cardiovascular Disease Risk Calculator is not validated in patients aged <40 years, we elected to use the previous Adult Treatment Panel III cutoffs for high cholesterol.[11] Clinical hyperlipidemia is defined by meeting any of the following 3 conditions: (1) low-density lipoprotein ≥160 mg/dL, (2) total cholesterol ≥240 mg/dL, or (3) answering yes to the question "Are you now taking medication to lower your cholesterol?"

Hyperlipidemia by self-report was defined by answering yes to any of the following 3 questions: (1) "Have you ever been told by a physician or other health professional that your blood cholesterol was high?", (2) "To lower your blood cholesterol, have you ever been told by a physician or other

health professional to take prescribed medicine?", or (3) "Are you now taking medication to lower your cholesterol?"

Diabetes mellitus

According to the current guidelines from the American Diabetes Association, diabetes mellitus can be clinically diagnosed by the following: (1) fasting glucose of ≥126 mg/dL after at least 8 hours of no caloric intake, (2) blood glucose ≥200 mg/dL after a 2-hour glucose challenge of 75-g anhydrous glucose dissolved in water, (3) hemoglobin A1C (HgA1C) ≥6.5% (48 mmol/mol), or (4) clinical symptoms of hyperglycemia with a random glucose level of ≥200 mg/dL.[12] Although HgA1C was collected for all participants, fasting glucose and the 2-hour glucose tolerance test results were only collected in those participants of the morning sessions. To avoid selection bias and reduction of the sample size, we chose to use only HgA1C as the clinical criterion for diagnosing diabetes mellitus. Clinical diabetes mellitus is defined by meeting any of the following 3 conditions: (1) HgA1C ≥6.5% (48 mmol/mol), (2) answering yes to the question "Are you now taking insulin?", or (3) answering yes to the question "Are you now taking pills to lower your blood sugar?"

Diabetes mellitus by self-report is defined as answering yes to any of the following 3 questions: (1) "Have you ever been told by a physician or health professional that you have diabetes mellitus or sugar diabetes mellitus?", (2) "Are you now taking insulin?", or (3) "Are you now taking diabetic pills to lower your blood sugar?"

Obesity

Body measurements and weight were collected at the mobile examination center using standardized techniques and equipment. Obesity is only assessed by clinical criteria and is determined by using both the waist to height ratio (WtHtR) and body mass index (BMI). WtHtR has been shown by some studies to be better correlated with whole-body fat percentage than BMI, waist circumference, or waist/hip ratio.[13] WtHtR was calculated as waist circumference (in centimeters) divided by height (in centimeters), rounded to the nearest thousandth. We use published cutoffs for WtHtR for predicting metabolic syndrome in young US adults.[14] Obesity using WtHtR is defined as WtHtR ≥0.578 in men and ≥0.580 in women. BMI is calculated as weight (in kilograms) divided by height (in meters squared), rounded to the nearest tenth. Obesity using BMI is defined as ≥30.0 kg/m^2 in both men and women.

Smoking

Smoking is only assessed by self-report and is defined by responses to the following 2 questions: (1) answering yes to "Have you smoked at least 100 cigarettes in your entire life?", and (2) answering every day or some days to "Do you now smoke cigarettes?"

Statistical Analysis

Adjusted prevalence and standard errors were calculated by adjusting for age (using age groups of 20–28, 29–37, and 38–45 years), sex, and race/ethnicity based on the 2013/2014 survey. Examination sample weights, which account for differential probabilities of selection, nonresponse, and noncoverage, were used for all analyses. Statistical analysis was performed using SAS software, version 9.4 (SAS Institute, Cary, NC). Standard errors were estimated using Taylor series linearization, a method that incorporates the sample weights and accounts for the complex sample design. The α level was set at 0.05. There were no adjustments made for multiple comparisons. Linear time trends over the 8 surveys were tested using sex-specific (combined, women, and men) logistic regression models. To capture risk factor trends in the context of social, economic, and political factors, we chose a simplified model (model 1) with adjustments for sex, age, and race/ethnicity only. In the sensitivity analysis, we accounted for whether having insurance affected the trends in risk factors, especially pertaining to self-report (model 2), with adjustments for sex, age, race/ethnicity, and insurance status. We also consider the additional effect of education (less than high school, high school graduate, some college, and college graduate) in the fully adjusted model (model 3), with adjustments for sex, age, race/ethnicity, race, and education. In all logistic models, the survey year was treated as an ordered categorical variable, and significance in trend was determined. Sensitivity and specificity of self-report to predict clinically diagnosed risk factors were calculated for each survey.

