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Cardiovascular Risk Profile Among Reproductive-Aged Women in the U.S.: The Behavioral Risk Factor Surveillance System, 2015–2020

Ellen Boakye, MD, MPH,[1] Chigolum P. Oyeka, MD, MPH,[1] Yaa A. Kwapong, MD, MPH,[1] Faith E. Metlock, BSN,[2] Sadiya S. Khan, MD, MSc,[3] Mamas A. Mamas, MBBCh,[4] Amanda M. Perak, MD, MS,[3,5] Pamela S. Douglas, MD,[6] Michael C. Honigberg, MD, MPP,[7,8,9] Khurram Nasir, MD, MPH, MSc,[10,11] Michael J. Blaha, MD, MPH,[1] Garima Sharma, MD[1,12]

Introduction: Suboptimal cardiovascular health is associated with adverse pregnancy outcomes and long-term cardiovascular risk. The authors examined trends in cardiovascular risk factors and correlates of suboptimal cardiovascular risk profiles among reproductive-aged U.S. women.

Methods: With data from 335,959 women in the Behavioral Risk Factor Surveillance System (2015–2020), the authors conducted serial cross-sectional analysis among nonpregnant reproductive-aged women (18–44 years) without cardiovascular disease who self-reported information on 8 cardiovascular risk factors selected on the basis of Life's Essential 8 metrics. The authors estimated the prevalence of each risk factor and suboptimal cardiovascular risk profile (≥2 risk factors) and examined trends overall and by age and race/ethnicity. Using multivariable Poisson regression, the authors assessed the sociodemographic correlates of suboptimal cardiovascular risk profile.

Results: The weighted prevalence of women aged <35 years was approximately 64% in each survey year. The prevalence of suboptimal cardiovascular risk profile increased modestly from 72.4% (71.6%–73.3%) in 2015 to 75.9% (75.0%–76.7%) in 2019 ($p<0.001$). This increase was mainly driven by increases in overweight/obesity (53.1%–58.4%; $p<0.001$). Between 2015 and 2019, significant increases in suboptimal cardiovascular risk profile were observed among non-Hispanic White (69.8%–72.6%; $p<0.001$) and Hispanic (75.1%–80.3%; $p<0.001$) women but not among non-Hispanic Black (82.7%–83.7%; $p=0.48$) or Asian (68.1%–73.2%; $p=0.09$) women. Older age, rural residence, and non-Hispanic Black and Hispanic race and ethnicity were associated with a higher prevalence of suboptimal cardiovascular risk profile.

Conclusions: There has been a modest but significant increase in suboptimal cardiovascular risk profile among U.S. women of reproductive age. Urgent preventive efforts are needed to reverse this

From the [1]Ciccarone Center for the Prevention of Cardiovascular Diseases, Johns Hopkins Medicine, Baltimore, Maryland; [2]Johns Hopkins School of Nursing, Baltimore, Maryland; [3]Department of Preventive Medicine, Feinberg School of Medicine, Northwestern University, Chicago, Illinois; [4]Cardiovascular Research Group, Centre for Prognosis Research, Keele University, Staffordshire, United Kingdom; [5]Ann & Robert H. Lurie Children's Hospital of Chicago, Chicago, Illinois; [6]Division of Cardiology, Duke Clinical Research Institute, Duke University, Durham, North Carolina; [7]Cardiovascular Research Center, Massachusetts General Hospital, Boston, Massachusetts; [8]Center for Genomic Medicine, Massachusetts General Hospital, Boston, Massachusetts; [9]Department of Medicine, Massachusetts General Hospital, Boston, Massachusetts; [10]Houston Methodist DeBakey Heart & Vascular Center, Houston, Texas; [11]Center for Outcomes Research, Houston Methodist, Houston, Texas; and [12]Inova Schar Heart and Vascular, Inova Fairfax Medical Campus, Falls Church, Virginia

Address correspondence to: Garima Sharma, MD, Inova Schar Heart and Vascular Institute, Inova Fairfax Medical Campus, 3300 Gallows Road, Falls Church, Virginia. E-mail: sharmagar@gmail.com.

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trend and improve cardiovascular health, particularly among subgroups at increased risk, to mitigate its implications.

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INTRODUCTION

Cardiovascular disease (CVD), including heart disease and stroke, remains the leading cause of death among women in the U.S., accounting for approximately 451,389 deaths among women in 2019.[1,2] Mortality attributed to CVD among women has steadily increased over the last decade.[1] CVD is now the leading cause of maternal mortality, accounting for >25% of all pregnancy-related deaths in the U.S.[3] Maternal CVD also increases the risk of preterm births and low birth weight.[4]

Suboptimal cardiovascular health (CVH) increases the long-term risk of CVD.[5,6] Among women of reproductive age, suboptimal CVH is also associated with an increased risk of adverse pregnancy outcomes (APOs), such as pre-eclampsia, preterm birth, and gestational diabetes. In addition, APOs are associated with short- and long-term complications for both mother and offspring.[7−10] It is therefore important to understand the burden and distribution of suboptimal CVH among women of reproductive age and identify groups at increased risk to inform targeted population health interventions aimed at improving overall CVH in reproductive years.

The American Heart Association (AHA) established Life's Essential 8 (LE8) as an actionable summary measure for improving and maintaining CVH.[11,12] LE8 components include a healthy diet; physical activity; adequate sleep; avoidance of nicotine exposure; healthy body weight; and optimal levels of blood pressure, lipids, and glucose.[11,12] Up-to-date population-representative data on the prevalence, distribution, and trends of various CVH metrics among U.S. women of reproductive age are lacking. In addition, sociodemographic characteristics associated with suboptimal CVH among women of reproductive age have not been well characterized.

Therefore, using data from the Behavioral Risk Factor Surveillance System (BRFSS), the largest and continuously conducted nationally representative survey of non-institutionalized adults in the U.S., this study examined contemporary prevalence and trends in CVD risk factors, as informed by the LE8 metrics, among U.S. women of reproductive age. It also assessed the sociodemographic characteristics associated with suboptimal cardiovascular risk profiles in this population.

