2014

Taking the Tension Out of Hypertension: A Prospective Study of Psychological Well-Being and Hypertension

Claudia Trudel-Fitzgerald
Laval University

Julia K. Boehm
Chapman University, jboehm@chapman.edu

Mika Kivimaki
University College London

Laura D. Kubzansky
Harvard School of Public Health

Recommended Citation
Trudel-Fitzgerald, C., Boehm, J. K., Kivimaki, M., & Kubzansky, L. D. (2014). Taking the tension out of hypertension: A prospective study of psychological well-being and hypertension. *Journal of Hypertension, 32*(6), 1222–1228. http://doi.org/10.1097/HJH.0000000000000175

Taking the Tension Out of Hypertension: A Prospective Study of Psychological Well-Being and Hypertension

HHS Public Access

Author manuscript

J Hypertens. Author manuscript; available in PMC 2016 September 02.

Published in final edited form as:

J Hypertens. 2014 June ; 32(6): 1222–1228. doi:10.1097/HJH.0000000000000175.

Taking the Tension Out of Hypertension: A Prospective Study of Psychological Well-Being and Hypertension

Claudia TRUDEL-FITZGERALD, B.A.[a], **Julia K. BOEHM, Ph.D.**[b], **Mika KIVIMAKI, Ph.D.**[c], and **Laura D. KUBZANSKY, Ph.D., MPH**[d]

[a] School of Psychology, Laval University, 2325 rue des Bibliothèques, Québec (Québec), CANADA, G1V 0A6

[b] Department of Psychology, Chapman University, One University Drive, Orange, CA 92688

[c] Department of Epidemiology and Public Health, University College London, 1-19 Torrington Place, WC1E 6BT London, UK

[d] Department of Social and Behavioral Sciences, Harvard School of Public Health, 677 Huntington Avenue, Boston, MA 02115, USA

Abstract

Background—Previous studies have shown that psychological well-being is associated with reduced risk of cardiovascular disease. However, whether well-being might be specifically associated with reduced risk of hypertension has not been rigorously investigated in prospective studies.

Objective—This study examined the prospective association between two measures of psychological well-being and incident hypertension.

Methods—Participants were 6,384 healthy British civil servants age 39 to 63 from the Whitehall II cohort. Psychological well-being (emotional vitality and optimism) and cardiovascular risk factors (demographic characteristics, health status, health behaviors, psychological ill-being) were assessed during the 1991-1994 baseline. Incident hypertension was defined by clinical measures of systolic or diastolic blood pressure >140/90 mmHg, self-reported physician-diagnosed hypertension, or treatment for hypertension. Follow-up assessments of hypertension took place approximately every three years through 2002-2004. Cox proportional hazards regression models estimated hazard ratios.

Results—There were 2,304 cases of incident hypertension during the follow-up period. High versus low emotional vitality was associated with a significantly reduced risk of hypertension in an

CORRESPONDENCE AND REPRINT REQUESTS Dr. Kubzansky, Department of Social and Behavioral Sciences, Harvard School of Public Health, 677 Huntington Avenue, Boston, MA 02115, USA; Phone: 617-432-3589; Fax: 617-432-3123; lkubzans@hsph.harvard.edu.

PREVIOUS PRESENTATIONS

Part of the work has been presented in posters at the 71st Annual Scientific Meeting of the American Psychosomatic Society, Miami, USA (March 2013), and at the 13th Annual Meeting of La Société québécoise de lipidologie, de nutrition et de métabolisme, Québec, Canada (May 2012).

CONFLICT OF INTEREST

None declared.

age-adjusted model (hazard ratio = 0.89; 95% confidence interval 0.80-0.98). This association was maintained after controlling for demographic characteristics and health status, but was slightly attenuated after adjusting for health behaviors and ill-being. Optimism was not significantly associated with hypertension.

Conclusions—High emotional vitality was associated with reduced hypertension risk; favorable health behaviors explained only part of the relationship. Associations did not differ by age, were similar for men and women and were maintained after accounting for ill-being.

Keywords

well-being; vitality; optimism; hypertension; blood pressure; longitudinal study; Whitehall II cohort; health behaviors; risk factors

INTRODUCTION

Cardiovascular disease (CVD) is a leading cause of death in developed countries [1, 2]. Although CVD is often preventable, the burden of disease remains substantial and additional approaches to prevention are needed [1, 3]. Research has mainly focuses on identifying modifiable risk factors, but additional insight may also be gained by identifying modifiable *protective* factors that can be targets of prevention. Psychological ill-being, often characterized by high levels of anxiety and depression, is associated with increased risk of CVD [4, 5]. However, psychological well-being may also be useful to investigate in the context of CVD.