Results

A total of 18 803 participants were included in 8 continuous surveys from 1999/2000 to 2013/2014. The unweighted sample size ranges from 1794 in 1999/2000 to 2448 in 2013/2014, including 10 032 women and 8771 men. This is representative of 105 million young adults living in the United States. The baseline characteristics of the weighted and unweighted samples are show in Table S1.

Figure 1 illustrates the adjusted prevalence of any 3 risk factors (hypertension, diabetes mellitus, or hyperlipidemia), which used both clinical criteria and self-report across time. The breakdown of risk factor prevalence by race/ethnicity using clinical criteria versus self -report is shown in Figure S1. Table 1 shows the prevalence of risk factors over time by

logistic regression using model 1, showing trends with a 10-year odds ratio. The adjusted prevalence of having any of the 3 risk factors (hypertension, diabetes mellitus, and hyperlipidemia) by clinical criteria declined slightly over the study period from 21.8% to 18.9% for all participants (*P* for trend=0.05). In contrast, the adjusted prevalence of any 3 risk factors increased over time from 17.8% to 26.5% when self-reported criteria were used (*P* for trend<0.01).

Over the study period, the adjusted prevalence of hypertension was unchanged by clinical criteria in all participants, men, and women (*P* for trend: *P*=0.32, *P*=0.07, and *P*=0.67, respectively). In contrast, hypertension increased by self-

