HHS Public Access

Author manuscript

Prev Med. Author manuscript; available in PMC 2021 July 01.

Published in final edited form as:

Prev Med. 2020 July ; 136: 106103. doi:10.1016/j.ypmed.2020.106103.

Positive emotions and favorable cardiovascular health: A 20-year longitudinal study

Julia K. Boehm, PhD[a], **Ying Chen, ScD**[b], **Farah Qureshi, ScD**[b,c], **Jackie Soo, ScD**[b], **Peter Umukoro, MD, ScD**[d], **Rosalba Hernandez, PhD**[e], **Donald Lloyd-Jones, MD, ScM**[f], **Laura D. Kubzansky, PhD, MPH**[b,c]

[a]Department of Psychology, Chapman University, 1 University Drive, Orange, CA 92866, USA

[b]Department of Social and Behavioral Sciences, Harvard T. H. Chan School of Public Health, 677 Huntington Avenue, Boston, MA 02115 USA

[c]Lee Kum Sheung Center for Health and Happiness, Harvard T. H. Chan School of Public Health, 677 Huntington Avenue, Boston, MA 02115 USA

[d]Department of Environmental Health, Harvard T. H. Chan School of Public Health, 677 Huntington Avenue, Boston, MA 02115 USA, now at Indiana University School of Medicine

[e]School of Social Work, University of Illinois at Urbana-Champaign, 1010 W. Nevada Street, Urbana, IL 61801, USA

[f]Department of Preventive Medicine, Northwestern University Feinberg School of Medicine, 420 E. Superior Street, Chicago, IL 60611, USA

Abstract

No studies have examined whether positive emotions lead to favorable cardiovascular health (CVH) early in the lifespan, before cardiovascular disease is diagnosed. Moreover, the direction of the association has not been thoroughly investigated. Among younger adults, we investigated whether baseline positive emotions were associated with better CVH over 20 years. We also considered whether baseline CVH was associated with subsequent positive emotions during the same period.

Address for correspondence: Dr. Julia K. Boehm, Department of Psychology, Chapman University, 1 University Drive, Orange, CA 92866; Phone: 714-997-6803; Fax: 714-997-6780; jboehm@chapman.edu.

CRediT Author Statement

Julia K. Boehm: Conceptualization, Writing - Original Draft, Supervision, Funding Acquisition
Ying Chen: Validation, Formal analysis, Writing - Review & Editing
Farah Qureshi: Validation, Formal Analysis, Writing - Review & Editing
Jackie Soo: Writing - Review & Editing
Peter Umukoro: Formal Analysis, Writing - Review & Editing
Rosalba Hernandez: Writing - Review & Editing
Donald Lloyd-Jones: Investigation, Writing - Review & Editing
Laura D. Kubzansky: Conceptualization, Writing - Review & Editing, Funding Acquisition

Disclosures

None.

Participants included 4,196 Black and White men and women from the Coronary Artery Risk Development in Young Adults Study. Positive emotions and cardiovascular-related parameters were each assessed in 1990 (this study's baseline), with repeated assessment through 2010. CVH was defined by blood pressure, lipids, body mass index, diabetes, and smoking status. Primary analyses used linear mixed effects models adjusting for potential confounders; secondary analyses stratified by race and sex.

Controlling for sociodemographic factors, greater baseline positive emotions were associated with better CVH across time (β=0.03, 95% confidence interval=0.007–0.06). However, positive emotions were unrelated to rate of change in CVH across time. Baseline CVH was also associated with greater average positive emotions across time (β=0.09, 95% confidence interval=0.02–0.15), but not rate of change. Positive emotions' association with CVH was stronger for women than men, but race did not modify associations.

Positive emotions in early to middle adulthood were associated with better CVH across several decades. Baseline CVH was also associated with greater positive emotions during follow-up. Future research may be able to disentangle these relationships by assessing positive emotions and CVH earlier in life.

Keywords

cardiovascular health; cardiovascular disease; health promotion; positive emotions

Introduction

Heart disease has been the leading cause of death in the U.S. for more than 50 years.[1, 2] To address this burden, the American Heart Association focuses not just on treatment, but also on promoting and maintaining the cardiovascular health (CVH) that most individuals possess at birth.[3] Favorable CVH is defined by being diabetes-free and a non-smoker, as well as meeting recommendations for healthy levels of blood pressure, lipids, and body mass index (BMI).[4] However, meeting all these criteria can be difficult to achieve and favorable CVH is relatively uncommon in adulthood. In a study of U.S. women ages 18–39 years, only 20% met criteria for favorable CVH.[4] The prevalence is even lower for adults who are middle-age or older and for some ethnic/racial minorities.[5–7] Nonetheless, people with versus without favorable CVH have lower risk for cardiovascular disease (CVD) and mortality.[8, 9] Thus, identifying factors that increase likelihood of achieving and maintaining favorable CVH is critical.

Investigators hypothesize that psychosocial characteristics may be upstream determinants of CVH because they influence human perceptions, interpersonal interactions, and health behaviors. Only a few studies have examined protective psychosocial factors (mostly from childhood) in relation to CVH.[10–13] Research suggests positive emotions such as happiness may be an antecedent, as they are associated with a range of health outcomes including greater longevity.[14–17] More specifically, positive emotions and related constructs have shown inverse associations with risk of developing CVD.[18–20] For example, in one prospective study across 10 years, adults who displayed more positive emotions in their

facial expressions had 22% reduced risk of incident heart disease when statistically accounting for sociodemographics, CVD risk factors, and negative emotions.[21]

In the current study, we examined whether positive emotions were longitudinally associated with CVH over a 20-year period. We hypothesized individuals with higher versus lower levels of baseline positive emotions would have healthier CVH scores across time and experience slower CVH deterioration. Because CVD risk factors, protective factors, and outcomes are not evenly distributed across race and sex,[22–24] secondary analyses explored whether these factors modify potential associations. Positive emotions could mark the absence of psychological distress rather than conferring independent benefit,[18] so we controlled for negative emotions along with sociodemographic factors. To explore the possible bidirectionality in the relationship, we examined whether baseline CVH predicted positive emotions during follow-up.

