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ORIGINAL RESEARCH

Community-Based Evaluation of the Associations Between Well-Being and Cardiovascular Disease Risk

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BACKGROUND: Although the effects of psychological health and optimism have been extensively investigated, data from community-based cohorts assessing the association between psychological health and cardiovascular disease risk factors are sparse, and the concurrent relationship between subjective well-being and cardiovascular health has not been studied.

METHODS AND RESULTS: The current cross-sectional study examined the association between well-being and cardiovascular risk factors among 719 individuals living in a middle- to low-income neighborhood. After adjusting for age, sex, race, body mass index, education, smoking status, and exercise status, we found that higher levels of well-being were significantly associated with lower odds of dyslipidemia (odds ratio [OR], 0.7 [95% CI, 0.55–0.85]) and hypertension (OR, 0.8 [95% CI, 0.63–0.92]). Greater well-being was also significantly associated with lower triglyceride levels (mean difference [M_{diff}], 7.6 [−14.31 to −0.78]), very low-density lipoprotein (M_{diff}, 0.9 [−1.71 to −0.16]), total cholesterol to high-density lipoprotein ratio (M_{diff}, 3.9 [−6.07 to −1.73]), higher high-density lipoprotein levels (M_{diff}, 1.6 [0.46–2.75]), and lower Framingham Risk Scores (M_{diff}, −7.1% [−10.84% to −3.16%]). Well-being also moderated the association between age and arterial stiffness. The strongest association between arterial stiffness and age was found for those with the lowest well-being scores; there was no association between age and arterial stiffness at high levels of well-being.

CONCLUSIONS: In a community-based cohort, individuals reporting higher levels of well-being have lower odds of hypertension and dyslipidemia as well as lower rates of age-dependent increase in vascular stiffness.

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Key Words: arterial stiffness ■ dyslipidemia ■ hypertension ■ lipids ■ well-being

Psychological well-being is fundamental to health, and an extensive literature suggests a robust association between mental and physical health.[1] Many studies have reported that negative psychological states, such as depression, anxiety, posttraumatic stress disorder, and chronic stress, promote the development of cardiovascular disease (CVD) and are associated with an increased risk of cardiovascular events, suggesting that psychological well-being may be a critical determinant of cardiovascular health.[2–8] However, although depression and anxiety have been shown to be inversely related to psychological well-being, the absence of psychological distress does not necessarily equate to psychological health or well-being.[9,10] Therefore, there is growing interest in studying whether psychological well-being per se is associated with lower CVD risk.

Investigations into the impact of aspects of well-being (eg, optimism, happiness) suggest that psychological well-being is associated with better cardiovascular health. Optimism, in particular, is robustly associated

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CLINICAL PERSPECTIVE

What Is New?

- Although positive psychological states have been found to be conducive for cardiovascular health, the effects of psychological well-being have not been studied.
- Using the Warwick-Edinburgh Mental Well-Being Scale, which captures both hedonic and eudaimonic aspects of well-being, we found that psychological well-being is associated with contemporaneous cardiovascular disease risk factors such as hypertension, dyslipidemia, and vascular stiffness.

What Are the Clinical Implications?

- Evaluation of psychological well-being may provide useful assessment of cardiovascular risk.
- Interventions to improve psychological well-being may be an effective strategy to mitigate the effects of age-related decline in cardiovascular health.

Nonstandard Abbreviations and Acronyms

AIx	aortic augmentation index
HEAL	Health, Environment and Action in Louisville study
WEMWBS	Warwick-Edinburgh Mental Well-Being Scale

with a reduced risk of cardiovascular events,[11] and a recent meta-analysis found that optimism was significantly associated with a 14% lower risk of all-cause mortality and a 35% lower risk of incident CVD events.[12] Similarly, happier nations report systematically lower levels of hypertension, and individuals with greater happiness have a lower risk of incident coronary heart disease.[2,8,13] Using the General Well-Being Schedule, which defines well-being as being less anxious and depressed, free from health concerns, having control over one's emotions, and being satisfied with life, Yanek et al found that those with higher levels of well-being were less likely to develop coronary artery disease, and that these protective effects were even stronger in those with high CVD risk.[14]

Although this research supports the notion that positive psychological states are conducive for cardiovascular health, extant research has assessed specific facets of psychological well-being rather than psychological well-being as a global construct. Such measurements of happiness, optimism, or purpose of life do not fully capture mental well-being. Psychological well-being is a complex construct that is considered to consist of 2 primary components, a eudaimonic component, which involves pursuing meaningful life goals that build on personal strengths, and hedonic well-being, which relates to attaining happiness and pleasure.[8,15,16] Most investigations to date have focused on the relationship between hedonic well-being and CVD risk, whereas the combined effect of both hedonic and eudaimonic well-being on cardiovascular health has not been studied.

