

ORIGINAL RESEARCH

Sex Differences in Temporal Trends of Cardiovascular Health in Young US Adults

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BACKGROUND: Favorable cardiovascular health (CVH) in young adulthood has been associated with lower future cardiovascular risk. We determined whether CVH and its sex differences in young adults have changed from 2007 to 2018.

METHODS AND RESULTS: We identified 10 206 individuals, aged 20 to 39 years, from the National Health Examination and Nutrition Survey data. CVH was assessed on the basis of the American Heart Association's Life's Simple 7 metrics (of 7). Changes in the mean number of ideal CVH components and the ideal proportion of individual components were calculated using linear regression analysis. Changes in sex difference trends were assessed with an interaction term between sex and calendar year. The mean (SD) age of the study population was 29.3 (5.8) years, and 5260 (51.5%) individuals were women. The mean (SD) ideal CVH component remained unchanged for both women (4.40 [1.22] to 4.48 [1.15]; $P=0.94$) and men (3.97 [1.27] to 3.93 [1.24]; $P=0.87$), with stable sex differences (P for interaction= 0.94). Nonetheless, sex differences in blood pressure widened as ideal blood pressure decreased in men (54.0% to 46.9%; $P=0.03$) but not in women (P for interaction <0.001). Concurrently, the proportion with ideal physical activity declined in women (57.3% to 49.4%; $P=0.04$) but remained stable in men (P for interaction= 0.03). Nonsmoking increased to a greater extent in women (64.1% to 70.5%; $P=0.05$) than in men (P for interaction= 0.01).

CONCLUSIONS: Sex disparities in CVH have persisted with exacerbated differences in blood pressure, physical activity, and smoking. These insights provide opportunities to promote equitable CVH.

Key Words: cardiovascular health ■ health disparities ■ primary prevention

Despite significant scientific and public health advances, cardiovascular disease (CVD) remains the leading cause of mortality in the United States.¹ Moreover, CVDs, principally ischemic heart disease, represent the leading cause of premature death worldwide.² CVD typically represents the downstream consequence of a confluence of longitudinal clinical, genetic, sociodemographic, lifestyle, and environmental risk factors. As improvements in CVD rates have stagnated in the general population, persistent and potentially widening disparities among younger individuals may highlight opportunities for prevention.³

Premature alterations of modifiable risk factors, including blood pressure (BP),⁴ cholesterol,⁵ glucose,⁶

and body mass index (BMI),⁷ magnify future CVD risks. Furthermore, awareness of altered risk factors is low among young adults.⁸ Early adverse health-related behaviors, including smoking, physical inactivity, and poor diets, additionally contribute to premature CVD event risk.⁹⁻¹¹ Early implementation of lifelong prevention measures may hinder initial development and progression of risk factors and reduce their differential prevalence rates across sociodemographics.^{12,13} However, broad implementation of prevention measures is typically costly and may have varied engagement.

Given the differential effects of traditional cardiovascular risk factors on CVD risks by sex, characterizing the sex-stratified temporal trends of cardiovascular

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CLINICAL PERSPECTIVE

What Is New?

- Sex differences in young US adults have widened with worsened blood pressure in men and increasing physical inactivity and declining tobacco smoking in women.
- Absolute proportions, temporal trends, and sex differences in ideal levels of risk factors further varied across race and ethnicity and socioeconomic status.

What Are the Clinical Implications?

- Tailoring efforts to address modifiable suboptimal risk factor levels early in life by sociodemographic subgroups may help to achieve ideal lifelong cardiovascular health.

Nonstandard Abbreviations and Acronyms

CVH	cardiovascular health
NHANES	National Health and Nutrition Examination Survey

health (CVH) among younger adults may better inform opportunities for earlier efficient prevention. Indeed, sex differences in clinical manifestations of CVD have been reported, including earlier elevation of systolic BP in men, rapid elevation of low-density lipoprotein cholesterol during menopause, and protective effect of estrogen on endothelial function.¹⁴ Nevertheless, epidemiological evidence on sex differences in CVH and the persistence of the differences across sociodemographic groups is lacking for young adults. Therefore, we assessed sex differences in temporal trends in overall CVH and its individual components in serial nationwide samplings of US adults aged 20 to 39 years.

METHODS

Data Source and Study Population

All data and materials are publicly available at the Centers for Disease Control and Prevention–National Center for Health Statistics repository and can be accessed at <https://www.cdc.gov/nchs/nhanes/index.htm>. The National Health and Nutrition Examination Survey (NHANES) is an ongoing health surveillance system of a representative sampling of the non-institutionalized civilian US population. As a serial cross-sectional study, mutually exclusive sets of participants are identified through stratified, multistage probability sampling for each 2-year cycle to undergo

comprehensive health measurements and interview on demographics, diet, and health care use.¹⁵ Appropriate strata, cluster, and weight parameters were applied to produce unbiased estimates of vital and health statistics.¹⁵ The protocols are elaborated elsewhere in detail.¹⁵ The current study was based on the 6 NHANES cycles conducted in 2007 to 2008, 2009 to 2010, 2011 to 2012, 2013 to 2014, 2015 to 2016, and 2017 to 2018. After excluding 1338 (11.6%) participants with incomplete CVH measurements, a final analytical sample of 10 206 adults, aged 20 to 39 years, combined from all 6 cycles was studied.

Population Characteristics

Demographics, health care use, and disease history were collected via face-to-face interview or self-administered questionnaires. Binary sex was self-determined as woman or man. Race and ethnicity were self-identified from fixed categories of race and ethnicity groups, which include Hispanic, Latino, or of Spanish origin, American Indian or Alaska Native, Asian (available only after cycle 7), Black or African American, Native Hawaiian or Pacific Islander, White, or other including multi-racial. On the basis of the responses, the released NHANES data on race and ethnicity comprised Hispanic or Mexican American, non-Hispanic Black, non-Hispanic White, and other. The Hispanic or Mexican American category includes Central/South American, Cuban, Mexican, Puerto Rican, Hispanic subgroups not individually identified, and unknown Hispanic origin. The other category includes non-Hispanic Asian/Pacific Islander and non-Hispanic individuals reporting multiple races and ethnicities.

Education attainment was categorized into completion below high school, high school, or college. Annual household income was obtained as a range value for last calendar year. Sources of health insurance included obtainment through employment, direct purchase, or federal- or state-sponsored programs. Self-reported history of cardiovascular disease included coronary heart disease, heart failure, myocardial infarction, or stroke.

Assessment of CVH

Anthropometric measurements and blood tests were conducted during on-site health examination. BMI was calculated as the ratio of weight in kilograms to height in squared meters. BP was measured on 3 consecutive occasions; the mean of the second and the third readings was adopted for the data analysis.¹⁶ Hypertension was defined as systolic BP ≥ 130 mm Hg, diastolic BP ≥ 80 mm Hg, or use of an antihypertensive medication. Overnight fasting blood cholesterol and glucose levels were enzymatically assessed. Hypercholesterolemia was defined as total cholesterol ≥ 240 mg/dL or use

of lipid-lowering medications. Diabetes was defined as fasting glucose ≥ 126 mg/dL or use of glucose-lowering medications.

Smoking status was determined from self-reported lifetime and daily average number of cigarettes smoked and duration of cessation. Number of days performing moderate- or vigorous-intensity recreational activities in a typical week was recorded. The Healthy Eating Index score¹⁷ was calculated on the basis of 24-hour dietary recall assessment, ranging from 0 to 100. Subsequently, the score was grouped into study population-specific tertile (<41.4, 41.4–53.6, ≥ 53.7).

The CVH assessment was based on modified version of the American Heart Association's Life's Simple 7 metrics (Table S1).¹⁸ The ideal level of each CVH component included the following: (1) untreated systolic BP <120 mm Hg and diastolic BP <80 mm Hg; (2) untreated total cholesterol <200 mg/dL; (3) untreated fasting glucose <100 mg/dL; (4) BMI <25 kg/m²; (5) never smoking; (6) ≥ 3 days of moderate-to-vigorous physical activity per week; and (7) Healthy Eating Index score ≥ 53.7 . The number of ideal CVH components ranged from 0 to 7.

Statistical Analysis

To obtain nationally representative estimates, all analyses were weighted by applying either mobile examination centers or interview weight pooled from the 6 NHANES cycles. In cases where the generated variable consists of both examination and interview measurements (ie, hypertension prevalence), we applied "the least common denominator rule," where the variable of interest that was collected on the smallest number of respondents is the least common denominator.¹⁵ Subgroup analyses by sex or race and ethnicity were conducted by specifying the parameter in the *domain* statement, except in the case of *PROC SURVEYFRQ* procedure, in which *tables* statement was used.

Population characteristics were reported as weighted mean (SD) or number (percentage). For continuous variables, women-to-men differences (95% CI) were computed on the absolute scale using linear regression analyses based on the *contrast* statement of the *PROC SURVEYREG* procedure. For categorical variables, sex differences were compared using 1-way ANOVA. In the primary analysis, the mean number of ideal CVH components and the ideal proportion of individual components were calculated for each cycle. For each sex group, weighted linear regression model was used to estimate time trends from 2007 to 2018; the β coefficient indicates the average change in the number or prevalence of ideal CVH components per cycle. Nonlinearity of secular trend was tested by adding quadratic or cubic terms into the regression models. Then, to assess whether sex differences have

changed across examinations, *P* values were derived by adding an interaction term between sex and calendar year (cycle) as a continuous variable to the model. With established impact of socioeconomic status on cardiovascular risk,¹⁹ secondary analyses evaluated sex differences in CVH across race and ethnicity, education attainment, and household income categories. In addition to the 2-way interaction terms, 3-way interaction terms were also included in the model to assess whether sex differences in linear trends differed across race and ethnicity. In addition, the slope of trends in sex differences was quantified across socioeconomic categories for each race and ethnicity.

All statistical tests were 2 sided, and statistical significance was set at a *P*<0.05, according to the Bonferroni correction of multiple comparisons when assessing differences across race and ethnicity. All analyses were performed using SAS version 9.4 (SAS Institute Inc, Cary, NC) and R version 4.1.0 (R Foundation for Statistical Computing, Vienna, Austria).

Ethical Approval

All participants of the NHANES provided written informed consent, and the research ethics boards of the National Center for Health Statistics approved all protocols. The present secondary data analysis study was approved by the Institutional Review Board of Massachusetts General Hospital (protocol number 2021P002212) and followed the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.

RESULTS

Population Characteristics

Of the 10 206 US adults aged 20 to 39 years (mean [SD] age, 29.3 [5.8] years; 51.5% women), 27.4% were Hispanic or Mexican American, 20.9% were non-Hispanic Black, 37.7% were non-Hispanic White, and 14.0% were of other race and ethnicity (Table 1 and Table S2). Women had lower systolic BP, total cholesterol, and fasting glucose concentrations yet higher BMI than men. Although they had lower BP, higher proportions of women were treated for hypertension compared with men. Although Hispanic or Mexican American individuals had the highest mean cholesterol (186.1 mg/dL) and glucose (101.4 mg/dL) concentrations, non-Hispanic Black individuals had the highest mean systolic BP (118.2 mm Hg) and BMI (30.1 kg/m²). Although non-Hispanic Black individuals had the highest treatment rates for hypertension, non-Hispanic White individuals had the highest treatment rates for hypercholesterolemia and diabetes. Compared with studied individuals, those excluded for missing CVH had comparable age, BP, and cholesterol distributions;

Table 1. Sex Differences in Baseline Characteristics

Characteristic	Sex		Sex difference (female-male)*
	Female	Male	
Total No.	5260	4946	
Age, y	29.4 (5.8)	29.3 (5.8)	0.0 (0.0 to 0.1)
Race and ethnicity			
Hispanic or Mexican American†	1481 (19.0)	1319 (20.8)	0.57
Non-Hispanic Black	1124 (13.6)	1007 (11.7)	
Non-Hispanic White	1942 (58.1)	1904 (58.4)	
Other‡	713 (9.4)	716 (9.2)	
Education attainment			
Below high school	928 (13.0)	1026 (15.6)	<0.001
High school	1053 (19.4)	1286 (25.7)	
College/university or above	3279 (67.6)	2634 (58.7)	
Annual household income, \$			
<5000	365 (4.6)	285 (3.1)	0.08
5000–24,999	1490 (23.9)	1388 (22.7)	
25,000–64,999	1901 (36.2)	1867 (38.0)	
≥65,000	1504 (35.4)	1406 (36.2)	
Health insurance			
Government programs	1286 (20.9)	687 (12.5)	<0.001
Private/single service plan	2543 (56.6)	2386 (56.5)	
None	1431 (22.6)	1873 (30.9)	
Systolic blood pressure, mm Hg	110.9 (11.6)	119.2 (11.8)	-8.3 (-8.4 to -8.2)
Diastolic blood pressure, mm Hg	67.4 (10.8)	70.7 (11.8)	-3.3 (-3.3 to -3.2)
Antihypertensive medication intake	219 (3.8)	173 (3.5)	0.2 (0.0 to 0.5)
Total cholesterol, mg/dL	181.6 (36.5)	185.5 (40.0)	-3.9 (-4.0 to -3.8)
HDL-C, mg/dL	56.4 (15.2)	47.2 (13.4)	9.2 (9.2 to 9.3)
Lipid-lowering medication intake	72 (1.3)	86 (2.0)	-0.6 (-3.2 to 1.8)
Fasting glucose, mg/dL	96.1 (22.2)	100.9 (26.8)	-4.8 (-5.0 to -4.5)
Glucose-lowering medication intake	58 (0.9)	50 (0.9)	0.1 (0.0 to 0.3)
Body mass index, kg/m ²	28.7 (8.1)	28.2 (6.7)	0.5 (0.4 to 0.5)
History of cardiovascular disease	11 (0.2)	11 (0.2)	0.0 (0.0 to 0.0)

Descriptive statistics are presented as weighted mean (SD) or number (weighted percentage). HDL-C indicates high-density lipoprotein cholesterol.

