

ORIGINAL RESEARCH

Depression and Anxiety Are Associated With Cardiovascular Health in Young Adults

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BACKGROUND: Cardiovascular health (CVH) declines in young adulthood, and mood disorders commonly emerge during this life stage. This study examined the association between depression, anxiety, and CVH metrics among young adults.

METHODS AND RESULTS: We conducted a cross-sectional analysis of participants aged 18 to 34 years who completed the Emory Healthy Aging Study Health History Questionnaire (n=875). We classified participants as having poor, intermediate, or ideal levels of the 8 CVH metrics using definitions set forth by the American Heart Association with adaptations when necessary. We defined depression and anxiety as absent, mild, or moderate to severe using standard cutoffs for Patient Health Questionnaire and General Anxiety Disorder scales. We used multivariable regression to examine the association between depression and anxiety and CVH, adjusting for age, sex, race and ethnicity, income, and education. The mean participant age was 28.3 years, and the majority identified as women (724; 82.7%); 129 (14.7%) participants had moderate to severe anxiety, and 128 (14.6%) participants had moderate to severe depression. Compared with those without anxiety, participants with moderate to severe anxiety were less likely to meet ideal levels of physical activity (adjusted prevalence ratio [aPR], 0.60 [95% CI, 0.44–0.82]), smoking (aPR, 0.90 [95% CI, 0.82–0.99]), and body mass index (aPR, 0.79 [95% CI, 0.66–0.95]). Participants with moderate to severe depression were less likely than those without depression to meet ideal levels of physical activity (aPR, 0.48 [95% CI, 0.34–0.69]), body mass index (aPR, 0.75 [95% CI, 0.61–0.91]), sleep (aPR, 0.79 [95% CI, 0.66–0.94]), and blood pressure (aPR, 0.92 [95% CI, 0.86–0.99]).

CONCLUSIONS: Anxiety and depression are associated with less ideal CVH in young adults. Interventions targeting CVH behaviors such as physical activity, diet, and sleep may improve both mood and CVH.

Key Words: anxiety ■ cardiovascular health ■ depression ■ young adults

Cardiovascular disease (CVD) remains the leading cause of mortality in the United States, accounting for 874 613 CVD deaths in 2019.¹ Prevention of CVD requires maintaining a healthy lifestyle and preventing or controlling CVD risk factors. In 2010, the American Heart Association (AHA) defined the concept of ideal cardiovascular health (CVH),² consisting of 3 health behaviors (diet, physical activity, and smoking) and 4 health factors (blood pressure, blood glucose, cholesterol, and body mass index [BMI]), which can be categorized as poor, intermediate, or ideal. Extensive research has shown that

adults with a higher number of ideal CVH metrics have a better quality of life,³ more years lived free of cardiovascular disease,⁴ lower cardiovascular disease incidence,⁵ and lower cardiovascular^{6–7} and total mortality.^{7,8} In 2022, the AHA updated the CVH construct, adding sleep as a CVH metric and acknowledging psychological health as foundational to cardiovascular health.⁹

Unfortunately, data from the National Health and Nutrition Examination Survey show a progressive decline in the prevalence of ideal CVH metrics in the United States with age.¹ Analyses from 5 prospective

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CLINICAL PERSPECTIVE

What Is New?

- Young adults with symptoms of depression are less likely than those without depression to meet recommended levels of physical activity and sleep and to have a healthy body mass index and blood pressure; similar results are seen for young adults with anxiety, which is also associated with smoking.

What Are the Clinical Implications?

- Cardiologists and other health professionals caring for young adults should consider administering standard screening tools for depression and anxiety and emphasizing the importance of physical activity, nutrition, and sleep for improving both mood disorders and cardiovascular health.

Nonstandard Abbreviations and Acronyms

AHA	American Heart Association
aPR	adjusted prevalence ratio
CVH	cardiovascular health
EHAS	Emory Healthy Aging Study
GAD-7	Generalized Anxiety Disorder-7
HHQ	Health History Questionnaire
PHQ-8	Patient Health Questionnaire-8

childhood cohort studies confirm that late adolescence is a common inflection point for CVH decline, and this decline is associated with subclinical CVD as measured by increased carotid intima media thickness.¹⁰ These findings point to the value of identifying factors associated with the loss or the preservation of CVH during young adulthood.¹¹ One possible factor contributing to decline in CVH is the mental health of young adults, as anxiety and depression commonly emerge during this life stage.^{12,13} Prior research among older adults confirms a relationship between these mental health factors and CVH. A 2022 systematic review of data from over 100 000 participants in 8 cross-sectional and 3 prospective studies found substantial evidence for the relationship between depressive symptoms and CVH.¹⁴ Both anxiety and depression were associated with poor CVH in a cross-sectional study of 13 743 adults ages 35 to 74 years in the ELSA-Brasil (Brazilian Longitudinal Study of Adult Health) study.¹⁵ Anxiety at ages 18 to 20 years was also associated with incident CVD later in life in a study of 49 321 Swedish men,¹⁶

and depression is a known risk factor for CVD and all-cause mortality.¹⁷

Notably, the mean age reported by the 2022 systematic review ranged from 42 to 65 years, suggesting that young adults remain an understudied population for this phenomenon despite the high incidence of mood disorders in this age group and the importance of CVH in this life stage. Most studies report the strongest relationships between mental health conditions and the CVH behaviors (physical activity, diet, and smoking), as well as body mass index (BMI), but did not always include sleep consistent with the earlier AHA definition of CVH. In the present study, we aimed to examine the association between both depression and anxiety and the 8 CVH metrics in young adults aged 18 to 34 using data from the EHAS (Emory Healthy Aging Study), a large cohort study of US adults. We assessed mild or moderate to severe depression and anxiety, and their relationship with each CVH metric, as well as total CVH.