Therefore, the present study was designed to capture the full spectrum of positive mental health by using the Warwick-Edinburgh Mental Well-Being Scale (WEMWBS)[17] and to evaluate its relationship to major CVD risk factors in adults. The WEMWBS was developed to provide a more psychometrically sound measurement of both the hedonic and eudaimonic components of well-being. Moreover, because psychological well-being varies systematically over the life course as well as sporadically because of episodic life events,[18] we chose to assess the cardiovascular impact of psychological well-being on contemporaneous CVD risk factors rather than long-term CVD development or events, which are more likely to be sensitive to episodic and stage-specific variability.

METHODS

Participants

Data were collected from May 2018 to September 2018 and 2019 from 735 participants recruited for a study to examine environmental influences on cardiovascular health (HEAL [Health, Environment and Action in Louisville] study; clincaltrials.gov NCT03670524). The data that support the findings of this study are available from the corresponding author upon reasonable request. Participants of the HEAL study were recruited from a primarily residential 4-square-mile area of south-central Louisville, Kentucky, with a total of ≈25000 residents. Eligibility criteria included age 25 to 70 years, primary residence in the study area, and meeting health requirements (eg, no active cancer diagnosis, not pregnant). Of the participants enrolled in the study, 16 were excluded because of missing WEMWBS responses. The final sample size was 719 participants.

Measures

Demographic Information

We asked the participants to provide the following demographic information: biologic sex (men or women), race (Black, White, other [ie, American Indian/Alaskan Native, Asian, Hawaiian/Pacific Islander, other]), age, education (high school or below, some college, college degree or higher), and annual household income (<$20000, $20 000–$44999, $45 000–$64999, ≥$65000).

Cardiovascular Disease History and Risk Factors

Participants were asked to self-report their history of the following CVD conditions and events (coded as yes, no, do not know): stroke/transient ischemic attack, carotid endarterectomy or angiography, stenting/carotid angioplasty, heart attack/myocardial infarction, angina/stable coronary artery disease/atherosclerosis, heart valve disease, heart flutter/atrial fibrillation, percutaneous coronary intervention, and congestive heart failure. A composite variable, previous CVD, was also created, indexing whether or not participants had experienced any of the CVD events list above (coded as yes or no). Participants then reported on the following CVD risk factors: (1) dyslipidemia/high cholesterol, diabetes, and hypertension/high blood pressure (coded as yes, no, borderline, or do not know); (2) exercise (Do you exercise regularly [>10 minutes each time])? (yes or no); (3) body mass index (BMI); (4) obesity (BMI >30); and (5) current smoker (yes or no). BMI was calculated based on participants' self-reported height and weight. As in previous work, current smoking status was confirmed by urinary cotinine with values >40 ng/mg creatinine considered a current smoker.[19,20] Participants' Framingham Risk Score was calculated to estimate the 10-year risk of CVD in participants without a prior history of CVD.[21] Framingham Risk Score was calculated using the following variables: sex (men or women), age (years), systolic blood pressure (millimeters of mercury), treatment for hypertension (yes or no), smoking (yes or no), diabetes (yes or no), high-density lipoprotein (HDL) (milligrams per deciliter), and total cholesterol (milligrams per deciliter).

Plasma Lipid Levels

Plasma lipid measurements were completed on a subsample of unfasted participants (n=660) who provided blood samples. Measurements included total cholesterol, triglycerides, HDL, low-density lipoprotein (LDL), and very low-density lipoprotein (VLDL). LDL levels were estimated using the Friedwald equation: LDL (milligrams per deciliter)=total cholesterol-HDL-(triglycerides/5). VLDL was estimated as VLDL=triglycerides/5.