*Sex differences for socioeconomic categorical variables are derived from ANOVA test; sex differences (95% CI) for continuous variables are computed on the absolute scale linear regression analyses.

†Comprises Central/South American, Cuban, Mexican, Puerto Rican, Hispanic subgroups not individually identified, and unknown Hispanic origin.

‡Comprises other race and ethnicity groups, including non-Hispanic Asian/Pacific Islander and non-Hispanic individual reporting multiple races and ethnicities.

however, they were less likely to be of non-Hispanic White race and ethnicity and had lower fasting glucose levels (98.1 versus 98.5 mg/dL) (Table S3).

Temporal Trends and Sex Differences in CVH

Between 2007 and 2018, women had a persistently higher number of ideal CVH components without significant widening or narrowing in sex discrepancies (*P* for interaction=0.94), irrespective of race and ethnicity (Table 2). The mean number of ideal CVH components did not change in women (4.40–4.48; *P*=0.94) or men (3.97–3.93; *P*=0.87) (Figure 1, Table S4, and Figure S1).

In examining individual CVH components, significant changes in sex disparities were observed for BP, tobacco smoking, and physical activity (Table 3, Figure 2, and Figure S2). Across cycles, men had progressively lower prevalence of ideal BP, as the sex difference increased from 25.6% (women, 79.6% versus men, 54.0%) in 2007 to 32.6% (women, 79.6% versus men, 46.9%) in 2018 (*P* for interaction <0.001). Such widened disparity was contributed by significant decline (β =-1.14%; *P*=0.03) per cycle in men with ideal BP with relative stagnancy in women. Sex differences in smoking also widened (*P* for interaction=0.01), as the prevalence of nonsmoking increased from 64.1% to 70.5% (β =1.14%; *P*=0.05) in women, but was

Table 2. Changes in the Mean Number and Sex Differences in Ideal CVH Components

Characteristic	Year						P for interaction*
	2007–2008	2009–2010	2011–2012	2013–2014	2015–2016	2017–2018	
Total No.	1742	1921	1703	1742	1675	1423	
Women	4.40 (1.22)	4.50 (1.18)	4.43 (1.15)	4.49 (1.19)	4.33 (1.17)	4.48 (1.15)	0.94
Men	3.97 (1.27)	3.91 (1.26)	4.04 (1.29)	4.08 (1.24)	3.94 (1.28)	3.93 (1.24)	
Race and ethnicity							
Hispanic or Mexican American, women*	4.58 (1.17)	4.68 (1.10)	4.59 (1.12)	4.64 (1.06)	4.53 (1.02)	4.54 (1.05)	0.82
Hispanic or Mexican American, men*	3.88 (1.27)	3.86 (1.34)	4.11 (1.25)	4.02 (1.19)	3.84 (1.23)	3.75 (1.18)	
Non-Hispanic Black, women	4.38 (1.22)	4.44 (1.21)	4.34 (1.15)	4.48 (1.21)	4.35 (1.28)	4.61 (1.22)	0.48
Non-Hispanic Black, men	4.13 (1.27)	4.12 (1.19)	3.92 (1.32)	4.01 (1.17)	4.04 (1.27)	4.22 (1.27)	
Non-Hispanic White, women	4.33 (1.23)	4.43 (1.16)	4.33 (1.15)	4.39 (1.24)	4.26 (1.17)	4.40 (1.14)	0.58
Non-Hispanic White, men	3.91 (1.28)	3.87 (1.23)	4.03 (1.28)	4.10 (1.26)	3.92 (1.28)	3.95 (1.27)	
Other, women†	4.58 (1.36)	4.68 (1.43)	4.87 (1.05)	4.77 (1.16)	4.31 (1.24)	4.59 (1.15)	0.49
Other, men†	4.46 (1.14)	4.06 (1.16)	4.08 (1.29)	4.11 (1.29)	4.08 (1.36)	3.85 (1.18)	

Values are presented as weighted mean (SD). CVH indicates cardiovascular health.

*P value is derived from regression models including an interaction term between sex and cycle (time) modeled as a continuous variable.

†Comprises Central/South American, Cuban, Mexican, Puerto Rican, Hispanic subgroups not individually identified, and unknown Hispanic origin.

‡Comprises other race and ethnicity groups, including non-Hispanic Asian/Pacific Islander and non-Hispanic individuals reporting multiple races and ethnicities.

largely unchanged for men. The proportion of women who fulfilled ideal physical activity level significantly decreased from 57.3% to 49.4% ($\beta=-2.06\%$; $P=0.04$), thereby contributing to widening sex disparity (P for interaction=0.03). Despite there being no significant reduction in men, only half achieved ideal physical activity by 2017 to 2018.

Although sex differences in ideal cholesterol remained unchanged (P for interaction=0.30), the prevalence of ideal cholesterol simultaneously increased in young women (69.2% to 78.2%; $P=0.002$) and men (64.0% to 72.6%; $P=0.003$) (Table 3, Figure 2, and Figure S2). Meanwhile, ideal BMI significantly decreased to comparable degrees in both sexes (P for interaction=0.30). By 2018, the proportion of young adults who achieved ideal BMI decreased to 35.3% in women ($P=0.02$) and 30.9% in men ($P=0.04$). Furthermore, the prevalence of ideal glucose and diet remained stagnant without significant changes in sex differences (ideal glucose, P for interaction=0.78; ideal diet, P for interaction=0.29). Last, although nearly all young adults did not yet develop dysglycemia, <40% adhered to the guideline-recommended diet.

Secondary Analyses

We also illustrated the ideal proportion and sex differences for each CVH component by race and ethnicity and socioeconomic status (Table S5 and Figures S3

and 4). There were nominal interactions for sex differences across racial and ethnic groups in total cholesterol (P for interaction=0.03), smoking (P for interaction=0.001), and physical activity (P for interaction=0.003) (Figure S4). On the basis of the pooled data from 2007 to 2018, the sex difference in ideal BP among Hispanic or Mexican American individuals was 31.5% (women, 84.2% versus men, 52.6%) (Table S5). A large sex difference in smoking was observed among Hispanic or Mexican American individuals because of 79.4% of nonsmoking women relative to 60.4% of men. Notably, a large (15.6%) sex difference in physical activity was observed in non-Hispanic Black individuals as 65.1% of women attained ideal activity level compared with 49.5% of their male counterparts; in contrast, sex difference was opposite (−4.5%) in non-Hispanic White individuals.

Changes in differences further varied across education and income gradient (Figures S5–S11 and Table S6). Although sex differences in BP increased in non-Hispanic White adults with high education attainment and income, such trends were the opposite in other race and ethnicity (Figure S5). The sex differences in nonsmoking decreased in Hispanic or Mexican American adults with greater education attainment but heightened in non-Hispanic White and other race and ethnicity subgroups with college degrees (Figure S9). Sex differences in ideal physical activity decreased in non-Hispanic White and other race and ethnicity

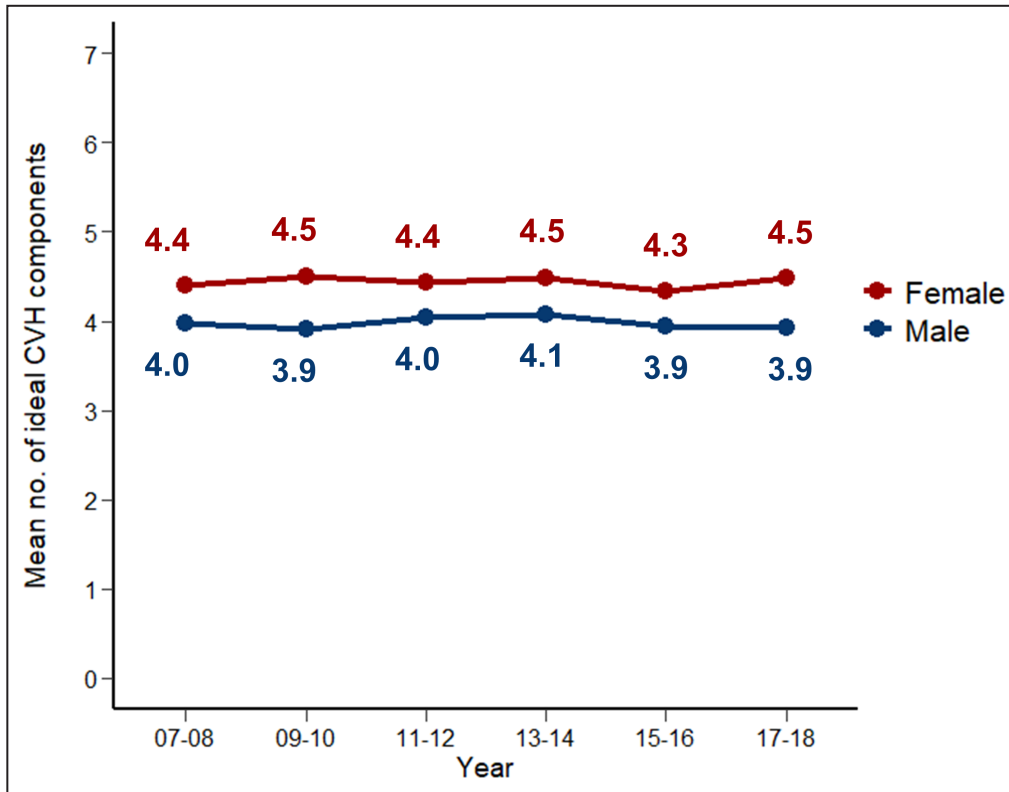


Figure 1. Changes in the mean number of ideal cardiovascular health (CVH) components among US adults, aged 20 to 39 years, from 2007 to 2018, by sex.

The β coefficient indicates the average change in the number of ideal CVH components per cycle. *P* value is derived from weighted linear regression using mean ideal number as dependent variables and cycles as independent variables. *P* for interaction by sex is derived from regression models including an interaction term between sex and cycle (time) modeled as a continuous variable.

subgroups with higher education but increased in non-Hispanic Black counterparts (Figure S10).

DISCUSSION

Our study examines trends in CVH by sex, race and ethnicity, and socioeconomic status and the persistence of sex differences in a nationwide sample of young US adults. Between 2007 and 2018, CVH has not improved or deteriorated with consistently more favorable overall indexes for women over time. The overall stable trajectory, however, masks widening sex disparities for key CVH components, including relatively worsening BPs and smoking status for men but worsening physical activity for women. The persistent suboptimal CVH indexes, and persistent and widening sex disparities for key indexes among US young adults, may have important implications for the primordial and primary prevention of CVD.