Psychological well-being can be conceptualized as having positive feelings and thoughts towards life. It includes constructs such as satisfaction, positive emotion, optimism, and emotional vitality, and represents something more than simply the opposite or absence of ill-being [6, 7]. A recent review identified two constructs of psychological well-being as having consistent associations with reduced risk of CVD: emotional vitality, that is, a whole-hearted spirit for life and the ability to regulate emotions; and optimism, a tendency to believe that good events will occur more frequently than bad events [8]. For example, one study found that both emotional vitality and optimism were associated with up to a 15% reduced risk of coronary heart disease after adjusting for conventional risk factors [9]. However, little work to date has considered emotional vitality or optimism in relation to hypertension, a key risk factor for CVD, as well as an important outcome in its own right [10-12].

Among the limited and primarily cross-sectional studies that have examined the association between psychological well-being and hypertension, findings are mixed. Some studies have found a protective effect of psychological well-being in relation to blood pressure [13-15]. For instance, happiness was inversely related to blood pressure levels after controlling for confounding variables including health behaviors and negative mood [15]. Other studies have reported a null or weak association between psychological well-being and ambulatory blood pressure or self-reported hypertension [16-19]. For example, in a two-year follow-up of older adults, baseline vitality was associated with a reduced risk of incident hypertension, although the association was attenuated after adjusting for conventional risk factors [18].

Given the mixed findings and limited number of prospective studies, additional research is warranted. Thus, our primary aim was to examine the prospective association between psychological well-being and incidence of hypertension using data from the Whitehall II cohort, a large sample of British civil servants. Because emotional vitality and optimism are robustly associated with CVD [8], those two measures of psychological well-being were investigated in relation to incident hypertension. We hypothesized that higher levels of emotional vitality and optimism would be associated with reduced risk of incident hypertension. We also investigated whether emotional vitality and optimism would be associated with a risk of hypertension if we considered cases of pre-hypertension as part of the outcome. Secondary analyses were conducted to assess whether the association between psychological well-being and hypertension, if any, varied by age or gender.

METHODS

Participants

The Whitehall II cohort is comprised of 10,308 British civil servants who were first examined during 1985-1988 (Phase 1). The Whitehall II cohort was initially designed to examine associations between social class and health, so the current analyses regarding psychological well-being were conceived after the data was collected. In the current study, Phase 3 (1991-1994; n = 8,815) was used as the baseline because psychological well-being (i.e., emotional vitality and optimism) was first measured then. For prospective analyses on incident hypertension, participants with missing data on psychological well-being (n = 523), with hypertension at baseline (n = 1,523), or without follow-up information (n = 385) were excluded, yielding a primary analytic sample of 6,384. When cases of pre-hypertension were included in the definition of incident hypertension, participants with pre-hypertension were also excluded at baseline, yielding an analytic sample of 3,112. All participants provided written informed consent. Human research ethics committees at University College London, University College London Hospital, and Harvard School of Public Health approved the research.

Measurement of Emotional Vitality and Optimism

Following previous work, five items regarding active engagement with the world, effective emotional regulation, and overall feelings of well-being were used to measure emotional vitality [9, 20]. Three of the five items were drawn from the Short Form-36 [21]. These included “How much of the time during the past 4 weeks did you feel full of life,” “...have a lot of energy,” and “...have you been a happy person,” (1 = *All the time,* 6 = *None of the time* [reverse-scored]). Two additional items were: “I have a sense of direction and purpose in my life,” (1 = *Strongly disagree*, 6 = *Strongly agree)*, and the reverse-scored “How often do you feel emotionally or mentally exhausted at the end of the day” (1 = *Hardly ever/never,* 4 = *Very often/always*). Each item was standardized ($M = 0$, $SD = 1$) and then averaged to form a composite with good internal consistency reliability ($\alpha = .79$). Higher scores indicated greater emotional vitality.

Optimism is defined as the expectation that more good than bad things will happen in life [22]. Because psychological well-being was not part of the initial focus of the Whitehall II

study, only one item was available to assess optimism: “Over the next 5-10 years I expect to have many more positive than negative experiences” (1 = *Strongly disagree,* 6 = *Strongly agree*).