METHODS

Study Sample

This study used data from the 2015−2020 BRFSS in this serial cross-sectional analysis. BRFSS is a nationally representative survey of non-institutionalized adults (aged ≥18 years) in the U.S. carried out by each state with support from the Centers for Disease Control and Prevention. It assesses health-related risk behaviors, chronic health conditions, and the use of preventive services. It uses an iterative proportional fitting weighting methodology, incorporating demographic characteristics such as age, sex, race/ethnicity, education level, and marital status, to make the data nationally representative.[13]

This study included nonpregnant women of reproductive age (18−44 years) in all 50 states and the District of Columbia who did not report any CVD (myocardial infarction, angina, or stroke). The median survey response rate was 47.2% in 2015, 47.0% in 2016, 45.1% in 2017, 49.4% in 2018, 49.4% in 2019, and 47.9% in 2020.[14−19] This study was exempted from review by an IRB because it used deidentified, publicly available BRFSS data. The authors followed the STROBE guidelines in reporting the findings.[20]

Measures

The risk factors assessed in this study included current smoking, overweight/obesity, diabetes, hypertension, hypercholesterolemia, physical inactivity, inadequate sleep, and poor diet. All risk factors were self-reported. Questions assessing smoking, diabetes, weight, and height (hence BMI) are included in all survey years. However, questions assessing hypercholesterolemia, hypertension, and details of physical activity and fruit/vegetable consumption are asked biennially in odd-numbered years (2015, 2017, 2019). Conversely, questions assessing sleep are part of the core questionnaire on even-numbered years (2016, 2018, and 2020). Therefore, this assessment of cardiovascular profile excluded sleep and focused on 7 metrics—smoking, diabetes, BMI, hypercholesterolemia, hypertension, physical

activity, and fruit/vegetable consumption—using data from odd-numbered years 2015, 2017, and 2019.

Overweight/obesity was defined on the basis of WHO guidelines (BMI ≥25kg/m^2 for non-Asian respondents and ≥23 kg/m^2 for Asian respondents).[21] Inadequate sleep was defined as sleeping <7 hours in 24 hours, as used in other studies.[22,23] Inadequate physical activity was defined as no physical activity or <150 minutes of physical activity per week.[24,25] Intake of fruits and vegetables was used as a proxy for the quality of a diet.[24,26,27] The exact questions used to assess the individual cardiovascular risk factors as well as how they were defined in this study have been presented in Appendix Table 1 (available online).

Sociodemographic characteristics considered in the analyses included age (18−24, 25−29, 30−34, 35−39, and 40−44 years), race/ethnicity (American Indian/Alaskan Native/Native Hawaiian/Pacific Islander, Hispanic, non-Hispanic Asian, non-Hispanic Black, non-Hispanic White, multiracial, and other), marital status (married, divorced, widowed, single, member of an unmarried couple), highest education level completed (less than high school, high school/some college, college graduate), employment (employed, out of work, homemaker, unable to work, student, retired), residence (rural, urban), healthcare coverage (yes, no), and income level. Annual family income was defined using federal poverty line cut offs for each state, taking into account the number of adults and children in the household, and categorized as below 100%, within 100%−200%, or above 200% of the poverty line.[28]

Statistical Analysis

First, the authors estimated the prevalence of each of the risk factors for each year and examined trends over the period, overall and then by age and race/ethnicity. Next, they tested trends in the prevalence of each risk factor using logistic regression with the survey year as a continuous variable. Then, using data from participants with complete information on all the risk factors of interest, they categorized participants into those with 0 or 1 risk factor versus those with multiple risk factors (≥2) (referred to as suboptimal cardiovascular risk profile in the remaining parts of this paper), as has been undertaken in a prior study.[29] Authors then estimated the prevalence of suboptimal cardiovascular risk profiles for each year (2015, 2017, and 2019) and examined trends overall and by age and race/ethnicity. In addition, using data from the 2019 BRFSS and Poisson regression models, yielding prevalence ratios with 95% CIs, they assessed the sociodemographic factors associated with suboptimal cardiovascular risk profile. Sociodemographic variables in the fully adjusted models included age, education, employment, income, rural/urban status, race/ethnicity, marital status, and healthcare coverage.

All analyses were conducted in October 2021 using Stata, Version 16 (StataCorp, College Station, TX). The survey command svy was used to account for the complex weighting methodology used by the BRFSS, and a 2-sided alpha (α) level of $p<0.05$ was used to determine statistical significance.

RESULTS

A total of 335,959 study participants were included (56,336 in 2015; 60,218 in 2016; 57,412 in 2017; 55,897 in 2018; 51,957 in 2019; and 54,139 in 2020). The weighted prevalence of women aged <35 years was approximately 64% in each survey year. Across all 6 years, there were 8,358 American Indian/Alaskan Native/Native Hawaiian/Pacific Islander persons (weighted 1.2%); 47,576 Hispanic persons (weighted 21.5%); 11,811 non-Hispanic Asian persons (weighted 7.1%); 34,932 non-Hispanic Black persons (weighted 13.9%); 217,801 non-Hispanic White persons (weighted 54.1%); 9,770 multiracial persons (weighted 1.8%); and 1,732 persons of other race/ethnicities (weighted 0.4%). A detailed sociodemographic description of the study population by year is presented in Table 1.

Between 2015 and 2020, the prevalence of overweight/obesity increased significantly (53.1%−58.4%; $p<0.001$) (Figure 1), with increasing trends seen across all age groups but mainly among non-Hispanic White (47.2%−54.2%; $p<0.001$), non-Hispanic Black (67.5%−72.3%; $p<0.001$), and Hispanic (61.8%−64.0%; $p=0.005$) women (Appendix Table 2, available online). Conversely, the overall prevalence of past 30-day cigarette smoking declined (16.0%−12.4%; $p<0.001$) (Figure 1), mainly among non-Hispanic White (20.0%−15.7%; p<0.001) and non-Hispanic Black (15.4%−11.9%; $p=0.001$) women. The overall prevalence of self-reported diabetes remained relatively stable (2.9%−3.0%; $p=0.09$) (Figure 1), with similar trends observed among different age and race/ethnicity groups (Appendix Table 2, available online).