First, sex disparities for BP are the largest and widening among young adults. Between 2001 and 2016, men aged 20 to 34 years had consistently higher systolic BP with alarmingly low hypertension treatment

(women, 33.0%; men, 21.4%) and control (women, 20.4%; men, 7.3%) rates.²⁰ Currently, there is a lack of event-based evidence on the clinical benefits of antihypertensive treatment in a low-risk group.²¹ The current BP guideline recommends pharmacological interventions and lifestyle modifications for adults with stage 1 hypertension based on an estimated 10-year atherosclerotic CVD risk threshold of 10%.²² As young adults generally have low 10-year risk, the low use of antihypertensive medications, and therefore low rate of optimal BP control, is unsurprising. Data suggest men have fewer health care visits and lower rates of health insurance coverage, which may contribute to worse hypertension management.²³ Thus, for young men without access or inclination to routine physician care, diversifying modes of screening and preventive strategies outside of traditional clinical delivery system (ie, media campaigns for accurate home BP measurements) may raise awareness and subsequent linkage to care.²³

Second, disaggregation of CVH yields heterogeneous sex disparities for health-related behaviors. Relative to men, the proportion of women with ideal

Table 3. Changes in the Prevalence of Ideal Levels of CVH Components by Sex

Component	Year						β (SE)*	P value†
	2007–2008	2009–2010	2011–2012	2013–2014	2015–2016	2017–2018		
Blood pressure								
Women	687 (79.6)	840 (81.6)	651 (78.2)	711 (81.6)	655 (75.4)	592 (79.6)	-0.49 (0.60)	0.46
Men	452 (54.0)	476 (52.1)	470 (54.1)	477 (57.3)	387 (48.2)	311 (46.9)	-1.14 (0.73)	0.03
Total cholesterol								
Women	616 (69.2)	737 (72.9)	602 (73.5)	672 (75.1)	679 (78.4)	615 (78.2)	1.82 (0.25)	0.002
Men	557 (64.0)	589 (66.4)	613 (70.1)	606 (70.9)	546 (70.8)	466 (72.6)	1.67 (0.26)	0.003
Fasting glucose								
Women	858 (97.5)	1002 (98.5)	806 (98.1)	873 (97.7)	856 (98.5)	749 (98.2)	0.09 (0.09)	0.40
Men	823 (97.4)	872 (97.7)	858 (98.2)	840 (99.0)	778 (96.9)	649 (98.5)	0.16 (0.21)	0.50
Body mass index								
Women	310 (40.0)	396 (42.2)	335 (40.9)	328 (38.0)	298 (36.7)	264 (35.3)	-1.17 (0.32)	0.02
Men	312 (37.3)	298 (33.3)	342 (37.8)	307 (34.3)	261 (32.4)	208 (30.9)	-1.10 (0.37)	0.04
Smoking status								
Women	597 (64.1)	665 (64.2)	592 (69.7)	618 (67.9)	630 (68.8)	549 (70.5)	1.14 (0.40)	0.05
Men	441 (50.5)	495 (55.6)	508 (59.3)	468 (55.8)	464 (57.5)	371 (53.2)	0.49 (0.85)	0.60
Physical activity								
Women	556 (57.3)	659 (61.4)	466 (52.7)	547 (57.8)	460 (47.3)	424 (49.4)	-2.06 (0.92)	0.04
Men	502 (57.5)	509 (52.7)	480 (51.8)	461 (54.0)	426 (51.7)	345 (53.1)	-0.64 (0.45)	0.23
Diet								
Women	281 (31.9)	308 (29.0)	237 (29.6)	272 (30.7)	257 (28.2)	268 (36.5)	0.37 (0.69)	0.62
Men	314 (36.5)	308 (33.5)	271 (32.6)	305 (35.7)	284 (36.4)	261 (38.0)	0.57 (0.55)	0.36

Values are presented as number (weighted percentage). CVH indicates cardiovascular health.

*The β coefficient indicates the average change in the ideal proportion per cycle.

†P value is derived from weighted linear regression using estimated mean percentages as dependent variables and cycles as independent variables.

physical activity level decreased, whereas it increased for nonsmoking status. Between 2001 and 2016, sex difference in global physical inactivity exceeded 8% (women, 31.7%; men, 23.4%) with visible increase in high-income countries.²⁴ A cross-sectional examination of nearly 400 000 US adults, aged 18 to 80 years, showed that nonadherence to moderate-to-vigorous aerobic physical activity was associated with female sex and non-Hispanic Black race and ethnicity.²⁵ Our observations now indicate that these disparities begin early in life. Analogous to our findings, another NHANES study reported that smoking rates were 10.4% lower in women among Hispanic individuals relative to no sex difference among non-Hispanic White individuals.²⁰ These varied sex and racial and ethnic differences in health behaviors may be attributable to complex interactions among established socioeconomic indicators of CVD specific to high-income countries (namely, income, educational attainment, and occupation).¹⁹ Yet, our findings convey challenges in generalizing the relations between demographics and lifestyle, as ideal health behaviors and sex disparities varied across race and ethnicity and socioeconomic gradient without defined directionality. Similarly, a nationwide study has also illustrated sex- and race and

ethnicity-selective associations of education level and poverty status with cigarette smoking.²⁶ Such inconsistencies imply that sex differences in risk factors cannot be isolated to a single sociodemographic factor. Future research is required to elucidate the confluence of race and ethnicity and socioeconomic status on sex-specific mechanisms and adaptiveness of behavioral change in younger individuals. Beyond, traditional sex roles (ie, childrearing) and sex-specific risk factors (ie, adverse pregnancy outcomes) confer opportunity for engagement to optimize cardiometabolic health in reproductive-aged women. Considering the largely unmet postpartum care even in high-risk women,²⁷ interventions should be flexible yet tailored enough to address maternal responsibilities and other barriers to consistent risk factor management.

Third, intervention studies aimed at attenuating cardiovascular risk among key racial and ethnic and socioeconomic subgroups are necessary early in life and will likely require distinct strategies. The combined effect of health promotion by barbers and medication prescription by pharmacists at barbershops has resulted in greater BP reduction among non-Hispanic Black middle-aged men compared with active control approach of lifestyle modification and physician

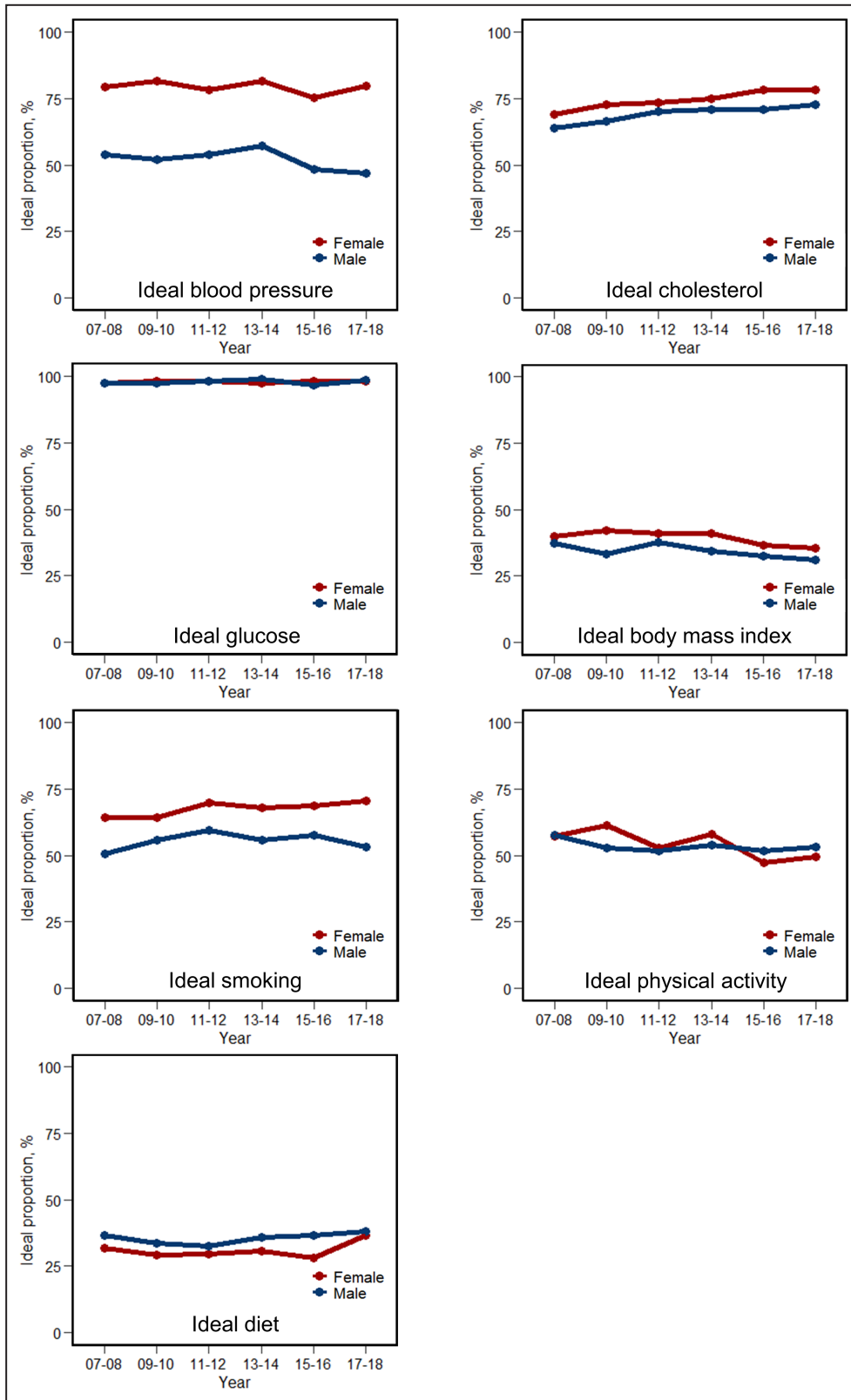


Figure 2. Changes in the ideal proportion of individual cardiovascular health components from 2007 to 2018, by sex.

visits.²⁸ Among largely early middle-aged women with children living in public housing in high-poverty urban census tracts, the opportunity to elevate to a neighborhood with a lower prevalence of poverty attenuated risk for high-grade obesity and dysglycemia.²⁹ Strategies to best engage and promote CVH among young adults are not well understood. Interventions outside traditional health care settings (ie, workplace) by unconventional mediums (ie, digital health) may widen opportunities for active surveillance and management in young adults with overall low health care use.³⁰ To mitigate sex, racial and ethnic, and socioeconomic inequity, understanding the capacity and barriers to resource use and decision making for lifestyle modification should be done within a multidimensional framework to enable feasible environments for change.¹²

Strengths and Limitations

The current study illustrates CVH trends among US young adults, who are rarely studied in large, representative samples. Our findings highlight the time-sensitive nature of maintaining favorable CVH earlier in life. Nonetheless, several limitations must be acknowledged. First, because of a cross-sectional design for each NHANES visit, we are unable to track individual trajectories of CVH by time. However, our study design permits an analysis of trends while maintaining a constant age. Second, our sex and racial and ethnic classifications are restricted to questions included in the NHANES. Nonbinary genders, racial and ethnic subclassifications, and excluded racial and ethnic categories may exhibit further heterogeneity. Third, self-reported measurements are subjected to recall bias. Changes in diagnostic thresholds and treatment guidelines may have resulted in nondifferential effects across strata.

In summary, the overall CVH in young US adults has remained unchanged with persistent sex disparities between 2007 and 2018. Key CVH metrics, including BP, physical activity, and smoking, exhibit worsening sex disparities. The optimal strategies to equitably optimize CVH among young adults toward primordial CVD prevention require further study.

ARTICLE INFORMATION

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Supplemental Material

Tables S1–S6
Figures S1–S11

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SUPPLEMENTAL MATERIAL

Table S1. Definition and categorization of cardiovascular health components

Component	Poor	Intermediate	Ideal
Blood pressure	SBP \geq 130 mm Hg or DBP \geq 80 mm Hg	SBP 120-129 mm Hg, DBP <80 mm Hg, or treated to goal	<120/80 mm Hg (untreated)
Total cholesterol	\geq 240 mg/dL	200-240 mg/dL or treated to goal	<200 mg/dL (untreated)
Fasting glucose	\geq 126 mg/dL	100-126 mg/dL or treated to goal	<100 mg/dL (untreated)
Body mass index	\geq 30 kg/m ²	25-30 kg/m ²	<25 kg/m ²
Cigarette smoking	Current smoker or former smoker for less than 12 months	Former smoker for greater than 12 months	Never smoker
Physical activity	0 days per week	1-3 days per week	\geq 3 days per week
Diet	Healthy Eating Index score <41.4	Healthy Eating Index score 41.4-53.6	Healthy Eating Index score \geq 53.7

*Categorization of cardiovascular health components are derived from the American Heart Association's Life's Simple 7 metrics.