Heart Rate, Blood Pressure, and Aortic Augmentation Index

Following a 10-minute rest period where participants remained seated with feet uncrossed and arm at level of the heart in a quiet state, blood pressure (systolic and diastolic) and heart rate were measured a total of 3 times, with a minute rest between each measure. These were immediately followed by a fourth measure of aortic augmentation index (AIx) via SphygmoCor XCEL (AtCor Medical, Sydney, Australia).[22] After removing the first blood pressure, the average brachial systolic and diastolic blood pressures and heart rate were used for analysis. AIx was calculated via waveform analysis.

Warwick-Edinburgh Mental Well-Being Scale

The WEMWBS is a 14-item measure of well-being focused on positive aspects of mental health, including positive affect (eg, I've been feeling optimistic about the future.), fulfilling interpersonal relationships (eg, I've been feeling loved.), and positive functioning (eg, I've been thinking clearly.).[17] Participants are asked to rate how much they have experienced each statement in the past 2 weeks on a 5-point Likert-type scale (1=none of the time to 5=all of the time). Scores ranged from 14 to 70, with higher scores indicating greater well-being. The WEMWBS has demonstrated good internal consistency, test–retest reliability, and criterion validity in terms of positive correlations with other measures of well-being, life satisfaction, and health.[17]

Procedure

We recruited participants using a multipronged approach, which involved mailing invitation letters to residents in the study area, canvassing at community events, posting on social media, and distributing flyers to residences in the study neighborhood. Participants were screened online or by telephone. Eligible participants were scheduled for an in-person exam. We collected biometric and psychological data during in-person exams held at several convenient sites in the neighborhood to facilitate participation. Study personnel met with the participants to describe the study and answer any questions that participants had. Participants then provided informed consent and visited health stations for physical exams (ie, measurements of blood pressure, vascular function) and sample (blood, urine, and saliva) collection. Study questionnaires were completed while participants waited at health stations or before checkout.

On average, the study visit lasted 90 minutes. Participants were compensated for their time. All methods and materials were approved by the institutional review board, and data were deidentified before analysis. Study data were collected and managed using Research Electronic Data Capture electronic data capture tools hosted at the University of Louisville. Research Electronic Data Capture is a secure, web-based software platform designed to support data capture for research studies.[23,24]

Statistical Analysis

Logistic regression was used to examine the association between the previous CVD event (yes or no) and well-being scores. Multinomial logistic regression models were used to examine the association between categorical outcomes of cardiovascular risk factors (yes, no, borderline) with well-being scores. These models were adjusted on an a priori basis for age, sex, race, BMI, education, smoking status, and exercise. Linear regression models were used to examine associations between well-being scores and continuous outcomes (systolic blood pressure, diastolic blood pressure, heart rate, lipids, and AIx). The following lipid measures were evaluated: plasma total cholesterol, HDL, LDL, VLDL, triglycerides, and 3 lipid ratios (total cholesterol/HDL, LDL/HDL, and triglycerides/HDL). Lipid ratios were log-transformed for normality. Models were adjusted a priori for age, sex, race, BMI, education, smoking status, and exercise status. For these analyses, we calculated odds ratios (ORs) per 10-point increase in well-being score because this was approximately 1 standard deviation change in well-being score. We also used linear regression models to test whether well-being modifies the known association between age and AIx. Linear regression models using AIx as the outcome and age as the predictor were stratified by 6 well-being categories to determine whether well-being scores modify the relationship between age and AIx. To retain a constant age in these categories, and to remove age as a confounder, we first created quartiles of age groups, then created 6 well-being groups of equal size within these age quartiles. These models were adjusted for age, sex, race, BMI, education, smoking status, and heart rate, which is known to be an independent predictor of arterial stiffness.[25] Statistical analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC) and GraphPad Prism version 8 (GraphPad Software, La Jolla, CA).