Methods

Participants

Participants were from the Coronary Artery Risk Development in Young Adults (CARDIA) Study,[25] which was established in 1985–1986 (Year 0) and enrolled 5,115 Black and White men and women ages 18–30. Participants were from Birmingham, AL, Chicago, IL, Minneapolis, MN, and Oakland, CA. Inclusion criteria were designed to yield approximately the same number of people in subgroups of race, sex, education (high school or less; more than high school) and age (18–24; 25–30) across enrollment sites. Participants visited one of four clinical centers for a medical exam (e.g., blood pressure assessment) and to answer questions about their health and sociodemographic characteristics. Those with history of symptomatic/clinical CVD were excluded during initial study enrollment.

In addition to Year 0, CARDIA participants had in-person examinations 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). Retention rates among survivors at each in-person examination were 91%, 86%, 81%, 79%, 74%, 72%, 72%, and 71%, respectively. Participant contact is maintained via telephone, mail, or email every 6 months, with annual interim medical history ascertainment. Over the last 5 years, >90% of surviving participants were directly contacted, and follow up for vital status is nearly complete through related contacts and National Death Index searches.

The 4,351 individuals who participated in the Year 5 data collection, when positive emotions were first assessed, were eligible for inclusion in the primary analytic sample. Of those, we excluded 47 missing data on positive emotions, 14 missing CVH assessed during the study period, and an additional 94 missing data on covariates, resulting in a primary analytic sample size of 4,196. Excluded (n=155) versus included participants were more likely to be Black (relative risk [RR]=2.21, 95% confidence interval [CI]=1.59, 3.08), have less than a college education (RR=2.60, 95% CI=1.73, 3.91), and be unmarried (RR=1.73, 95% CI=1.20, 2.48). Excluded versus included participants also had lower positive emotions (mean [M]excluded=7.71, standard deviation [SD]=2.9 versus Mincluded=8.31, SD=2.7; p=0.02).

To explore the possibility of bidirectionality, a separate analytic sample was created to assess baseline CVH on positive emotions over time. From the initial 4,351 eligible participants, 150 were missing complete data on CVH at baseline, an additional 4 were missing any assessment of positive emotions during the follow-up period, and 94 more were missing data on covariates, resulting in a sample of 4,103.

The CARDIA study was approved by Institutional Review Boards at the data coordinating center and across field centers where individuals provided informed consent.

Positive Emotions

Following prior work,[26] self-reported positive emotions were derived from 4 positively-worded items ("I was happy," "I felt hopeful about the future," "I felt that I was just as good as other people," "I enjoyed life") from the Center for Epidemiological Studies Depression (CES-D) Scale,[27] which was assessed at 5-year intervals between Years 5 and 25. Response options ranged from *rarely or none of the time* to *most or all of the time*. Items were summed with higher scores indicating higher levels of positive emotions (M=8.31, SD=2.69, 0–12). Internal consistency of the four items was acceptable (α=.73) and past work suggests the measure is valid.[28, 29] The positive emotions score was standardized (M=0, SD=1) for analyses.

Cardiovascular Health

Favorable CVH was defined by meeting recommended levels (yes, no) on five components:[4] 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 diabetes diagnosis; and 5) currently being a non-smoker. CVH components were either clinically-assessed (blood pressure, cholesterol, BMI; details are reported elsewhere)[25] or self-reported (medication use, diabetes status, smoking status) at each assessment of the CARDIA Study. Evidence from another cohort suggests such self-reports are consistent with objective assessments.[30] Moreover, self-reported smoking status among CARDIA participants was consistent with measured levels of serum cotinine.[31]

CVH scores (ranging from 0–5) were calculated by summing the total number of components for which participants met recommended levels at each available assessment during the study period (from Years 5 to 25). Individuals meeting recommended levels on all five components had the highest possible score of 5. Although some researchers define CVH by including diet and exercise (i.e., ideal CVH),[3] we did not because those health behaviors may confound or be on the pathway linking positive emotions with CVH. Instead, we included diet and exercise as covariates to examine whether they attenuated associations.

Covariates

Covariates were selected based on past research and included sociodemographic and health-related factors assessed in Year 5 (unless otherwise noted).[18] Sociodemographic factors included age, sex (men, women), race (White, Black), marital status (married, unmarried), education (less than a high school diploma, high school diploma, some college, college

degree or higher), and family income ($0-$24,999, $25,000-$49,999, $50,000-$74,999, ≥ $75,00). Limited diet information was available at Year 5, and included only self-reported frequency of weekly fast food consumption (M=2.0, SD=2.2). Physical activity was assessed with the CARDIA Physical Activity History Questionnaire,[32] which asked about participants' engagement in eight vigorous-intensity activities (e.g., swimming) and five moderate-intensity activities (e.g., walking) during the past 12 months. Scores for each activity were calculated based on intensity, frequency, and duration.[33] An overall score was created by summing scores across all activities; the sum was then used to create a 4-category physical activity measure ranging from low to high. Participants also self-reported how many drinks of wine, beer, and liquor they typically consumed in a week. Following CARDIA convention, men who drank ≥14 drinks per week and women who drank ≥7 drinks per week were categorized as consuming high levels of alcohol.[34] Participants self-reported at each assessment period whether or not "a doctor or nurse ever said that you have…" heart problems or cancer (yes, no); diagnosis of heart problems or cancer were used as time-updated variables. Consistent with previous examinations of the CES-D Scale's measurement structure,[27, 29] negative emotions were self-reported at each assessment period with five items ("I felt that I could not shake off the blues…" "I felt depressed," "I felt lonely," "I had crying spells," "I felt sad"). Higher scores indicated greater negative emotions (M=2.24, SD=2.70, 0–15; α=.84). A continuous score of negative emotions was used as a time-updated variable in sensitivity analyses.