†Abbreviations: DBP, diastolic blood pressure; SBP, systolic blood pressure

Table S2. Baseline characteristics by race

Characteristic	Race				§P value
	†Hispanic/ Mexican American	Non-Hispanic Black	Non-Hispanic White	‡Other	
No.	2 800	2 131	3 846	1 429	
Age, year	29.3 (5.8)	28.9 (5.8)	29.4 (5.8)	29.5 (5.6)	<0.001
Male sex	1 319 (52.1)	1 007 (46.0)	1 904 (49.9)	716 (49.3)	0.09
Education level					<0.001
Below high school	1 027 (33.3)	346 (15.3)	476 (8.7)	105 (7.5)	
High school	682 (25.5)	575 (28.1)	886 (21.5)	196 (14.9)	
College/university or above	1 091 (41.2)	1 210 (56.6)	2 484 (69.8)	1 128 (77.6)	
Annual household income					<0.001
Less than \$5,000	183 (4.0)	179 (6.7)	198 (3.2)	91 (4.5)	
\$5,000 to \$24,999	883 (31.4)	667 (31.6)	1 065 (19.9)	263 (17.7)	
\$25,000 to \$64,999	1 145 (42.6)	794 (38.5)	1 348 (35.2)	481 (35.6)	
\$65,000 or above	589 (22.0)	491 (23.2)	1 235 (41.8)	594 (42.3)	
Health insurance					<0.001
Government programs	460 (15.7)	591 (27.0)	688 (14.9)	235 (16.6)	
Private/single service plan	952 (35.8)	852 (40.4)	2 244 (66.4)	881 (61.0)	
None	1 388 (48.5)	688 (32.6)	914 (18.7)	313 (22.4)	
Systolic blood pressure, mm Hg	114.5 (12.0)	118.2 (13.7)	114.9 (11.8)	113.4 (12.0)	<0.001
Diastolic blood pressure, mm Hg	67.5 (11.4)	69.4 (12.7)	69.4 (10.8)	69.7 (10.7)	<0.001
Antihypertensive medication intake	53 (1.9)	135 (6.5)	166 (3.8)	38 (2.5)	<0.001
Total cholesterol, mg/dL	186.1 (37.9)	177.7 (38.2)	183.6 (38.8)	185.3 (37.1)	<0.001
HDL-C, mg/dL	49.4 (14.0)	54.5 (15.3)	52.2 (15.2)	51.9 (14.7)	<0.001
Lipid-lowering medication intake	30 (1.0)	32 (1.5)	166 (3.8)	13 (1.9)	<0.001
Fasting glucose, mg/dL	101.4 (27.3)	98.1 (28.2)	97.4 (22.3)	98.9 (18.6)	0.004
Glucose-lowering medication intake	19 (0.6)	33 (1.5)	83 (2.0)	7 (0.3)	0.002
Body mass index, kg/m ²	29.5 (6.9)	30.1 (8.2)	28.1 (7.5)	26.6 (6.3)	<0.001
History of cardiovascular disease	0 (0.0)	9 (0.4)	11 (0.2)	2 (0.1)	0.01

*Descriptive statistics are presented as weighted means (standard deviation) or number (weighted percentage).

†Comprises Central/South American, Cuban, Mexican, Puerto Rican, Hispanic subgroups not individually identified, and unknown Hispanic origin.

‡Comprises other race groups, including Non-Hispanic Asian/Pacific Islander and Non-Hispanic individual reporting multiple races.

§Differences in baseline characteristics across race are derived from analysis of variance test.

||Abbreviation: HDL-C, high-density lipoprotein cholesterol

Table S3. Differences in baseline characteristics between included versus excluded participants

Characteristic	Included	Excluded	[§] <i>P</i> value
No.	10 206	1 338	
Age, year	29.3 (5.8)	29.6 (5.7)	0.27
Race			<0.001
†Hispanic/Mexican American	2 800 (19.9)	251 (23.3)	
Non-Hispanic Black	2 131 (12.6)	203 (15.5)	
Non-Hispanic White	3 846 (58.2)	239 (48.0)	
‡Other	1 429 (9.3)	189 (13.2)	
Education attainment			0.01
Below high school	1 954 (14.3)	203 (19.2)	
High school	2 339 (22.5)	186 (20.0)	
College/university or above	5 913 (63.2)	491 (60.8)	
Annual household income			0.21
Less than \$5,000	650 (3.9)	48 (5.6)	
\$5,000 to \$24,999	2 878 (23.3)	221 (25.0)	
\$25,000 to \$64,999	3 768 (37.0)	264 (35.0)	
\$65,000 or above	2 910 (35.8)	202 (34.5)	
Health insurance			<0.001
Government programs	1 973 (16.7)	239 (25.9)	
Private/single service plan	4 929 (56.5)	367 (46.0)	
None	3 304 (26.7)	274 (28.1)	
Systolic blood pressure, mm Hg	115.1 (12.4)	115.0 (13.5)	
Diastolic blood pressure, mm Hg	69.1 (11.4)	69.5 (11.7)	0.32
Antihypertensive medication intake	392 (3.7)	37 (5.0)	0.12
Total cholesterol, mg/dL	183.6 (38.3)	182.3 (38.2)	0.22
HDL-C, mg/dL	51.9 (14.9)	52.4 (15.9)	0.22
Lipid-lowering medication intake	158 (1.6)	7 (0.7)	0.07
Fasting glucose, mg/dL	98.5 (24.6)	98.1 (14.2)	0.01
Glucose-lowering medication intake	108 (0.9)	10 (0.5)	0.28
Body mass index, kg/m ²	28.5 (7.5)	28.2 (7.4)	0.14
History of cardiovascular disease	22 (0.2)	2 (0.5)	0.30

*Descriptive statistics are presented as weighted means (standard deviation) or number (weighted-percentage).

†Comprises Central/South American, Cuban, Mexican, Puerto Rican, Hispanic subgroups not individually identified, and unknown Hispanic origin.

‡Comprises other race groups, including Non-Hispanic Asian/Pacific Islander and Non-Hispanic-individual reporting multiple races.

§Differences in baseline characteristics are derived from independent t-test or chi-square test.

||Abbreviation: HDL-C, high-density lipoprotein cholesterol

Table S4. Average change in the mean number of ideal cardiovascular health components per cycle

Characteristic	Year						§ β (SE)	<i>P</i> value
	2007-2008	2009-2010	2011-2012	2013-2014	2015-2016	2017-2018		
No.	1 742	1 921	1 703	1 742	1 675	1 423		
Female	4.40 (1.22)	4.50 (1.18)	4.43 (1.15)	4.49 (1.19)	4.33 (1.17)	4.48 (1.15)	-0.00 (0.01)	0.94
Male	3.97 (1.27)	3.91 (1.26)	4.04 (1.29)	4.08 (1.24)	3.94 (1.28)	3.93 (1.24)	-0.00 (0.02)	0.87
By race								
†Hispanic/Mexican American, female	4.58 (1.17)	4.68 (1.10)	4.59 (1.12)	4.64 (1.06)	4.53 (1.02)	4.54 (1.05)	-0.02 (0.02)	0.32
†Hispanic/Mexican American, male	3.88 (1.27)	3.86 (1.34)	4.11 (1.25)	4.02 (1.19)	3.84 (1.23)	3.75 (1.18)	-0.02 (0.02)	0.32
Non-Hispanic Black, female	4.38 (1.22)	4.44 (1.21)	4.34 (1.15)	4.48 (1.21)	4.35 (1.28)	4.61 (1.22)	-0.00 (0.02)	0.89
Non-Hispanic Black, male	4.13 (1.27)	4.12 (1.19)	3.92 (1.32)	4.01 (1.17)	4.04 (1.27)	4.22 (1.27)	0.01 (0.02)	0.60
Non-Hispanic White, female	4.33 (1.23)	4.43 (1.16)	4.33 (1.15)	4.39 (1.24)	4.26 (1.17)	4.40 (1.14)	-0.00 (0.02)	0.89
Non-Hispanic White, male	3.91 (1.28)	3.87 (1.23)	4.03 (1.28)	4.10 (1.26)	3.92 (1.28)	3.95 (1.27)	0.01 (0.02)	0.60
‡Other, female	4.58 (1.36)	4.68 (1.43)	4.87 (1.05)	4.77 (1.16)	4.31 (1.24)	4.59 (1.15)	-0.04 (0.05)	0.36
‡Other, male	4.46 (1.14)	4.06 (1.16)	4.08 (1.29)	4.11 (1.29)	4.08 (1.36)	3.85 (1.18)	-0.08 (0.03)	0.01

*Values are presented as weighted means (standard deviation).

†Comprises Central/South American, Cuban, Mexican, Puerto Rican, Hispanic subgroups not individually identified, and unknown Hispanic origin.

‡Comprises other race groups, including Non-Hispanic Asian/Pacific Islander and Non-Hispanic individuals reporting multiple races.

§The β coefficient indicates the average change in the mean ideal number per cycle.

||*P* value is derived from weighted linear regression using estimated mean ideal number as dependent variables and cycles as independent variables.

Table S5. Sex differences in ideal level of cardiovascular health components by race, education attainment, and household income