RESULTS

Demographic characteristics of study participants are listed in Table 1. On average, participants were 49.5 years of age, and most participants were women, White, and had some education beyond high school. Although relatively few participants had been previously diagnosed with CVD conditions (3%–9%), 46% of the participants were obese, 37% were current smokers, and 40% had hypertension. The average WEMWBS score was 50.6 (SD, 9.8; range, 14–70), which is similar to findings from previous work with other populations.[17]

Associations Between Participant Characteristics and Well-Being Score

As shown in Figure 1, a higher well-being score was associated with being men, Black, and between the ages of 58 and 71 years. Individuals who reported exercising regularly or those who had a college or higher degree had higher well-being scores. Obesity and self-reported smoking were associated with lower scores on the well-being scale. Income showed a graded association; progressively higher income was associated with a higher well-being score, such that participants

Table 1. Participant Characteristics and CVD Risk Factors and History

Categorical variables	n (%), N=719
Race	
Black	126 (18%)
White	556 (77%)
Other	37 (5%)
Sex	
Women	441 (61%)
Highest education level	
≤High school diploma	231 (32%)
Some college	277 (39%)
≥4-y degree	210 (29%)
Annual household income	
<$20 000	169 (25%)
$20 000–$44 999	202 (30%)
$45 000–$64 999	155 (23%)
≥$65 000	157 (23%)
CVD risk factors	
Exercise	428 (57%)
Obese	328 (46%)
Current smoker	263 (37%)
Diabetes	140 (20%)
Hypertension	289 (40%)
Dyslipidemia	163 (23%)
CVD history	
Previous CVD	150 (21%)
Stroke/TIA	48 (7%)
CEA/carotid angioplasty	21 (3%)
Myocardial infarction	46 (6%)
Angina/stable CAD	32 (4%)
Heart valve disease	23 (3%)
Heart flutter/A-Fib	62 (9%)
PCI	42 (6%)
Congestive heart failure	34 (5%)
Continuous variables	Mean (SD)
Age	49.5 (12.6)
BMI	30.5 (7.4)
Framingham Risk Score	9.4 (8.5)
Systolic blood pressure, mm Hg	128.2 (17.4)
Diastolic blood pressure, mm Hg	78.7 (11.3)
Heart rate, bpm	77.0 (13.0)
Augmentation index, %	26.5 (13.8)
Cholesterol, mg/dL	195.6 (43.3)
HDL, mg/dL	56.0 (15.2)
LDL, mg/dL	107.9 (37.6)
VLDL, mg/dL	31.4 (19.1)
Triglycerides, mg/dL	151.9 (81.7)

Race caetgory "other" includes individuals identifying as American Indian/Alaskan Native, Asian, Hawaiian/Pacific Islander, or other race not listed. Numbers for CVD risk factors and CVD history represent the count/percentage of participants endorsing these conditions. Exercise: numbers represent those endorsing exercising regularly; Framingham Risk Score: calculated for participants without previous history of CVD (n=553); obese: BMI >30; previous CVD: composite score of all CVD events. A-Fib indicates atrial fibrillation; BMI, body mass index; CAD, coronary artery disease; CEA, carotid endarterectomy; CVD, cardiovascular disease; HDL, high-density lipoprotein; LDL, low-density lipoprotein; PCI, percutaneous coronary intervention; TIA, transient ischemic attack; and VLDL, very low-density lipoprotein.