Statistical Analyses

Analyses were conducted in Stata 15.1 (α=.05, two-tailed). Associations between positive emotions and covariates were assessed by considering mean levels of positive emotions across participant characteristics. Primary analyses used linear mixed effects models with random intercepts to examine how baseline positive emotions were associated with the continuous CVH score and the rate of change in CVH score across time. Mixed models used the residual maximum likelihood method and a compound symmetry covariance structure. We investigated three models: 1) adjusted for age only; 2) adjusted for sociodemographic characteristics (age, sex, race, marital status, education, family income); and 3) additionally adjusted for baseline fast food consumption, physical activity, and alcohol consumption, as well as time-updated heart disease and cancer diagnoses.

Separate sensitivity analyses explored whether additionally adjusting for time-updated negative emotions or excluding people with heart problems or cancer diagnoses at baseline altered associations. Secondary analyses examined positive emotion's association with CVH stratified by either sex or race in linear mixed effects models. Secondary analyses further used generalized estimating equations with the Poisson distribution (given the relatively common outcomes) to consider likelihood of meeting recommended levels for each separate CVH component (e.g., cholesterol).

To investigate possible bidirectionality, we used an additional set of linear mixed effects models to examine how baseline CVH was associated with positive emotions and the rate of change in positive emotions across time. The same set of covariates as described previously were controlled.

Results

Participant Characteristics

Consistent with sampling procedures, approximately half of participants were women (55%) and half were Black (48%). At baseline (Year 5), more than half of participants were unmarried (59%) and roughly a third had earned a high school diploma or less (31%), attended some college (30%), or earned a college degree or more (39%). Most participants had a family income of <$24,999 (38%) or $25,000-$49,999 (38%); fewer participants reported ≥$50,000 (24%). Table 1 presents baseline positive emotions across categories of participant characteristics.

The proportion of individuals with healthy status on all five CVH components was low and decreased over time. In Year 5, when participants were on average 30 years old, only 15.5% of individuals had favorable CVH (i.e., healthy status on all five CVH components). For the overall sample, the prevalence decreased to 14.2% in Year 7, 12.7% in Year 10, 7.9% in Year 15, 6.8% in Year 20, and 4.6% in Year 25 (when participants were on average 50 years old).

Positive Emotions' Association with Cardiovascular Health

Across an average follow-up period of 20.08 years, positive emotions were significantly and positively associated with CVH levels pooled across time in an age-adjusted model (Table 2; Model 1). The positive association was slightly attenuated when additionally controlling for sociodemographic characteristics, fast food consumption, physical activity, alcohol consumption, and diagnosis of heart problems or cancer (Table 2; Models 2 and 3). In addition, each model showed that CVH decreased significantly across time. However, the interaction between positive emotions and time was not statistically significant, suggesting the rate of decline in CVH did not depend on initial positive emotion levels.

Sensitivity analyses indicated the magnitude of association between positive emotions and CVH was only slightly attenuated when time-updated negative emotions were considered with all other covariates (β=0.02, 95% CI=−0.003, 0.05). Moreover, negative emotions were associated with CVH during follow-up (β=−0.006, 95% CI=−0.01, −0.0003). Results from the linear mixed effects models were nearly identical when excluding 390 participants who had a baseline diagnosis of heart problems or cancer (Supplemental Table 1).

In secondary analyses, there was no interaction between race and positive emotions in relation to CVH (Table 3; β=−0.03, 95% CI=−0.09, 0.02, p=.2). However, sex and positive emotions did interact (β=0.06, 95% CI=0.007, 0.11, p=.03). Women with higher levels of baseline positive emotions tended to have higher CVH levels during follow-up (Table 3). By contrast, the association was weaker for men with wider CIs.

Generalized estimating equations with the full analytic sample showed higher baseline positive emotions were weakly associated with greater likelihood of meeting recommendations for healthy BMI, healthy blood pressure, and non-smoking in age-adjusted models (Supplemental Table 2). With further adjustment for sociodemographics, fast food consumption, physical activity, alcohol consumption, and diagnosis of heart

problems or cancer, baseline positive emotions were no longer or only weakly associated with the individual components of CVH (Supplemental Table 2).

Cardiovascular Health's Association with Positive Emotions

Baseline CVH was positively associated with positive emotions in an age-adjusted model (Table 4; Model 1). The association was still evident albeit somewhat weaker after adjusting for sociodemographics, fast food consumption, physical activity, alcohol consumption, and diagnosis of heart problems or cancer (Table 4; Models 2 and 3). This indicates individuals with higher CVH scores earlier in adulthood also show higher levels of subsequent positive emotions. Notably, positive emotions significantly increased across time, but baseline CVH did not interact with time to predict rate of change in positive emotions. Interactions between baseline CVH and sex or race were not statistically significant (data not shown).

Discussion

Despite recent calls for promoting favorable CVH, the antecedents of CVH, particularly psychosocial contributors, have not been longitudinally examined.[35] This is the first study to examine positive emotions' association with CVH using prospective longitudinal data across as many as 20 years. Individuals with higher levels of positive emotions were more likely to have healthier CVH scores during follow-up. These associations were evident after accounting for sociodemographic factors, health status, and potential pathway variables such as physical activity. Although the size of associations may seem relatively small, they are consistent with findings from older adults[13] and may translate into a substantial impact at the population level or when effects accumulate over time.[36, 37] Moreover, the effect sizes reported here for positive emotions are comparable in size to other correlates of CVH. For example, each one year increase in age showed a decrease in CVH comparable in magnitude to the increase in CVH associated with one SD increase in positive emotions.