Ideal blood pressure				Ideal total cholesterol			
	Female	Male	Difference (female-male)		Female	Male	Difference (female-male)
Race				Race			
Hispanic/Mexican American	1 250 (84.2)	700 (52.6)	31.5 (28.8 to 34.1)	Hispanic/Mexican American	1 106 (75.2)	834 (64.1)	10.9 (7.9 to 13.2)
Non-Hispanic Black	767 (67.7)	482 (48.4)	19.1 (17.5 to 21.3)	Non-Hispanic Black	871 (77.9)	743 (74.3)	3.6 (2.1 to 5.3)
Non-Hispanic White	1 534 (80.1)	981 (51.8)	28.2 (26.5 to 30.3)	Non-Hispanic White	1 416 (74.0)	1 323 (70.3)	3.8 (1.6 to 5.8)
Other	585 (81.4)	410 (57.8)	23.6 (20.9 to 25.6)	Other	528 (72.1)	477 (66.8)	5.2 (2.9 to 7.8)
Education attainment				Education attainment			
Below high school	738 (79.1)	510 (49.7)	29.2 (27.4 to 31.1)	Below high school	691 (73.7)	657 (65.1)	8.6 (6.1 to 11.0)
High school	811 (78.6)	650 (52.0)	26.6 (24.3 to 29.0)	High school	802 (76.2)	886 (69.2)	7.0 (4.2 to 9.9)
College/university or above	2 587 (79.6)	1 413 (52.8)	26.9 (24.7 to 28.9)	College/university or above	2 428 (74.3)	1 834 (70.3)	4.0 (1.8 to 6.5)
Household income				Household income			
Less than \$5,000	287 (77.8)	152 (52.7)	25.0 (23.2 to 27.4)	Less than \$5,000	270 (63.5)	210 (77.1)	-13.4 (-16.0 to -10.0)
\$5,000 to \$24,999	1 166 (80.9)	734 (54.5)	26.3 (24.4 to 29.1)	\$5,000 to \$24,999	1 122 (76.0)	966 (72.1)	4.0 (2.2 to 6.1)
\$25,000 to \$64,999	1 455 (76.6)	957 (51.9)	24.6 (22.2 to 27.5)	\$25,000 to \$64,999	1 421 (74.6)	1 253 (67.6)	7.0 (5.3 to 9.2)
\$65,000 or above	1 228 (81.3)	730 (49.8)	31.4 (29.0 to 34.2)	\$65,000 or above	1 108 (74.3)	948 (68.6)	5.7 (3.1 to 8.1)
Ideal fasting glucose				Ideal body mass index			
	Female	Male	Difference (female-male)		Female	Male	Difference (female-male)
Race				Race			
Hispanic/Mexican American	1 448 (97.9)	1 280 (97.5)	0.4 (-0.9 to 2.2)	Hispanic/Mexican American	431 (29.1)	312 (22.6)	6.6 (4.1 to 8.7)
Non-Hispanic Black	1 093 (97.3)	980 (97.4)	-0.1 (-2.9 to 2.6)	Non-Hispanic Black	281 (24.7)	382 (38.0)	-13.3 (-16.0 to -10.7)
Non-Hispanic White	1 901 (98.3)	1 857 (98.2)	0.1 (-2.4 to 2.7)	Non-Hispanic White	805 (42.9)	702 (33.7)	9.2 (6.9 to 12.5)
Other	702 (98.2)	703 (98.5)	-0.3 (-3.2 to 2.9)	Other	414 (53.6)	332 (42.5)	11.1 (8.8 to 14.9)
Education attainment				Education attainment			
Below high school	904 (97.5)	996 (97.6)	-0.1 (-2.7 to 2.8)	Below high school	249 (28.6)	338 (33.9)	-5.3 (-8.1 to -1.9)
High school	1 026 (97.7)	1 245 (97.3)	0.2 (-2.6 to 2.9)	High school	346 (34.2)	446 (34.0)	0.1 (-0.6 to 1.1)
College/university or above	3 214 (98.3)	2 579 (98.3)	0.0 (0.0 to 0.1)	College/university or above	1 336 (42.1)	944 (34.5)	7.3 (4.2 to 10.3)
Household income				Household income			
Less than \$5,000	355 (97.9)	278 (97.6)	0.2 (-3.1 to 3.0)	Less than \$5,000	135 (37.9)	129 (51.9)	-14.1 (-17.7 to -11.5)
\$5,000 to \$24,999	1 459 (98.4)	1 347 (97.8)	-0.3 (-3.9 to 3.5)	\$5,000 to \$24,999	476 (35.5)	542 (41.6)	-6.0 (-9.5 to -4.2)
\$25,000 to \$64,999	1 859 (98.2)	1 814 (97.6)	0.6 (-2.9 to 3.2)	\$25,000 to \$64,999	642 (35.8)	623 (34.0)	1.6 (0.1 to 3.6)
\$65,000 or above	1 471 (97.7)	1 381 (98.7)	-1.0 (-3.8 to 2.1)	\$65,000 or above	678 (44.4)	434 (28.3)	15.9 (12.0 to 19.5)
Ideal smoking status				Ideal physical activity			
	Female	Male	Difference (female-male)		Female	Male	Difference (female-male)
Race				Race			
Hispanic/Mexican American	1 179 (79.4)	784 (60.4)	18.8 (4.9 to 21.2)	Hispanic/Mexican American	972 (64.2)	816 (60.9)	3.3 (0.4 to 5.6)
Non-Hispanic Black	824 (73.8)	612 (61.8)	11.9 (8.4 to 15.3)	Non-Hispanic Black	740 (65.1)	500 (49.5)	15.6 (12.9 to 19.0)
Non-Hispanic White	1 073 (60.7)	886 (50.6)	10.0 (6.9 to 13.5)	Non-Hispanic White	997 (48.0)	1 070 (52.5)	-4.5 (-8.0 to -1.1)
Other	575 (77.1)	465 (65.2)	12.0 (9.6 to 14.8)	Other	403 (58.1)	337 (48.2)	9.9 (7.0 to 12.2)
Education attainment				Education attainment			
Below high school	571 (56.7)	462 (44.2)	12.4 (9.7 to 15.2)	Below high school	721 (76.4)	736 (72.7)	3.7 (0.4 to 6.8)
High school	653 (57.4)	600 (46.0)	11.2 (8.8 to 14.0)	High school	725 (64.9)	802 (61.0)	3.9 (0.9 to 6.6)
College/university or above	2 427 (72.5)	1 685 (62.3)	10.2 (7.5 to 12.9)	College/university or above	1 666 (47.0)	1 185 (45.1)	1.9 (0.0 to 4.0)
Household income				Household income			
Less than \$5,000	234 (58.4)	156 (53.5)	5.0 (2.3 to 7.9)	Less than \$5,000	237 (60.7)	157 (55.3)	5.4 (2.6 to 8.0)
\$5,000 to \$24,999	916 (59.4)	665 (48.0)	11.3 (8.8 to 13.9)	\$5,000 to \$24,999	1 000 (64.1)	836 (59.0)	5.1 (2.8 to 7.9)
\$25,000 to \$64,999	1 312 (64.6)	1006 (53.4)	11.1 (9.6 to 14.0)	\$25,000 to \$64,999	1 130 (54.9)	1 060 (55.3)	-0.4 (-3.9 to 3.0)
\$65,000 or above	1 189 (76.3)	920 (62.2)	14.0 (11.9 to 16.4)	\$65,000 or above	745 (44.8)	670 (48.4)	-3.6 (-6.5 to -0.2)
Ideal diet							
	Female	Male	Difference (female-male)				
Race							
Hispanic/Mexican American	414 (29.1)	432 (33.0)	-3.9 (-7.7 to -1.3)				
Non-Hispanic Black	414 (36.8)	376 (38.3)	-1.5 (-3.9 to 0.4)				
Non-Hispanic White	652 (31.8)	750 (36.6)	-4.8 (-7.2 to -2.0)				
Other	143 (21.8)	185 (29.8)	-8.0 (-10.9 to -5.7)				
Education attainment							
Below high school	322 (36.6)	404 (39.5)	-2.9 (-5.9 to -0.2)				
High school	391 (39.8)	527 (42.4)	-2.6 (-5.2 to 0.0)				
College/university or above	910 (27.4)	812 (31.2)	-3.6 (-6.5 to -0.4)				
Household income							
Less than \$5,000	119 (35.5)	106 (39.4)	-3.9 (-6.7 to -0.8)				
\$5,000 to \$24,999	530 (36.5)	534 (39.9)	-3.4 (-5.8 to -0.3)				
\$25,000 to \$64,999	595 (32.9)	684 (36.5)	-3.6 (-5.8 to -0.5)				
\$65,000 or above	375 (25.8)	419 (30.6)	-4.8 (-7.2 to -1.9)				

*Estimates are reported as number (weighted percentages).

†Hispanic/Mexican American group includes Central/South American, Cuban, Mexican, Puerto Rican, Hispanic subgroups not individually identified, and unknown Hispanic origin.

‡Other race group includes Non-Hispanic Asian/Pacific Islander and on-Hispanic individual reporting multiple races.

Table S6. *P* value for trends in sex differences across socioeconomic gradient by race

Socioeconomic indicator	CVH component	Race			
		*Hispanic/ Mexican American	Non-Hispanic Black	Non-Hispanic White	†Other
Education	Blood pressure	0.729	0.045	0.333	0.178
	Total cholesterol	0.940	0.673	0.317	0.412
	Glucose	0.188	0.642	0.903	0.371
	Body mass index	0.593	0.835	0.173	0.735
	Non-smoking	0.077	0.442	0.421	0.370
	Physical activity	0.244	0.647	0.094	0.460
	Diet	0.291	0.415	0.835	0.289
Household income	Blood pressure	0.406	0.976	0.489	0.725
	Total cholesterol	0.838	0.676	0.257	0.890
	Glucose	0.730	0.319	0.872	0.702
	Body mass index	0.141	0.413	0.060	0.883
	Non-smoking	0.913	0.489	0.155	0.874
	Physical activity	0.791	0.794	0.417	0.841
	Diet	0.298	0.904	0.775	0.590

*Hispanic/Mexican American comprises Central/South American, Cuban, Mexican, Puerto Rican, Hispanic subgroups not individually identified, and unknown Hispanic origin.

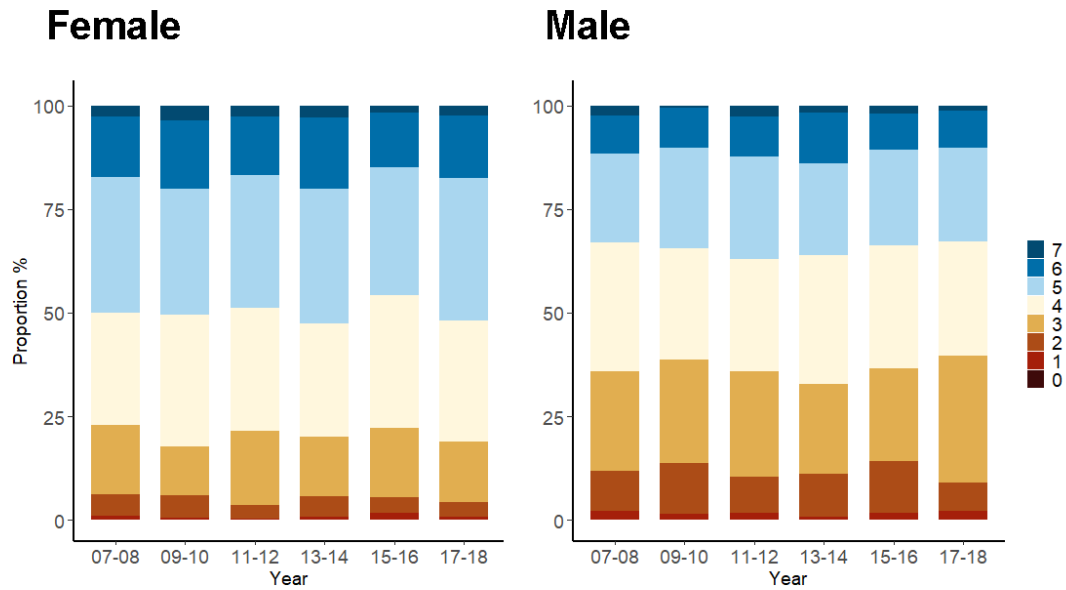
†Other race group comprises Non-Hispanic Asian/Pacific Islander and Non-Hispanic individual reporting multiple races.

‡Education attainment is categorized as below high school, high school, or college.

§Household income is categorized as less than \$5,000, \$5,000 to \$24,999, \$25,000 to \$64,999, or \$65,000 or above.

||Abbreviation: CVH, cardiovascular health

Figure S1. Distributions of ideal number of CVH components from 2007 to 2018 by sex

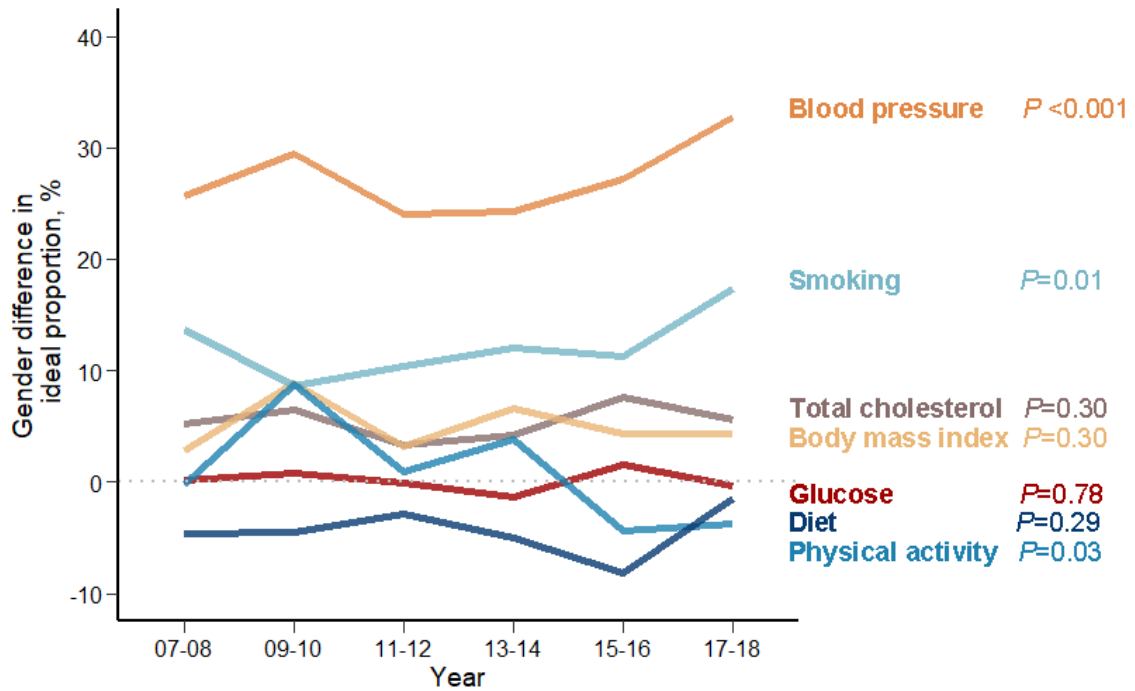


No. ideal	Female						Male					
	07-08	09-10	11-12	13-14	15-16	17-18	07-08	09-10	11-12	13-14	15-16	17-18
7	2.6	3.7	2.6	2.8	1.8	2.5	2.6	3.7	2.6	2.8	1.8	2.5
6	14.7	16.3	14.2	17.2	13.1	15.0	14.7	16.3	14.2	17.2	13.1	15.0
5	32.7	30.4	32.0	32.5	30.9	34.3	32.7	30.4	32.0	32.5	30.9	34.3
4	27.0	31.9	29.8	27.3	32.0	29.3	27.0	31.9	29.8	27.3	32.0	29.3
3	16.7	11.7	17.7	14.4	16.7	14.5	16.7	11.7	17.7	14.4	16.7	14.5
2	5.2	5.5	3.5	4.8	3.7	3.6	5.2	5.5	3.5	4.8	3.7	3.6
1	1.1	0.5	0.3	0.8	1.8	0.7	1.1	0.5	0.3	0.8	1.8	0.7
0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1

*Values are presented as weighted percentages.