METHODS

Study Population

The EHAS is a prospective cohort study that aims to characterize factors associated with aging.¹⁸ The study includes English-speaking US adults aged ≥18 years. Participants were recruited from Emory Healthcare clinical practices as well as online. Self-reported demographic and health-related data were collected at baseline using the Health History Questionnaire (HHQ). For the current study, we used cross-sectional HHQ data only from EHAS participants ages 18 to 34 years who completed the survey between 2015 and 2019 and did not report a history of coronary heart disease, congestive heart failure, heart attack, or stroke (n=929). We excluded 54 participants missing data on any of the independent or dependent variables for a final sample size of 875. The EHAS was approved by the Emory University Institutional Review Board, and all participants provided informed consent at the time of study enrollment. The data that support the findings of this study are available from the author M. Marcus upon reasonable request.

Cardiovascular Health Metrics

Using AHA 2010 cardiovascular health definitions, with minor adaptations based on data collected in the EHAS as noted below and summarized in Table S1, we classified participants as having poor, intermediate, or ideal levels of the original 7 cardiovascular health metrics. We also included sleep, the newest AHA CVH metric in the 2022 update,⁹ but were unable to use the updated 2022 definitions and scoring system because of limitations of the EHAS data set. Each participant

received 0 (poor), 1 (intermediate), or 2 (ideal) points for each cardiovascular health metric. We summed the scores for all metrics except sleep to create a total CVH score ranging from 0 to 14 for each participant, consistent with the AHA 2010 CVH definitions. We then classified this total CVH score as low (0–7), moderate (8–11), or high (12–14) on the basis of previous studies in adults demonstrating a graded relationship between these classifications and subclinical atherosclerosis.¹⁹ Participants who reported a history of coronary heart disease, congestive heart failure, heart attack, or stroke were excluded.

We classified participants as having poor, intermediate, or ideal smoking status based on whether they were current smokers, former smokers, or had never smoked, respectively. The HHQ asked participants how often they usually engage in mild, moderate, or strenuous exercise each week. We classified those who answered “none” as having poor physical activity, those who reported getting less than 75 minutes of moderate/strenuous and <150 minutes of mild physical activity as intermediate, and those who reported getting at least 75 minutes of moderate/strenuous or at least 150 minutes of mild physical activity as having ideal physical activity. To construct participants’ diet metric, we used 5 diet questions asked in the HHQ. Participants received 1 point each if they ate >4 servings of fruit or vegetables in a day, ate at least 6 servings of whole grain in a week, ate >2 servings of fish in a week, or drank <3 beverages with added sugar in a week. Participants also earned 1 point for reporting that they avoided eating prepackaged and processed foods, sought lower sodium options when eating out, and avoided salt when cooking at home. After totaling up all diet points, we classified participants who received a dietary score of 0 to 1 as having poor diet, and those who received a score of 2 to 3 points or 4 to 5 points as having intermediate or ideal diet, respectively.

We used participants’ self-reported height and weight to create a BMI variable as kg/m². We classified participants with a BMI >30 mg/kg² as having poor BMI, those with a BMI between 25 and 30 mg/kg² as having intermediate BMI, and those with a BMI <25 mg/kg² as having ideal BMI. Participants who reported that they had never been diagnosed with high blood pressure, high cholesterol, or diabetes were classified as having ideal levels of each of these metrics. Those who reported having high blood pressure, high cholesterol, or diabetes and currently taking medication for each were classified as having intermediate levels of each metric, while those who reported having either condition without taking medication were classified as having poor levels of each metric. We calculated participants’ average nightly sleep duration based on their self-reported typical sleep time and wake time.

We classified participants as having ideal sleep if they reported 7 to <9 hours of sleep, as intermediate if they reported sleeping 6 to <7 or 9 to <10 hours, and as poor if they reported sleeping >10 hours or <6 hours of sleep per night.

Mental Health Factors

The HHQ assessed participants for depression using the Patient Health Questionnaire-8 (PHQ-8). We then classified participants as having no depression if the PHQ-8 score was 0 to 4, mild depression if the PHQ-8 score was 5 to 9, or moderate to severe depression if the PHQ-8 score was ≥10. The HHQ also assessed participants for anxiety using the Generalized Anxiety Disorder-7 (GAD-7) questionnaire. We then classified participants as having no anxiety if the GAD-7 score was 0 to 4, mild anxiety if the GAD-7 score was 5 to 9, or moderate to severe anxiety if the GAD-7 score was ≥10. We classified participants as having both anxiety and depression if they had a PHQ-8 score of ≥5 and a GAD-7 score of ≥5.