The prevalence of self-reported hypertension remained relatively stable overall between 2015 and 2019 (9.9%−10.1%; $p=0.57$) (Figure 1) and in all race/ethnicity groups. However, among young women aged 18−24 years, there was a significant increase in the prevalence of hypertension (4.5%−5.7%; $p=0.018$) (Appendix Table 3, available online). The authors observed a decrease in the overall prevalence of self-reported hypercholesterolemia (16.2%−12.6%; $p<0.001$) (Figure 2) and inadequate sleep (35.4%−33.3%; $p<0.001$) (Figure 1) but an increase in the prevalence of physical inactivity

Table 1. Sociodemographic Characteristics of the Study Population by Survey Year (BRFSS, 2015–2020)

Characteristic	Total Unweighted *n*=335,959 (weighted %)	2015 Unweighted *n*=56,336 (weighted %)	2016 Unweighted *n*=60,218 (weighted %)	2017 Unweighted *n*=57,412 (weighted %)	2018 Unweighted *n*=55,897 (weighted %)	2019 Unweighted *n*=51,957 (weighted %)	2020 Unweighted *n*=54,139 (weighted %)
Age, years							
18–24	63,713 (27.0)	10,487 (27.4)	11,151 (27.5)	10,883 (27.1)	10,677 (26.9)	9,899 (26.7)	10,616 (26.6)
25–29	55,999 (17.0)	8,964 (17.1)	10,166 (16.9)	9,802 (16.9)	9,568 (17.2)	8,580 (16.6)	8,919 (17.0)
30–34	65,879 (20.2)	11,048 (19.6)	11,906 (20.0)	11,434 (20.3)	10,878 (20.2)	10,261 (20.8)	10,352 (20.5)
35–39	74,333 (17.6)	12,451 (17.0)	13,366 (17.7)	12,705 (17.9)	12,374 (17.3)	11,535 (17.9)	11,902 (17.8)
40–44	76,035 (18.2)	13,386 (18.9)	13,629 (17.9)	12,588 (17.8)	12,400 (18.3)	11,682 (18.0)	12,350 (18.1)
Race/ethnicity							
Non-Hispanic White	217,801 (54.1)	37,102 (54.9)	39,591 (55.2)	37,257 (54.4)	35,784 (53.8)	33,500 (53.4)	34,567 (53.0)
Non-Hispanic Black	34,932 (13.9)	5,798 (13.9)	6,662 (14.2)	5,969 (13.8)	6,098 (14.3)	5,200 (13.6)	5,205 (13.5)
American Indian/Alaskan Native/Native Hawaiian/Pacific Islander	8,358 (1.2)	1,298 (1.2)	1,327 (1.2)	1,525 (1.2)	1,470 (1.2)	1,312 (1.2)	1,426 (1.2)
Non-Hispanic Asian	11,811 (7.1)	2,033 (6.7)	2,039 (6.5)	1,937 (7.4)	1,959 (6.9)	1,725 (7.1)	2,118 (7.8)
Hispanic	47,576 (21.5)	7,707 (21.0)	8,093 (20.7)	8,108 (21.1)	8,002 (21.7)	7,713 (22.5)	7,953 (22.3)
Other	1,732 (0.4)	234 (0.4)	213 (0.3)	228 (0.4)	328 (0.4)	317 (0.5)	412 (0.4)
Multiracial	9,770 (1.8)	1,552 (1.8)	1,629 (1.8)	1,686 (1.8)	1,628 (1.8)	1,572 (1.8)	1,703 (1.8)
Highest education level completed							
Less than high school	21,915 (11.4)	3,746 (12.6)	4,176 (11.8)	3,749 (11.7)	3,685 (10.8)	3,364 (10.8)	3,206 (10.7)
High school/some college	176,287 (58.6)	29,381 (58.5)	31,634 (58.7)	30,209 (58.3)	29,266 (58.6)	27,391 (59.0)	28,486 (58.2)
College graduate	137,172 (30.1)	23,113 (28.9)	24,464 (29.6)	23,344 (30.0)	22,852 (30.6)	21,108 (30.1)	22,343 (31.1)
Employment							
Employed	225,846 (62.2)	37,010 (60.4)	40,118 (61.5)	38,591 (62.0)	38,199 (64.4)	35,565 (63.5)	36,363 (61.4)
Out of work	21,601 (7.4)	3,339 (7.2)	3,533 (6.6)	3,486 (6.9)	3,291 (6.3)	2,998 (6.5)	4,954 (10.7)
Homemaker	40,128 (12.9)	7,738 (14.6)	7,769 (13.7)	6,946 (13.4)	6,449 (12.3)	6,077 (12.8)	5,149 (10.7)
Unable to work	13,528 (3.8)	2,273 (3.7)	2,524 (3.8)	2,288 (3.6)	2,282 (3.8)	2,035 (3.6)	2,126 (4.0)
Student	31,466 (13.6)	5,423 (13.8)	5,664 (14.2)	5,497 (13.9)	5,135 (13.0)	4,799 (13.5)	4,948 (13.0)
Retired	570 (0.2)	103 (0.3)	110 (0.2)	94 (0.2)	88 (0.2)	76 (0.1)	99 (0.3)
Marital status							
Married	155,673 (41.4)	27,822 (42.7)	28,629 (41.7)	26,692 (41.4)	25,223 (41.2)	23,688 (41.8)	23,619 (39.4)
Divorced/separated	36,904 (9.2)	6,329 (9.6)	6,672 (9.5)	6,293 (9.1)	6,166 (9.0)	5,721 (8.9)	5,723 (9.2)
Widowed	2,395 (0.6)	376 (0.6)	434 (0.6)	410 (0.6)	417 (0.6)	372 (0.6)	386 (0.6)
Single	115,328 (40.7)	18,034 (39.4)	20,144 (40.3)	19,761 (40.8)	19,712 (41.3)	17,901 (40.4)	19,776 (42.2)
Member of an unmarried couple	24,219 (8.1)	3,546 (7.7)	4,113 (7.9)	4,030 (8.1)	4,154 (7.9)	4,042 (8.4)	4,334 (8.5)
Income, poverty line							
Below			10,993 (21.3)	8,759 (21.3)	10,049 (19.8)	9,327 (20.8)	9,366 (19.5)
Within 100%–200%			12,261 (19.7)	9,527 (19.7)	11,228 (19.5)	10,764 (20.0)	10,596 (18.7)

