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Association between sagittal abdominal diameter-to-height ratio and arteriosclerotic cardiovascular disease among the United States adults: A cross-sectional study

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ABSTRACT

Objectives: Abdominal obesity is recognized as a significant determinant of Arteriosclerotic cardiovascular disease (ASCVD), with sagittal abdominal diameter (SAD) being considered a more precise indicator of visceral fat. Nevertheless, the association between SAD and ASCVD remains unexplored in large-scale general-population studies.

Methods: The study included 11,211 participants aged 20 to 80 from the National Health and Nutrition Examination Survey. Logistic regression models were utilized to evaluate the association between the SAD-to-height ratio (SADHtR) and ASCVD. Subgroup analyses based on age categories, sex, diabetes, and hypertension were conducted to assess result robustness.

Results: The median SADHtR value was 0.13 (0.12–0.15), and 1,006 cases (7.46 %) of ASCVD were recorded. Multivariable models showed that each standard deviation increase in SADHtR was positively associated with higher odds of ASCVD (OR 1.48, 95 % CI 1.36–1.62 in model 1; OR 1.41, 95 % CI 1.28–1.54 in model 2; OR 1.18, 95 % CI 1.08–1.30 in model 3). Comparing the first quartile of SADHtR to the second to fourth quartiles, positive associations with ASCVD were observed in models 1 and 2. However, in model 3, only the fourth quartile of SADHtR remained statistically significant (OR 1.58, 95 % CI 1.17–2.15), with all p-values for the trend being less than 0.05. No interactions were found in the subgroup analyses.

Conclusion: This study demonstrates a positive association between SADHtR and ASCVD in the general adult population of the United States. Our findings indicate that SADHtR, especially when $\geq$ 0.155, could be a valuable metric for assessing the risk of ASCVD.

1. Introduction

Arteriosclerotic cardiovascular disease (ASCVD) is a prevalent vascular complication that significantly contributes to global disability and mortality (Roth et al., 2020; Theo et al., 2020). It is closely linked to various metabolic diseases and chronic kidney diseases (Khan et al., 2023; Ostrominski et al., 2023). In the United States, cardiovascular disease (CVD) accounts for 30.5 % of all causes of mortality (Virani et al., 2020). Notably, the escalating prevalence of obesity and diabetes has become a major factor in the development of ASCVD (Chobufo et al., 2022; O'Hearn et al., 2022).

Given the current state of ASCVD, it is imperative to identify the risk factors among individuals who are obese or overweight. Previous studies have established that visceral adiposity plays a pivotal role in the development of metabolic diseases and CVD (Zhang et al., 2023). However, the commonly used clinical measure, body mass index (BMI), fails to accurately reflect visceral adiposity (Jackson et al., 2002). Similarly, waist circumference (WC), another clinical metric, has limitations in distinguishing between subcutaneous fat and visceral fat (Agrawal et al., 2023). Moreover, other examination methods such as

Abbreviations: ASCVD, Arteriosclerotic cardiovascular disease.; CVD, cardiovascular disease.; SAD, sagittal abdominal diameter.; SADHtR, SAD-to-height ratio.; BMI, body mass index.; WC, waist circumference.; NHANES, National Health and Nutrition Examination Survey.; PIR, poverty-income ratio.; DXA, Dual-energy X-ray Absorptiometry.; CT, Computed Tomography.; MRI, Magnetic Resonance Imaging.; OR, odds ratio.; CI, confidence interval.; MEC, mobile examination center.; SD, standard deviation.; IQR, interquartile range.; ADI, abdominal diameter index.

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Dual-energy X-ray Absorptiometry (DXA) are less cost-effective compared to body measurements, with Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) being particularly expensive and impractical for the general population (Silver et al., 2010). Consequently, we need a more accurate and cost-effective method to identify visceral adiposity.