Analyses were conducted using continuous and tertiled scores of each psychological well-being indicator. For continuous scores, a standardized score ($M = 0$, $SD = 1$) was used to facilitate interpretation of the findings (i.e., change in risk of hypertension for each standard deviation increase in psychological well-being). Tertiles of emotional vitality and optimism were determined by the distribution of scores to examine potential threshold effects. To categorize emotional vitality tertiles, standardized scores ranging from −3.39 to −0.41 were low (33.0%), scores from −0.41 to 0.51 were moderate (33.7%), and scores from 0.51 to 2.19 were high (33.3%). To categorize optimism tertiles, standardized scores from −3.16 to −0.55 were low (37.4%), scores from −0.55 to 0.32 were moderate (39.2%), and scores from 0.32 to 1.19 were high (23.4%). Tertiles (rather than quartiles) yielded the most even distribution of participants while also providing a sufficient number of hypertension cases per tertile.

Because the five items comprising the emotional vitality score were not all available in subsequent phases, and because optimism was not consistently assessed across the follow-up, time invariant vitality and optimism as well as covariates were used in all statistical analyses. Inspection of the distribution of covariates as measured at later phases (e.g., phase 5, phase 7) across baseline levels of psychological well-being suggested the patterning in covariates was highly similar over time.

Measurement of Hypertension

The primary prospective analyses used assessments of hypertension taken at each phase between Phase 3 and Phase 7 (2002-2004; mean follow-up 11.8 years, $SD = 0.7$). Medical examinations during Phases 3, 5 (1997-1999), and 7 provided clinically assessed levels of blood pressure. Blood pressure was measured twice while sitting after 5 minutes of rest with the Hawksley random-0 sphygmomanometer (Phases 3 and 5) and OMRON HEM 907 (Phase 7). The two readings were averaged for measures of systolic and diastolic blood pressure [23]. Participants with systolic blood pressure (SBP) ≥ 140 mmHg or diastolic blood pressure (DBP) ≥ 90 mmHg were identified as hypertensive cases. In Phases 4 (1995-1997), 5, and 7, participants also self-reported physician-diagnosed hypertension and use of hypertensive medication. These were added to the clinically-based criteria for identifying cases of incident hypertension. Separate analyses examined whether adding pre-hypertension cases (SBP = 120-140 mmHg; DBP = 80-90 mmHg) to the definition of incident hypertension altered associations. When pre-hypertension was included in the definition, the number of new cases of hypertension dropped substantially as individuals with pre-hypertensive status at baseline were also removed from the analytic sample, resulting in a highly conservative analysis.

Measurement of Covariates

Factors that could confound associations or be on the pathway linking psychological well-being with hypertension were included as covariates. Potential confounders included

demographic covariates assessing age (years), sex (men, women), ethnicity (white, non-white), marital status (married/cohabitating, other), and employment grade (administrative [highest level], professional [middle level], clerical/support [lowest level]). Health-related covariates included physician-diagnosed diabetes (yes, no) and hospital visit for myocardial infarction (yes, no). Potential pathway covariates that could link psychological well-being and hypertension included smoking status (current, former, never), alcohol consumption (low/moderate [women: <15 units/week; men: <22 units/week], high [women: ≥15 units/week; men: ≥22 units/week]), hours of physical activity (<1.5 hours/week, ≥1.5 hours/week of moderate and vigorous exercise), daily fruit and vegetable consumption (yes, no), and body mass index (BMI; kg/m^2). Finally, a broad measure of psychological ill-being was created with three items from the Short Form-36 [21]. Participants indicated (0 = *no*, 1 = *yes*) whether emotional problems like depression or anxiety led them to reduce their activities, accomplish less, or be less careful. Item scores were summed with total scores ranging from 0 to 3, and higher scores indicating greater ill-being (α = 0.78).

All covariates were measured at the Phase 3 baseline, except for gender (assessed at Phase 1) and ethnicity (derived from the Phase 1 and 5 questionnaires). Covariates were assessed by self-report, except BMI which was measured in a medical examination. BMI and current/past smoking status had the most missing data (4.2% and 2.1%, respectively); other covariates had 0-0.1% missing data.