Contrary to initial hypotheses, positive emotions were not associated with a slower rate of decline in CVH across time. These findings could suggest that positive emotions contribute to establishing a foundation for favorable CVH, but over time other factors contribute to how slowly or quickly CVH deteriorates or whether it can be maintained. Processes leading to health declines are entrenched by early to middle adulthood, at ages prior to our study period. Identifying factors that help establish higher initial levels of CVH is important as they may set up a reserve from which to draw on when declines occur. With larger reserves, it may take longer to deteriorate into poor CVH.

Unlike prior work, the current study had nearly equal numbers of men and women, as well as Blacks and Whites, and was sufficiently powered to detect subgroup differences. Particularly noteworthy, associations between positive emotions and CVH were similar for Blacks and Whites; to our knowledge this is the first study to assess potential differences by race. Also notable was that associations differed somewhat between men and women whereby women tended to have stronger associations between positive emotions and CVH compared with men. It is unclear why this might be. Past research has not typically reported differences in positive emotions and related psychosocial factors based on sex.[38] Moreover, positive emotions appear to be similarly protective against CVD for both men and women.[21]

However, some evidence suggests that effects of psychosocial factors on cardiovascular outcomes are more potent in women.[39] Furthermore, there are known sex-related differences in the cardiovascular system (e.g., hormonal influences, anatomy, physiology),[40] as well as in CVD prevalence and timing of onset.[41] Consistent with past work showing women are more likely to have better CVH than men,[42] fewer men (12.1%) than women (18.1%) in the analytic sample started with favorable CVH. This discrepancy may make it difficult to see relatively small effects of positive emotions in a group that already has poorer CVH. It will be important to determine whether associations hold in other samples.

Positive emotions' association with each individual CVH component was weak, especially after controlling for sociodemographic and health-related variables. This may suggest that no specific CVH component is driving the primary findings, but rather the impact on overall CVH may be greater than the sum of its parts. In other words, preserving CVH on the whole may be beneficial for the long-term prevention of CVD, rather than focusing on any single component.[35]

A notable strength of this study is that CARDIA's repeated assessments provided an opportunity to examine whether baseline health is prospectively associated with changes in positive emotions over time. Although the relationship between positive emotions and CVH is likely bidirectional to some extent, it is important to determine their temporal sequencing to inform strategies for prevention and intervention. If future studies can show that positive emotions contribute causally to attaining and preserving favorable CVH, then positive emotions may serve as a novel therapeutic target with the ultimate goal of improving CVH over the long-term.[43] However, no work to date investigates whether favorable CVH is longitudinally related to positive emotions. Present findings demonstrate baseline CVH was associated with greater positive emotions, but did not impact rate of change in positive emotions over time. Thus, positive emotions and CVH may be tracking together. It is clear individuals with high versus low levels of positive emotions tend to have higher CVH scores (Supplemental Figure 1). However, we cannot conclusively determine whether the association is truly bidirectional or if effects are primarily occurring in one direction. If effects are set earlier in the lifespan, further disentangling these associations may only be possible with data collected from younger individuals.

Other limitations of the current study include the inability to generalize to other populations such as rural communities, non-Whites, or non-Blacks. In addition, there was imperfect assessment of diet via fast food consumption and findings should be viewed cautiously until work with more robust measures are available (e.g., validated food frequency questionnaires). Further potential confounders (e.g., hormonal influences) could also be considered in other cohorts where the relevant data is available. In addition, positive emotions were derived from an inventory originally designed to assess depressive symptoms. However, a meta-analysis of the factor structure of the CES-D Scale reliably derived the positive emotions component, as did the original article.[27, 28] Other research has assessed positive emotions similarly and reported associations with incident stroke.[20] Moreover, in our study, higher levels of positive emotions were associated with being married and having higher education and income levels, in ways consistent with findings from studies using other validated measures of positive emotions.[44] Future work could examine alternative

approaches to assessing positive emotions (including other validated self-report measures or facial coding of smiling). This would complement lab-based studies in which positive emotions are directly manipulated or assessed via ecological momentary assessment to examine effects on health-relevant acute physiological responses. Consistent with the findings reported here, such studies suggest that positive emotions may be associated with healthier cardiovascular and immune function.[15, 17, 45]

These limitations are balanced by substantial strengths including low attrition rates in a diverse sample comprised of Black and White men and women from various educational backgrounds. The longitudinal design allowed for up to 20 years of follow-up across a period in the lifespan when health often declines. We statistically controlled for a wide range of potential confounding (e.g., socioeconomic status) and pathway variables (e.g., physical activity). Associations were consistent regardless of which variables were in the model, including negative emotions. Finally, we used a metric of CVH comprised mostly of objectively-assessed factors, which shows validity via associations with healthy longevity and allows health to be quantified prior to diagnosis of disease.

Conclusions

We found evidence suggesting positive emotions are prospectively associated with better CVH through young adulthood to middle age, but not with rate of change in CVH. Moreover, it is not clear whether positive emotions or CVH comes first; they may occur in tandem. Thus, an important implication is that efforts to protect CVH in middle to later adulthood may be beyond the etiologic window for effectiveness. Instead, it may be important to consider positive emotions' association with the preservation of favorable CVH in adolescence or even childhood, before a trajectory of CVH is established or CVH becomes compromised.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Sources of Funding

This specific research study was supported by the National Institute on Aging (NIA; R03AG046342). The Coronary Artery Risk Development in Young Adults Study (CARDIA) is conducted and supported by the National Heart, Lung, and Blood Institute (NHLBI) in collaboration with the University of Alabama at Birmingham (HHSN268201800005I & HHSN268201800007I), Northwestern University (HHSN268201800003I), University of Minnesota (HHSN268201800006I), and Kaiser Foundation Research Institute (HHSN268201800004I). Rosalba Hernandez was funded by NHLBI (1K01HL130712-01A4) and Farah Qureshi was supported by training grants from the National Institutes of Health (T32 098048 and T32 CA 009001). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. This manuscript has been reviewed by CARDIA for scientific content.