Covariates

The HHQ asked participants to self-report their age, sex assigned at birth, race, and whether they were of Hispanic/Latino ethnicity. If participants reported Hispanic/Latino ethnicity, we assigned them to the “Hispanic” ethnic category, regardless of which race they selected, consistent with National Institutes of Health reporting guidelines. Otherwise, we assigned participants to the racial category they selected. Participants reported total household income from all sources before taxes and deductions during the past 12 months. Participants’ self-reported the total income of their household from all sources before taxes and deductions during the past 12 months as belonging to 1 of 8 levels, which we combined as <\$50 000, >\$50 000 but <\$100 000, and ≥\$100 000 to allow for approximately equal distribution among income groups. Participants also reported the highest level of education completed, which we categorized as less than college, a college degree, or graduate/professional schooling.

Statistical Analysis

We report demographic characteristics using descriptive statistics such as counts and proportions or means and SDs. We also report the prevalence of poor, intermediate, or ideal levels of each cardiovascular health metric. We used logistic regression to examine the prevalence ratio of meeting ideal levels of each of the 8 cardiovascular health metrics by presence of mild or moderate to severe anxiety relative to no anxiety and by presence of mild or moderate to severe depression relative to no depression, as well as the presence

of both any anxiety and any depression relative to no anxiety or depression. We used linear regression to examine the association between the total cardiovascular health score and the presence of mild or moderate to severe anxiety relative to no anxiety and by presence of mild or moderate to severe depression relative to no depression, as well as the presence of both any anxiety and any depression relative to no anxiety or depression. Consistent with prior studies, we decided a priori to adjust all models for age, sex, education, income, and race or ethnicity. We attempted to formally assess for effect measure modification between sex and anxiety/depression and ideal CVH, but models did not converge because of the limited number of men in the sample; thus, we report results for the full sample and include a sensitivity analysis for men only. All analyses were performed using SAS 9.4 (SAS Institute, Cary, NC).

RESULTS

Among 875 included participants, the mean age was 28.3 years. The majority of participants identified as women (724; 82.7%) and non-Hispanic White (613; 71%). Sixty-two percent of participants had no anxiety, while 23% and 14.7% had mild and moderate to severe anxiety, respectively. Similarly, 61% of participants had no depression, while 24.8% and 14.6% had mild and moderate to severe depression, respectively. While 49.6% of the same had neither anxiety nor depression, 26.7% had both anxiety and depression. See [Table 1](#) for a description of the study population.

The mean CVH score was 10.4, which was higher in women (10.5) compared with men (9.9). The majority (487; 55.7%) of participants had overall moderate CVH scores of 8 to 11. Less than 3% of the cohort met criteria for ideal diet; 43.1% had ideal physical activity patterns, 69.7% had ideal sleep duration, and 84.6% had ideal (non) smoking status. Sixty-one percent had ideal BMI, 90% had ideal cholesterol, 93.3% had ideal blood pressure, and 98.4% had ideal diabetes status ([Table 2](#)).

Compared with those with no anxiety, participants with moderate to severe anxiety were less likely to meet ideal levels of physical activity (adjusted prevalence ratio [aPR], 0.60 [95% CI, 0.44–0.82]), smoking (aPR, 0.90 [95% CI, 0.82–0.99]), and BMI (aPR, 0.79 [95% CI, 0.66–0.95]) ([Figure \[A\]](#), [Table S2](#)). Those with mild anxiety were also less likely to have ideal levels for these 3 CVH metrics, though these findings were not statistically significant. Compared with those without anxiety, participants with moderate to severe anxiety were also less likely to have high total CVH (aPR, 0.80 [95% CI, 0.70–0.96]). The total CVH score was 0.31 points lower in participants with mild anxiety (95% CI, –0.59 to –0.04) and 0.82 points lower in participants

Table 1. Characteristics of 875 Young Adults Participating in the Emory Health Aging Study, 2015 to 2019

Characteristic	n (%)
Age (mean and SD)	28.3 (4.1)
Sex	
Male	151 (17.3)
Female	724 (82.7)
Race or ethnicity	
Non-Hispanic White	613 (70.1)
Non-Hispanic Black	108 (12.3)
Hispanic	52 (5.9)
Other	102 (11.7)
Education level	
Less than college	162 (18.6)
Bachelor's degree	330 (37.8)
Graduate or professional degree	381 (43.6)
Income	
≤\$49 999	256 (29.7)
\$50 000 to \$99 999	292 (33.9)
≥\$100 000	314 (36.4)
Anxiety	
None	545 (62.3)
Mild	201 (23.0)
Moderate to severe	129 (14.7)
Depression	
None	530 (60.6)
Mild	217 (24.8)
Moderate to severe	128 (14.6)
Neither anxiety nor depression	434 (49.6)
Either anxiety or depression	207 (23.7)
Both anxiety and depression	234 (26.7)

with moderate-to-severe anxiety (95% CI, –1.15 to –0.49). Results were no longer significant when the sample was restricted to men only in the sensitivity analysis.