Statistical Analyses

All analyses were conducted using SAS 9.3 [24] with a 5% level of significance. Multiple imputation procedures were used to impute missing data on covariates. Cross-sectional analyses compared baseline levels of psychological well-being across covariates using chi-square tests and analyses of variance. For prospective analyses, Cox proportional hazards regression models estimated hazard ratios (HR) and 95% confidence intervals (CI). The association between continuous psychological well-being and incident hypertension was examined in four nested models that controlled for baseline covariates. The first model adjusted for age only; the second model minimally-adjusted for demographics (age, sex, ethnicity, marital status, employment grade). The third model added health status (diabetes, myocardial infarction) and the fourth model added behavior-related covariates (smoking status, alcohol consumption, exercise, fruit and vegetable consumption, BMI). An additional model adjusted for demographics, health status, and ill-being. Next, tertiles of emotional vitality and optimism were used to examine possible threshold effects in the same set of models.

Secondary analyses stratified models by age (<55 years vs. ≥55 years) and gender (men vs. women), as well as examined the association between ill-being and incident hypertension. Further prospective analyses investigated whether psychological well-being was associated with incident hypertension when pre-hypertensive cases were included. Kleinbaum and Klein's guidelines [25] for testing the assumption of proportional hazards were followed. Minor violations of the assumption were found in some models, but overall findings remained the same when strategies to meet the assumption were implemented. Thus, as

suggested by others [26, 27], findings with standard proportional hazards models are presented.

RESULTS

Baseline Characteristics

At the Phase 3 baseline, participants were on average 49.2 years old (*SD* = 6.0; range 39-63). A majority of participants were men (68.1%) and white (91.8%). Mean BMI was 24.9 kg/m^2 and participants generally reported no history of diabetes or myocardial infarction (>99%). Because the distribution of risk factors according to tertiles of emotional vitality and optimism was highly similar, only descriptive statistics across tertiles of emotional vitality are presented in Table 1.

Psychological Well-Being and Incident Hypertension

There were 2,304 cases of incident hypertension during the follow-up period. Findings for the association between emotional vitality and risk of hypertension are presented in Table 2. In the age-adjusted model, each standard deviation increase in emotional vitality was associated with a 5% reduced risk of hypertension. The association was maintained when demographic characteristics and health status were added, and was somewhat attenuated when subsequent models adjusted for health behaviors. Findings were also somewhat attenuated after adjusting for ill-being (HR = 0.96, 95% CI: 0.92-1.00). Considering tertiles of emotional vitality, associations were similar if somewhat more pronounced (Table 2). The highest emotional vitality levels were significantly related to 10-11% reduced risk of incident hypertension (95% CIs: 0.80-0.99) in the first three models and 9% reduced risk (95% CI: 0.82-1.00) after accounting for health behaviors. Effect estimates when adjusting for ill-being were similar to those obtained after adjusting for health behaviors.

Optimism was not significantly associated with incident hypertension in any of the models. For example, in the age-adjusted model, continuous (HR = 1.00, 95% CI: 0.96-1.04) and categorical (highest level; HR = 0.99, 95% CI: 0.89-1.10) optimism was unrelated to hypertension, and findings were consistent in more fully adjusted models.

Secondary Analyses

Findings regarding the association between optimism and incident hypertension remained unchanged (i.e., null) when analyses were stratified by age ($n_{<55\ years}$ = 4,832; $n_{\geq 55\ years}$ = 1,552) and gender (n_{men} = 4,345; n_{women} = 2,039). The association between emotional vitality and hypertension was similar to findings from the pooled analysis across age groups and across men and women. Tests of the interactions of emotional vitality with either age or gender were not significant, suggesting that neither age nor gender moderated the relationship between emotional vitality and incident hypertension.

Ill-being was not significantly associated with incident hypertension when included in minimally-adjusted models with continuous emotional vitality (ill-being HR = 1.02, 95% CI: 0.97-1.08) or with optimism (ill-being HR = 1.02, 95% CI: 0.97-1.08). Ill-being on its

own was also not significantly associated with incident hypertension in minimally-adjusted models without either psychological well-being variable (HR = 1.02, 95% CI: 0.97-1.08).

When participants who became pre-hypertensive over the follow-up were included in the definition of case status for incident hypertension (n_{cases} = 1,622), neither emotional vitality nor optimism was significantly associated with hypertension in any model.

