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# Optimism and cardiovascular health: Longitudinal findings from the CARDIA Study

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## Abstract

**Objective:** Favorable cardiovascular health is associated with greater longevity free of cardiovascular disease. Although the prevalence of cardiovascular health decreases with age, less is known about protective factors that promote and preserve it over time. We investigated whether optimism was associated with better cardiovascular health over a 10-year period.

**Methods:** Participants included 3,188 Black and White men and women from the Coronary Artery Risk Development in Young Adults Study. Self-reported optimism was assessed in 2000 (this study's baseline) with the revised Life Orientation Test. Favorable cardiovascular health was defined by healthy status on five components of cardiovascular functioning that were repeatedly assessed through 2010 either clinically or via self-report (blood pressure, lipids, body mass index, diabetes, and smoking status). Linear mixed effects models examined whether optimism predicted cardiovascular health over time, adjusting for covariates such as sociodemographic characteristics, health behaviors, health status, and depression diagnosis.

**Results:** In models adjusting for sociodemographic characteristics, optimism was associated with better cardiovascular health across all time points (β=0.08, 95% confidence interval=0.04-0.11, $p \leq .001$), but not with rate of change in cardiovascular health. Findings were similar when adjusting for additional covariates. Optimism did not interact significantly with race ($p=0.85$), but did with sex such that associations appeared stronger for women than men ($p=0.03$).

**Conclusions:** Optimism may contribute to establishing future patterns of cardiovascular health in adulthood, but other factors may be more strongly related to how slowly or quickly cardiovascular health deteriorates over time.

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**Keywords**

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## Introduction

Cardiovascular disease (CVD) is the leading cause of death both in the U.S. and worldwide (1). However, individuals who feel optimistic about the future (i.e., those who expect more good than bad outcomes) show a lower risk of experiencing a heart attack, stroke, or cardiovascular death in prospective studies, independent of psychological distress and plausible confounders (2-4). A recent meta-analysis confirmed these findings and reported that individuals with higher levels of optimism have a 35% lower risk of experiencing a cardiovascular event compared to individuals with lower levels of optimism (5). Thus, optimism and related strengths-based constructs have been recognized as potential protective factors in the prevention of CVD (6), perhaps because optimism promotes healthy behaviors (e.g., physical activity) and is related to effective goal pursuit and coping with challenges (7, 8).

Conventional CVD prevention strategies aim to mitigate existing risk factors (e.g., lowering high levels of blood pressure with medication or altering diet to lose weight). However, treating risk factors to prevent CVD in a high-risk population is quite different from primordial prevention, which promotes factors that preserve cardiac health across the lifespan. Indeed, once risk factors such as hypertension or obesity have developed, CVD risk dramatically increases and can be difficult to reverse (9). Preventing risk factors from developing in the first place leads to a greater likelihood of maintaining cardiovascular health (CVH) across the lifespan. The concept of CVH was developed by the American Heart Association to shift focus away from risk and towards promoting and preserving health (10). Favorable CVH is achieved by having healthy levels of blood pressure, lipids, and body mass index (BMI), accompanied by being diabetes-free and a non-smoker (11). Evidence indicates that individuals with favorable CVH have substantially lower risk for CVD and mortality (12, 13), but adulthood prevalence is surprisingly low. In one U.S. study, favorable CVH was attained by only 20% of women ages 18-39 (11). For adults who are middle-age or older, the prevalence is even lower (13, 14).