Compared with those with no depression, participants with moderate to severe depression were less likely to meet ideal levels of physical activity (aPR, 0.48 [95% CI, 0.34–0.69]), blood pressure (aPR, 0.92 [95% CI, 0.86–0.99]), BMI (aPR, 0.75 [95% CI, 0.61–0.91]), and sleep (aPR, 0.79 [95% CI, 0.66–0.94]) ([Figure \[B\]](#), [Table S2](#)). Participants with mild depression were also less likely to meet ideal levels of cholesterol (aPR, 0.91 [95% CI, 0.86–0.97]), physical activity (aPR, 0.69 [95% CI, 0.71–0.85]) and BMI (aPR, 0.81 [95% CI, 0.71–0.93]). Compared with those without depression, participants with moderate to severe depression were also less likely to have high total CVH (aPR, 0.65 [95% CI, 0.49–0.86]). The total CVH score was 0.62 points lower in participants with mild depression (95% CI, –0.89, –0.36) and 1.13 points lower in participants with moderate-to-severe depression (95% CI: –1.47 to

Table 2. Prevalence of Meeting Poor, Intermediate, or Ideal Levels of Each of the 8 Cardiovascular Health Metrics by Presence of Depression or Anxiety in 875 Young Adults Participating in the Emory Health Aging Study, 2015 to 2019

Characteristic	Overall, n (%)	Depression, n (%)			Anxiety, n (%)			Neither anxiety nor depression, n (%)			Either anxiety or depression, n (%)	Both anxiety and depression, n (%)
		None	Mild	Moderate-severe	None	Mild	Moderate-severe	None	Mild	Moderate-severe		
Sleep												
Poor	90 (10.3)	47 (8.6)	20 (10.0)	23 (17.8)	47 (8.9)	17 (7.8)	26 (20.3)	37 (8.5)		20 (9.7)	33 (14.1)	
Intermediate	175 (20.0)	112 (20.6)	31 (15.5)	32 (24.8)	93 (17.6)	48 (22.1)	34 (26.6)	80 (18.4)		45 (21.7)	50 (21.4)	
Ideal	609 (69.7)	386 (70.8)	149 (74.5)	74 (57.4)	389 (73.5)	152 (70.1)	68 (53.1)	317 (73.0)		141 (68.1)	151 (64.5)	
Diet												
Poor	514 (58.7)	321 (58.9)	117 (58.2)	76 (58.9)	311 (58.7)	120 (55.3)	83 (64.8)	256 (59.0)		120 (58.0)	138 (59.0)	
Intermediate	336 (38.4)	208 (38.2)	79 (39.3)	49 (38.0)	204 (38.5)	89 (41.0)	43 (33.6)	164 (37.8)		84 (40.6)	88 (37.6)	
Ideal	25 (2.9)	16 (2.9)	5 (2.5)	4 (3.10)	15 (2.8)	8 (3.7)	2 (1.6)	14 (3.2)		3 (1.4)	8 (3.4)	
Physical activity												
Poor	166 (19.0)	80 (14.7)	43 (21.4)	43 (33.3)	67 (12.6)	56 (25.8)	43 (33.6)	49 (11.3)		49 (23.7)	68 (29.1)	
Intermediate	332 (37.9)	203 (37.3)	76 (37.8)	53 (41.1)	190 (35.9)	85 (39.2)	57 (44.5)	161 (37.1)		71 (34.3)	100 (42.7)	
Ideal	377 (43.1)	262 (48.1)	82 (40.8)	33 (25.6)	273 (51.5)	76 (35.0)	28 (21.9)	224 (51.6)		87 (42.0)	66 (28.2)	
Smoking												
Poor	40 (4.6)	14 (2.6)	9 (4.5)	17 (13.2)	10 (1.9)	11 (5.1)	19 (14.8)	7 (1.6)		10 (4.8)	23 (9.8)	
Intermediate	95 (10.9)	51 (9.4)	27 (13.4)	17 (13.2)	54 (10.2)	21 (9.7)	20 (15.6)	38 (8.8)		29 (14.0)	28 (12.0)	
Ideal	740 (84.6)	480 (88.1)	165 (82.1)	95 (73.6)	466 (87.9)	185 (85.3)	89 (69.5)	389 (89.6)		168 (81.2)	183 (78.2)	
Body mass index												
Poor	148 (16.9)	76 (13.9)	35 (17.4)	37 (28.7)	63 (11.9)	42 (19.4)	43 (33.6)	50 (11.5)		39 (18.8)	59 (25.2)	
Intermediate	196 (22.4)	120 (22.0)	47 (23.4)	29 (22.5)	112 (21.1)	57 (26.3)	27 (21.1)	90 (20.7)		52 (25.1)	54 (23.1)	
Ideal	531 (60.7)	349 (64.0)	119 (59.2)	63 (48.8)	355 (67.0)	118 (54.4)	58 (45.3)	294 (67.7)		116 (56.0)	121 (51.7)	
Cholesterol												
Poor	83 (9.5)	44 (8.1)	23 (11.4)	16 (12.4)	38 (7.2)	30 (13.8)	15 (11.7)	29 (6.7)		24 (11.6)	30 (12.8)	
Intermediate	4 (0.5)	2 (0.4)	1 (0.5)	1 (0.8)	1 (0.2)	1 (0.5)	2 (1.6)	1 (0.2)		1 (0.5)	2 (0.9)	
Ideal	788 (90.0)	499 (91.6)	177 (88.1)	112 (86.8)	491 (92.6)	186 (85.7)	111 (86.7)	404 (93.1)		182 (87.9)	202 (86.3)	
Blood pressure												
Poor	41 (4.7)	21 (3.9)	9 (4.5)	11 (8.5)	16 (3.0)	11 (5.1)	14 (10.9)	14 (3.2)		9 (4.4)	18 (7.7)	
Intermediate	18 (2.1)	12 (2.2)	3 (1.5)	3 (2.3)	10 (1.9)	3 (1.4)	5 (3.9)	9 (2.1)		4 (1.9)	5 (2.1)	
Ideal	816 (93.3)	512 (93.9)	189 (94.0)	115 (89.2)	504 (95.1)	203 (93.6)	109 (85.2)	411 (94.7)		194 (93.7)	211 (90.2)	
Diabetes												
Poor	3 (0.3)	2 (0.4)	0 (0.0)	1 (0.8)	1 (0.2)	2 (0.9)	0 (0.0)	1 (0.2)		1 (0.5)	1 (0.4)	
Intermediate	11 (1.3)	5 (0.9)	4 (2.0)	2 (1.6)	4 (0.8)	1 (0.5)	6 (4.7)	4 (0.9)		1 (0.5)	6 (2.6)	
Ideal	861 (98.4)	538 (0.9)	197 (98.0)	126 (97.7)	525 (99.1)	214 (98.6)	122 (95.3)	429 (98.9)		205 (99.0)	227 (97.0)	
Overall CVH score*												
Low (0-7)	61 (7.0)	30 (5.5)	11 (5.5)	20 (15.5)	22 (4.2)	15 (6.9)	24 (18.8)	17 (3.9)		18 (8.7)	26 (11.1)	
Moderate (8-11)	487 (55.7)	283 (51.9)	124 (61.7)	80 (62.0)	270 (50.9)	133 (61.3)	84 (65.6)	215 (49.5)		123 (59.4)	149 (63.7)	
High (12-14)	327 (37.4)	232 (42.6)	66 (32.8)	29 (22.5)	238 (44.9)	69 (31.8)	20 (15.6)	202 (46.5)		66 (31.9)	59 (25.2)	