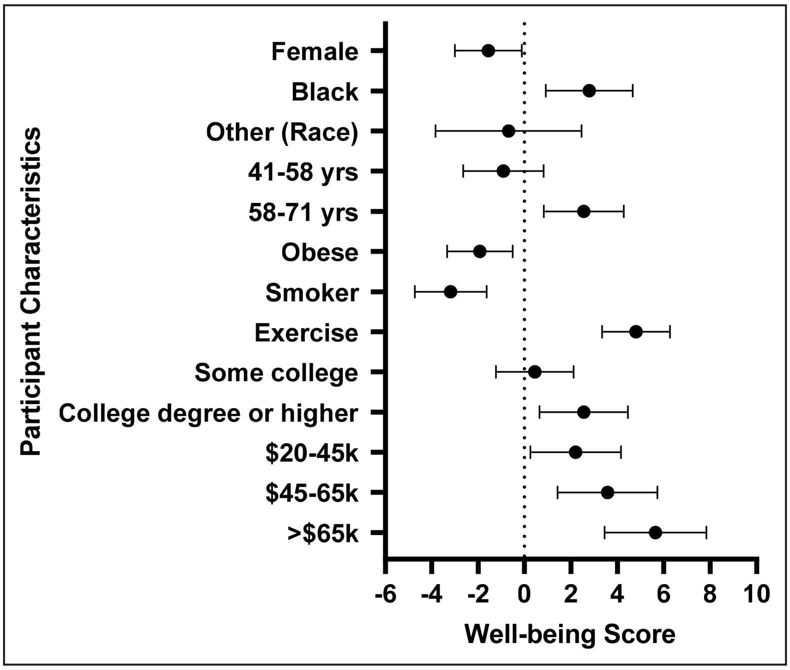

Figure 1. Associations between participant characteristics and subjective well-being score.
Values represent difference in Warwick-Edinburgh Mental Well-Being Scale score compared with the reference group (n=719). Reference group=men, White, <41 years of age, nonobese (body mass index [BMI] <30), nonsmoker, no exercise, high school education or less, household income <$20 000. Models were adjusted for age (continuous), sex (men or women), race (Black, White), BMI (continuous), education (some college, college or higher), and smoking status (never, current, former).

with the highest incomes (>$65 000) reported greater well-being in comparison with participants who were in the lowest income category (<$20 000).

Associations Between History of CVD and CVD Risk Factors and Well-Being Score

Next, we examined the association between well-being with previous history of CVD and contemporaneous CVD risk factors. We considered the 3 major cardiovascular risk factors, dyslipidemia, hypertension, and diabetes. We did not observe an association between well-being and previous CVD event. However, the adjusted associations between well-being and contemporaneous CVD risk factors showed a negative association between well-being and self-reported dyslipidemia (OR, 0.68 per 10-point increase in well-being [95% CI, 0.55–0.85]) and hypertension (OR, 0.76 [95% CI, 0.63–0.92]); lower scores of well-being were associated with CVD risk factors such as dyslipidemia and hypertension (Figure 2). No significant associations were found for self-reported diabetes. Borderline dyslipidemia, hypertension, and diabetes were not associated with the psychological well-being score.

Because we found an inverse association between dyslipidemia and well-being, we next assessed whether individual lipids and lipid ratios were related to well-being (Table 2). For every 10-point increase in the well-being score, there was a 1.60 mg/dL increase in HDL, a 7.55 mg/dL decrease in triglycerides, a 0.93 mg/dL decrease in VLDL, and decreases in lipid ratios (range, −3.92% to −6.85%). There were no significant associations between the well-being score and systolic blood pressure and heart rate (Table 3). However, we did find evidence of an association between well-being score and both diastolic blood pressure (95% CI, −1.69 to 0.11) and arterial stiffness (as measured by AIx [95% CI, −2.11 to 0.09]), although our CIs crossed the null. Furthermore, we found a strong negative association between well-being score and Framingham Risk Score, with a 7.1% lower Framingham Risk Score (95% CI, −11.7% to −1.7%) per 10-point increase in well-being.

We then performed linear regression to determine whether well-being modifies the association between age and arterial stiffness (Figure 3). We found that arterial stiffness as reflected by AIx was associated with age. Each year of increase in age was associated with a 0.19% higher AIx (95% CI, 0.10–0.28). We