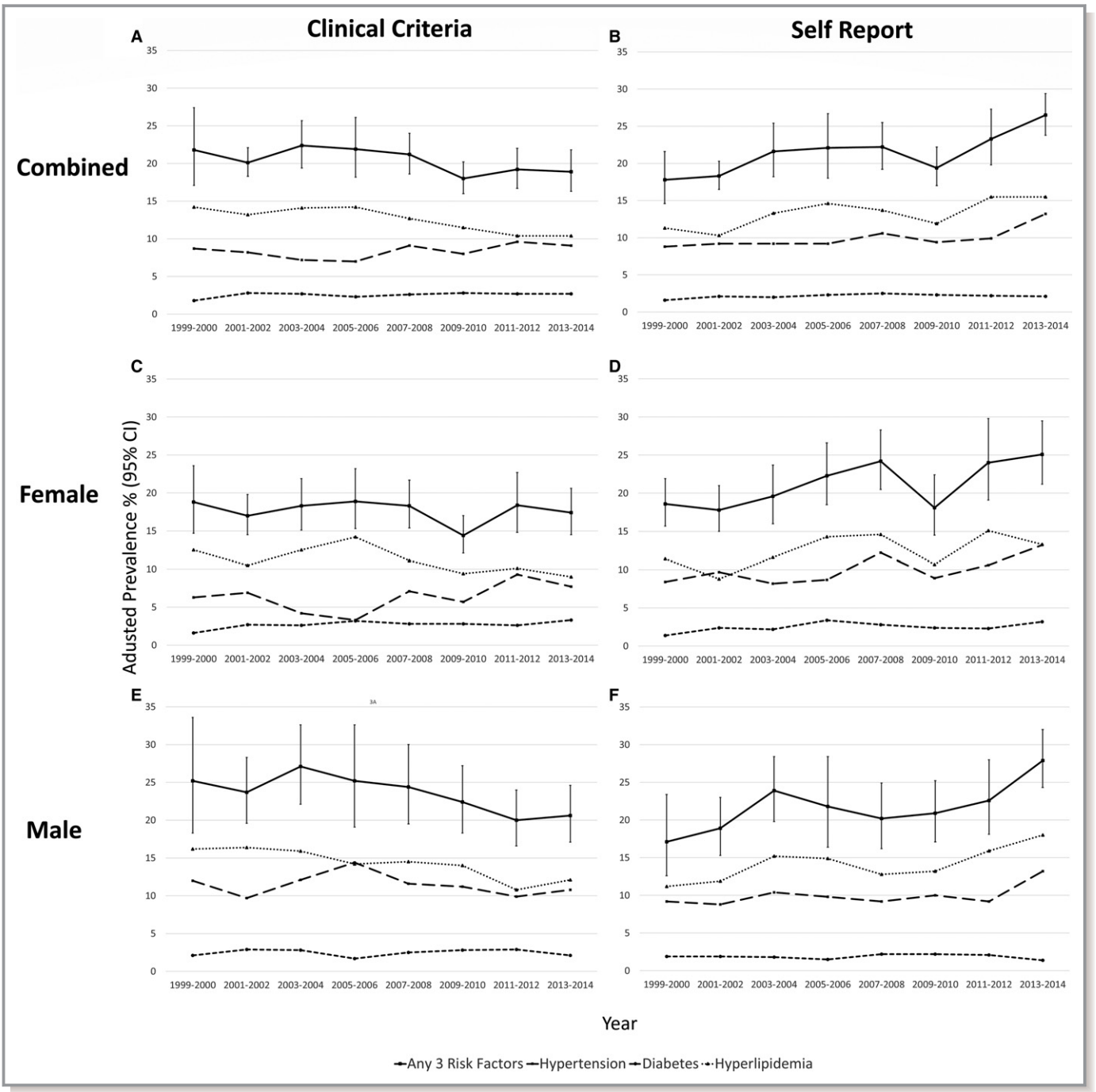

Figure 1. Adjusted prevalence of risk factors by year for all participants combined (**A** and **B**), for women (**C** and **D**), and for men (**E** and **F**). Diagnosis by a standard clinical criterion in left column (**A**, **C**, and **E**). Diagnosis presented by self-report in the right column (**B**, **D**, and **F**). Any 3 risk factors refer to having any one of hypertension, diabetes mellitus, or hyperlipidemia.

Table 1. Risk Factor Prevalence Comparing 1999/2000 With 2013/2014 and 10-Year Trends (Model 1)

Risk Factor	Prevalence, %		*P* Value	10-y Odds Ratio*	95% CI	*P* Value
	1999/2000	2013/2014				
Any 3 risk factors†						
Clinical diagnosis						
Combined	21.8	18.9	0.32	0.87	0.76–1.00	0.05
Women	18.8	17.4	0.60	0.94	0.80–1.10	0.45
Men	25.2	20.6	0.27	0.81	0.67–0.97	0.03
Self-report						
Combined	17.8	26.5	<0.01	1.33	1.18–1.49	<0.01
Women	18.6	25.1	0.01	1.30	1.12–1.51	<0.01
Men	17.1	27.9	<0.01	1.35	1.13–1.61	<0.01
Hypertension						
Clinical diagnosis						
Combined	8.7	9.1	0.84	1.11	0.90–1.37	0.32
Women	6.3	7.7	0.38	1.31	0.98–1.76	0.07
Men	12	10.8	0.75	0.94	0.69–1.27	0.67
Self-report						
Combined	8.8	13.2	0.03	1.29	1.07–1.55	<0.01
Women	8.4	13.2	0.03	1.33	1.08–1.64	<0.01
Men	9.2	13.2	0.21	1.25	0.93–1.67	0.14
Diabetes mellitus						
Clinical diagnosis						
Combined	1.8	2.7	0.24	1.14	0.86–1.52	0.35
Women	1.6	3.3	0.06	1.34	0.99–1.83	0.06
Men	2.1	2.1	0.98	0.97	0.63–1.50	0.90
Self-report						
Combined	1.6	2.1	0.39	1.16	0.88–1.53	0.29
Women	1.4	3.2	0.02	1.36	1.02–1.83	0.04
Men	1.9	1.4	0.61	0.98	0.59–1.64	0.95
Hyperlipidemia						
Clinical diagnosis						
Combined	14.2	10.4	0.06	0.77	0.66–0.89	<0.01
Women	12.5	9.0	0.13	0.79	0.65–0.96	0.02
Men	16.2	12.1	0.09	0.74	0.62–0.90	<0.01
Self-report						
Combined	11.3	15.5	0.03	1.30	1.13–1.49	<0.01
Women	11.4	13.3	0.45	1.26	1.02–1.56	0.03
Men	11.2	18	0.02	1.34	1.10–1.63	<0.01
Smoking						
Self-report						
Combined	29.2	23.8	0.06	0.77	0.67–0.88	<0.01
Women	25.2	21.6	0.23	0.80	0.69–0.94	<0.01
Men	33.7	26.3	0.03	0.74	0.63–0.86	<0.01