Despite the low prevalence of CVH in adults, relatively little research has investigated factors that may promote CVH across the lifespan. Given optimism's association with CVD (5), it may be relevant for the preservation of favorable CVH as well. Results from three cross-sectional studies that used a metric of CVH incorporating physical activity and diet (called ideal CVH) showed that racially and ethnically diverse participants who reported higher versus lower levels of optimism were more likely to have ideal CVH (15-17). Although suggestive of optimism's links with CVH, the direction of effects remains ambiguous as cross-sectional findings are subject to concerns of reverse causality, such that better CVH may lead to more optimism rather than the reverse. Only one study to date has examined optimism's prospective longitudinal association with CVH. In a cohort of Finnish young adults, greater baseline optimism was associated with ideal CVH 6

years later when accounting for age, sex, baseline CVH, and medication use (18). While promising, participants in this study were fairly homogenous. Other work has indicated that risk and protective factors are unequally distributed across socioeconomic status and other social structural factors (19). Thus, additional evidence is needed to ascertain if optimism is longitudinally associated with CVH in populations with greater ethnic, racial, and socioeconomic diversity.

Building on prior work, we examined whether optimism prospectively predicted better CVH over a 10-year period in a cohort of White and Black individuals with diverse educational backgrounds. Given that some health behaviors may confound or act as underlying mechanisms in optimism's association with cardiovascular outcomes (2, 7), we followed early work in this area and defined CVH as favorable levels of blood pressure, lipids, BMI, diabetes status, and cigarette smoking (11). We hypothesized that individuals with higher versus lower levels of optimism would have better CVH over the follow-up period and experience a slower deterioration in CVH scores over time. We also hypothesized that individuals with higher versus lower levels of optimism would be more likely to be healthy on all five individual components of CVH during the follow-up period. Given social disparities in cardiovascular outcomes – including higher rates of heart disease-related hospitalization for men than women and higher rates of morbidity and mortality for Blacks than Whites (20, 21) – we also examined whether the association between optimism and CVH would be similar across categories of sex and race. Some investigators have speculated that optimism and related constructs simply mark the absence of psychological distress rather than conferring independent benefit (2), so we evaluated this possibility with the expectation that associations are independent of depression diagnosis and other potential confounders like sociodemographic characteristics (2).

## Methods

### Participants

Data came from the Coronary Artery Risk Development in Young Adults (CARDIA) Study, which was initiated in 1985-1986 (Year 0) with 5,115 Black and White men and women who were 18-30 years old at enrollment (22). Stratified sampling ensured approximately the same number of participants in subgroups by race, sex, education (high school or less and more than high school) and age (18-24 and 25-30) from each of four locations: Birmingham, AL, Chicago, IL, Minneapolis, MN, and Oakland, CA. Individuals with a history of symptomatic/clinical CVD were excluded during the initial study enrollment. In-person follow-up assessments are ongoing and have been conducted in 1987-88 (Year 2), 1990-91 (Year 5), 1992-93 (Year 7), 1995-1996 (Year 10), 2000-01 (Year 15), 2005-06 (Year 20), 2010-11 (Year 25), and 2015-2016 (Year 30). At each in-person follow-up, retention rates for survivors were 91%, 86%, 81%, 79%, 74%, 72%, 72%, and 71% respectively. Contact with CARDIA participants has been maintained via telephone, mail, or email every 6 months, along with annual medical history assessments. More than 90% of surviving cohort members have been directly contacted and vital status is nearly complete through searches in the National Death Index or family contacts.

Optimism was assessed in Year 15, so only the 3,671 individuals who participated in the Year 15 data collection were eligible for the analytic sample. Of those, 16 did not have complete data on optimism, 24 did not have at least one assessment of CVH during the study period, and an additional 443 were missing data on covariates. This yielded an analytic sample size of 3,188 individuals. Compared to participants in the analytic sample, those who were excluded ($n$ = 483) were more likely to be older, female, and have lower levels of education. Participants were not excluded from the analytic sample due to existing chronic conditions or disease (e.g., heart disease or cancer) as these conditions are informative with regard to initial health status and the role it likely plays in the association between optimism and CVH.

This study was approved by the Institutional Review Boards at each field center and individuals provided written informed consent prior to participating.