Abbreviations

BMI	body mass index
CVD	cardiovascular disease
CVH	cardiovascular health

CES-D	Center for Epidemiological Studies Depression
CI	confidence interval
CARDIA	Coronary Artery Risk Development in Young Adults
M	mean
RR	relative risk
SD	standard deviation

References

1. Benjamin EJ, Virani SS, Callaway CW, Chamberlain AM, Chang AR, Cheng S, Chiuve SE, Cushman M, Delling FN, Deo R, de Ferranti SD, Ferguson JF, Fornage M, Gillespie C, Isasi CR, Jimenez MC, Jordan LC, Judd SE, Lackland D, Lichtman JH, Lisabeth L, Liu S, Longenecker CT, Lutsey PL, Mackey JS, Matchar DB, Matsushita K, Mussolino ME, Nasir K, O'Flaherty M, Palaniappan LP, Pandey A, Pandey DK, Reeves MJ, Ritchey MD, Rodriguez CJ, Roth GA, Rosamond WD, Sampson UKA, Satou GM, Shah SH, Spartano NL, Tirschwell DL, Tsao CW, Voeks JH, Willey JZ, Wilkins JT, Wu JH, Alger HM, Wong SS and Muntner P. Heart disease and stroke statistics-2018 update: A report from the American Heart Association. Circulation. 2018;137:e67–e492. doi: 10.1161/cir.0000000000000558 [PubMed: 29386200]
2. Heron M and Anderson RN. Changes in the leading cause of death: Recent patterns in heart disease and cancer mortality. NCHS data brief, *no* 254 2016.
3. Lloyd-Jones DM, Hong Y, Labarthe D, Mozaffarian D, Appel LJ, Van Horn L, Greenlund K, Daniels S, Nichol G, Tomaselli GF, Arnett DK, Fonarow GC, Ho PM, Lauer MS, Masoudi FA, Robertson RM, Roger V, Schwamm LH, Sorlie P, Yancy CW and Rosamond WD. Defining and setting national goals for cardiovascular health promotion and disease reduction: the American Heart Association's strategic impact goal through 2020 and beyond. Circulation. 2010;121:586–613. doi: 10.1161/CIRCULATIONAHA.109.192703 [PubMed: 20089546]
4. Daviglus ML, Stamler J, Pirzada A, Yan LL, Garside DB, Liu K, Wang R, Dyer AR, Lloyd-Jones DM and Greenland P. Favorable cardiovascular risk profile in young women and long-term risk of cardiovascular and all-cause mortality. JAMA. 2004;292:1588–92. doi: 10.1001/jama.292.13.1588 [PubMed: 15467061]
5. Pool LR, Ning H, Lloyd-Jones DM and Allen NB. Trends in racial/ethnic disparities in cardiovascular health among US adults from 1999–2012. Journal of the American Heart Association. 2017;6. doi: 10.1161/jaha.117.006027
6. Daviglus ML, Pirzada A, Durazo-Arvizu R, Chen J, Allison M, Aviles-Santa L, Cai J, Gonzalez HM, Kaplan RC, Schneiderman N, Sorlie PD, Talavera GA, Wassertheil-Smoller S and Stamler J. Prevalence of low cardiovascular risk profile among diverse Hispanic/Latino adults in the United States by age, sex, and level of acculturation: The Hispanic Community Health Study/Study of Latinos. Journal of the American Heart Association. 2016;5. doi: 10.1161/jaha.116.003929
7. Wilsgaard T, Loehr LR, Mathiesen EB, Lochen ML, Bonaa KH, Njolstad I and Heiss G. Cardiovascular health and the modifiable burden of incident myocardial infarction: the Tromso Study. BMC Public Health. 2015;15:221. doi: 10.1186/s12889-015-1573-0 [PubMed: 25885647]
8. Lloyd-Jones DM, Leip EP, Larson MG, D'Agostino RB, Beiser A, Wilson PW, Wolf PA and Levy D. Prediction of lifetime risk for cardiovascular disease by risk factor burden at 50 years of age. Circulation. 2006;113:791–8. doi: 10.1161/circulationaha.105.548206 [PubMed: 16461820]
9. Allen NB, Zhao L, Liu L, Daviglus M, Liu K, Fries J, Shih YT, Garside D, Vu TH, Stamler J and Lloyd-Jones DM. Favorable cardiovascular health, compression of morbidity, and healthcare costs: forty-year follow-up of the CHA Study (Chicago Heart Association Detection Project in Industry). Circulation. 2017;135:1693–1701. doi: 10.1161/circulationaha.116.026252 [PubMed: 28461414]