*The overall cardiovascular health (CVH) score excludes the sleep metric because of differences in scoring from the 2010 and 2022 American Heart Association CVH construct.

−0.79). In the sensitivity analysis, men with moderate to severe depression were less likely to meet ideal levels of physical activity (aPR, 0.42 [95% CI, 0.19–0.95]).

Participants with both anxiety and depression were less likely to have ideal cholesterol (aPR, 0.96 [95% CI, 0.93–0.99]), ideal physical activity (aPR, 0.76 [95% CI, 0.68–0.86]), and ideal BMI (aPR, 0.89 [95% CI, 0.83–0.95]), and were less likely to have high total CVH (aPR, 0.84 [95% CI, 0.75–0.95]) compared with those without anxiety or depression. Participants with both anxiety and depression also had total CVH scores that were 0.84 points lower than those with neither anxiety nor depression (95% CI, −1.12 to −0.57).

DISCUSSION

In this study of 875 young adults aged 18 to 34 years participating in the EHAS, we found that anxiety and depression were associated with several of the cardiovascular health metrics. The strongest associations were found with physical activity and BMI; individuals with either anxiety or depression or both were less likely to meet the ideal state for these 2 metrics. In addition, those with anxiety were less likely to be non-smokers, while depression was associated with being less likely to meet the ideal cholesterol, blood pressure, and sleep metrics. Both anxiety and depression (alone and in combination) were associated with lower overall total cardiovascular health.

Our results are consistent with other studies that have found strong correlations between these mental health factors and cardiovascular health among older adults. The 2022 systematic review of associations between depressive symptoms and CVH¹⁴ included studies from the United States,^{20–24} Brazil,^{15,25} Finland,²⁶ China,^{27,28} and France.²⁹ The most consistent associations were seen for depressive symptoms and the behavioral CVH factors (smoking, physical activity, and diet) as well as BMI, as seen in our study. Notably, the 3 prospective studies included in this review found that individuals with worsening depression over time were more likely to have lower CVH scores later in life²⁴ and that individuals with higher CVH were less likely to develop depression in future years,^{22,25} suggesting a bi-directional nature to this relationship. While there have been fewer studies of the relationship between anxiety and CVH, our results are consistent with the lower CVH scores found in those with anxiety in cohorts from China²⁸ and Brazil.¹⁵

Mechanisms linking mental health and cardiovascular health are likely multifactorial. Depression is characterized by anhedonia and lack of motivation,¹³ which may limit one's ability to engage in physical activity³⁰ and adhere to a healthy dietary pattern. Individuals with either depression or anxiety may eat less heart-healthy foods or smoke³¹ to cope with their

negative emotional state. Selective serotonin reuptake inhibitors, commonly used to treat both anxiety and depression, can be associated with weight gain and therefore a nonideal BMI.³² Finally, depression, anxiety, and poor cardiovascular health share numerous social and structural determinants of health such as lack of access to high-quality education, unfavorable built environments, poverty, traumatic life experiences, and discrimination.³³