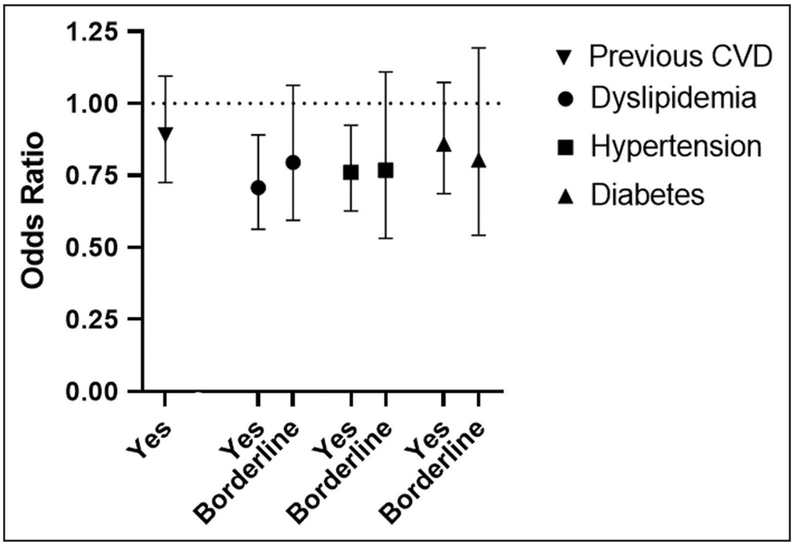

Figure 2. Associations between CVD and CVD risk factors with subjective well-being score.
OR and 95% CI for CVD risk factors associated with the WEMWBS score for subjective well-being (n=719) in comparison with the reference group with no reported dyslipidemia, hypertension, or diabetes per 10-point higher WEMWBS score. ORs were adjusted for age (continuous), sex (men or women), race (Black, White), body mass index (continuous), education (some college, college or higher) smoking status (never, current, former), and regular exercise (yes or no). CVD indicates cardiovascular disease; OR, odds ratio; and WEMWBS, Warwick-Edinburgh Mental Well-Being Scale.

also observed evidence of effect modification by well-being score on the relationship between age and AIx (*P* value for interaction=0.059). When we stratified the data by the well-being score (6 categories), we found that the association between AIx and age was strongest among those with the lowest well-being (0.39% [95% CI, 0.16–0.62]). We observed a nonlinear dose-dependent decrease in the association between age and AIx. In those in the highest well-being category, there was no association between age and AIx (0.02% [95% CI, −0.17 to 0.21]).

Table 2. Associations Between Plasma Lipids and Well-Being Score

Lipid	Estimate	95% CI	*P* value
Total cholesterol	−2.05	−5.76 to 1.65	0.277
HDL	1.60	0.46 to 2.75	0.006
LDL	−2.18	−5.40 to 1.05	0.185
VLDL	−0.93	−1.71 to −0.16	0.018
Triglycerides	−7.55	−14.31 to −0.78	0.029
TCHOL/HDL	−3.92	−6.07 to −1.73	<0.001
LDL/HDL	−4.43	−7.98 to −0.74	0.019
Triglycerides/HDL	−6.85	−11.71 to −1.73	0.010

N=660. Values represent difference in lipids (milligrams per deciliter) or lipid ratios (percent difference) per 10-point increase in the Warwick-Edinburgh Mental Well-Being Scale score.

Models were adjusted for age (continuous), sex (men or women), race (Black, White), body mass index (continuous), education (some college, college or higher), smoking status (never, current, former), and regular exercise (yes or no). HDL indicates high-density lipoprotein; LDL, low-density lipoprotein; TCHOL, total cholesterol; and VLDL, very low-density lipoprotein.

DISCUSSION

The major findings of the study were that higher levels of self-reported well-being are associated with a decreased likelihood of having dyslipidemia and hypertension and decreased risk for CVD. Greater well-being scores were also associated with better lipid profiles

Table 3. Associations Between Well-Being Score and Blood Pressure, Heart Rate, Arterial Stiffness, and FRS

Outcome	Estimate	95% CI	*P* value
Systolic BP	−0.70	−2.02 to 0.62	0.296
Diastolic BP	−0.79	−1.69 to 0.11	0.085
Heart rate	−0.61	−1.64 to 0.42	0.248
AIx	−1.01	−2.11 to 0.09	0.071
FRS	−7.08	−10.84 to −3.16	<0.001

n=697 for BP and heart rate, n=652 for AIx, and n=553 for FRS. Values represent difference (percent difference for FRS) per 10-unit increase in the Warwick-Edinburgh Mental Well-Being Scale score.

Models were adjusted for age (continuous), sex (men or women), race (Black, White), body mass index (continuous), education (some college, college or higher) and smoking status (never, current, former), and regular exercise (yes or no). AIx model was additionally adjusted for heart rate (beats per min). AIx indicates aortic augmentation index; BP, blood pressure; and FRS, Framingham Risk Score.