(*continued on next page*)

Table 1. Sociodemographic Characteristics of the Study Population by Survey Year (BRFSS, 2015–2020) (*continued*)

Characteristic	Total Unweighted *n*=335,959 (weighted %)	2015 Unweighted *n*=56,336 (weighted %)	2016 Unweighted *n*=60,218 (weighted %)	2017 Unweighted *n*=57,412 (weighted %)	2018 Unweighted *n*=55,897 (weighted %)	2019 Unweighted *n*=51,957 (weighted %)	2020 Unweighted *n*=54,139 (weighted %)
>200%			35,220 (59.0)	28,911 (59.0)	34,484 (60.7)	31,674 (59.2)	33,956 (61.8)
Rural/urban status							
Urban	—	—	—	—	49,084 (94.8)	45,476 (94.5)	47,799 (94.7)
Rural	—	—	—	—	6,813 (5.2)	6,481 (5.5)	6,340 (5.3)

BRFSS, Behavioral Risk Factor Surveillance System.

(49.1%–51.6%; $p<0.001$) (Figure 2) and poor diet (80.2%–81.6%; $p=0.003$) (Figure 2). The prevalence of inadequate sleep decreased modestly between 2016 and 2020 (35.4%–33.3%; $p<0.001$) (Appendix Table 4, available online).

Table 2 shows the trends in the prevalence of suboptimal cardiovascular risk profile (≥2 risk factors) overall and by age and race/ethnicity groups. Prevalence of suboptimal cardiovascular risk profile was 72.4% (71.6%–73.3%) in 2015, remained relatively stable at 72.7% (71.8%–73.5%) in 2017, but increased modestly to 75.9% (75.0%–76.7%) in 2019. An increase in suboptimal cardiovascular risk profile was seen across all age groups, with the most significant increase observed among those aged <35 years: 18–24 years (65.0%–71.2%; $p<0.001$), 25–29 years (71.2%–75.9%; $p=0.003$), and 30–34 years (73.1%–77.1%; $p=0.002$). Across all 3 years, the prevalence of suboptimal cardiovascular risk profile was highest among non-Hispanic Black women. Significant increases in the prevalence of suboptimal cardiovascular risk profile were observed among non-Hispanic White (69.8%–72.6%; $p<0.001$) and Hispanic (75.1%–80.3%; $p<0.001$) women but not among non-Hispanic Black (82.7%–83.7%; $p=0.48$), non-Hispanic Asian (68.1%–73.2%; $p=0.09$), and Native American/American Indian/Native Hawaiian (77.9%–80.8%; $p=0.44$) women.

Table 3 shows the sociodemographic characteristics associated with suboptimal cardiovascular risk profile. Increasing age, rural residence, non-Hispanic Black, and Hispanic race/ethnicity were significantly associated with higher prevalence of suboptimal cardiovascular risk profile. For example, women aged 25–29 years (adjusted prevalence ratio [aPR]=1.07; 95% CI=1.03, 1.12), 30–34 years (aPR=1.10; 95% CI=1.06, 1.14), 35–39 years (aPR=1.10; 95% CI=1.06, 1.15), and 40–44 years (aPR=1.14; 95% CI=1.09, 1.18) had higher adjusted prevalence of suboptimal cardiovascular risk profile than those aged 18–24 years. Similarly, non-Hispanic Black (aPR=1.11; 95% CI=1.08, 1.15) and Hispanic (aPR=1.06; 95% CI=1.03, 1.10) women had a significantly greater prevalence of suboptimal cardiovascular risk profile than non-Hispanic White women. Notably, rural residence was associated with a higher prevalence of suboptimal cardiovascular risk profile (aPR=1.10; 95% CI=1.07, 1.13) even after adjusting for other sociodemographic characteristics (Table 3). Conversely, higher education and higher income were associated with a lower prevalence of suboptimal cardiovascular risk profile. For example, women with at least a college education had an 18% lower prevalence of suboptimal cardiovascular risk profile than women with less than a high school education (aPR=0.82; 95% CI=0.79, 0.86). Similarly, women