Continued

Table 1. Continued

Risk Factor	Prevalence, %		*P* Value	10-y Odds Ratio*	95% CI	*P* Value
	1999/2000	2013/2014				
Obesity						
BMI						
Combined	27.2	35.8	<0.01	1.29	1.16–1.44	<0.01
Women	30.9	37.7	0.02	1.18	1.04–1.34	0.01
Men	23.7	33.9	<0.01	1.42	1.22–1.64	<0.01
WtHtR						
Combined	31.7	40.1	0.01	1.306	1.153–1.479	<0.01
Women	33.9	44.7	<0.01	1.364	1.183–1.573	<0.01
Men	29.5	35.6	0.13	1.250	1.064–1.468	<0.01

BMI indicates body mass index; WtHtR, waist/height ratio.
*Odds ratio adjusted for sex and age group.
†Any 3 risk factors, including hypertension, hyperlipidemia, and diabetes mellitus.

report in all participants, which was significant in women, but not men (*P* for trend: *P*<0.01, *P*<0.01, and *P*=0.14, respectively). Likewise, the adjusted prevalence of diabetes mellitus by clinical diagnosis remained unchanged in all participants, men, and women (*P* for trend: *P*=0.35, *P*=0.06, and *P*=0.90, respectively), but increased over time by self-report in women only (*P* for trend: *P*=0.04). The adjusted prevalence of hyperlipidemia by clinical criteria declined over time in all participants, men, and women (*P* for trend: *P*<0.01, *P*=0.02, and *P*<0.01, respectively), but the adjusted prevalence of hyperlipidemia increased by self-report in all participants, men, and women (*P*<0.01, *P*=0.03, and *P*<0.01, respectively). The adjusted prevalence of smoking declined significantly in all participants, men, and women (*P* for trend: *P*<0.01, *P*=0.01, and *P*<0.01, respectively). Meanwhile, obesity by BMI increased significantly over time in all participants, men, and women (*P*<0.01, *P*<0.01, and *P*<0.01, respectively). Obesity by WtHtR showed the same trend as by BMI, but with an increase in prevalence.

Figure 2 illustrates the adjusted prevalence of concurrent risk factors over the study period. The risk factors considered include hypertension, hyperlipidemia, and diabetes mellitus by clinical criteria as well as obesity by BMI and smoking. Most participants had either 0 or 1 risk factor, whereas few had >3 risk factors (0.6%–1.3%). Using logistic regression for trend (model 1), the proportion of participants with ≥2 and ≥3 risk factors did not change over time (*P*=0.99 and *P*=0.15, respectively).

Table 2 illustrates the trends in sensitivity and specificity of using self-reported risk factors to predict any 3 clinically diagnosed risk factors, including hypertension, hyperlipidemia, and diabetes mellitus. Over the study period, sensitivity of self-reported risk factors improved while specificity declined (*P*<0.01, for both). This means that, over time, participants became more cognizant of their risk factors when they were truly present, but also increased their reporting of risk factors that were not present. The sensitivity and specificity of each risk factor by year are presented in Table S2.

Figure 3 illustrates the adjusted prevalence of hypertension, diabetes mellitus, and hyperlipidemia, diagnosed by clinical criteria, as well as smoking and obesity, diagnosed by BMI, over the study period. This figure demonstrates our best estimation of what is happening with young adult risk factors over time. Although obesity has increased and smoking has declined, the prevalence of hypertension, hyperlipidemia, and diabetes mellitus have remained the same over the past decade. The adjusted prevalence by year and sex for each risk factor is presented in Tables S2 through S5.