In contrast, there is good evidence that physical activity, healthy dietary patterns, and sleep habits can help prevent and alleviate the symptoms of depression and anxiety. A recent meta-analysis of 49 prospective studies found that physical activity is associated with a reduced incidence of depression across a wide range of populations, including young adults.³⁴ Randomized trials have shown that structured exercise programs can reduce symptoms of both major depression³⁵ and anxiety disorders.³⁶ Healthy dietary patterns including high intakes of fruits, vegetables, fish, and whole grains are associated with a reduced incidence of depression in observational studies.³⁷ Randomized trials show that interventions to promote healthy dietary patterns can be effective for depression and anxiety as well, although findings are more robust for the treatment of depression and among women.³⁸ A recent meta-analysis of 65 randomized controlled trials of interventions to improve sleep demonstrated that improving sleep is associated with improved mental health overall, as well as depression and anxiety specifically.³⁹

Our study has several limitations. Data are from individuals recruited through health care practices and online, and the study population is not representative of the broader United States population. Most individuals identified as women and had relatively high levels of income and educational attainment. The overall CVH score and prevalence of ideal CVH metrics were higher in this study than in general young adults,¹ reflective of these structural assets. Notably, the prevalence of depression and anxiety symptoms at levels consistent with these clinical diagnoses were comparable with young adults.^{12,13} All data were self-reported, and therefore subject to desirability bias and the selection bias and data quality concerns associated with online surveys.

Young adults often do not undergo routine blood pressure, cholesterol, or glucose screening when appropriate despite national guidelines. Many young adults are therefore unaware of having hypertension, hyperlipidemia, or diabetes,⁴⁰ and thus the true prevalence of having ideal levels of these CVH factors may be lower than reported. In contrast, some participants with a history of gestational hypertension or diabetes, or with a general history of hypertension, hyperlipidemia, or diabetes that has resolved with lifestyle changes, may have been inaccurately categorized as