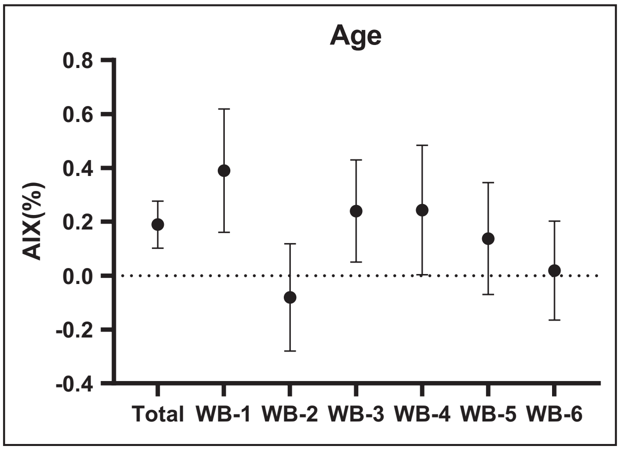

Figure 3. Associations between AIx and age stratified by the WEMWBS score.

Graph shows increase in AIx for each year increase in age for different scores on the WEMWBS, where 1 is the lowest WB score category and 6 is the highest. The average age of participants in each WB score category was similar (range, 48.3–50.4 years; n=652). *P* values for interaction (WB-1=reference): WB-2=0.002, WB-3=0.157, WB-4=0.174, WB-5=0.0497, WB-6=0.034. Note that for the entire cohort, there was a 0.19% increase in AIx for 1-year increase in age. Models were adjusted for age (continuous), sex (men or women), race (Black, White), body mass index (continuous), education (some college, college or higher), an smoking status (never, current, former), and heart rate (beats per minute). AIx indicates augmentation index; WB, well-being; and WEMWBS, Warwick-Edinburgh Mental Well-Being Scale.

in terms of higher HDL and lower VLDL, triglycerides, and lipid ratios. Significantly, we found that reported well-being exerted a strong modulatory influence on the relationship between age and arterial stiffness. Although there was a robust association between age and arterial stiffness in those who reported low levels of well-being, in those reporting higher levels of well-being there was no association between age and arterial stiffness, potentially indicating that the adverse vascular effects of aging could be, in part, modified by better psychological well-being.

Our findings are consistent with previous work showing that positive psychological states are associated with lower CVD risk and mortality.[2,8] The present findings extend this concept by showing that assessments that capture both the hedonistic and eudemonic aspects of psychological well-being are robustly associated with not just future CVD risk and CVD outcomes but also with certain contemporaneous CVD risk factors. This finding is significant because well-being can vary over the life course and could also change in response to a variety of contextual and social factors; therefore, longitudinal studies may not capture how well-being relates to CVD risk factors in the moment. Moreover, because negative mental states such as depression and anger can precipitate CVD events, it is difficult to reliably quantify the direct effect of positive mental health on CVD outcomes in longitudinal cohort studies that extend over several years. Our finding that previous CVD was not associated with well-being lends further support to the need for contemporaneous assessment of these factors.

We found that being Black was associated with higher well-being scores than being White, which is consistent with previous work.[26] However, the reasons for the apparently higher levels of reported well-being of Black people remain unclear and may be attributable more to social/contextual factors and assessment biases rather than race per se[26]; thus, additional research is needed. We also found that older individuals (58–71 years of age) reported greater well-being than younger individuals (41–58 years of age), and that there was a strong proportional increase in well-being and income. Such relationships have been well-described in the literature. Happiness increases over the life course; period effects show first decreasing and then increasing trends in happiness particularly after 50 years of age.[27] Likewise, studies have shown a modest correlation between income and well-being.[28] Obesity and exercise have also been linked to well-being; physical activity has been reported to be robustly associated with the prevalence of depression and anxiety, although the directionality of the relationship remains unclear.[29] Finally, our finding that smokers report lower levels of well-being is consistent with previous work showing that smokers report lower subjective well-being,[30] and that psychological disorders are strongly associated with smoking.[31]