10. Appleton AA, Buka SL, Loucks EB, Rimm EB, Martin LT and Kubzansky LD. A prospective study of positive early-life psychosocial factors and favorable cardiovascular risk in adulthood. Circulation. 2013;127:905–12. doi: 10.1161/circulationaha.112.115782 [PubMed: 23339873]
11. Slopen N, Chen Y, Guida JL, Albert MA and Williams DR. Positive childhood experiences and ideal cardiovascular health in midlife: Associations and mediators. Prev Med. 2017;97:72–79. doi: 10.1016/j.ypmed.2017.01.002 [PubMed: 28087467]
12. Hernandez R, Kershaw KN, Siddique J, Boehm JK, Kubzansky LD, Diez-Roux A, Ning H and Lloyd-Jones DM. Optimism and cardiovascular health: Multi-Ethnic Study of Atherosclerosis (MESA). Health Behav Policy Rev. 2015;2:62–73. doi: 10.14485/HBPR.2.1.6 [PubMed: 26213688]
13. Boehm JK, Soo J, Chen Y, Zevon ES, Hernandez R, Lloyd-Jones D and Kubzansky LD. Psychological well-being's link with cardiovascular health in older adults. Am J Prev Med. 2017. doi: 10.1016/j.amepre.2017.06.028
14. Pressman SD and Cohen S. Does positive affect influence health? Psychol Bull. 2005;131:925–71. doi: 10.1037/0033-2909.131.6.925 [PubMed: 16351329]
15. Pressman SD, Jenkins BN and Moskowitz JT. Positive affect and health: What do we know and where next should we go? Annu Rev Psychol. 2018. doi: 10.1146/annurev-psych-010418-102955
16. Martin-Maria N, Miret M, Caballero FF, Rico-Uribe LA, Steptoe A, Chatterji S and Ayuso-Mateos JL. The impact of subjective well-being on mortality: A meta-analysis of longitudinal studies in the general population. Psychosom Med. 2017;79:565–575. doi: 10.1097/psy.0000000000000444 [PubMed: 28033196]
17. Steptoe A Happiness and Health. Annu Rev Public Health. 2019. doi: 10.1146/annurevpublhealth-040218-044150
18. Boehm JK and Kubzansky LD. The heart's content: the association between positive psychological well-being and cardiovascular health. Psychol Bull. 2012;138:655–691. doi: 10.1037/a0027448 [PubMed: 22506752]
19. Ostir GV, Berges IM, Markides KS and Ottenbacher KJ. Hypertension in older adults and the role of positive emotions. Psychosom Med. 2006;68:727–33. doi: [PubMed: 17012526]
20. Ostir GV, Markides KS, Peek MK and Goodwin JS. The association between emotional well-being and the incidence of stroke in older adults. Psychosom Med. 2001;63:210–5. doi: 10.1097/00006842-200103000-00003 [PubMed: 11292267]
21. Davidson KW, Mostofsky E and Whang W. Don't worry, be happy: Positive affect and reduced 10-year incident coronary heart disease: The Canadian Nova Scotia Health Survey. Eur Heart J. 2010;31:1065–1070. doi: 10.1093/eurheartj/ehp603 [PubMed: 20164244]
22. Cooper R, Cutler J, Desvigne-Nickens P, Fortmann SP, Friedman L, Havlik R, Hogelin G, Marler J, McGovern P, Morosco G, Mosca L, Pearson T, Stamler J, Stryer D and Thom T. Trends and disparities in coronary heart disease, stroke, and other cardiovascular diseases in the United States: findings of the national conference on cardiovascular disease prevention. Circulation. 2000;102:3137–47. doi: 10.1161/01.cir.102.25.3137 [PubMed: 11120707]
23. Mensah GA, Mokdad AH, Ford ES, Greenlund KJ and Croft JB. State of disparities in cardiovascular health in the United States. Circulation. 2005;111:1233–41. doi: 10.1161/01.cir.0000158136.76824.04 [PubMed: 15769763]
24. Havranek EP, Mujahid MS, Barr DA, Blair IV, Cohen MS, Cruz-Flores S, Davey-Smith G, Dennison-Himmelfarb CR, Lauer MS, Lockwood DW, Rosal M and Yancy CW. Social determinants of risk and outcomes for cardiovascular disease: a scientific statement from the American Heart Association. Circulation. 2015;132:873–98. doi: 10.1161/cir.0000000000000228 [PubMed: 26240271]
25. Friedman GD, Cutter GR, Donahue RP, Hughes GH, Hulley SB, Jacobs DR Jr., Liu K and Savage PJ. CARDIA: study design, recruitment, and some characteristics of the examined subjects. J Clin Epidemiol. 1988;41:1105–16. doi: 10.1016/0895-4356(88)90080-7 [PubMed: 3204420]
26. Ortega FB, Lee DC, Sui X, Kubzansky LD, Ruiz JR, Baruth M, Castillo MJ and Blair SN. Psychological well-being, cardiorespiratory fitness, and long-term survival. Am J Prev Med. 2010;39:440–8. doi: 10.1016/j.amepre.2010.07.015. [PubMed: 20965381]