Previous research has shown that supine sagittal abdominal diameter (SAD) or SAD-to-height ratio (SADHtR) exhibits a stronger association with visceral fat volume compared to BMI or standing WC (Kahn, 2021, 2023). Obtaining SAD measurements using a sliding-beam caliper is relatively simple in clinical practice (NHANES, 2016). Several studies have found associations between SAD or SADHtR and factors such as Framingham risk score (Xiao et al., 2018), glucose metabolism (Firouzi et al., 2018), nonalcoholic steatohepatitis, significant fibrosis (Kim et al., 2019), metabolic syndrome risk (Summer et al., 2023), etc. Although some studies in the past decade have explored the association between SAD and CVD, the results remain controversial, and the number of relevant studies and participants from the general population is limited. Therefore, our objective was to investigate the association between SADHtR and ASCVD in a large population. To achieve this, we conducted a cross-sectional study using the National Health and Nutrition Examination Survey (NHANES) dataset. Our hypothesis posited that SADHtR would be positively associated with ASCVD in the general adult population of the U.S.

2. Methods and materials

2.1. Study population

The study initially enrolled 116,876 participants from NHANES 2011–2016. Subsequently, 95,580 participants who did not undergo the SAD examination and 11 who did not undergo the height examination were excluded. Next, participants with missing data on ASCVD were excluded, followed by those lacking information on covariates such as smoking, drinking, poverty-income ratio (PIR), and education level. Ultimately, the final analysis included 11,211 participants aged 20 to 80 years. The flowchart was drawn in Fig. 1. Prior to the study, written consent was acquired from all participants. The study protocol, Protocol #2011–17 and Continuation of Protocol #2011–17, received approval from the Research Ethics Review Board at the National Center for Health Statistics. Throughout the study, strict compliance with reporting guidelines specified in Strengthening the Reporting of Observational Studies in Epidemiology was upheld (von Elm et al., 2007).

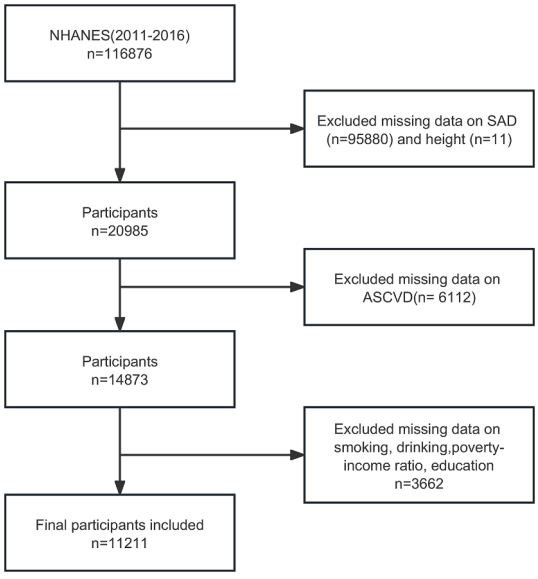

Fig. 1. Flow chart of the inclusion of adult participants from NHANES 2011–2016. Abbreviation: NHANES, National Health and Nutrition Examination Surveys; SAD, sagittal abdominal diameter; ASCVD, Arteriosclerotic cardiovascular disease.

2.2. Measurement of SADHtR

Trained health technicians conducted body measurements in the mobile examination center (MEC). The assessment of SAD involves the participant lying supine on the examination table, with an abdominal caliper utilized to measure the external distance between the anterior abdominal wall and lower back at the iliac level. The mean SAD is calculated by averaging up to four readings; typically, two readings are used unless a difference exceeding 0.5 cm between the initial two measurements prompts the inclusion of the three closest readings for the mean value (Stein et al., 2007). In cases where two outlying measurements are equidistant from the means of the two closest measurements, all four readings are incorporated to derive the mean SAD value. SADHtR is determined by dividing the average SAD (cm) by the individual's standing height (cm), measured using a stadiometer equipped with a fixed vertical backboard and adjustable headpiece (Zhang et al., 2022).

2.3. Definition of ASVCD

NHANES participants were interviewed by trained interviewers regarding their physical conditions at home. Those who reported a history of coronary heart disease, angina, heart attack, or stroke were diagnosed with ASCVD. The diagnosis criteria followed the 2013 American College of Cardiology and the American Heart Association Guidelines on the Treatment of Blood Cholesterol to Reduce Atherosclerotic Cardiovascular Risk in Adults (Stone et al., 2014).