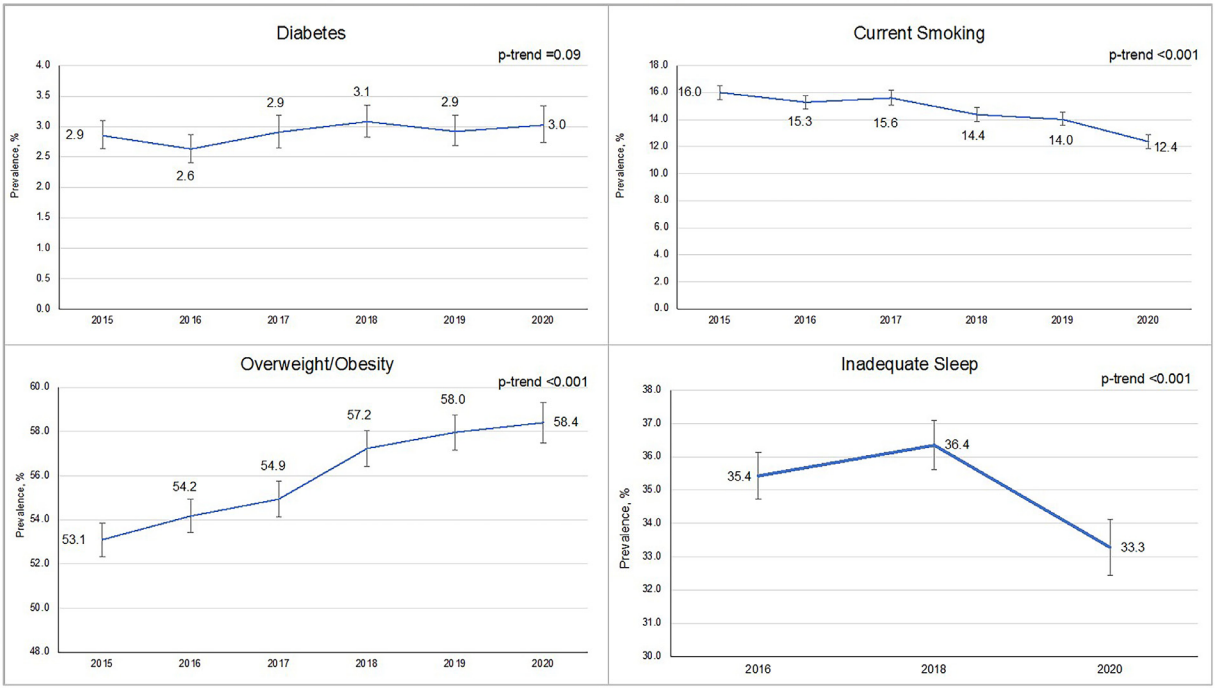

Figure 1. Prevalence of overweight/obesity, smoking, diabetes, and inadequate sleep among U.S. women of reproductive age by age and race/ethnicity (BRFSS, 2015–2020).
BRFSS, Behavioral Risk Factor Surveillance System.

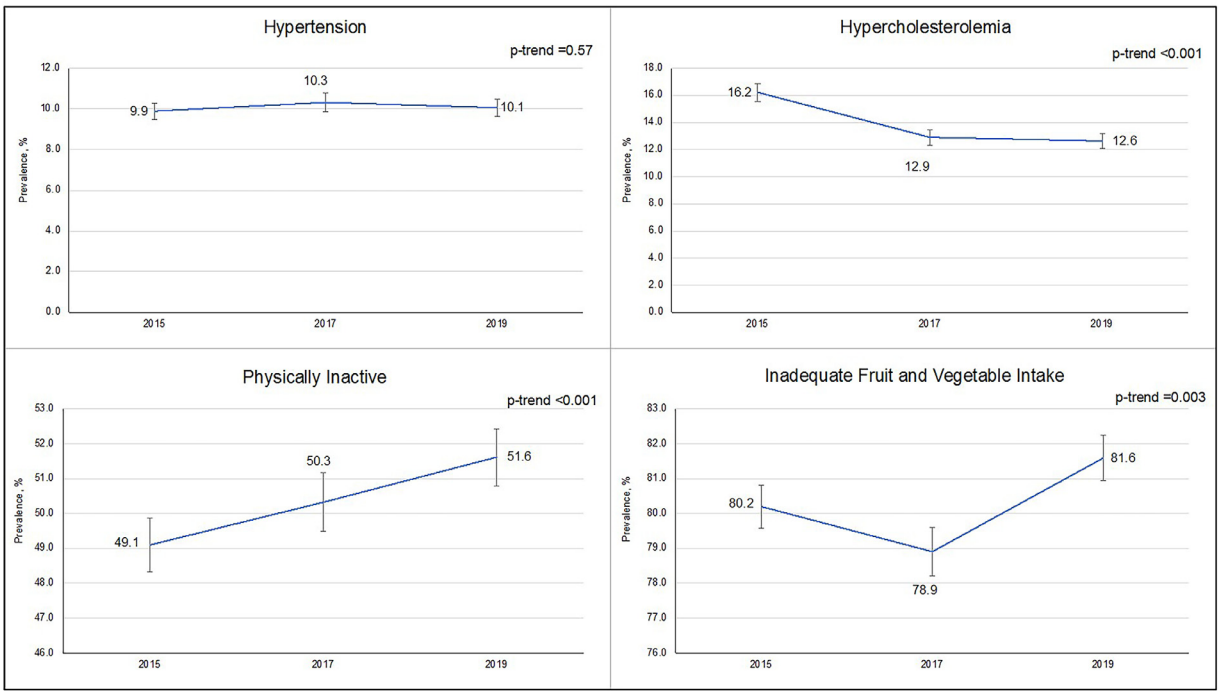

Figure 2. Prevalence of hypertension, hypercholesterolemia, physical inactivity, and poor diet among U.S. women of reproductive age by age and race/ethnicity (BRFSS, 2015, 2017, 2019).
BRFSS, Behavioral Risk Factor Surveillance System.

Table 2. Prevalence of Suboptimal Cardiovascular Health and Absolute Prevalence Differences With 95% CIs Among U.S. Women of Reproductive Age, BRFSS, 2015–2019