27. Radloff LS. The CES-D Scale: A self-report depression scale for research in the general population. Appl Psychol Meas. 1977;1:385–401. doi:
28. Shafer AB. Meta-analysis of the factor structures of four depression questionnaires: Beck, CES-D, Hamilton, and Zung. J Clin Psychol. 2006;62:123–146. doi: 10.1002/jclp.20213 [PubMed: 16287149]
29. Sheehan TJ, Fifield J, Reisine S and Tennen H. The measurement structure of the Center for Epidemiologic Studies Depression Scale. J Pers Assess. 1995;64:507–521. doi: 10.1207/s15327752jpa6403_9 [PubMed: 7760258]
30. Kehoe R, Wu SY, Leske MC and Chylack LT Jr. Comparing self-reported and physician-reported medical history. Am J Epidemiol. 1994;139:813–8. doi: 10.1093/oxfordjournals.aje.a117078 [PubMed: 8178794]
31. Wagenknecht LE, Burke GL, Perkins LL, Haley NJ and Friedman GD. Misclassification of smoking status in the CARDIA study: a comparison of self-report with serum cotinine levels. Am J Public Health. 1992;82:33–6. doi: 10.2105/ajph.82.1.33 [PubMed: 1536331]
32. Pereira MA, FitzerGerald SJ, Gregg EW, Joswiak ML, Ryan WJ, Suminski RR, Utter AC and Zmuda JM. A collection of physical activity questionnaires for health-related research. Med Sci Sports Exerc. 1997;29:S1–205. doi: [PubMed: 9243481]
33. Jacobs J, Hahn L, Haskell WL, Pirie P and Sidney S. Validity and reliability of a short physical activity history: CARDIA and the Minnesota Heart Health Program. J Cardiopulmon Rehab. 1989;9:448–459. doi: 10.1097/00008483-198911000-00003
34. Halanych JH, Safford MM, Kertesz SG, Pletcher MJ, Kim YI, Person SD, Lewis CE and Kiefe CI. Alcohol consumption in young adults and incident hypertension: 20-year follow-up from the Coronary Artery Risk Development in Young Adults Study. Am J Epidemiol. 2010;171:532–9. doi: 10.1093/aje/kwp417 [PubMed: 20118194]
35. Lloyd-Jones DM. Cardiovascular health and protection against CVD: more than the sum of the parts? Circulation. 2014;130:1671–3. doi: 10.1161/circulationaha.114.012869 [PubMed: 25273999]
36. Roberts BW, Kuncel NR, Shiner R, Caspi A and Goldberg LR. The power of personality: the comparative validity of personality traits, socioeconomic status, and cognitive ability for predicting important life outcomes. Perspect Psychol Sci. 2007;2:313–345. doi: 10.1111/j.1745-6916.2007.00047.x. [PubMed: 26151971]
37. Friedman HS and Booth-Kewley S. The ‘disease-prone personality’: A meta-analytic view of the construct. Am Psychol. 1987;42:539–555. doi: 10.1037//0003-066x.42.6.539 [PubMed: 3619180]
38. Diener E and Ryan K. Subjective well-being: A general overview. South African Journal of Psychology. 2009;39:391–406. doi: 10.1177/008124630903900402
39. Thurston RC and Kubzansky LD. Multiple sources of psychosocial disadvantage and risk of coronary heart disease. Psychosom Med. 2007;69:748–55. doi: 10.1097/PSY.0b013e31815772a3 [PubMed: 17942839]
40. McSweeney JC, Rosenfeld AG, Abel WM, Braun LT, Burke LE, Daugherty SL, Fletcher GF, Gulati M, Mehta LS, Pettey C and Reckelhoff JF. Preventing and Experiencing Ischemic Heart Disease as a Woman: State of the Science: A Scientific Statement From the American Heart Association. Circulation. 2016;133:1302–31. doi: 10.1161/cir.0000000000000381 [PubMed: 26927362]
41. Mosca L, Barrett-Connor E and Wenger NK. Sex/gender differences in cardiovascular disease prevention: what a difference a decade makes. Circulation. 2011;124:2145–54. doi: 10.1161/circulationaha.110.968792 [PubMed: 22064958]
42. Simon M, Boutouyrie P, Narayanan K, Gaye B, Tafflet M, Thomas F, Guibout C, Perier MC, Pannier B, Jouven X and Empana JP. Sex disparities in ideal cardiovascular health. Heart. 2017;103:1595–1601. doi: 10.1136/heartjnl-2017-311311 [PubMed: 28754808]
43. Kubzansky LD, Huffman JC, Boehm JK, Hernandez R, Kim ES, Koga HK, Feig EH, Lloyd-Jones DM, Seligman MEP and Labarthe DR. Positive psychological well-being and cardiovascular disease: JACC health promotion series. J Am Coll Cardiol. 2018;72:1382–1396. doi: 10.1016/j.jacc.2018.07.042 [PubMed: 30213332]

44. Lyubomirsky S, King L and Diener E. The benefits of frequent positive affect: does happiness lead to success? Psychol Bull. 2005;131:803–55. doi: 10.1037/0033-2909.131.6.803 [PubMed: 16351326]

45. Marsland AL, Pressman SD and Cohen S. Positive affect and immune function. Psychoneuroimmunology. 2007;2:761–779. doi:

Highlights

- Correlates of cardiovascular health were examined in Black and white men and women
- Greater positive emotions were associated with cardiovascular health across 20 years
- Associations were stronger for women than men, but race did not modify associations
- Future work could explore associations earlier in life, before health deteriorates

Table 1:

Mean levels of positive emotions by participant characteristics at Year 5 (N=4,196).

Participant Characteristics	n (%)	Mean Positive Emotions (SD)	p^b
Age			
21–30 Years	2,143 (51.1)	8.29 (2.7)	0.7
31 Years or Older	2,053 (48.9)	8.33 (2.7)	
Sex			
Male	1,882 (44.8)	8.48 (2.6)	<0.001
Female	2,314 (55.2)	8.17 (2.8)	
Race			
White	2,182 (52.0)	8.51 (2.6)	<0.001
Black	2,014 (48.0)	8.09 (2.8)	
Marital Status			
Married	1,711 (40.8)	8.78 (2.6)	<0.001
Unmarried[a]	2,485 (59.2)	7.99 (2.7)	
Education			
Less than High School	246 (5.9)	7.62[c] (2.7)	<0.001
High School	1,058 (25.2)	7.96[c] (2.8)	
Some College	1,254 (29.9)	8.25[d] (2.7)	
College or Higher	1,638 (39.0)	8.69[e] (2.6)	
Family Income			
$0–$24,999	1,601 (38.2)	7.87[c] (2.8)	<0.001
$25,000–$49,999	1,588 (37.9)	8.38[d] (2.7)	
$50,000–$74,999	609 (14.5)	8.83[e] (2.5)	
≥$75,000	398 (9.5)	9.00[e] (2.4)	
Weekly Fast Food Consumption			
0 or 1 Time(s)	2,046 (48.8)	8.35 (2.7)	0.3
2 Times or More	2,150 (51.2)	8.27 (2.7)	
Physical Activity Level			
Low	1,323 (31.5)	7.86[c] (2.7)	<0.001
Moderate	1,038 (24.7)	8.26[d] (2.7)	
Moderate-High	991 (23.6)	8.61[e] (2.6)	
High	844 (20.1)	8.72[e] (2.6)	
Alcohol Consumption			
Low to Moderate	3,699 (88.2)	8.35 (2.7)	0.02
High	497 (11.8)	8.04 (2.8)	
Diagnosis of Heart Problems[f]			
Yes	341 (8.2)	8.28 (2.8)	0.9
No	3,827 (91.8)	8.31 (2.7)	
Diagnosis of Cancer[f]			

Participant Characteristics	n (%)	Mean Positive Emotions (SD)	p^b
Yes	57 (1.4)	8.07 (2.7)	0.5
No	4,132 (98.6)	8.32 (2.7)	
Negative Emotions[f, g]			
Low to Moderate	3,154 (75.2)	9.00 (2.4)	<0.001
High	1,039 (24.8)	6.21 (2.4)	

[a] The unmarried category includes participants who were widowed, divorced, separated, never married, or other.