## Optimism

Optimism, or having positive expectations for the future, was assessed once in CARDIA with 6 validated items from the revised Life Orientation Test (23). This measure has demonstrated good discriminant validity when compared with related constructs such as neuroticism and mastery, as well as appropriateness for younger through older adults and adequate internal consistency (23-25); it was also reliable in the current study ($\alpha$ = .77). An example item is “I am always optimistic about my future” and response options ranged from *strongly agree* (1) to *strongly disagree* (5). Items were summed such that higher scores indicated greater optimism ($M$ = 22.94, $SD$ = 3.59, minimum = 8, maximum = 30). Optimism was standardized ($M$ = 0, $SD$ = 1) before analysis to enhance interpretation of the findings.

## Cardiovascular Health

Consistent with past research (11), favorable CVH was defined by meeting recommended levels (yes/no) on five components: 1) not currently using blood pressure medication, systolic blood pressure ≤120 mmHg, and diastolic blood pressure ≤80 mmHg; 2) not currently using lipid medication and total cholesterol <200 mg/dL; 3) BMI <25 kg/m$^2$; 4) no history of a diagnosis of diabetes; and 5) currently being a non-smoker. A total CVH score was calculated by summing the total number of components for which each participant met recommended levels (0-5) at each available assessment during Years 15, 20, and 25.

At each year of assessment, blood pressure levels, cholesterol levels, and BMI were clinically-assessed by staff in study clinics; medication use, diabetes status, and smoking status were self-reported. Blood pressure was assessed with a random zero sphygmomanometer (in Year 15) and an Omron model HEM907XL (in Years 20 and 25) while participants were seated. Three readings were taken; the average of the second and third readings were used in analyses. Blood was drawn from the antecubital vein after participants had fasted for 12 hours; enzymatic procedures were used to assess serum total cholesterol (26). Height and weight were assessed when participants were wearing light clothing but no shoes. BMI was calculated as weight (kg) divided by height squared (m$^2$). Self-reports of the remaining components of favorable CVH tend to be consistent with

more objective assessments (27-31). For example, in earlier waves of the CARDIA Study, self-reported smoking status among CARDIA participants was consistent with levels of serum cotinine (a biomarker of nicotine) and misclassification was low (32).

## Covariates

Covariates were assessed at baseline (Year 15) and selected based on previous research (2). Covariates included age (years), sex (men or women), race (White or Black), marital status (married or unmarried), education (less than a high school diploma, high school diploma, some college, or college degree or higher), and income ($0-$24,999, $25,000-$49,999, $50,000-$74,999, or ≥$75,000). Comprehensive dietary information was unavailable, but participants self-reported how often they ate at fast food restaurants each week, which was dichotomized into two categories: 0-1 time versus 2 or more times. Physical activity was assessed with the CARDIA Physical Activity History Questionnaire (33), which asked about participants' engagement in eight vigorous activities (e.g., swimming) and five moderate activities (e.g., walking) during the past 12 months. Consistent with previous research, scores for each activity were calculated based on the activity's intensity, frequency, and duration (34). Next, an overall activity score was created by summing scores across all activities; the sum was then used to create a 4-category measure of physical activity ranging from low to high levels. Participants also self-reported whether or not "a doctor or nurse ever said that you have…" heart problems or, in a separate question, cancer (yes or no). History of depression diagnosis was assessed by asking participants to indicate whether a doctor had ever diagnosed them with depression. Not all participants had the relevant depression diagnosis information, so samples for analyses that included this variable were slightly smaller than the overall analytic samples (N = 3,167).

## Statistical Analyses

Mean levels of optimism were evaluated across each covariate. Primary analyses evaluated if optimism was associated with the total CVH score and the rate of change in CVH across time in linear mixed effects models with random intercepts. The residual maximum likelihood method and a compound symmetry covariance structure were used in a set of three mixed models: 1) adjusted for age only; 2) adjusted for sociodemographic characteristics (age, sex, race, marital status, education, income); and 3) adjusted further for fast food consumption, physical activity, and diagnosis of heart problems or cancer. Three sensitivity analyses were conducted. The first explored whether excluding people with a self-reported history of heart problems or cancer at baseline influenced the primary findings. The second replaced baseline diagnosis of heart problems or cancer with time-updated diagnosis in fully-adjusted models. The third added depression diagnosis to fully-adjusted models.