2.4. Definition of covariates

Our study included demographic variables such as age, sex, ethnicity, education level, and PIR. Participants were categorized as low-income ($\leq$1.3), middle-income (1.3–3.5), or high-income (>3.5) based on their PIR (USDA, 2016). Drinkers were defined as male participants consuming two or more drinks per day and female participants consuming one or more drinks per day (Qiu et al., 2022). Smoking status was classified as never, former, or current smokers, while physical activity status was determined by participation in recreational activities.

Participants were diagnosed with diabetes mellitus if they met any of the following criteria: elevated fasting glucose, random glucose, HbA1c, history of diabetes, or use of anti-glycemic medication. Hypertension was diagnosed if participants had elevated blood pressure on at least three occasions, were taking anti-hypertensive medication, or had received a medical diagnosis of hypertension. Hyperlipidemia could be diagnosed if participants had elevated total cholesterol, triglycerides, low-density lipoprotein, or low levels of high-density lipoprotein (Gu et al., 2023), see the detailed information in Supplementary Table 2.

2.5. Statistical analyses

Data analyses were conducted between November and December 2023 using weighted methods throughout the entire process. Sample weights were calculated as 1/3 multiplied by the 2-year MEC weight. For statistical differences among quartiles of SADHtR, continuous variables were presented as mean $\pm$ standard error (SE) or medians with interquartile range (IQR) and compared using one-way ANOVA or Kruskal-Whallis H test, while categorical variables were presented as weighted percentages and compared using the chi-square test. Binary logistic regression models (odds ratio [OR] and 95 % confidence interval [CI]) were employed to evaluate the effect of SADHtR on ASCVD with adjustment for major covariates. Three models were estimated: Model 1

adjusted for age, sex, and ethnicity; Model 2 included additional adjustments for education, PIR, smoking, drinking, and physical activity; Model 3 was further adjusted for hypertension, diabetes mellitus, and hyperlipidemia. The multivariate model incorporated clinically relevant factors (Li et al., 2021) and significant covariates identified in the univariate analysis. The selection of covariates was also informed by existing studies investigating risk factors for ASCVD (Magnani et al., 2023; Mortensen et al., 2023). To explore non-linearity, SADHtR was categorized into quartiles, and its associations with ASCVD were examined using multivariate regression models. Subgroup analyses were performed by age (20–39, 40–59, ≥60 years), sex (male, female), diabetes (yes or no), and hypertension (yes or no) using stratified logistic regression models, while interaction among subgroups was inspected by the likelihood ratio test. Each stratification was adjusted for age, sex, ethnicity, educational level, poverty-income ratio, smoking, drinking, physical activity, diabetes, hypertension, and hyperlipidemia, excluding the stratification factor itself. Missing values were deleted, and no imputed methods were used. All analyses were performed using R 4.3.2 (https://www.R-project.org, The R Foundation) and Free Statistics software version 1.7.1. Statistical significance was defined as a pre-specified 2-sided P value of less than 0.05.

3. Results

3.1. Weighted characteristics of the participants according to SADHtR quartiles

The study included a total of 11,211 participants. Those in the lowest quartile of SADHtR were characterized by younger age, higher PIR, and greater physical activity, while those in the highest quartile were older, had more middle-income, and engaged less in physical activity. Both the lowest and highest SADHtR groups had a higher proportion of female participants. With increasing SADHtR, there was a decrease in the proportion of non-Hispanic whites, individuals with higher education levels, and current smokers, but an increase in the proportion of drinkers, diabetes, hypertension, and hyperlipidemia patients. These differences between the four SADHtR groups were statistically significant ($p < 0.05$) and are summarized in Table 1.

3.2. Association between SADHtR and ASCVD in logistics regression models

In the univariable analysis, each standard deviation (SD) increase in SADHtR was associated with a higher risk of ASCVD (OR 1.62, 95 % CI 1.51–1.73). Age, male gender, diabetes, hypertension, and hyperlipidemia were also positively associated with ASCVD (see Supplementary Table 1). In the multivariable models, each SD increase in SADHtR

Table 1
Weighted characteristics of adult participants according to quartile of SADHtR from NHANES 2011–2016 (n = 11,211).