DISCUSSION

The aim of this study was to evaluate the prospective association between psychological well-being and incident hypertension in middle-aged men and women. Each standard deviation increase in emotional vitality was significantly associated with a 4-5% reduced risk of incident hypertension when controlling for demographic characteristics and health status. Findings were also largely maintained after adjusting for health behaviors and psychological ill-being. Furthermore, in tertiled analyses, the highest emotional vitality levels were associated with a 9-11% reduced risk of hypertension, although findings do not clearly point to a threshold effect or a dose-response gradient. Including cases of pre-hypertension to our definition of incident hypertension yielded a null association with emotional vitality. However, it is worth noting that hypertension is a common outcome, with nearly a third of the sample developing hypertension over the follow-up period, and even more when adding pre-hypertensive status to the case definition. The high prevalence suggests there may be many routes to hypertension, and may make it more difficult to parse the magnitude of risk according to specific risk factors.

Generally, findings with emotional vitality were consistent with those of previous work, which also found somewhat attenuated associations when covariates were included [18]. Others have suggested that health behaviors may partly account for the relationship between psychological well-being and hypertension [18, 28], but in the present study the hazard ratios for the association between emotional vitality and hypertension remained unchanged while the 95% CIs widened slightly when considering behaviors. Given that the magnitude of attenuation in the effect estimates was relatively limited with the addition of health behaviors, it remains unclear as to how strongly these behaviors can contribute to understanding any observed association between emotional vitality and incident hypertension. Similarly, the association between emotional vitality and hypertension remained marginally significant when ill-being was taken into account. Although ill-being was associated with emotional vitality, it seems likely that emotional vitality's association with incident hypertension is largely independent of ill-being because ill-being on its own was not associated with hypertension.

Optimism was not associated with incident hypertension, in either overall or stratified models. While optimism may simply not be related to hypertension, given the relatively strong association between optimism and CVD [8, 9] other explanations are possible. A single item measure may be unreliable and make it difficult to detect effects. While other hypertension studies using multi-item composites have reported null associations [16, 17], these previous studies were cross-sectional and most measured ambulatory blood pressure

levels. Thus, it remains unclear whether optimism is prospectively related to incident hypertension.

The consistency of findings across age and gender groups with regard to emotional vitality and incident hypertension suggests a robust although small relationship. For example, stratified analyses indicated that emotional vitality was protective against hypertension for both younger and older participants, and for both men and women. Other aspects of the study mitigate concerns about reverse causality. For example, individuals with hypertension were excluded from analyses to ensure psychological well-being preceded the development of hypertension.

This study has several strengths. The prospective design across an average of approximately 12 years rigorously investigated the relationship between psychological well-being and incident hypertension. Using both clinically-assessed and self-reported criteria for hypertension enhances internal validity, and the large sample size included men and women of varying ages. Nonetheless, some limitations should be mentioned. Despite its large size, the sample is somewhat homogeneous. Replication of this study with a more diverse sample would increase generalizability. Optimism was measured with one item, but other existing multi-item questionnaires [22] may assess the construct more comprehensively. The indicators of psychological well-being were measured during a single assessment at study baseline. Given that psychological well-being is dynamic and may vary over time [29], different patterns in the relationship between well-being and incident hypertension could be observed with repeated measures of these psychological constructs. Finally, it is possible that participants with lower baseline levels of optimism or emotional vitality developed psychological difficulties (e.g., depression) over the course of the study and were lost to follow-up, which could have influenced the results through selection bias. However, only 4% of the original baseline sample was excluded before conducting the analyses because of missing data that were necessary for the Cox regressions, which may lessen concerns about potential effects of selection bias. Moreover, participants who were included in the analyses but dropped out later on did not differ significantly in psychological well-being from participants with complete hypertension information throughout the follow-up period.

These findings add to knowledge regarding the relationship between psychological well-being and hypertension, and also suggest directions for future research. Given that health behaviors did not substantially alter associations between emotional vitality and incident hypertension, other mediating pathways like physiological responses (neuroendocrine, immune, and inflammatory processes) or modifying psychosocial factors (social support, coping strategies) should be further examined [30]. Greater insight might also be gained with repeated measures of psychological well-being over time. For example, in a 24-year study, individuals exhibiting a trajectory of “increasing depression” had a higher risk of hypertension compared to individuals with a “low/transient depression” trajectory [31]. Similar analyses could be conducted to determine the extent to which different trajectories of psychological well-being are related to hypertension.