We conducted two secondary analyses as well. First, we evaluated interaction terms in primary models for optimism*race and optimism*sex; then we examined optimism's association with CVH stratified by either sex or race in linear mixed effects models. Second, among all participants we used generalized estimating equations with the Poisson distribution (given the relatively common outcomes; 35) to examine optimism's relationship

with likelihood of meeting recommended levels for each individual component of CVH. All analyses were conducted in Stata MP 15.1 (36) with $\alpha = .05$, two-tailed.

## Results

### Participant characteristics

Participants were on average 40.18 years old (SD = 3.64) at Year 15. As would be expected based on the sampling procedures, approximately half of participants were women (55%) and half were Black (47%). Roughly a quarter of participants earned a high school diploma or less (23%), about one third attended some college (31%), and nearly half earned a college degree or more (46%). Approximately one third of participants had a family income of more than $75,000 a year (36%); however, a slightly higher proportion earned less than $50,000 (42%). More than half of participants were married (61%). Table 1 shows mean levels of optimism by participant characteristics at baseline. Higher levels of optimism tended to be associated with being married, having higher levels of education and family income, engaging in more physical activity, and not having a depression diagnosis.

### Optimism's Association with Cardiovascular Health

At the Year 15 baseline, only 7.6% of the sample had favorable CVH (i.e., healthy status on all five components of CVH). Over 10 years of follow-up, the prevalence of favorable CVH declined to 4.3% at the Year 25 assessment. This pattern of diminishing CVH across time was also evident in the sequentially-adjusted mixed models that examined the association between baseline levels of optimism and CVH over the study period (Table 2). On average, participants experienced a decline in CVH across time after adjusting for age ($\beta = -0.05$, 95% confidence interval [CI] = −0.06, −0.05, $p < 0.001$). Across all time points, more versus less optimistic participants had healthier levels of CVH after minimally adjusting for age ($\beta = 0.11$, 95% CI = 0.07, 0.14, $p < .001$). The association was slightly attenuated after adjusting for sociodemographic factors (Table 2, Model 2), but remained essentially unchanged when further adjusting for baseline health behaviors and diagnoses of heart problems or cancer (Table 2, Model 3). This suggests the association between optimism and CVH was robust to potential confounders. However, tests for an interaction between optimism and time found no evidence that rate of decline in CVH differed by level of baseline optimism ($p > 0.10$).

In three separate fully-adjusted sensitivity analyses, findings for optimism's association with CVH over time were nearly identical when excluding the 446 participants who had a history of heart problems or cancer at baseline ($\beta = 0.06$, 95% CI = 0.02, 0.09, $p = 0.003$), when baseline diagnosis of heart problems or cancer was replaced with time-varying diagnoses ($\beta = 0.07$, 95% CI = 0.04, 0.10, $p < 0.001$), or when adjusting for baseline depression diagnosis ($\beta = 0.07$, 95% CI = 0.03, 0.10, $p < 0.001$).

In secondary analyses adjusting for age and sociodemographic factors, including an interaction term in separate mixed models suggested the association between optimism and CVH did not vary significantly by race ($p_{optimism*race} = 0.85$), but did by sex ($p_{optimism*sex} =$

0.03). In stratified analyses (Table 3), women with higher levels of optimism tended to have higher levels of CVH during the follow-up period relative to men.

Additional analyses using generalized estimating equations models with the full analytic sample showed that higher baseline levels of optimism were associated with greater likelihood of meeting recommendations on the individual components of healthy blood pressure, non-smoking, and healthy BMI in age-adjusted models (Table 4). Findings were attenuated after adjustment for additional covariates.