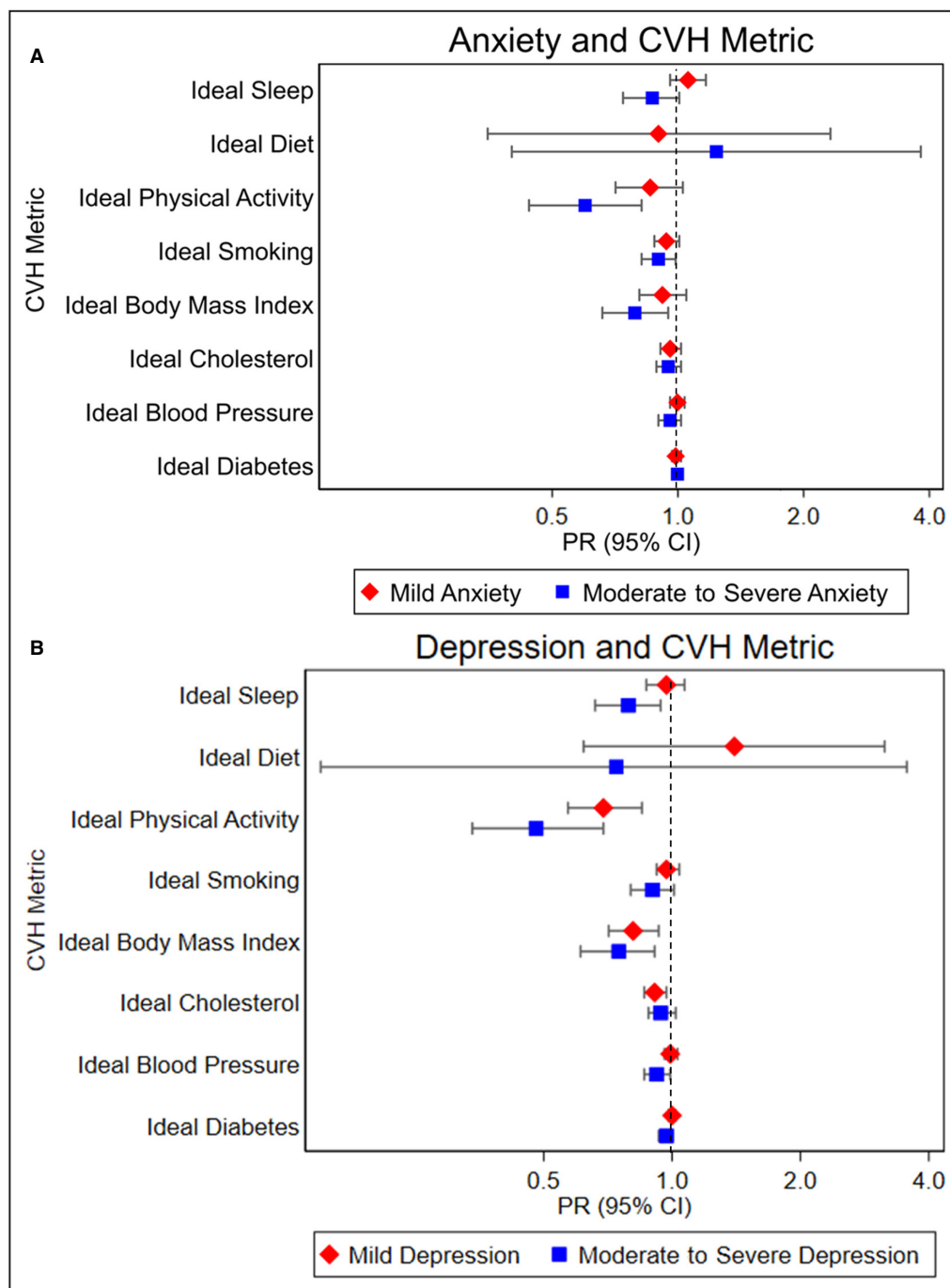


Figure 1. Adjusted prevalence ratios (95% CI) of young adults in the Emory Healthy Aging Study meeting each of the ideal cardiovascular health metrics by presence of any, mild, and moderate to severe anxiety (A) and any, mild, and moderate to severe depression (B).

All models adjusted for age, sex, race and ethnicity, education, and income. Point estimates and 95% CIs are available in Table S2. CVH indicates cardiovascular health; and PR, prevalence ratio.

having poor CVH metrics and thus the true prevalence of ideal levels of these CVH factors may have been higher than reported.

Importantly, data were collected before the onset of the COVID-19 pandemic, during which the incidence of depression and anxiety has risen sharply in this age

group.⁴¹ The prevalence of ideal cardiovascular health is also expected to decline⁴² because of increases in sedentary behavior,⁴³ changes in dietary quality,⁴⁴ and weight gain⁴⁵ associated with public health mitigation measures and the stress of living through a global pandemic. Future research should continue to

investigate the important relationship between mental health and cardiovascular health in response to the pandemic, especially in young adults whose long-term health may experience some of the greatest impact. Finally, our analyses were conducted before the AHA updated the cardiovascular health to “Life’s Essential 8” in June 2022.⁹ While we were able to assess the relationship between mood disorders and sleep duration, we were unable to use the new AHA cardiovascular health scoring because of the self-reported nature of the EHAS data set. The new metric definitions and scoring present cardiovascular health on a continuum and encourage providers and policy makers to use a positive framing to encourage progression toward health. They also stress the importance of psychological health and social determinants to cardiovascular health and overall well-being. Future research should continue to investigate the importance of depression and anxiety to this revised definition of cardiovascular health for young adults in particular.

In summary, depression and anxiety are associated with less ideal cardiovascular health in young adults. Given these findings and the importance of achieving and sustaining cardiovascular health early in life to prevent CVD, we urge providers treating young adults to promote healthy lifestyle behaviors to support both mental and cardiovascular health.

ARTICLE INFORMATION

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Supplemental Material

Tables S1–S2

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SUPPLEMENTAL MATERIAL

Table S1. American Heart Association 2010 Cardiovascular Health Metrics and 2022 Sleep Health Metric as adopted for the Emory Healthy Aging Study cohort

Metric	Level of Cardiovascular Health for Each Metric		
	Poor	Intermediate	Ideal
Tobacco Smoking			
AHA Definition for adults 20y and older	Current smoking	Former <12 months	Never or quit >12 months ago
EHAS Adaptation	---	---	---
Physical Activity			
AHA Definition for adults 20y and older	None	1-149 min/week moderate or 1-74 min/week vigorous or 1-149 min/week moderate + vigorous	150 min/week moderate or 75 min/week vigorous or ≥ 150 min/wk moderate + vigorous
EHAS Adaptation	None	Any activity level that does not meet ideal physical activity levels as defined	2 OR 3 days a week of moderate/strenuous activity for 40 minutes or more; 4 or 5+ days a week of moderate/strenuous activity for 20 minutes or more; 3 days a week of mild exercise for 60 minutes or more; 4 or 5+ days a week of mild exercise for 40 minutes or more
Healthy Diet Pattern, number of components from AHA diet score*			
AHA Definition for adults 20y and older	0-1 components	2-3 components	4-5 components
EHAS Adaptation	---	---	---
Body Mass Index			
AHA Definition for adults 20y and older	≥ 30 kg/m ²	≥ 25 and < 30 kg/m ²	< 25 kg/m ²
EHAS Adaptation	---	---	---
Total Cholesterol, mg/dL			
AHA Definition for adults 20y and older	≥ 240 mg/dL	200-239 mg/dL	< 200 mg/dL
EHAS Adaptation	Reports having high cholesterol and no medication use	Reports having high cholesterol and lipid lowering medication use	Does not report having high cholesterol
Blood Pressure			
AHA Definition for adults 20y and older	\geq SBP 140 or \geq DBP 90 mm Hg	SBP 120-139 or DBP 80-89 mm Hg or treated to goal	SBP < 120 and DBP < 80 mm Hg
EHAS Adaptation	Reports having high blood pressure and no	Reports having high blood pressure and	Does not report having high blood pressure