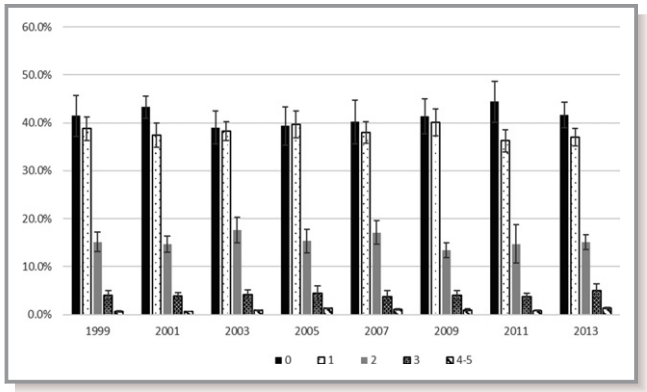

Figure 2. Prevalance of concurrent risk factors by survey. Prevalence of 0, 1, 2, 3, or 4 to 5 atherosclerotic risk factors by survey. Risk factors defined by clinical criteria include hypertension, hyperlipidemia, diabetes mellitus, and obesity (defined by body mass index ≥30 kg/m^2). Smoking is assessed by self-report, for a maximum of 5 possible risk factors.

Table 2. Trend for Specificity and Sensitivity of Using Self-Report to Predict Clinical Diagnosis of Any 3 Risk Factors (Hypertension, Hyperlipidemia, and Diabetes Mellitus)

Year	Sensitivity (95% CI)	Specificity (95% CI)
1999/2000	86.0 (83.2–88.8)	63.0 (56.3–69.7)
2001/2002	87.3 (85.7–88.9)	56.2 (51.8–60.6)
2003/2004	86.6 (83.8–89.3)	59.1 (54.4–63.9)
2005/2006	88.4 (86.8–90.0)	60.1 (53.9–66.3)
2007/2008	88.7 (86.8–90.7)	62.2 (57.4–66.9)
2009/2010	90.0 (88.5–91.4)	58.7 (52.3–65.2)
2011/2012	89.3 (87.7–90.9)	51.5 (46.7–56.3)
2013/2014	90.5 (88.9–92.1)	53.5 (48.9–58.1)
10-y Odds ratio	0.796 (0.672–0.944)	1.350 (1.158–1.575)
P value for trend	0.009	0.0002

Sensitivity analysis was performed on the trend of risk factor prevalence over time using logistic regression models (Table S6). Model 2 accounted for having health insurance in addition to sex, age group, and race/ethnicity. There was little change in 10-year odds ratios by either clinical criteria or self-report. Model 3 accounts for education level in addition to insurance status, sex, age group, and race/ethnicity. The prevalences by clinical criteria and self-report are largely the same, except that clinical hypertension in women may be increasing (*P* value from 0.07–0.04) and that smoking in women may not be significantly declining (*P* value from <0.01–0.10).

Discussion

In this nationally representative study, we found diverging temporal trends in atherosclerotic risk factors when examined by clinical criteria versus self-report. The presence of any of 3 risk factors (hypertension, diabetes mellitus, and hyperlipidemia) was stable from 1999 to 2014 when applying a standard clinical criteria, but increased when the diagnosis relied on self-report. This divergence was most evident in the adjusted prevalence of hyperlipidemia: by clinical criteria, the prevalence was declining; but when examined by self-report, the opposite was true. Although clinical and self-reported risk factor definitions will inevitably differ, our central finding is that the rate of divergence (self-report increasing relative to clinical criteria) has increased. This finding has important implications for studies that rely on patient report of risk factors. Similarly, because the medical history a patient provides is frequently coded into the medical record, this also brings into question the reliability of administrative data sets for this age group.

There are many possible reasons for our findings. One explanation could be that the diagnostic criteria for atherosclerotic risk factors changed over the study period. The definitions of hypertension became increasingly conservative.[15–18] Hence, there was a tendency toward lower blood pressure goals over time, which may bias toward increased physician diagnosis. In hyperlipidemia, the low-density lipoprotein goal had been <100 mg/dL for much of the study period, but in 2013, the guidelines recommended that treatment for hyperlipidemia be based on comorbid risk factors.[10,19] This guideline change would make it harder for young people, who have fewer comorbid conditions, to be diagnosed with hyperlipidemia. Last, in diabetes mellitus, the guidelines included the use of HgA1C in 2010.[20,21] The addition of HgA1C would make it easier for patients to get tested and diagnosed.

Another reason for the discrepancy between risk factor prevalence by self-report and clinical criteria could be access to health care. Better access to care means more opportunities to be diagnosed with a risk factor, and changes in access over time could affect self-reported prevalence. The Affordable Care Act, passed in 2010, would have also increased access to care, but open enrollment and the individual mandate did not start until 2014, which was after the study period.[22] In the sensitivity analysis (model 2), we adjusted for access to health insurance and found that there were no differences in trends from our previous model.