Characteristics	2015	2017	2019	2017 versus 2015	2019 versus 2017	2019 versus 2015	*p*-trend
Overall	72.4 (71.6, −73.3)	72.7 (71.8, 73.5)	75.9 (75.0, −76.7)	0.3 (−1.0, 1.5)	**3.2 (2.0, 4.4)**	**3.4 (2.2, 4.6)**	**<0.001**
Age, years							
18–24	65.0 (62.3, 67.5)	65.3 (63.2, 67.4)	71.2 (69.2, −73.0)	0.3 (−3.0, 3.7)	**5.8 (3.0, 8.7)**	**6.2 (2.9, 9.4)**	**<0.001**
25–29	71.2 (69.0, −73.4)	73.3 (71.3, 75.3)	75.9 (73.7, 77.9)	2.1 (−0.9, 5.1)	2.5 (−0.4, 5.5)	**4.6 (1.6, 7.7)**	**0.003**
30–34	73.1 (71.2, 74.9)	75.3 (73.6, 77.0)	77.1 (75.3, 78.8)	2.2 (−0.2, 4.7)	1.8 (−0.7, 4.2)	**4.0 (1.5, 6.5)**	**0.002**
35–39	74.1 (72.4, −75.8)	75.8 (74.0, 77.4)	76.9 (75.1, −78.6)	1.7 (−0.7, 4.1)	1.1 (−1.3, 3.6)	**2.8 (0.3, 5.3)**	**0.028**
40–44	76.3 (74.7, −77.9)	75.8 (74.0, −77.5)	79.5 (77.9, 81.0)	−0.5 (−2.9, 1.8)	**3.7 (1.4 − 6.0)**	**3.1 (1.0, 5.3)**	**0.004**
Race/ethnicity							
Non-Hispanic White	69.8 (68.7, 70.8)	69.9 (68.8, 70.9)	72.6 (71.6, 73.5)	0.1 (−1.3, 1.6)	**2.7 (1.3, 4.1)**	**2.8 (1.4, 4.2)**	**<0.001**
Non-Hispanic Black	82.7 (80.4, 84.8)	81.6 (79.6, 83.4)	83.7 (81.5, 85.6)	−1.2 (−4.1, 1.7)	2.1 (−0.7, 4.9)	0.9 (−2.1, 4.0)	0.48
American Indian/ Alaskan Native/ Native Hawaii	77.9 (70.8, −83.6)	75.0 (69.1, −80.1)	80.8 (75.5, −85.1)	−2.9 (−11.3, 5.5)	5.8 (−1.5, 13.1)	2.9 (−5.1, 10.9)	0.44
Non-Hispanic Asian	68.1 (62.9, 72.9)	66.1 (61.2, 70.7)	73.2 (68.5, −77.5)	−2.0 (−9.0, 4.9)	**7.2 (0.6, 13.7)**	5.1 (−1.6, 11.9)	0.09
Hispanic	75.1 (72.8, −77.2)	76.4 (74.1, −78.4)	80.3 (78.2, −82.3)	1.3 (−1.8, 4.4)	**4.0 (1.0, 7.0)**	**5.3 (2.3, 8.3)**	**<0.001**
Multiracial	67.2 (60.5, 73.2)	76.6 (71.9, 80.7)	74.3 (69.3, 78.7)	**9.4 (1.7, 17.2)**	−2.3 (−8.8, 4.1)	7.1 (−0.8, 15.0)	0.10

Boldface indicates statistical significance (p<0.05).
Note: Suboptimal: ≥2 cardiovascular risk factors.
BRFSS, Behavioral Risk Factor Surveillance System.

with income >200% of the federal poverty line had a lower prevalence of suboptimal cardiovascular risk profile than those with income below the federal poverty line (aPR=0.95; 95% CI=0.92, 0.98) (Table 3).

DISCUSSION

Efforts to prevent and manage cardiovascular risk factors are crucial owing to the health implications and costs associated with CVD. The AHA developed the LE8 to enhance health promotion, and continuous surveillance of these metrics is integral to CVD prevention.[30] Specifically, surveillance of CVH during key life periods, such as reproductive years for women, is critical because prepregnancy cardiovascular risk factors are associated with increased risk for APOs, such as pre-eclampsia and preterm births, with short- and long-term implications on both the mother and child.[31–35]

In this nationally representative survey of U.S. women of reproductive age without known CVD, the authors found that the prevalence of overweight/obesity, physical inactivity, and non-ideal diet (proxied by low fruit and vegetable intake) increased, whereas cigarette smoking, inadequate sleep, hypercholesterolemia decreased, and diabetes and hypertension remained stable. The prevalence of suboptimal cardiovascular risk profile increased modestly across all age groups. Older age, lack of employment, rural residence, and non-Hispanic Black and Hispanic race/ethnicity were associated with higher prevalence, whereas higher education and income were associated with lower prevalence.

A recent study using data from 2007–2018 NHANES also demonstrated that the proportion of women who fulfilled ideal physical activity levels significantly decreased over the period.[36] In addition, there was a significant decline in the proportion of women who had an ideal BMI.[36] A prior study using data from the National Vital Statistics System also showed that between 2016 and 2019, the prevalence of prepregnancy obesity increased from 26.1% to 29.0%.[37] This observation was seen mainly among non-Hispanic White, non-Hispanic Black, and Hispanic women, comparable with the findings of the present study.[37] Overweight/obesity not only increases the risk of other cardiovascular risk factors such as hypertension and diabetes but is also an independent risk factor for CVD and APOs.[38,39] It is important to mention the disproportionately high prevalence of overweight/obesity among non-Hispanic Black women across all 6 years under consideration. Several factors have been suggested to contribute to the observed high rates of overweight/obesity among Black women, including psychosocial stress stemming from racial–ethnic discrimination and neighborhood characteristics, for example, racially segregated neighborhoods. Residential segregation has been posited to negatively affect health and socioeconomic outcomes through a variety of

Table 3. Sociodemographic Characteristics Associated With Suboptimal Cardiovascular Health Among Women of Reproductive Age, BRFSS, 2019