Variables	Total	Q1(0.075–0.117)	Q2(0.117–0.134)	Q3(0.134–0.155)	Q4(0.155–0.250)	*P* value
Number	11,211	2812	2719	2921	2759	
Age(years), ±SE	47.89 ± 0.38	40.70 ± 0.58	48.80 ± 0.41	51.52 ± 0.39	51.79 ± 0.51	< 0.0001
Sex, N (%)						< 0.0001
Female	5745(51.6)	1386(52.7)	1257(46.6)	1414(48.5)	1688(59.4)	
Male	5466(48.4)	1426(47.3)	1462(53.4)	1507(51.5)	1071(40.6)	
Ethnicity, N (%)						< 0.0001
Non-Hispanic White	4601(69.0)	1237(72.1)	1084(69.4)	1173(67.1)	1107(66.7)	
Non-Hispanic Black	2468(10.4)	494(8.1)	554(9.2)	644(10.7)	776(14.4)	
Mexican American	1428(7.7)	199(4.9)	343(7.4)	456(9.7)	430(9.3)	
Other Hispanic	1147(5.5)	205(4.4)	289(5.7)	351(6.6)	302(5.7)	
Other Race - Including Multi-Racial	1567(7.3)	677(10.5)	449(8.4)	297(5.9)	144(3.9)	
Education, N (%)						< 0.0001
Less than high school	2158(13.1)	367(8.9)	504(12.4)	644(15.9)	643(15.9)	
Highschool	2454(20.7)	487(15.4)	568(20.0)	686(23.0)	713(25.7)	
More than high school	6599(66.2)	1958(75.7)	1647(67.6)	1591(61.1)	1403(58.4)	
Poverty-income ratio, N (%)						< 0.0001
≤1.3	3600(21.5)	804(18.9)	764(19.3)	967(22.3)	1065(26.3)	
> 1.3,≤3.5	4090(35.2)	950(31.3)	999(34.5)	1065(35.5)	1076(40.4)	
> 3.5	3521(43.33)	1058(49.8)	956(46.1)	889(42.3)	618(33.2)	
Drinking, N (%)						< 0.0001
No	9979(85.6)	2417(82.4)	2384(83.3)	2626(86.8)	2552(90.6)	
Yes	1232(14.4)	395(17.6)	335(16.7)	295(13.2)	207(9.4)	
Smoking, N (%)						< 0.0001
Never	6381(56.4)	1764(63.7)	1552(56.0)	1573(53.7)	1492(50.8)	
Former	2675(25.2)	452(17.1)	643(24.8)	808(28.8)	772(31.8)	
Now	2155(18.4)	596(19.2)	524(19.2)	540(17.4)	495(17.4)	
Physical activity, N (%)						< 0.0001
No	5407(43.2)	970(28.6)	1229(39.7)	1510(49.8)	1698(57.9)	
Yes	5804(56.8)	1842(71.4)	1490(60.3)	1411(50.2)	1061(42.1)	
Diabetes Mellitus, N (%)						< 0.0001
No	9155(85.9)	2705(97.3)	2356(90.8)	2318(83.5)	1776(68.8)	
Yes	2056(14.1)	107(2.7)	363(9.2)	603(16.5)	983(31.2)	
Hypertension, N (%)						< 0.0001
No	6489(62.0)	2275(83.7)	1698(65.1)	1492(53.5)	1024(41.1)	
Yes	4722(38.0)	537(16.3)	1021(34.9)	1429(46.5)	1735(58.9)	
Hyperlipidemia, N (%)						< 0.0001
No	3542(31.2)	1550(53.6)	827(29.0)	656(20.5)	509(17.9)	
Yes	7669(68.8)	1262(46.4)	1892(71.0)	2265(79.5)	2250(82.1)	

For statistical differences among quartiles of SADHtR, continuous variables were presented as mean ± standard error (SE) or medians with interquartile range (IQR) and compared using one-way ANOVA or Kruskal-Whallis H test, while categorical variables were presented as weighted percentages and compared using the chi-square test.
Abbreviation: SADHtR, sagittal abdominal diameter to height ratio; NHANES, National Health and Nutrition Examination Survey; Q, quartile; SE: standard error.