Last, improved health vigilance in Americans could contribute to the increasing self-report of atherosclerotic risk factors. Many health awareness campaigns, such as Healthy People 2020, the National Diabetes Education Program, the Heart Truth, Know Stroke, and smokefree.gov, have raised awareness of cardiovascular disease and the contribution of atherosclerotic risk factors. The 2015 Nielsen Global Health and Wellness survey found that consumers around the world are attempting to take charge of their health by making more healthful food choices, such as reducing sugar, cholesterol, trans and saturated fat, and sodium.[23] In this study, we found that the sensitivity of self-reported risk factors increased over time, whereas the specificity of self-report decreased. This finding is consistent with the theory that young adults are growing more vigilant of their vascular risk factors, leading to increased self-report.

For the purposes of this study, we chose to adjust for sex, age group, and race/ethnicity, as previous studies have done, so that we can examine risk factor prevalence in the setting of the varying social and economic climate in the United States. In the sensitivity analysis, we did explore the impact of health insurance (model 2) and education (model 3). We found that education only affected women, likely because the proportion of women with higher education is increasing and higher education has been inversely related to cardiovascular risk factors.[24–26]

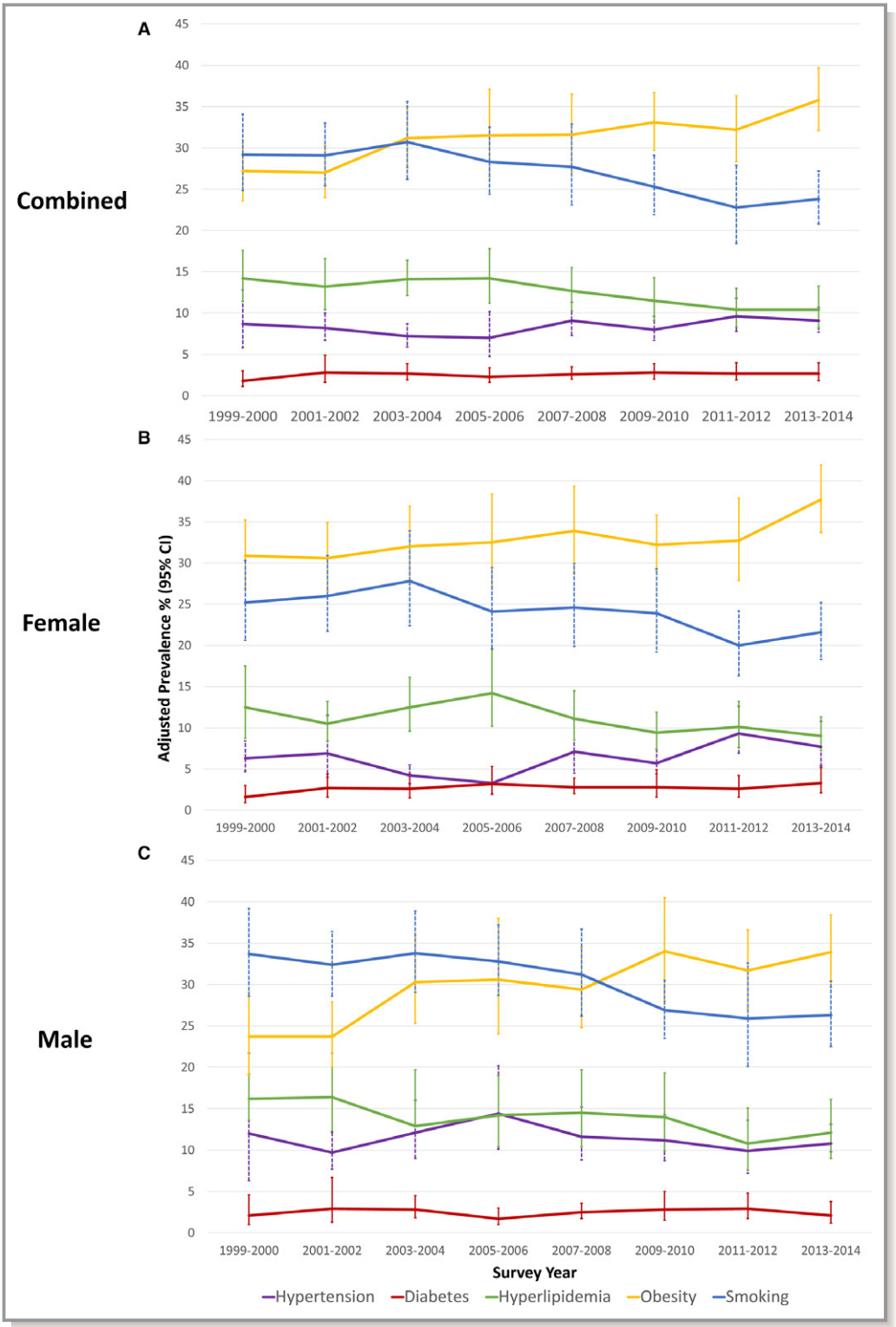

Figure 3. Adjusted risk factor prevalence for young adults (20–45 years old), by year for all participants combined (**A**), women (**B**), and men (**C**). Obesity is defined by body mass index.

Several studies have found similar trends in the prevalence of atherosclerotic risk factors in young adults. Our findings are consistent with prior works using NHANES on hypertension, hyperlipidemia, and smoking in the young adult subgroup analysis.[27–29] There was a discrepancy in the trends of diabetes mellitus, in which Menke et al found an increasing prevalence, which was likely because they used self-report to establish the diagnosis of diabetes mellitus.[30]

Last, in the trends of obesity, Flegal et al found only increasing prevalence in women but not men.[31] This difference could be, in part, because of the extended age window for young adults in our study and the inclusion of additional survey years.

Not only did the prevalence of atherosclerotic risk factors not change over time, the proportion of patients with multiple risk factors has also stayed the same. Specifically, the increasing incidence of strokes in young adults cannot be attributed to a growing number of patients with multiple risk factors. Another possible explanation for the trends that we see in young adult cardiovascular disease could be poorer control of risk factors, despite the stability in the prevalence and distribution. The NHANES reports that, although there was a significant decline in the proportion of older adults (>60 years old) with uncontrolled risk factors (blood pressure, low-density lipoprotein, and current smoking), there was no change in the proportion of younger adults with the same uncontrolled risk factors.[32] This finding could explain why the incidences of AMI and strokes in young adults have not improved.