[b] Differences between groups were tested using ANOVA; for more than two subgroups, means with different subscripts (c, d, e) are significantly different from one another.

[f] Sample sizes may vary due to missing baseline data on these time-updated variables.

[g] Negative emotions were used as a binary variable for this table (low to moderate <3; high ≥3), but a continuous variable in all other analyses.

Table 2:

Association between baseline positive emotions (standardized) and cardiovascular health scores (continuous) during follow-up (N=4,196).[a]

	Model 1 β (95% CI)	Model 2 β (95% CI)	Model 3 β (95% CI)
Positive Emotions	0.06 (0.03, 0.08)	0.03 (0.007, 0.06)	0.03 (−0.001, 0.05)
Time[b]	−0.05 (−0.05, −0.05)	−0.05 (−0.05, −0.05)	−0.05 (−0.05, −0.05)
Age	−0.04 (−0.04, −0.03)	−0.05 (−0.06, −0.04)	−0.05 (−0.05, −0.04)
Female		0.29 (0.24, 0.35)	0.28 (0.23, 0.33)
Black		−0.17 (−0.22, −0.11)	−0.16 (−0.21, −0.10)
Married		−0.002 (−0.02, 0.02)	−0.0002 (−0.02, 0.02)
Education			
Less than High School		Reference	Reference
High School		0.13 (0.01, 0.25)	0.09 (−0.03, 0.21)
Some College		0.22 (0.10, 0.34)	0.16 (0.04, 0.28)
College or Higher		0.56 (0.44, 0.68)	0.49 (0.37, 0.61)
Family Income			
≤$24,999		Reference	Reference
$25,000–49,999		−0.02 (−0.08, 0.04)	−0.02 (−0.08, 0.05)
$50,000–$74,999		0.02 (−0.07, 0.11)	0.01 (−0.08, 0.10)
≥$75,000		0.06 (−0.05, 0.16)	0.06 (−0.04, 0.16)
Fast Food Consumption			−0.01 (−0.04, −0.008)
Physical Activity			
Low			Reference
Moderate			0.03 (−0.04, 0.10)
Moderate-High			0.10 (0.02, 0.17)
High			0.16 (0.08, 0.23)
Alcohol Consumption			
Low to Moderate			Reference
High			−0.25 (−0.33, −0.17)
Heart Problems[c]			−0.05 (−0.09, −0.001)
Cancer[c]			−0.0005 (−0.07, 0.07)

[a] Linear mixed effects models were used to estimate the association.

[b] Because positive emotions did not interact with time (interaction term in age-adjusted model: β=0.0008; p=0.2), the interaction term was not included in any of the models presented.

[c] Time-updated variable.

Table 3:

Association between baseline positive emotions (standardized) and cardiovascular health scores (continuous) during follow-up, stratified by sex or race (N=4,196).[a,b]

Women (n=2,314)	Men (n=1,882)	Blacks (n=2,014)	Whites (n=2,182)
β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
0.03 (0.001, 0.06)	0.01 (−0.03, 0.06)	0.01 (−0.03, 0.04)	0.04 (0.004, 0.08)

[a] Linear mixed effects models were used to estimate the association.

[b] The sex-stratified model adjusted for age, race, marital status, education, and family income, while the race-stratified model adjusted for age, sex, marital status, education, and family income.

Table 4:

Association between baseline cardiovascular health scores (continuous) and positive emotions (continuous) during follow-up (N=4,103).[a]

	Model 1 β (95% CI)	Model 2 β (95% CI)	Model 3 β (95% CI)
Cardiovascular Health	0.16 (0.09, 0.22)	0.09 (0.02, 0.15)	0.06 (−0.003, 0.13)
Time	0.009 (0.004, 0.01)	0.008 (0.003, 0.01)	0.009 (0.004, 0.01)
Age	0.0005 (−0.02, 0.02)	−0.04 (−0.06, −0.02)	−0.04 (−0.05, −0.02)
Female		−0.17 (−0.29, −0.04)	−0.17 (−0.29, −0.04)
Black		−0.10 (−0.24, 0.03)	−0.08 (−0.21, 0.06)
Married		−0.14 (−0.18, −0.09)	−0.14 (−0.19, −0.10)
Education			
Less than High School		Reference	Reference
High School		0.20 (−0.09, 0.50)	0.12 (−0.18, 0.42)
Some College		0.60 (0.30, 0.90)	0.48 (0.18, 0.78)
College or Higher		0.84 (0.54, 1.15)	0.72 (0.42, 1.02)
Family Income			
≤$24,999		Reference	Reference
$25,000–49,999		0.26 (0.11, 0.41)	0.25 (0.09, 0.40)
$50,000–$74,999		0.40 (0.19, 0.61)	0.36 (0.15, 0.57)
≥$75,000		0.63 (0.38, 0.89)	0.60 (0.34, 0.85)
Fast Food Consumption			0.004 (−0.02, 0.03)
Physical Activity			
Low			Reference
Moderate			0.25 (0.08, 0.41)
Moderate-High			0.53 (0.36, 0.70)
High			0.58 (0.40, 0.80)
Alcohol Consumption			
Low to Moderate			Reference
High			−0.15 (0.35, 0.05)
Heart Problems[c]			−0.10 (−0.24, 0.05)
Cancer[c]			0.02 (−0.19, 0.24)

[a] Linear mixed effects models were used to estimate the association.

[b] Because cardiovascular health did not interact with time (interaction term in age-adjusted model: β=0.001; p=0.20), the interaction term was not included in any of the models presented.

[c] Time-updated variable.