remained positively associated with the odds of ASCVD (OR 1.48, 95 % CI 1.36–1.62 in model 1; OR 1.41, 95 % CI 1.28–1.54 in model 2; OR 1.18, 95 % CI 1.08–1.30 in model 3). In addition, in comparison to the first quartile of SADHtR, higher odds of ASCVD were observed in the second, third, and fourth quartiles. In model 1, the ORs and 95 % (CIs) were 1.38 (1.02, 1.85), 1.73 (1.31, 2.27), and 2.93 (2.29, 3.76), respectively, with a significant trend ($p < 0.0001$). Model 2 showed similar findings, with ORs and 95 % CIs of 1.40 (1.02, 1.92), 1.66 (1.23, 2.25), and 2.59 (1.98, 3.40) and a significant trend ($p < 0.0001$). In model 3, the second to fourth quartiles of SADHtR had ORs and 95 % CIs of 1.10 (0.78, 1.55), 1.19 (0.85, 1.66), and 1.58 (1.17, 2.15), respectively, compared to the first quartile, with a significant trend ($p < 0.001$). Detailed results can be found in Table 2.

3.3. Associations between SADHtR and ASCVD among different subgroups

SADHtR (per SD increase) demonstrated an association with a higher risk of ASCVD across two age groups, with ORs and 95 % CIs of 0.92 (0.53, 1.61), 1.25 (1.06, 1.48), and 1.09 (0.93, 1.26) for the (20–39), (40–59), and (≥60) age groups, respectively, with no significant interaction effect ($p = 0.24$). Both male and female groups also showed higher odds of ASCVD with SADHtR (per SD increase), with ORs and 95 % CIs of 1.23 (1.04, 1.46) and 1.13 (0.96, 1.34), respectively, with no significant interaction effect ($p = 0.76$). In individuals with diabetes, each SD increase in SADHtR was associated with a 22 % higher risk of ASCVD (OR and 95 % CI: 1.22 [1.01, 1.47]), whereas the association was weaker in those without diabetes (OR and 95 % CI: 1.17 [1.01, 1.36]), with no significant interaction ($p = 0.51$). Similarly, in individuals without hypertension, each SD increase in SADHtR was associated with a 30 % higher risk of ASCVD (OR and 95 % CI: 1.30 [1.05, 1.60]), while the association was weaker in those with hypertension (OR and 95 % CI: 1.15 [1.02, 1.29]), with no significant interaction effect ($p = 0.18$). Further details are presented in Fig. 2.

4. Discussion

Our study revealed a significant positive correlation between SADHtR and ASCVD risk in the general population of U.S. adults. This association persisted even after comprehensive adjustment for covariates. Furthermore, the positive association remained consistent across various subgroups, including age, sex, diabetes mellitus, and hypertension.

A previous cohort study (Rådholm et al., 2017), consisting of 635 type 2 diabetes patients without prior myocardial infarction or stroke, reported findings consistent with our study. Over a mean follow-up period of 7.1 years, the study demonstrated that after adjusting for covariates, SAD > 25 cm remained the sole anthropometric measurement associated with major cardiovascular events (hazard ratio 2.81, 95 %CI 1.37–5.76, $p = 0.005$), surpassing WC and BMI. In our investigation, we also observed a significant association between SAD and adverse ASCVD events. However, we utilized SADHtR as the independent variable, which is potentially more informative in predicting ASCVD compared to SAD alone. Additionally, our study encompassed the general population rather than focusing solely on individuals with diabetes. Notably, subgroup analysis revealed no significant interaction among groups based on diabetes mellitus (yes or no).