This study has several limitations. First, like all survey data, the NHANES is subject to sampling error or nonsampling error. Second, because of the sample size, the power is limited in detecting small changes in prevalence, particularly among subgroups defined by sex, age, and race/ethnicity. Third, because of the survey methods, some of the clinical criteria may not be completely accurate. For example, hypertension is calculated using several blood pressure measurements at a single examination but would be more accurate if averaged at multiple examinations. Similarly, we used a single criterion for diagnosing diabetes mellitus, but ideally, every patient would undergo a fasting and oral glucose challenge so that any of the 3 clinical criteria may be used for diagnosis. Fourth, there was no comparable clinical measure for smoking. A clinical measure for smoking, such as continine, cannot differentiate between firsthand and secondhand smoking or quantify the number of cigarettes over a lifetime; hence, we did not think it was comparable to a self-reported assessment. Finally, we do not consider all possible cardiovascular risk factors, such as triglycerides, exercise, or diet, which may be the focus of future study.

Despite these limitations, our study has some important strengths. We used well-defined clinical criteria for risk factors across all the surveys, so although the point estimates of risk factors in each survey may not be precise, the trend of risk factor prevalence over time remains robust. Similarly, the same survey questions were used in all surveys to assess self-report of risk factors. The NHANES data are collected using a rigorous study protocol, including extensive quality-control procedures, and are meticulously designed to be representative of the US noninstitutionalized, civilian population.

There is little doubt that atherosclerosis remains an important contributor of strokes in young adults and that atherosclerotic risk factors should be seriously addressed. However, there is little evidence that atherosclerotic risk factor prevalence in young adults overall is increasing enough to explain an increase in cardiovascular disease. In addition, it appears that the method of risk factor diagnosis, whether by clinical diagnosis or self-report, is vitally important to the assessment of risk factor prevalence.

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Disclosures

None.

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