## Discussion

Although favorable CVH is associated with beneficial outcomes including lower risk of mortality (12), it is relatively uncommon in middle to older adulthood and factors that increase the likelihood of maintaining favorable CVH over the life course are poorly understood. As many have noted, it may be easier to preserve favorable CVH than to restore it (37). Despite recent work calling for the promotion of CVH as a key part of the national agenda, adulthood antecedents of favorable CVH have not been investigated in longitudinal studies and potential psychological contributors are particularly underexplored (37).

Somewhat alarmingly, the current research found that less than 10% of middle-aged adults met recommended guidelines for the five CVH components (i.e., achieved favorable CVH). However, our findings suggest that optimism may be an important attribute for CVH maintenance in early middle age. In this diverse sample of Black and White men and women, those with higher versus lower levels of optimism were more likely to have healthier CVH scores across a follow-up period of as many as 10 years. These findings were robust to statistical adjustment of sociodemographic characteristics, health behaviors, health status, and even depression diagnosis. Such findings are consistent with and extend findings from three previous cross-sectional studies and one longitudinal study that also found optimism was associated with greater likelihood of having CVH (15-18). Although baseline optimism was associated with healthier CVH scores in the current study, optimism was not associated with a slower decline in CVH scores across time. This may suggest that optimism contributes to establishing favorable CVH, but other factors influence the rate of deterioration in CVH or whether it persists over time. Given that favorable CVH during middle-age can drastically reduce one’s lifetime risk for CVD (9), it will be critical to identify factors that can protect or foster favorable CVH at younger ages, before CVH is compromised. Optimism may be one such factor, but future studies that examine these associations earlier in the life course are needed.

Optimism’s association with CVH appeared similar for Blacks and Whites, which is consistent with past cross-sectional work that did not detect effect modification of the optimism-CVH relationship by race/ethnicity (17). However, the current findings do suggest that the association between optimism and CVH may be modified by sex such that women showed stronger effects than men (although it is important to note that optimism was positively associated with better CVH among both women and men). Optimism itself and its associations with CVH or heart disease have not typically shown sex differences (15, 38, 39). However, there are known sex differences in CVH, with women typically showing

higher prevalence of CVH than men (40). That pattern is consistent in our analytic sample, with women more likely to have favorable CVH (i.e., meeting recommendations on all five components of CVH) at baseline (9.7%) compared with men (5.2%). Such discrepancies may make it more difficult to detect optimism's association with CVH in men, so further research is needed – especially early in life before components of CVH deteriorate – to confirm that such effect modification is stable.

In addition to associations with the overall measure of CVH, optimism showed links with the individual components of healthy blood pressure, healthy BMI, and non-smoking in age-adjusted models. These associations were somewhat attenuated when covariates related to socioeconomic status were included (e.g., when adding sociodemographic factors to an age-adjusted model, a one standard deviation change in optimism went from 6% to 3% greater likelihood of having healthy blood pressure levels), but are consistent with findings from past research on CVH (15) and research specific to the individual components of CVH (41). Optimism was not associated with the individual components of healthy cholesterol (measured by total cholesterol levels and use of lipid medication) and being diabetes-free, but null associations between optimism and these outcomes have been previously reported (42, 43). Although maintaining healthy body weight or avoiding cigarette smoking are important goals in their own right, clustered health and behavior factors may have a larger effect on subsequent health and longevity than any single factor (44-46). Thus, optimism's more robust associations with the overall composite of CVH versus any single component suggests that considering effects on multiple factors jointly can provide additional insight (37).