†Abbreviation: CVH, cardiovascular health

Figure S2. Changes in sex differences in ideal proportion of individual CVH component from 2007 to 2018

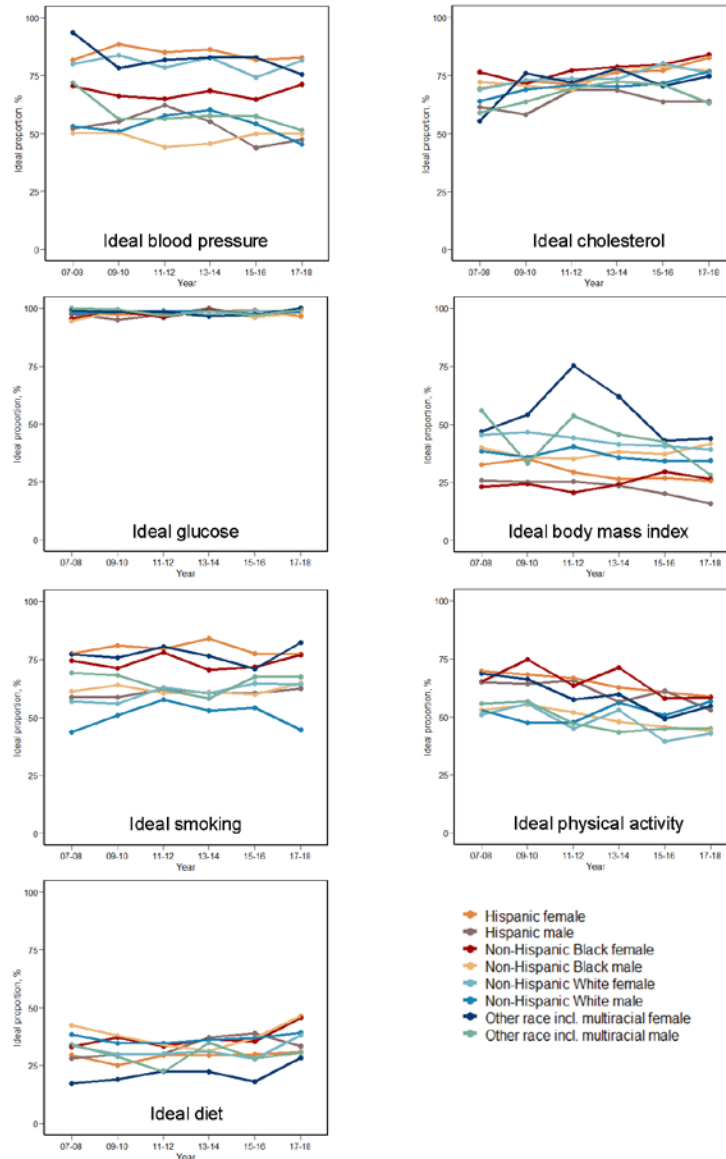


*Values above 0% (dotted line) indicate higher percentages of ideal level in female. Values below 0% indicate higher percentages of ideal level in male. Values aligning with 0% indicate no sex differences.

† P for interaction by sex is derived from regression models including an interaction term between sex and cycle (time) modelled as a continuous variable.

‡Abbreviation: CVH, cardiovascular health

Figure S3. Changes in the ideal proportion of individual CVH from 2007 to 2018 by sex and race

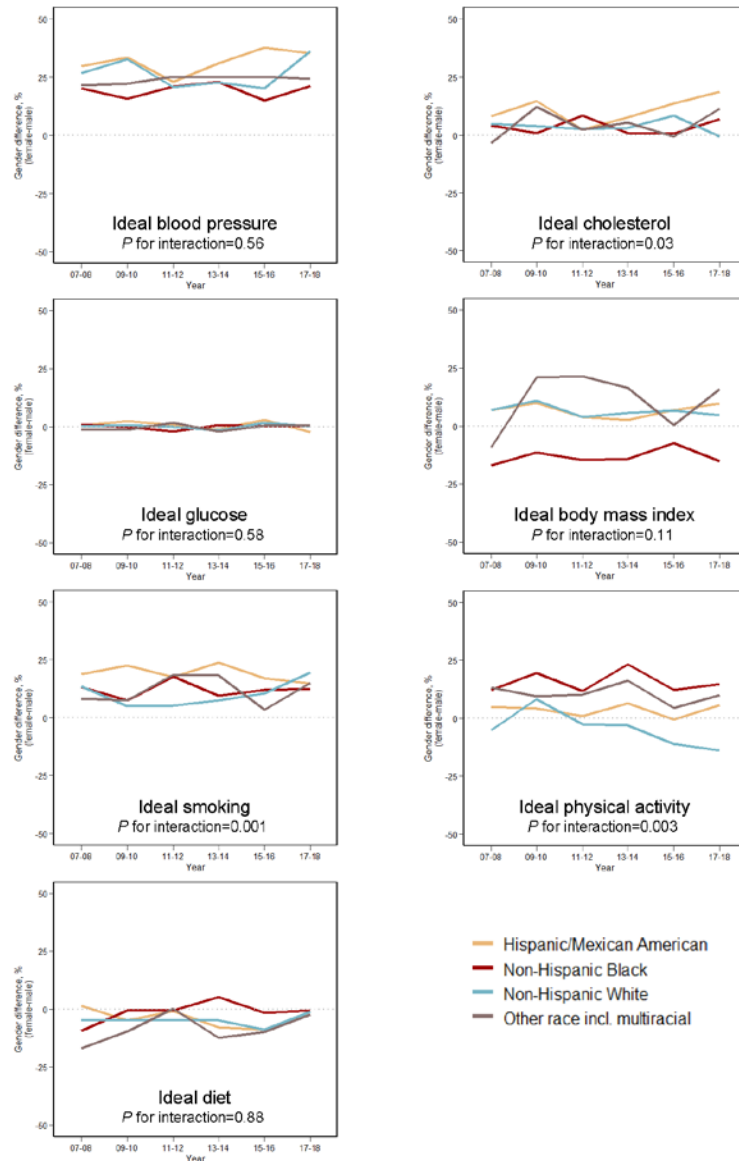


*Hispanic/Mexican American includes Central/South American, Cuban, Mexican, Puerto Rican, Hispanic subgroups not individually identified, and unknown Hispanic origin.

†Other includes Non-Hispanic Asian/Pacific Islander and Non-Hispanic individual reporting multiple races.

‡Abbreviation: CVH, cardiovascular health

Figure S4. Changes in sex differences in ideal level of individual cardiovascular health component from 2007 to 2018 by race



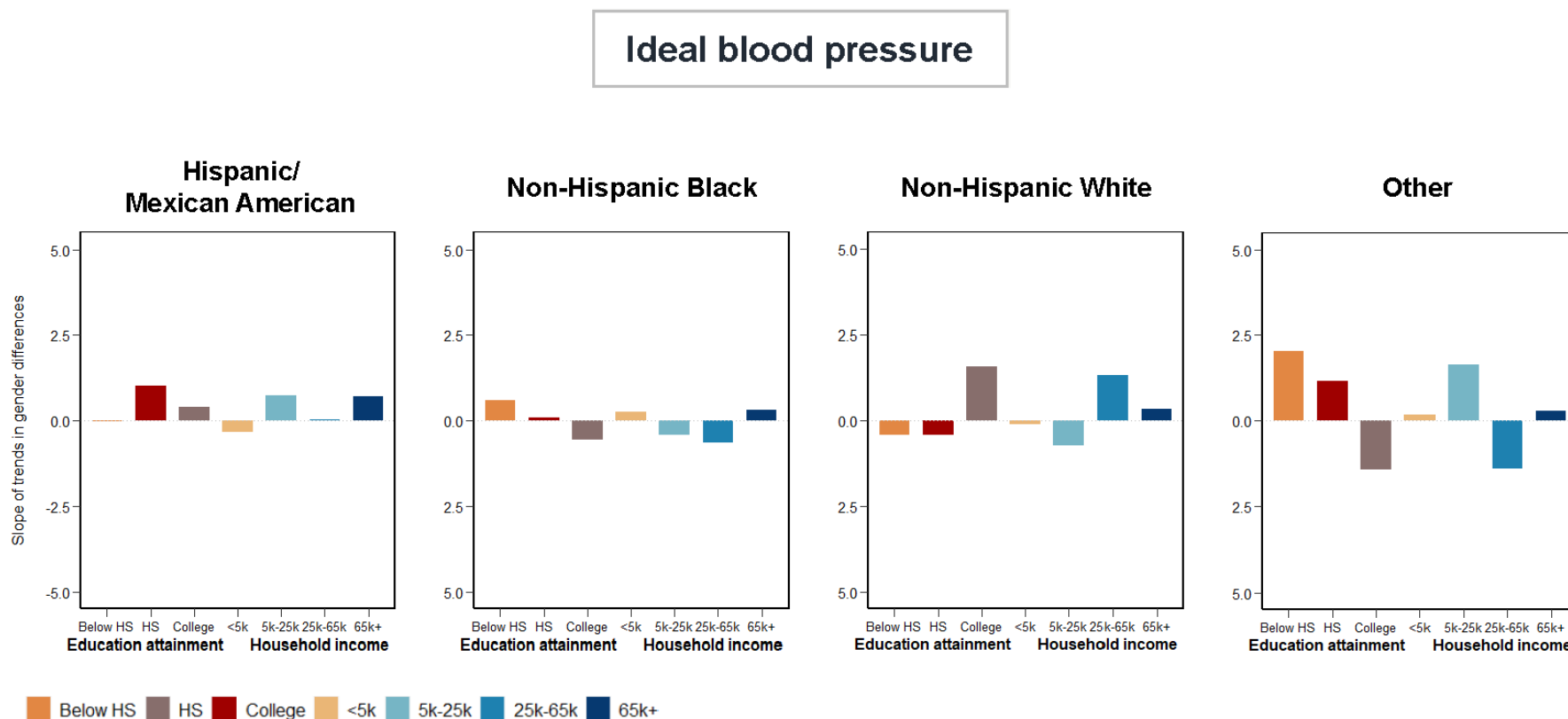
*Values above 0% indicate higher percentages of ideal level in female.

†P for interaction by race indicates whether sex differences differed across race.

‡Hispanic/Mexican American includes Central/South American, Cuban, Mexican, Puerto Rican, Hispanic subgroups not individually identified, and unknown Hispanic origin.

§Other includes Non-Hispanic Asian/Pacific Islander and Non-Hispanic individual reporting multiple races.

Figure S5. Slope of temporal trends in sex differences of ideal blood pressure between 2007 and 2018 by socioeconomic status



*The slope estimates are derived from weighted linear regression model.

†Education attainment is categorized as completion below high school, high school, or college.