To our knowledge, this is the first prospective study to examine whether emotional vitality and optimism have protective effects on incident hypertension over more than a decade. The

findings add to a growing literature suggesting that interventions that aim to increase emotional vitality (in addition to decreasing ill-being) may protect cardiovascular health [8]. Recent studies show that cognitive-behavioral therapy or practicing relaxation strategies influence mental and physical health not only by reducing ill-being, but also by increasing well-being [32, 33]. Unhealthy behaviors, which may be influenced by psychological well-being [34], might also be targeted to lower hypertension risk. Future interventions ought to evaluate the direct impact of such approaches on hypertension.

ACKNOWLEDGEMENTS

We appreciate participation of the Whitehall II cohort members, Civil Service departments, Occupational Health and Safety Agency, and Council of Civil Service Unions. We also thank members of the Whitehall II research team.

FUNDING

Support for this research was provided by the Robert Wood Johnson Foundation through a grant, “Exploring the Concept of Positive Health,” to the Positive Psychology Center of the University of Pennsylvania, Martin Seligman, project director. Ongoing data collection for the Whitehall II Study is funded by the Medical Research Council (K013351), National Institute on Aging (AG13196), National Heart Lung and Blood Institute (HL36310), and British Heart Foundation. CTF is supported by a Michael Smith Foreign Study Supplement (Canadian Institutes of Health Research); MK is supported by the Medical Research Council and a professorial fellowship from the Economic and Social Research Council.

REFERENCES

1. World Health Organization. Global status report on noncommunicable diseases. WHO Press, World Health Organization; Switzerland: 2010.
2. Lozano R, Naghavi M, Foreman K, Lim S, Shibuya K, Aboyans V, et al. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: A systematic analysis for the Global Burden of Disease Study 2010. Lancet. Dec 15.2012 380:2095–2128. [PubMed: 23245604]
3. Lloyd-Jones D, Adams RJ, Brown TM, Carnethon M, Dai S, De Simone G, et al. Heart disease and stroke statistics--2010 update: A report from the American Heart Association. Circulation. Feb 23.2010 121:e46–e215. [PubMed: 20019324]
4. Steptoe A, Kivimaki M. Stress and cardiovascular disease. Nat Rev Cardiol. Jun.2012 9:360–370. [PubMed: 22473079]
5. Suls J, Bunde J. Anger, anxiety, and depression as risk factors for cardiovascular disease: The problems and implications of overlapping affective dispositions. Psychol Bull. Mar.2005 131:260–300. [PubMed: 15740422]
6. Diener E, Emmons RA. The independence of positive and negative affect. J Pers Soc Psychol. 1984; 47:1105–1117. [PubMed: 6520704]
7. Ryff CD, Love GD, Urry HL, Muller D, Rosenkranz MA, Friedman EM, et al. Psychological well-being and ill-being: Do they have distinct or mirrored biological correlates? Psychother Psychosom. 2006; 75:85–95. [PubMed: 16508343]
8. Boehm JK, Kubzansky LD. The heart's content: The association between positive psychological well-being and cardiovascular health. Psychol Bull. Jul.2012 138:655–691. [PubMed: 22506752]
9. Boehm JK, Peterson C, Kivimaki M, Kubzansky LD. A prospective study of positive psychological well-being and coronary heart disease. Health Psychol. 2011; 30:259–267. 05. [PubMed: 21553969]
10. Roger VL, Go AS, Lloyd-Jones DM, Benjamin EJ, Berry JD, Borden WB, et al. Heart disease and stroke statistics--2012 update: a report from the American Heart Association. Circulation. Jan 3.2012 125:e2–e220. [PubMed: 22179539]
11. Heart and Stroke Foundation. [March 6th, 2012] Statistics. http://www.heartandstroke.com/site/c.ikIQLcMWJtE/b.3483991/k.34A8/Statistics.htm.

12. Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: A systematic analysis for the Global Burden of Disease Study 2010. Lancet. Dec 15.2012 380:2224–2260. [PubMed: 23245609]
13. Ostir GV, Berges IM, Markides KS, Ottenbacher KJ. Hypertension in older adults and the role of positive emotions. Psychosom Med. Sep-Oct;2006 68:727–733. [PubMed: 17012526]
14. Richman LS, Kubzansky L, Maselko J, Kawachi I, Choo P, Bauer M. Positive emotion and health: Going beyond the negative. Health Psychol. Jul.2005 24:422–429. [PubMed: 16045378]
15. Steptoe A, Wardle J. Positive affect and biological function in everyday life. Neurobiol Aging. Dec.2005 26:108–112. [PubMed: 16213629]
16. Conway F, Magai C, Springer C, Jones SC. Optimism and pessimism as predictors of physical and psychological health among grandmothers raising their grandchildren. J Res Pers. 2008; 42:1352–1357.
17. Raikkonen K, Matthews KA. Do dispositional pessimism and optimism predict ambulatory blood pressure during school days and nights in adolescents? J Pers. Jun.2008 76:605–630. [PubMed: 18399951]
18. Richman LS, Kubzansky LD, Maselko J, Ackerson LK, Bauer M. The relationship between mental vitality and cardiovascular health. Psychol Health. 2009; 24:919–932. [PubMed: 20205036]
19. Wright TA, Cropanzano R, Bonett DG, Diamond WJ. The role of employee psychological well-being in cardiovascular health: When the twain shall meet. J Organiz Behav. 2009; 30:193–208. 02.
20. Kubzansky LD, Thurston RC. Emotional vitality and incident coronary heart disease: Benefits of healthy psychological functioning. Arch Gen Psychiatry. Dec.2007 64:1393–1401. [PubMed: 18056547]
21. Ware J, Sherbourne C. The MOS 36-item short-form health survey (SF-36): Conceptual framework and item selection. Med Care. 1992; 30:473–483. [PubMed: 1593914]
22. Scheier MF, Carver CS. Optimism, coping, and health: Assessment and implications of generalized outcome expectancies. Health Psychol. 1985; 4:219–247. [PubMed: 4029106]
23. Kivimaki M, Batty GD, Singh-Manoux A, Ferrie JE, Tabak AG, Jokela M, et al. Validating the Framingham Hypertension Risk Score: Results from the Whitehall II study. Hypertension. Sep. 2009 54:496–501. [PubMed: 19597041]
24. What's New in SAS® 9.3 [computer program]. Version. SAS Institute Inc.; Cary, NC: 2012.
25. Kleinbaum, DG.; Klein, M. Survival analysis: A self-learning text. 2nd ed.. Springer-Verlag; New York: 2010.
26. Tabachnick, BG.; Fidell, LS. Survival/Failure Analysis.. In: Tabachnick, BG.; Fidell, LS., editors. Using Multivariate Statistics. 5th ed.. Allyn and Bacon; Boston, MA: 2007. p. 506-566.
27. Wright, RE. Survival analysis.. In: Grimm, LG.; Yarnold, PR., editors. Reading and understanding more multivariate statistics. American Psychological Association; Washington, DC: 2000. p. 363-407.
28. Begley TM, Lee C, Czajka JM. The relationships of Type A behavior and optimism with job performance and blood pressure. J Bus Psychol. 2000; 15:215–227.
29. Fujita F, Diener E. Life satisfaction set point: Stability and change. J Pers Soc Psychol. 2005; 88:158–164. 01. [PubMed: 15631581]
30. Steptoe A, Dockray S, Wardle J. Positive affect and psychobiological processes relevant to health. J Pers. Dec.2009 77:1747–1776. [PubMed: 19796062]
31. Nabi H, Chastang JF, Lefevre T, Dugravot A, Melchior M, Marmot MG, et al. Trajectories of depressive episodes and hypertension over 24 years: The Whitehall II prospective cohort study. Hypertension. Apr.2011 57:710–716. [PubMed: 21339474]
32. Padesky CA, Mooney KA. Strengths-based cognitive-behavioural therapy: A four-step model to build resilience. Clin Psychol Psychother. Jul-Aug;2012 19:283–290. [PubMed: 22653834]
33. Seligman ME, Steen TA, Park N, Peterson C. Positive psychology progress: Empirical validation of interventions. Am Psychol. Jul-Aug;2005 60:410–421. [PubMed: 16045394]

34. Boehm JK, Vie LL, Kubzansky LD. The promise of well-being interventions for improving health risk behaviors. Cur Cardiovasc Risk Rep. 2012; 6:511–519.