We set out to investigate whether optimism's association with favorable CVH (defined by being diabetes-free and non-smoker, as well as having healthy levels of blood pressure, lipids, and BMI) would persist when statistically adjusting for physical activity and diet, which have been characterized as both potential confounding and mechanistic variables (2, 7). Including baseline levels of fast food consumption and physical activity in analytic models did not substantially alter associations between optimism and CVH. At a minimum, these findings suggest that these health behaviors do not confound optimism's association with CVH. We did not formally test for mediation in the current work because a stronger study design and a better measure of diet is needed to test the potential explanatory power of these factors more convincingly. However, these two health behaviors are likely only one route by which optimism influences CVH. Future work may want to consider additional biobehavioral factors such as sleep (47-49), as well as other psychosocial processes. For example, optimism may buffer effects of stress through enhancing effective coping strategies or increased levels of social support; in addition, optimism can lead to higher feelings of control, persistence in the face of challenge, and more effective goal attainment strategies (e.g., proactive pursuit, disengaging from unattainable goals), which may foster better cardiovascular function (8, 50-53).

Although optimism is typically considered a trait, it can change over time as people age or during key transitions in life (54). Experimental interventions can also improve optimism (55), but it is unclear whether such interventions influence cardiovascular function. Thus,

optimism may be a novel target for fostering better CVH; however, additional experimental evidence is needed to confirm and refine clinical recommendations (6).

This study is limited by the observational nature of the data and the possibility of residual confounding. Even some of the variables that were measured were assessed in a narrow way (e.g., diet via fast food consumption). Moreover, although there is no evidence for genetic confounding of the association between optimism and cardiovascular outcomes, we cannot fully rule it out. In addition, findings may not generalize to older or younger populations, or those of other ethnic and racial backgrounds. Although we considered effect modification by sex and race, we did not consider whether other psychosocial factors (e.g., life stressors) moderate optimism's association with CVH. Finally, the size of optimism's association with CVH was relatively small ($r$ = .10 at baseline, which parallels results in Table 2); however, even small effects can be meaningful when considering the population level or that effects accrue across the lifespan (56, 57). Furthermore, optimism's effect in this study is comparable in magnitude to other known correlates of health such as income.

The current study has substantial strengths including a longitudinal design with follow-up across as many as 10 years. In addition, the sample was comprised of Black and White men and women with diverse educational backgrounds. Optimism's association with CVH was not markedly diminished when taking depression diagnosis into account, or a variety of other potential confounders such as socioeconomic status or health status. Thus, reported associations appear relatively robust. Finally, CVH was conceptualized with many objectively-assessed components and has demonstrated links with healthy outcomes in older age (11). Taken together, findings indicate that optimism is longitudinally associated with better CVH in a diverse cohort of middle-age individuals. However, optimism was not associated with the rate of change in CVH. As such, it may be critical to examine whether optimism can contribute to the maintenance of CVH earlier in life, before deteriorative processes are activated.

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## Abbreviations

| | |
|---|---|
| **BMI** | body mass index |
| **CVD** | cardiovascular disease |
| **CVH** | cardiovascular health |
| **CARDIA** | Coronary Artery Risk Development in Young Adults |

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**Table 1.**

Mean levels of baseline optimism by participant characteristics at baseline (N=3,188).