	anti-hypertension medication use	anti-hypertension medication use	
Fasting Plasma Glucose, mg/dL			
AHA Definition for adults 20y and older	≥126 mg/dL	100-125 mg/dL or treated to goal	<100 mg/dL
EHAS Adaptation	Reports having diabetes and no diabetes medication use	Reports having diabetes and diabetes medication use	Does not report having diabetes
Sleep, average hours per night †			
AHA Definition for adults 20y and older	Points for each range of average sleep hours per night (higher points indicate more optimal sleep): 100: 7–<9 hours; 90: 9–<10 hours; 70: 6–<7 hours; 40: 5–<6 or ≥10 hours; 20: 4–<5 hours; 0: <4 hours		
EHAS Adaptation	≥10 or <6 hours	9–<10 or 6–<7 hours	7–<9 hours
<p>AHA = American Heart Association; EHAS = Emory Healthy Aging Study; SBP = systolic blood pressure; DBP = diastolic blood pressure.</p> <p>*Participants received one point each if they ate a) more than four servings of fruit or vegetables in a day, b) at least six servings of whole grain in a week, c) more than two servings of fish in a week, or d) drank less than three beverages with added sugar in a week. Participants also earned one point for e) reporting that they avoided eating prepackaged and processed foods, sought lower sodium options when eating out, and avoided salt when cooking at home.</p> <p>†The 2022 AHA CVH Metrics are no longer categorized as poor, intermediate, or ideal but are instead presented as a spectrum of 0 to 100 points.</p> <p>--- indicates no adaptation needed</p>			

Table S2. Adjusted Prevalence Ratios (95% CI) of young adults in the Emory Healthy Aging Study meeting ideal levels of each of the cardiovascular health metrics by presence of any, mild, and moderate-to-severe anxiety; any, mild, and moderate-to-severe depression; and both anxiety and depression.

Cardiovascular Health Metric	Prevalence Ratio	Lower 95%CI	Upper 95% CI
Ideal Sleep			
No Anxiety	1.00	--	--
Mild Anxiety	1.06	0.96	1.17
Mod-Sev Anxiety	0.87	0.74	1.01
No Depression	1.00	--	--
Mild Depression	0.97	0.87	1.07
Mod-Sev Depression*	0.79	0.66	0.94
Both Anxiety & Depression	0.94	0.84	1.05
Ideal Diet			
No Anxiety	1.00	--	--
Mild Anxiety	0.90	0.35	2.33
Mod-Sev Anxiety	1.24	0.40	3.84
No Depression	1.00	--	--
Mild Depression	1.40	0.62	3.15
Mod-Sev Depression	0.74	0.15	3.55
Both Anxiety & Depression	1.14	0.74	1.74
Ideal Physical Activity			
No Anxiety	1.00	--	--
Mild Anxiety	0.86	0.71	1.03

Mod-Sev Anxiety*	0.60	0.44	0.82
No Depression	1.00	--	--
Mild Depression*	0.69	0.57	0.85
Mod-Sev Depression*	0.48	0.34	0.69
Both Anxiety & Depression*	0.76	0.68	0.86
Ideal (non)-Smoking			
No Anxiety	1.00	--	--
Mild Anxiety	0.94	0.88	1.01
Mod-Sev Anxiety*	0.90	0.82	0.99
No Depression	1.00	--	--
Mild Depression	0.97	0.92	1.04
Mod-Sev Depression	0.90	0.80	1.01
Both Anxiety & Depression	0.97	0.94	1.00
Ideal Body Mass Index			
No Anxiety	1.00	--	--
Mild Anxiety	0.92	0.81	1.05
Mod-Sev Anxiety*	0.79	0.66	0.95
No Depression	1.00	--	--
Mild Depression*	0.81	0.71	0.93
Mod-Sev Depression*	0.75	0.61	0.91
Both Anxiety & Depression*	0.89	0.83	0.95
Ideal Cholesterol			
No Anxiety	1.00	--	--
Mild Anxiety	0.96	0.91	1.02
Mod-Sev Anxiety	0.95	0.89	1.02

No Depression	1.00	--	--
Mild Depression*	0.91	0.86	0.97
Mod-Sev Depression	0.94	0.88	1.02
Both Anxiety & Depression*	0.96	0.93	0.99
Ideal Blood Pressure			
No Anxiety	1.00	--	--
Mild Anxiety	1.00	0.96	1.04
Mod-Sev Anxiety	0.96	0.90	1.02
No Depression	1.00	--	--
Mild Depression	0.99	0.96	1.03
Mod-Sev Depression*	0.92	0.86	0.99
Both Anxiety & Depression	0.98	0.96	1.01
Ideal Diabetes			
No Anxiety	1.00	--	--
Mild Anxiety	0.99	0.97	1.02
Mod-Sev Anxiety	1.00	0.97	1.02
No Depression	1.00	--	--
Mild Depression	1.00	0.98	1.02
Mod-Sev Depression	0.97	0.93	1.00
Both Anxiety & Depression	0.99	0.98	1.01

All models adjusted for age, sex, race/ethnicity, education, and income.

*Denotes statistical significance