Table 1

Distribution of Covariates at Baseline According to Levels of Emotional Vitality

	Emotional Vitality			
	Low	**Moderate**	**High**	***p*-value**
	***n* = 2,105**	***n* = 2,154**	***n* = 2,125**	
Mean age, years (SD)	48.21 (5.65)	49.06 (6.03)	50.38 (6.09)	< 0.0001
Sex				< 0.0001
Male	1,355 (64.37%)	1,475 (68.48%)	1,515 (71.29%)	
Female	750 (35.63%)	679 (31.52%)	610 (28.71%)	
Ethnicity				< 0.0001
White	1,990 (94.54%)	1,981 (91.97%)	1,890 (88.94%)	
Non-white	115 (5.46%)	173 (8.03%)	235 (11.06%)	
Marital status				< 0.0001
Married or cohabitating	1,445 (69.22%)	1,687 (78.36%)	1,738 (81.94%)	
Other	647 (30.78%)	466 (21.64%)	383 (18.06%)	
Grade of employment				0.0004
Administrative	801 (38.09%)	845 (39.25%)	849 (39.95%)	
Professional	1,023 (48.64%)	942 (43.75%)	922 (43.39%)	
Clerical	279 (13.27%)	366 (17.00%)	354 (16.66%)	
Smoking status				0.0002
Never smoker	1,009 (49.10%)	1,066 (50.81%)	1,114 (53.07%)	
Former smoker	710 (34.55%)	715 (34.08%)	742 (35.35%)	
Current smoker	336 (16.35%)	317 (15.11%)	243 (11.58%)	
Alcohol consumption				0.02
Low/moderate	1,774 (84.32%)	1,797 (83.46%)	1,833 (86.42%)	
High	330 (15.68%)	356 (16.54%)	288 (13.58%)	
Exercise				< 0.0001
< 1.5 hours/week	874 (41.52%)	700 (32.50%)	555 (26.12%)	
≥ 1.5 hours/week	1,231 (58.48%)	1,454 (67.50%)	1,570 (73.88%)	
Fruit and vegetable consumption				< 0.0001
No	847 (40.24%)	852 (39.55%)	716 (33.69%)	
Yes	1,258 (59.76%)	1,302 (60.45%)	1,409 (66.31%)	
Mean BMI, kg/m^2 (SD)	24.76 (3.62)	25.00 (3.53)	24.94 (3.39)	0.07
Diabetes				0.93
No	2,085 (99.10%)	2,134 (99.16%)	2,107 (99.20%)	
Yes	19 (0.90%)	18 (0.84%)	17 (0.80%)	
Myocardial infarction				0.83
No	2,099 (99.76%)	2,147 (99.72%)	2,121 (99.81%)	
Yes	5 (0.24%)	6 (0.28%)	4 (0.19%)	
Ill-being (SD)	0.78 (1.08)	0.20 (0.58)	0.07 (0.37)	< 0.0001

Abbreviations: BMI, body mass index; SD, standard deviation.

Notes. All covariates were measured at baseline. Percentages refer to the column percent of individuals within each emotional vitality category with that characteristic. Differences among the proportions or means of each covariate according to level of vitality come from χ^2 or analysis of variance tests.

Table 2

Hazard Ratios and 95% Confidence Intervals for the Association between Emotional Vitality (Continuous and Categorical Scores) and Incident Hypertension

	Hazard Ratio	95% Confidence Interval	*p*-value
Continuous			
Model 1[a]	0.95	0.91-0.99	0.02
Model 2[b]	0.95	0.92-1.00	0.03
Model 3[c]	0.96	0.92-1.00	0.03
Model 4[d]	0.96	0.92-1.00	0.07
Categorical			
Model 1[a]			
Low	Reference		
Moderate	0.93	0.84-1.03	0.15
High	0.89	0.80-0.98	0.02
Model 2[b]			
Low	Reference		
Moderate	0.93	0.85-1.03	0.19
High	0.89	0.81-0.99	0.03
Model 3[c]			
Low	Reference		
Moderate	0.94	0.85-1.03	0.20
High	0.90	0.81-0.99	0.04
Model 4[d]			
Low	Reference		
Moderate	0.92	0.83-1.02	0.11
High	0.91	0.82-1.00	0.06

Note. There were 6,384 participants and 2,304 cases in each model.

[a]Adjusted for age

[b]Adjusted for demographics (age, gender, ethnicity, marital status, and grade of employment)

[c]Adjusted for covariates in Model 2 and health status (diabetes, myocardial infarction)

[d]Adjusted for covariates in Model 3 and health behaviors (smoking status, alcohol consumption, exercise, fruit and vegetable consumption, body mass index)