			Suboptimal cardiovascular health[a]			
			Model 1		Model 2	
Characteristics	Unweighted *n* (weighted %)	Weighted prevalence of suboptimal CVH, % (95%CI)	Prevalence ratio (95% CI)	*p*-value	Adjusted prevalence ratio (95% CI)	*p*-value
Overall	35,653	75.9 (75.0, 76.7)	—		—	
Age, years						
18–24	6,071 (24.7)	71.2 (69.2, 73.0)	ref		ref	
25–29	5,589 (16.1)	75.9 (73.7, 77.9)	**1.07 (1.03, 1.11)**	**0.001**	**1.07 (1.03, 1.12)**	**0.001**
30–34	6,987 (20.7)	77.1 (75.3, 78.8)	**1.08 (1.05, 1.12)**	**<0.001**	**1.10 (1.06, 1.14)**	**<0.001**
35–39	8,224 (18.7)	76.9 (75.1, 78.6)	**1.08 (1.04, 1.12)**	**<0.001**	**1.10 (1.06, 1.15)**	**<0.001**
40–44	8,782 (19.7)	79.5 (77.9, 81.0)	**1.12 (1.08, 1.15)**	**<0.001**	**1.14 (1.09, 1.18)**	**<0.001**
Highest education						
Less than high school	1,714 (8.7)	87.1 (84.1, 89.7)	ref		ref	
High school to less than college	18,017 (57.9)	78.2 (77.0, 79.3)	**0.90 (0.87, 0.93)**	**<0.001**	**0.93 (0.89, 0.97)**	**0.001**
College or more	15,894 (33.4)	68.9 (67.7, 70.1)	**0.79 (0.76, 0.82)**	**<0.001**	**0.82 (0.79, 0.86)**	**<0.001**
Employment						
Employed	25,182 (65.3)	75.9 (74.9, 76.8)	ref		ref	
Out of work	1,908 (6.1)	83.1 (80.2, 85.7)	**1.10 (1.06, 1.13)**	**<0.001**	**1.04 (1.01, 1.08)**	**0.023**
Homemaker	3,928 (12.3)	74.7 (72.0, 77.3)	0.98 (0.95, 1.02)	0.42	**0.94 (0.91, 0.98)**	**0.004**
Unable to work	1,335 (3.3)	94.0 (91.6, 95.7)	**1.24 (1.21, 1.27)**	**<0.001**	**1.13 (1.10, 1.17)**	**<0.001**
Student	3,082 (12.9)	68.0 (65.1, 70.8)	**0.90 (0.86, 0.94)**	**<0.001**	**0.92 (0.87, 0.96)**	**0.001**
Retired	56 (0.1)	94.6 (85.6, 98.1)	**1.25 (1.17, 1.32)**	**<0.001**	**1.23 (1.16, 1.31)**	**<0.001**
Annual family income, poverty line[a]						
Below	5,853 (19.5)	82.6 (80.6, 84.5)	ref		ref	
Within 100% –200%	7,305 (20.2)	80.6 (78.7, 82.3)	0.98 (0.94, 1.01)	0.13	1.02 (0.98, 1.05)	0.36
>200%	22,394 (60.3)	72.1 (71.0, 73.1)	**0.87 (0.85, 0.90)**	**<0.001**	**0.95 (0.92, 0.98)**	**0.003**
Rural/urban status						
Urban	31,443 (94.9)	75.4 (74.6, 76.3)	ref		ref	
Rural	4,210 (5.1)	83.9 (81.7, 86.0)	**1.11 (1.08, 1.14)**	**<0.001**	**1.10 (1.07, 1.13)**	**<0.001**
Race/ethnicity						
Non-Hispanic White	23,893 (55.1)	72.6 (71.6, 73.5)	ref		ref	
Non-Hispanic Black	3,608 (13.4)	83.7 (81.5, 85.6)	**1.15 (1.12, 1.19)**	**<0.001**	**1.11 (1.08, 1.15)**	**<0.001**
American Indian/ Alaskan Native/ Native Hawaii	858 (1.1)	80.8 (75.5, 85.1)	**1.11 (1.05, 1.18)**	**0.001**	1.05 (0.99, 1.12)	0.12
Non-Hispanic Asian	1,173 (7.3)	73.2 (68.5, 77.5)	1.01 (0.95, 1.07)	0.77	1.06 (0.99, 1.13)	0.11
Hispanic	4,833 (20.9)	80.3 (78.2, 82.3)	**1.11 (1.08, 1.14)**	**<0.001**	**1.06 (1.03, 1.10)**	**<0.001**
Multiracial	1,080 (1.8)	74.3 (69.3, 78.7)	1.02 (0.96, 1.09)	0.71	1.01 (0.95, 1.08)	0.83
Other	208 (0.4)	74.3 (64.4, 82.1)	1.02 (0.91, 1.15)	0.48	1.01 (0.90, 1.14)	0.76
Marital status						
Married	17,153 (44.2)	74.7 (73.5, 75.9)	ref		ref	
Divorced	3,977 (9.1)	81.9 (79.5, 84.1)	1.10 (1.06, 1.13)	<0.001	1.02 (0.98, 1.05)	0.34
Widowed	235 (0.5)	83.5 (73.2, 90.3)	1.12 (1.01, 1.24)	0.035	1.03 (0.93, 1.14)	0.60

(*continued on next page*)

Table 3. Sociodemographic Characteristics Associated With Suboptimal Cardiovascular Health Among Women of Reproductive Age, BRFSS, 2019 (*continued*)

Characteristics	Unweighted *n* (weighted %)	Weighted prevalence of suboptimal CVH, % (95%CI)	Suboptimal cardiovascular health[a]			
			Model 1		Model 2	
			Prevalence ratio (95% CI)	*p*-value	Adjusted prevalence ratio (95% CI)	*p*-value
Single	11,563 (38.3)	75.9 (74.5, 77.2)	1.02 (0.99, 1.04)	0.22	1.02 (1.00, 1.05)	0.09
Member of an unmarried couple	2,638 (7.9)	74.7 (71.7, 77.5)	1.00 (0.96, 1.04)	0.99	0.99 (0.95, 1.04)	0.82
Healthcare coverage						
No	4,214 (14.2)	79.5 (76.8, 82.1)	ref		ref	
Yes	31,307 (85.8)	75.3 (74.4, 76.1)	**0.95 (0.91, 0.98)**	**0.002**	1.02 (0.98, 1.05)	0.38

Boldface indicates statistical significance (p<0.05).
Note: Suboptimal: ≥2 CVH components.
Model 1: Bivariate Poisson regression with suboptimal CVH (yes, no) as the outcome and each variable in the table as an independent variable.
Model 2: Multivariable Poisson regression with suboptimal CVH (yes, no) as the outcome and age, education, employment, income, rural/urban status, race/ethnicity, marital status, and healthcare coverage as independent variables.
[a]Suboptimal : ≥2 CVH components.
BRFSS, Behavioral Risk Factor Surveillance System; CVH, cardiovascular health.

modes, including sorting into low-opportunity neighborhoods that often lack safety, walkability, neighborhood cohesion, and availability of healthy food options.[40–42] Multimodal approaches such as culturally appropriate evidence-based behavioral interventions, including health education, healthy diet, increasing physical activity, pharmacotherapies, as well as measures to address psychosocial stressors (e.g., improving social connectedness and self-efficacy), are needed to reverse the rising prevalence of overweight/obesity among women of reproductive age.[43]