| Participant Characteristics | n (percent) | Baseline Optimism | |
|---|---|---|---|
| | | Mean (SD) | *p* [a] |
| Age | | | 0.09 |
| 32-40 years | 1,591 (49.9) | 23.04 (3.67) | |
| 41-51 years | 1,597 (59.1) | 22.83 (3.52) | |
| Sex | | | 0.1 |
| Men | 1,432 (44.9) | 22.82 (3.53) | |
| Women | 1,756 (55.1) | 23.03 (3.70) | |
| Race | | | 0.17 |
| White | 1,689 (53.0) | 23.02 (3.61) | |
| Black | 1,499 (47.0) | 22.84 (3.57) | |
| Marital Status | | | <0.001 |
| Married | 1,943 (61.0) | 23.32 (3.41) | |
| Unmarried | 1,245 (39.1) | 22.33 (3.79) | |
| Education Level | | | <0.001 |
| Less than high school | 148 (4.6) | 21.49 (3.24) | |
| High school | 581 (18.2) | 21.93 (3.65) | |
| Some college | 1,007 (31.6) | 22.93 (3.46) | |
| College or more | 1,452 (45.6) | 23.48 (3.57) | |
| Family Income | | | <0.001 |
| $0-$24,999 | 512 (16.1) | 21.43 (3.78) | |
| $25,000-$49,999 | 823 (25.8) | 22.57 (3.57) | |
| $50,000-$74,999 | 702 (22.0) | 23.02 (3.48) | |
| ≥$75,000 | 1,151 (36.1) | 23.81 (3.33) | |
| Physical Activity Level | | | <0.001 |
| Low | 1,177 (36.9) | 22.57 (3.70) | |
| Moderate | 810 (25.4) | 22.86 (3.56) | |
| Moderate-high | 632 (19.8) | 23.13 (3.52) | |
| High | 569 (17.9) | 23.60 (3.39) | |
| Weekly Fast Food Consumption | | | 0.1 |
| 0-1 times | 1,198 (37.6) | 23.07 (3.61) | |
| 2 or more times | 1,990 (62.4) | 22.86 (3.58) | |
| Diagnosis of Heart Problems | | | 0.8 |
| Yes | 357 (11.2) | 22.90 (3.79) | |
| No | 2,831 (88.8) | 22.94 (3.57) | |
| Diagnosis of Cancer | | | 0.9 |
| Yes | 100 (3.1) | 22.97 (3.71) | |
| No | 3,088 (96.9) | 22.94 (3.56) | |
| Diagnosis of Depression [b] | | | <0.001 |

| Participant Characteristics | n (percent) | Baseline Optimism | |
|---|---|---|---|
| | | Mean (SD) | *p* [a] |
| Yes | 492 (15.5) | 21.18 (4.06) | |
| No | 2,675 (84.5) | 23.27 (3.40) | |

[a] Differences in mean optimism scores were calculated using ANOVA.

[b] Sample size may vary due to missing data on baseline depression diagnosis.

**Table 2.**

Associations between baseline optimism (standardized) and total cardiovascular health scores during follow-up (N=3,188).

| | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| | **β (95% CI)** | ***p*** | **β (95% CI)** | ***p*** | **β (95% CI)** | ***p*** |
| Optimism | 0.11 (0.07, 0.14) | <0.001 | 0.08 (0.04, 0.11) | <0.001 | 0.07 (0.04, 0.11) | <0.001 |
| Time | −0.05 (−0.06, −0.05) | <0.001 | −0.05 (−0.06, −0.05) | <0.001 | −0.05 (−0.06, −0.05) | <0.001 |
| Age | −0.03 (−0.04, −0.02) | <0.001 | −0.04 (−0.05, −0.03) | <0.001 | −0.04 (−0.05, −0.03) | <0.001 |
| Female | | | 0.29 (0.23, 0.36) | <0.001 | 0.27 (0.21, 0.34) | <0.001 |
| Black | | | −0.22 (−0.29, −0.14) | <0.001 | −0.19 (−0.27, −0.12) | <0.001 |
| Married | | | 0.02 (−0.06, 0.10) | 0.6 | 0.02 (−0.06, 0.10) | 0.6 |
| Education | | | | | | |
| Less than High School | | | Reference | -- | Reference | -- |
| High School | | | 0.17 (−0.01, 0.34) | 0.06 | 0.16 (−0.01, 0.34) | 0.07 |
| Some College | | | 0.12 (−0.05, 0.30) | 0.2 | 0.13 (−0.04, 0.30) | 0.1 |
| College or Higher | | | 0.47 (0.30, 0.65) | <0.001 | 0.46 (0.29, 0.64) | <0.001 |
| Income | | | | | | |
| ≤$24,999 | | | Reference | -- | Reference | -- |
| $25,000-$49,999 | | | −0.07 (−0.18, 0.05) | 0.3 | −0.07 (−0.18, 0.04) | 0.2 |
| $50,000-$74,999 | | | −0.07 (−0.19, 0.03) | 0.3 | −0.07 (−0.19, 0.05) | 0.2 |
| ≥$75,000 | | | −0.06 (−0.18, 0.07) | 0.4 | −0.08 (−0.20, 0.05) | 0.2 |
| Fast Food ≥2 times a week | | | | | −0.16 (−0.23, −0.09) | <0.001 |
| Physical Activity | | | | | | |
| Low | | | | | Reference | -- |
| Moderate | | | | | 0.06 (−0.03, 0.14) | 0.2 |
| Moderate-High | | | | | 0.04 (−0.06, 0.13) | 0.4 |
| High | | | | | 0.15 (0.06, 0.25) | 0.002 |
| Diagnosis of Heart Problems | | | | | 0.07 (−0.03, 0.18) | 0.1 |
| Diagnosis of Cancer | | | | | 0.03 (−0.16, 0.22) | 0.7 |