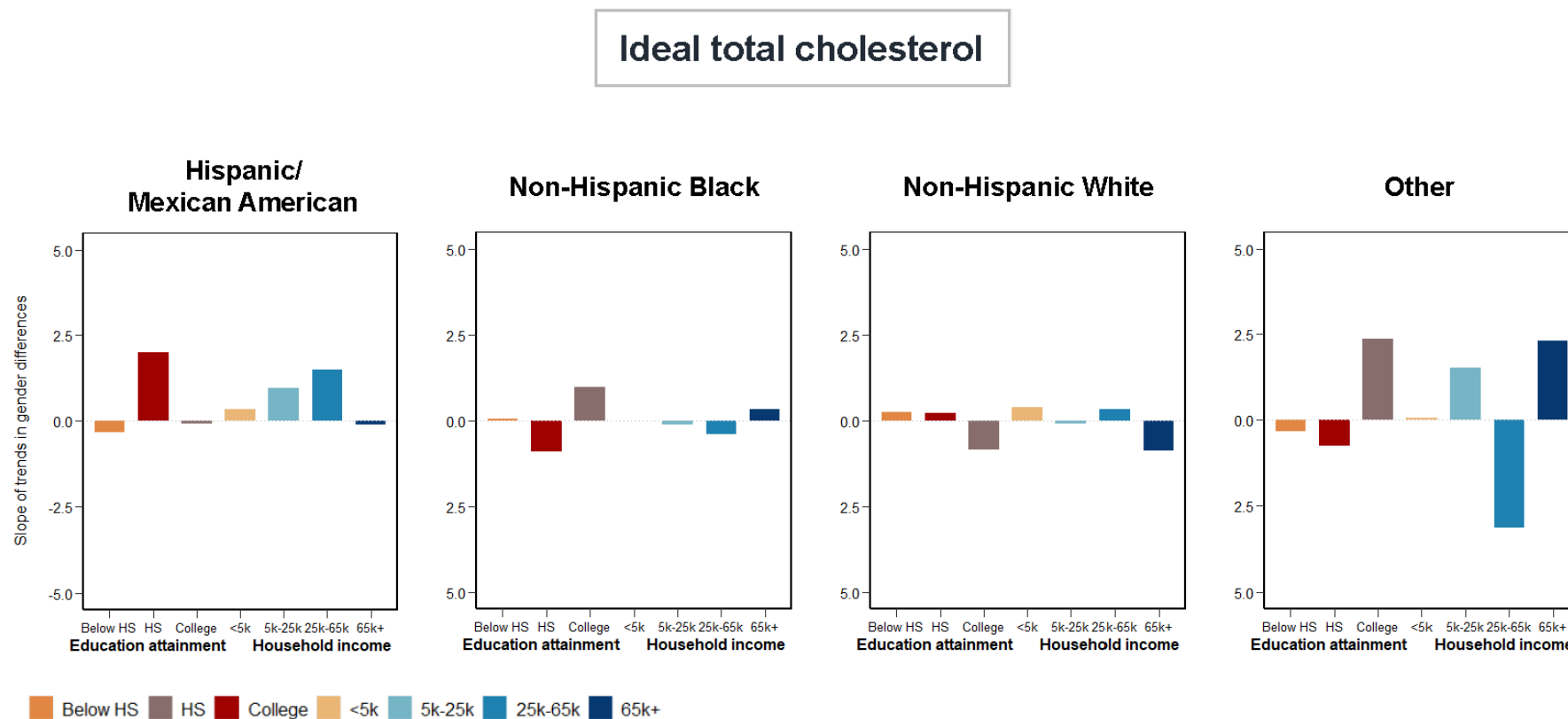
‡Annual household income is categorized as below \$5,000, \$5,000 to \$24,999, \$25,000 to \$64,999, or \$65,000 or above.

§Hispanic/Mexican American includes Central/South American, Cuban, Mexican, Puerto Rican, Hispanic subgroups not individually identified, and unknown Hispanic origin.

||Other includes Non-Hispanic Asian/Pacific Islander and Non-Hispanic individual reporting multiple races.

#Abbreviation: HS, high school

Figure S6. Slope of temporal trends in sex differences of ideal total cholesterol between 2007 and 2018 by socioeconomic status



*The slope estimates are derived from weighted linear regression model.

†Education attainment is categorized as completion below high school, high school, or college.

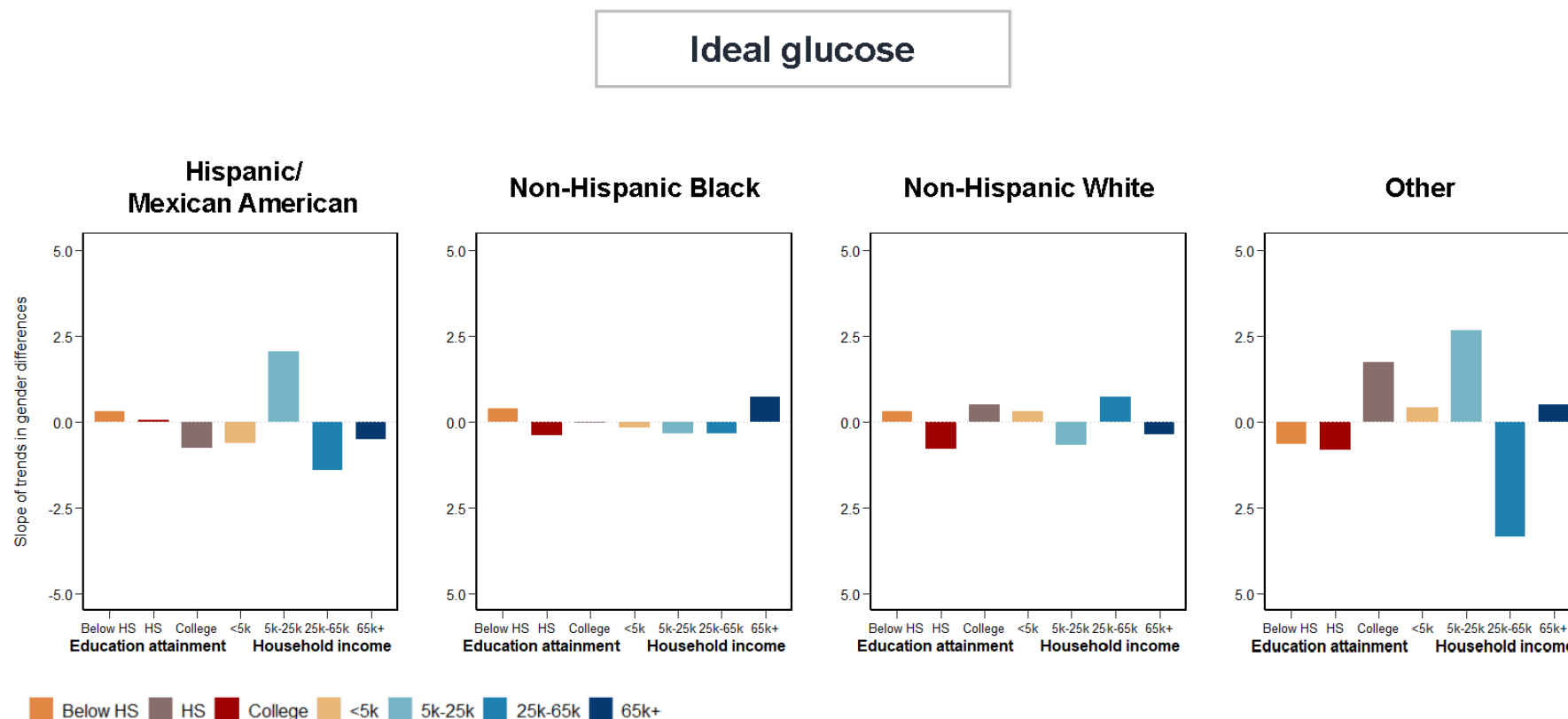
‡Annual household income is categorized as below \$5,000, \$5,000 to \$24,999, \$25,000 to \$64,999, or \$65,000 or above.

§Hispanic/Mexican American includes Central/South American, Cuban, Mexican, Puerto Rican, Hispanic subgroups not individually identified, and unknown Hispanic origin.

||Other includes Non-Hispanic Asian/Pacific Islander and Non-Hispanic individual reporting multiple races.

#Abbreviation: HS, high school

Figure S7. Slope of temporal trends in sex differences of ideal glucose between 2007 and 2018 by socioeconomic status



*The slope estimates are derived from weighted linear regression model.

†Education attainment is categorized as completion below high school, high school, or college.

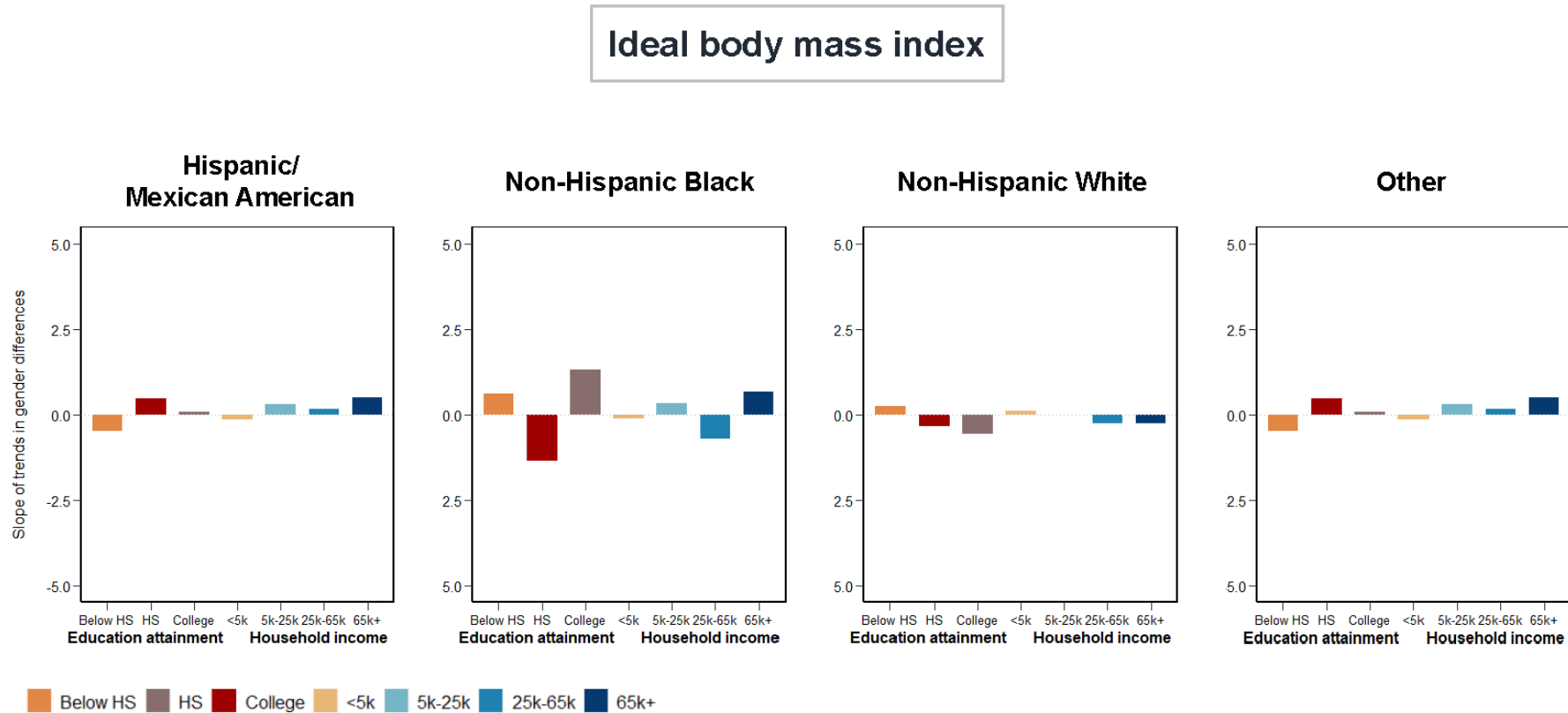
‡Annual household income is categorized as below \$5,000, \$5,000 to \$24,999, \$25,000 to \$64,999, or \$65,000 or above.

§Hispanic/Mexican American includes Central/South American, Cuban, Mexican, Puerto Rican, Hispanic subgroups not individually identified, and unknown Hispanic origin.

||Other includes Non-Hispanic Asian/Pacific Islander and Non-Hispanic individual reporting multiple races.

#Abbreviation: HS, high school

Figure S8. Slope of temporal trends in sex differences of ideal body mass index between 2007 and 2018 by socioeconomic status



*The slope estimates are derived from weighted linear regression model.

†Education attainment is categorized as completion below high school, high school, or college.