Previous studies on the association between positive mental states have reported that higher levels of optimism are associated with lower total cholesterol and lower LDL cholesterol, but no associations were found between optimism and triglycerides or HDL.[32] However, in their study of the association between plasma lipids and psychological well-being (assessed using a control, autonomy, satisfaction, and pleasure scale [Control Autonomy Satisfaction and Pleasure Scale]), Soo et al reported that higher levels of well-being were associated lower triglycerides and HDL cholesterol.[33] Likewise, using a composite scale assessing a range of well-being facets (including autonomy, personal growth, purpose-of-life, self-acceptance), Radler et al found that high levels of psychological well-being predict high HDL cholesterol and low triglycerides.[34] Our findings extend the results of previous studies by showing a significant relationship between a comprehensive score of well-being and a favorable lipid profile. Such consistent relationships of a favorable lipid profile with different instruments for the assessment of well-being underscore the robustness of the relationship. Nevertheless, additional work is required to determine to what extent the effects of well-being are attributable to positive mental states alone and to what extent they are derived from positive health behavior of individuals reporting higher levels of well-being. Significantly, the effects sizes observed in our study for dyslipidemia (a 32% reduction in risk per 10-point increase in well-being) and hypertension (24% reduction in risk) are in the same range as those reported for reduction in the risk of cardiovascular events or mortality for optimism (35%) and happiness (22%).[2] Thus, it seems possible that long-term effects of psychological well-being on cardiovascular events and mortality may be attributable in part to the contemporaneous reductions in cardiovascular risk factors such as dyslipidemia and hypertension.

Our results show that the relationship between AIx and age was modified in those reporting moderately high or high levels of well-being. AIx is the percent of central pulse pressure attributed to reflected wave overlap in systole and is a noninvasive indicator of arterial stiffness.[35] Values of AIx are predictive of cardiovascular mortality and are correlated with changes in vascular function and peripheral organ damage.[36,37] In both healthy men and women, AIx is positively related to age and is therefore believed to be a robust indicator of vascular aging.[38] Consistent with this relationship, we found that each year increase in age was associated with ≈0.2% increase in AIx, which is consistent with the range (0.5%–0.6%) reported previously for healthy men and women.[38] However, the age-dependent increase in vascular stiffness was significantly lower in those reporting higher levels of well-being than those reporting lower levels of well-being. This finding is significant because it suggests that higher levels of well-being could increase resilience toward age-associated decline in vascular function and diminish the age-dependent increase in the risk of cardiovascular events and mortality. This potential ability of well-being to counteract the effects of aging on vascular function requires further empirical attention. Additional investigations are also needed to elucidate the biochemical mechanisms underlying the relationship between well-being and vascular aging.

Overall, the findings of our study suggest that interventions to improve well-being may be a way to reduce 2 important CVD risk factors, dyslipidemia and hypertension, as well as overall CVD risk, and potentially mitigate the effect of age-related declines in cardiovascular health. Mindfulness-based approaches to improve self-regulation of attention toward and nonjudgmental awareness of present-moment experiences may be particularly useful in this domain.[39] Although there are formal programs (eg, Mindfulness-Based Cognitive Therapy) with strong empirical support for improving well-being,[40] brief 10- to 15-minute, single-session mindfulness interventions (eg, body scan) also have demonstrated improvements in positive affect and physiological functioning (eg, blood pressure).[41,42] Positive psychology interventions (eg, identifying and using personal strengths, performing acts of kindness) that aim to promote optimism, gratitude, and positive affect also have demonstrated efficacy in improving psychological well-being in populations with CVD or at risk for CVD.[43–46]

The current findings need to be considered in the context of the study's limitations. Notably, some measures were self-reports and thus are subject to potential biases (eg, recall, social desirability). The present cross-sectional design does not permit causal-oriented hypothesis testing. Moreover, because the sample was drawn from a limited area, the findings may not be generalizable to other populations. Despite these limitations, our results indicate a robust association between well-being and important CVD risk factors that calls for further investigation. It will be especially important to investigate the interplay between well-being, CVD, dyslipidemia, and hypertension over time to better determine causality as well as the timing and duration of such effects.

CONCLUSIONS

Increased well-being is associated with decreased CVD risk, dyslipidemia, and hypertension, and may have potential in mitigating age-related changes in the vascular system. Additional research, particularly longitudinal designs, will be useful in better understanding associations between well-being and CVD, including ways that improving well-being may provide protective or mediating effects.

ARTICLE INFORMATION

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Disclosures

None.

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