**Table 3.**

Race-stratified or sex-stratified association between baseline optimism (standardized) and total cardiovascular health scores during follow-up (N=3,188). [a]

| | White (n=1,689) | Black (n=1,499) | Men (n=1,432) | Women (n=1,756) |
|---|---|---|---|---|
| | β (95% CI) | β (95% CI) | β (95% CI) | β (95% CI) |
| Optimism | 0.06 (0.01, 0.11) † | 0.09 (0.04, 0.14) † | 0.05 (0.00, 0.10) * | 0.10 (0.05, 0.14) ‡ |
| Time | −0.04 (−0.05, −0.04) ‡ | −0.06 (−0.07, 0.14) ‡ | −0.05 (−0.05, −0.04) ‡ | −0.06 (0.05, 0.14) ‡ |

[a] Models adjusted for time, age, sex (in race-stratified models only), race (in sex-stratified models only), education, income, and marital status. The interaction term of optimism with sex ($p$=0.03) was statistically significant, however the interaction terms of optimism with race was not statistically significant ($p$=0.85).

* $p < .05$

† $p < .01$

‡ $p < .001$

**Table 4.**

Associations between baseline optimism and the relative risk of meeting recommended levels of each component of cardiovascular health during follow-up (N=3,188). [a]

| Components of Cardiovascular Health | Model 1 [b] | | Model 2 [c] | | Model 3 [d] | |
|---|---|---|---|---|---|---|
| | RR (95% CI) | *p* | RR (95% CI) | *p* | RR (95% CI) | *p* |
| Healthy blood pressure | 1.06 (1.02, 1.10) | 0.004 | 1.04 (1.00, 1.08) | 0.06 | 1.03 (1.00, 1.07) | 0.08 |
| Healthy cholesterol | 1.01 (0.97, 1.05) | 0.6 | 1.01 (0.98, 1.05) | 0.5 | 1.01 (0.98, 1.05) | 0.5 |
| Non-smoking | 1.08 (1.03, 1.14) | 0.002 | 1.04 (0.98, 1.09) | 0.2 | 1.04 (0.99, 1.10) | 0.1 |
| Healthy BMI | 1.06 (1.00, 1.13) | 0.05 | 1.06 (1.00, 1.13) | 0.06 | 1.05 (0.99, 1.11) | 0.1 |
| Non-diabetic | 1.01 (0.98, 1.05) | 0.5 | 1.01 (0.98, 1.04) | 0.5 | 1.01 (0.98, 1.04) | 0.6 |

[a] Generalized estimating equations with Poisson distribution and log link were used to estimate the relative risk of meeting recommendations for each component of cardiovascular health among all participants. The effect estimate represents the likelihood of meeting recommended levels of each cardiovascular health component in relation to a one standard deviation increase in baseline optimism.

[b] Adjusted for age only.

[c] Adjusted for age, sex, race, education, income, and marital status.

[d] Adjusted for age, sex, race, education, income, marital status, fast food consumption, physical activity, and diagnosis of heart problems or cancer.