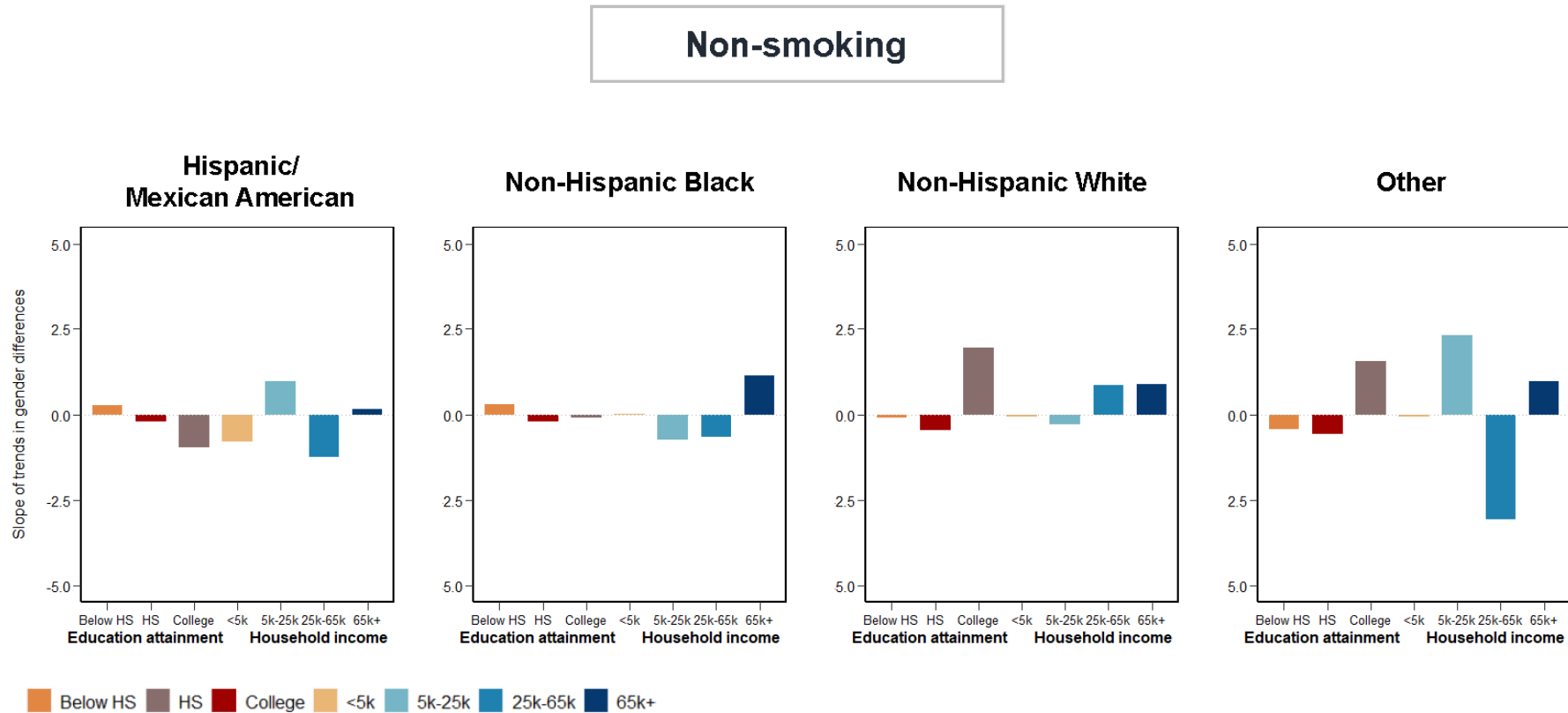
‡Annual household income is categorized as below \$5,000, \$5,000 to \$24,999, \$25,000 to \$64,999, or \$65,000 or above.

§Hispanic/Mexican American includes Central/South American, Cuban, Mexican, Puerto Rican, Hispanic subgroups not individually identified, and unknown Hispanic origin.

||Other includes Non-Hispanic Asian/Pacific Islander and Non-Hispanic individual reporting multiple races.

#Abbreviation: HS, high school

Figure S9. Slope of temporal trends in sex differences of non-smoking status between 2007 and 2018 by socioeconomic status



*The slope estimates are derived from weighted linear regression model.

†Education attainment is categorized as completion below high school, high school, or college.

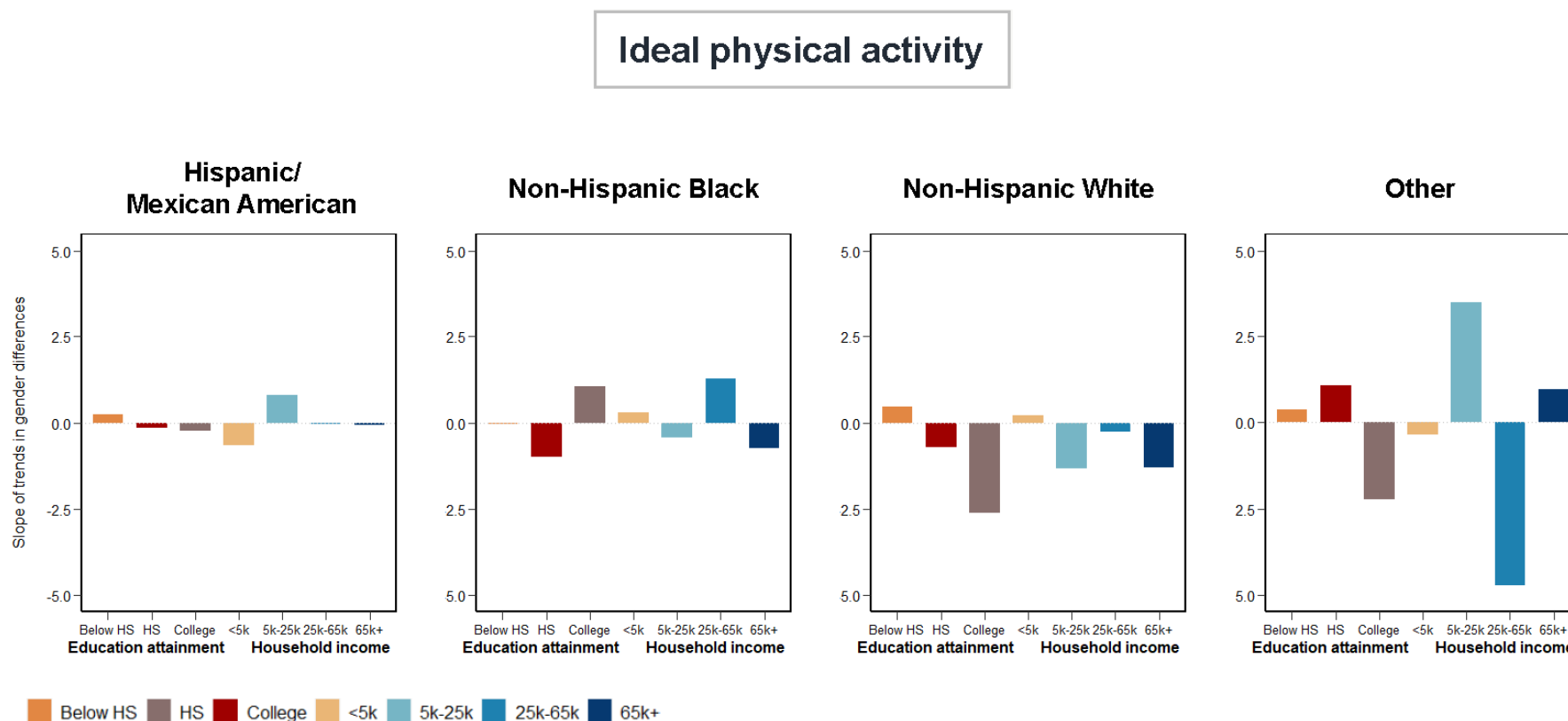
‡Annual household income is categorized as below \$5,000, \$5,000 to \$24,999, \$25,000 to \$64,999, or \$65,000 or above.

§Hispanic/Mexican American includes Central/South American, Cuban, Mexican, Puerto Rican, Hispanic subgroups not individually identified, and unknown Hispanic origin.

||Other includes Non-Hispanic Asian/Pacific Islander and Non-Hispanic individual reporting multiple races.

#Abbreviation: HS, high school

Figure S10. Slope of temporal trends in sex differences of ideal physical activity between 2007 and 2018 by socioeconomic status



*The slope estimates are derived from weighted linear regression model.

†Education attainment is categorized as completion below high school, high school, or college.

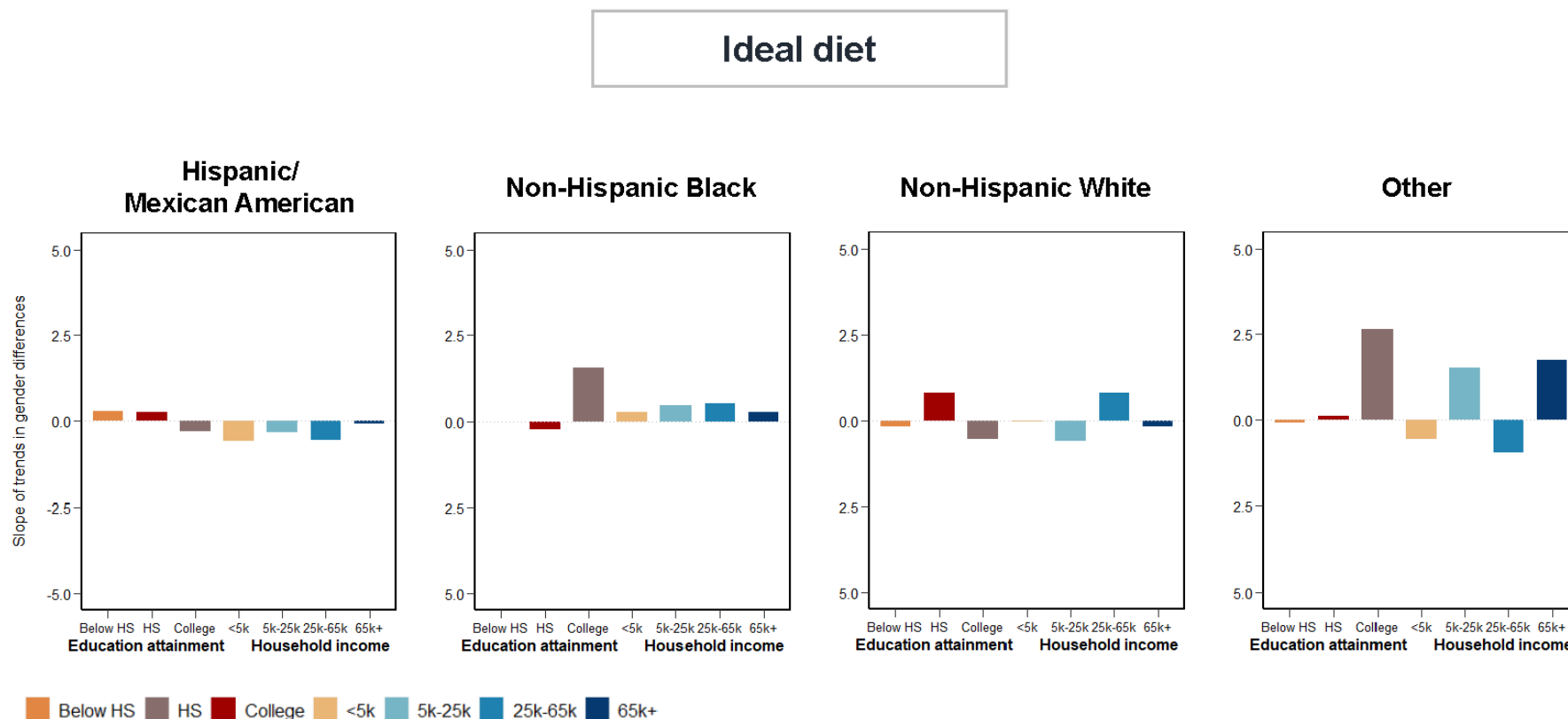
‡Annual household income is categorized as below \$5,000, \$5,000 to \$24,999, \$25,000 to \$64,999, or \$65,000 or above.

§Hispanic/Mexican American includes Central/South American, Cuban, Mexican, Puerto Rican, Hispanic subgroups not individually identified, and unknown Hispanic origin.

||Other includes Non-Hispanic Asian/Pacific Islander and Non-Hispanic individual reporting multiple races.

#Abbreviation: HS, high school

Figure S11. Slope of temporal trends in sex differences of ideal diet between 2007 and 2018 by socioeconomic status



*The slope estimates are derived from weighted linear regression model.

†Education attainment is categorized as completion below high school, high school, or college.

‡Annual household income is categorized as below \$5,000, \$5,000 to \$24,999, \$25,000 to \$64,999, or \$65,000 or above.

§Hispanic/Mexican American includes Central/South American, Cuban, Mexican, Puerto Rican, Hispanic subgroups not individually identified, and unknown Hispanic origin.

||Other includes Non-Hispanic Asian/Pacific Islander and Non-Hispanic individual reporting multiple races.

#Abbreviation: HS, high school