Another important observation is the decrease in the prevalence of self-reported hypercholesterolemia and inadequate sleep. Prior studies have shown a decreasing trend in hypercholesterolemia, specifically in low-density lipoprotein among U.S. adults, which may be attributed to the widespread use of statins and newer low-density lipoprotein–lowering therapies.[44,45] Another recent study showed that between 2007 and 2018, the prevalence of ideal cholesterol increased among young U.S. women.[36] The present study's observed changes in self-reported hypercholesterolemia may be related to food supply and dietary changes.[46] Contemporary trends in inadequate sleep (<7 hours of sleep per night for adults),[22] a new metric added by the AHA to enhance health promotion, among U.S. reproductive-aged women have not been studied. This study shows that between 2016 and 2020, the prevalence of inadequate sleep among reproductive-aged women slightly decreased, which may be due to increased rates of unemployment or underemployment as a result of the recession during the pandemic in 2020.[47] This observation is important, one in the right direction, because insufficient sleep is associated with poor psychological health and independently predicts CVD events.[48,49]

The authors observed a modest increase in suboptimal cardiovascular risk profile, an observation driven mainly by increases in overweight/obesity prevalence. Parallel to the findings of the present study, Wang et al.,[50] using birth certificate data from the National Center for Health Statistics, showed that the prevalence of optimal prepregnancy CVH, defined in the study as the absence of hypertension, diabetes, and smoking and the presence of ideal BMI, decreased significantly among U.S. women of reproductive age between 2011 and 2019. Although the decline in optimal prepregnancy CVH reported in the study mentioned earlier was observed across the different race/ethnicity groups, significant racial/ethnic disparities persisted.[50] The present study demonstrates that even when additionally considering health behaviors, which were not included in the study mentioned earlier, the prevalence of optimal CVH among U.S. women of reproductive age has decreased. Across all the years examined in this study, non-Hispanic Black and Hispanic women had a higher prevalence of suboptimal cardiovascular risk profile than non-Hispanic White women, who had a prevalence comparable with that of non-Hispanic Asian women.

It is essential to highlight that in addition to the racial/ethnic disparities in suboptimal cardiovascular risk profile, this study found significant correlations to other sociodemographic characteristics, including education, income, and rural/urban residence status. Women with

lower education and those with income below the federal poverty line had a significantly higher prevalence of suboptimal CVH than those with higher education and income. Of note, this study found that women who lived in rural areas had a significantly higher adjusted prevalence of suboptimal cardiovascular risk profile than those who lived in urban areas. Similar rural/urban disparities have been demonstrated in the prevalence of cardiovascular risk factors, cardiovascular outcomes, and maternal morbidity and mortality.[51–55] Addressing the factors underlying rural/urban disparities in suboptimal CVH, including social determinants of health (SDOH) and healthcare access, will improve rural health and bridge the rural/urban disparities in health outcomes.[53] Using data from National Health Interview Survey, Sharma and colleagues[29] highlighted the impact of adverse SDOH on CVH. Higher aggregate adverse SDOH score, which was a composite of economic instability, neighborhood characteristics, weak social support and stress, limited education, food insecurity, and difficult healthcare access, was associated with suboptimal CVH.[29]

Limitations

This study utilized data from the BRFSS, the largest continuously conducted health survey among U.S. adults, to examine contemporary prevalence and trends in the 8 cardiovascular risk factors, including sleep and suboptimal cardiovascular risk profile, among U.S. women of reproductive age. The findings of this study should be interpreted in the context of some limitations. First, data from the BRFSS are self-reported, with the potential for misclassification and underestimation of the true prevalence of the cardiovascular risk factors assessed. For example, data from 2011–2016 NHANES, which are based on self-report and laboratory assessment, showed the prevalence of diabetes among U.S. women of reproductive age to be 4.5% (3.2% for diagnosed diabetes and 1.3% for undiagnosed diabetes), which is higher than estimates of diabetes prevalence reported in the present study, which ranged from 2.6% to 3.1% for the years 2015–2020.[56] In addition, the CVH risk factors used in this study do not necessarily align with the AHA-defined LE8, which uses objectively measured risk factors. Furthermore, because none of the CVH risk factors in the BRFSS are objectively measured, a sensitivity analysis using objectively measured data points was not possible in this analysis. In addition, detailed data on all 8 CVH metrics were not available every year; hence, this study's definition of suboptimal cardiovascular risk profile (2015, 2017, 2019) was based on 7 of the 8 metrics (sleep not included). In addition, in defining the cardiovascular risk profile, the authors excluded participants who did not have complete information on all the 7 metrics used. This may have led to bias in the estimates. Finally, owing to the observational nature of this study, the authors cannot rule out residual confounding in the assessment of the correlates of suboptimal cardiovascular risk profile.

CONCLUSIONS

The survey found a high prevalence of suboptimal cardiovascular risk profile among nonpregnant reproductive-aged women. Between 2015 and 2019, there was a modest increase in suboptimal cardiovascular risk profile, driven by higher rates of overweight/obesity, physical inactivity, and non-ideal diet. This increase is likely to persist and may be more pronounced after coronavirus disease 2019 (COVID-2019) pandemic owing to the increase in rates of physical inactivity during and after the pandemic in 2020. Urgent preventive efforts are needed to address this increase, particularly among high-risk subgroups. These efforts should target individual-level factors, SDOH, and healthcare system delivery. Health education, preconception management of risk factors, and addressing disparities are also crucial. Structural and policy changes are necessary to improve health equity and promote CVH among women.

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CREDIT AUTHOR STATEMENT

Ellen Boakye: Conceptualization, Methodology, Formal analysis, Writing – original draft. Chigolum P. Oyeka: Writing – original draft, Visualization, Writing – review & editing. Yaa A. Kwapong: Writing – review & editing. Faith E. Metlock: Writing – review & editing. Sadiya S. Khan: Writing – review & editing. Mamas A. Mamas: Writing – review & editing. Amanda M. Perak: Writing – review & editing. Pamela S. Douglas: Writing – review & editing. Michael C. Honigberg: Writing – review & editing. Khurram Nasir: Writing – review & editing. Michael J. Blaha: Conceptualization, Methodology, Writing – review & editing, Supervision. Garima Sharma: Conceptualization, Methodology, Writing – review & editing, Supervision.

SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.focus.2024.100210.

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