As a metabolic disorder is associated with ASCVD, several studies have explored the link between SAD and cardiometabolic components. For instance, a cross-sectional study of 1,214 adolescents aged 12–19 years in the 2011–2016 U.S. NHANES revealed that SAD was positively linked to elevated blood pressure, triglycerides, fasting blood glucose, and lower high-density lipoprotein levels after adjusting for covariates (Gaston et al., 2019). Another cross-sectional study of 3,071 non-diabetic adults between 20 and 64 years old in the 2011–2012 U.S. NHANES reported that SADHtR exhibited better diagnostic accuracy for cardiometabolic disorders than BMI after adjusting for covariates (Kahn and Bullard, 2016). Our study utilized the U.S. NHANES dataset as well. However, we included a larger population and performed more comprehensive adjustments for covariates. Moreover, we found a positive association between SADHtR and ASCVD independent of metabolic disorders, which may hold significant clinical implications beyond those observed in the aforementioned studies.

Furthermore, some different results were identified in previous studies. For instance, a cohort study encompassing 1,751 men and 1,990 women aged 60 years, initially free of CVD, observed 375 incident cases of CVD during an 11-year follow-up period (Carlsson et al., 2013). In male participants, SAD and SADHtR demonstrated a significant association with an elevated risk of CVD. However, after adjusting for CVD risk factors, these associations lost statistical significance among female participants. Our study, comprising a larger and more diverse age range (20–80 years), revealed no significant difference in the odds ratio (OR) for the association between SADHtR and ASCVD among males and females (p for interaction = 0.76). Similarly, another cohort study examined 111 male bridge and tunnel workers from New York City who were free of ischemic CVD at baseline (Ehrlich and Smith, 2011). After a 12-year follow-up, the univariate analysis indicated a positive association between the abdominal diameter index (ADI), calculated as the supine SAD divided by thigh circumference, and incident ischemic CVD. However, controlling for other cardiovascular risk factors rendered ADI statistically insignificant (RR = 4.37, P = 0.063). In contrast, our study employed SADHtR instead of ADI and included both male and female participants. Notably, the positive association between SADHtR and ASCVD persisted even after adjusting for covariates. Furthermore, our study boasted a substantially larger sample size.

Our study has several strengths. Firstly, SADHtR is a more practical clinical measurement compared to DXA, CT, or MRI. Secondly, our large sample size, weighted according to NHANES methodology, ensures that

Table 2
Association between SADHtR and ASCVD in logistics regression models in adults from NHANES 2011–2016.

Variable	Model 1		Model 2		Model 3	
	OR (95 %CI)	*P* value	OR (95 %CI)	*P* value	OR (95 %CI)	*P* value
SADHtR (per SD increase)	1.48(1.36,1.62)	<0.0001	1.41(1.28,1.54)	<0.0001	1.18(1.08,1.30)	0.001
SADHtR quartiles						
Q1(0.075–0.117)	Ref (1)		Ref (1)		Ref (1)	
Q2(0.117–0.134)	1.38(1.02,1.85)	0.04	1.40(1.02,1.92)	0.04	1.10(0.78,1.55)	0.58
Q3(0.134–0.155)	1.73(1.31,2.27)	<0.001	1.66(1.23,2.25)	0.002	1.19(0.85,1.66)	0.30
Q4(0.155–0.250)	2.93(2.29,3.76)	<0.0001	2.59(1.98,3.40)	<0.0001	1.58(1.17,2.15)	0.004
P for trend		<0.0001		<0.0001		<0.001

Model 1: adjusted for age, sex, and ethnicity.
Model 2: adjusted for model 1 + education, poverty-income ratio, smoking, drinking, and physical activity.
Model 3: adjusted for model 2 + hypertension, diabetes mellitus, and hyperlipidemia.
Abbreviation: SADHtR, sagittal abdominal diameter to height ratio; ASCVD, arteriosclerotic cardiovascular disease; SD, standard deviation; Q, quartile; OR, odds ratio; CI, confidence interval; Ref, reference; NHANES, National Health and Nutrition Examination Survey.

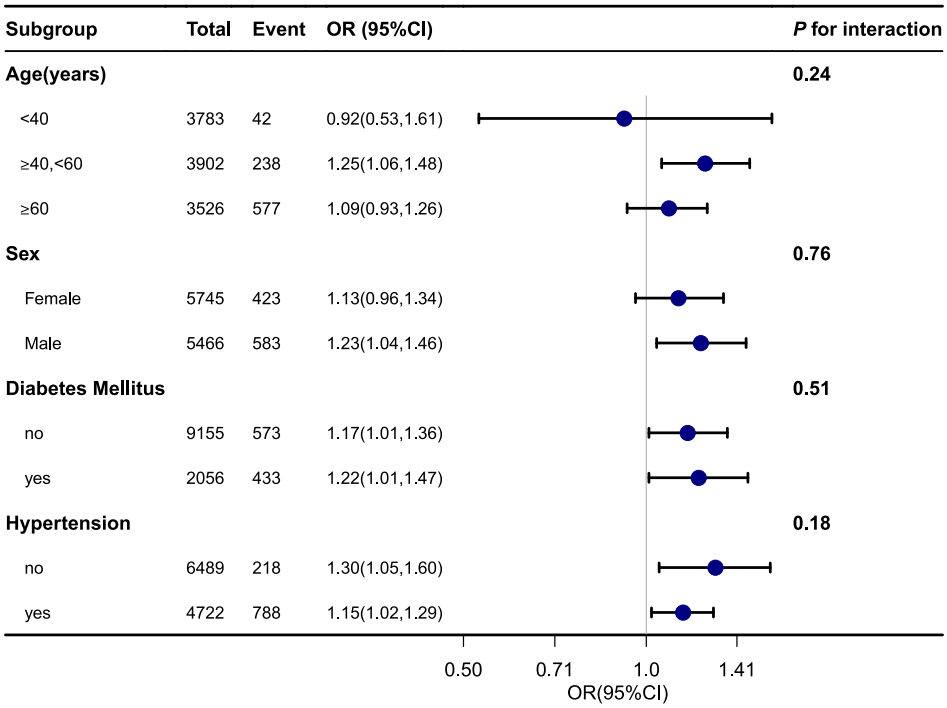

Fig. 2. Subgroup analyses between the SADHtR (per SD increase) and ASCVD in adults from NHANES 2011–2016. Each stratification was adjusted for age, sex, ethnicity, educational level, poverty-income ratio, smoking, drinking, physical activity, diabetes, hypertension, and hyperlipidemia, excluding the stratification factor itself. Abbreviation: NHANES, National Health and Nutrition Examination Surveys; SADHtR, sagittal abdominal diameter-to-height ratio; ASCVD, Arteriosclerotic cardiovascular disease; SD, standard deviation; OR, odds ratio; CI, confidence interval.

our results are representative of the general U.S. adult population. Thirdly, we bolstered the robustness of our results through the use of multivariable-adjusted models and subgroup analyses.

However, our study also has limitations. Firstly, as a cross-sectional study, we cannot establish a causal relationship between SADHtR and ASCVD. Given the design of the NHANES dataset, conducting a cohort study was not feasible. Secondly, ASCVD was determined based on questionnaire surveys, as NHANES participants did not undergo coronary angiography. Thirdly, potential unknown confounders may be present in the study. Nonetheless, we addressed this issue through adjustment with multivariable models, and suggest that future Randomized Controlled Trials may offer a resolution.

5. Conclusions

Our study revealed a significant, independent positive association between SADHtR and ASCVD in the U.S. adult population, even after adjusting for other cardiometabolic risk factors such as hypertension and diabetes mellitus. These findings highlight the potential clinical utility of regularly measuring SADHtR in patients, as it is both easy to measure and cost-effective. Identification of individuals with elevated SADHtR, particularly when $\geq$ 0.155, may facilitate the timely implementation of preventative and intervention measures, ultimately reducing the burden of ASCVD.

6. Consent to participate

Informed consent was obtained from all individual participants included in the study.

Ethics approval

Approval was obtained from the NCHS Research Ethics Review Board. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

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CRediT authorship contribution statement

Xi Gu: Writing – original draft, Visualization, Validation, Methodology, Formal analysis, Data curation, Conceptualization. **Dou Tang:** Software, Data curation. **Yan Xuan:** Data curation. **Ying Shen:** Supervision. **Leiqun Lu:** Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The datasets generated during and analyzed during the current study are available in the NHANES repository, https://www. cdc.gov/nchs/nhanes/.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2024.102707.

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