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The Prospective Association between Positive Psychological Well-Being and Diabetes

Julia K. Boehm,
Department of Psychology, Chapman University

Mika Kivimaki,
Department of Epidemiology and Public Health, University College London

Claudia Trudel-Fitzgerald, and
School of Psychology, Laval University (now at Department of Social and Behavioral Sciences, Harvard School of Public Health)

Laura D. Kubzansky
Department of Social and Behavioral Sciences, Harvard School of Public Health.

Abstract

Objective—Positive psychological well-being has protective associations with cardiovascular outcomes, but no studies have considered its association with diabetes. This study investigated links between well-being and incident diabetes.

Methods—At study baseline (1991-1994), 7,800 middle-aged British men and women without diabetes indicated their life satisfaction, emotional vitality, and optimism. Diabetes status was determined by self-reported physician diagnosis and oral glucose tolerance test (screen detection) at baseline and through 2002-2004. Incident diabetes was defined by physician-diagnosed and screen-detected cases combined and separately. Logistic regression estimated the odds of developing diabetes controlling for relevant covariates (e.g., demographics, depressive symptoms). Models were also stratified by gender and weight status.

Results—There were 562 combined cases of incident diabetes during follow-up (up to 13 years). Well-being was not associated with incident diabetes for combined physician-diagnosed and screen-detected cases. However, when examining the 288 physician-diagnosed cases, life satisfaction (OR=0.85, 95% CI=0.76-0.95) and emotional vitality (OR=0.86, 95% CI=0.77-0.97) were associated with up to a 15% decrease in the odds of physician-diagnosed diabetes, controlling for demographics (results were similar with other covariates). Optimism was not associated with physician-diagnosed diabetes and no well-being indicator was associated with screen-detected diabetes. Gender and weight status were not moderators.

Conclusions—Life satisfaction and emotional vitality, but not optimism, were associated with reduced risk of physician-diagnosed diabetes. These findings suggest well-being may contribute to reducing risk of a prevalent and burdensome condition although intervention studies are needed to

Correspondence and reprint requests should be sent to Dr. J. Boehm, Department of Psychology, Chapman University, One University Drive, Orange, CA 92866; Phone: 714-997-6803; Fax: 714-997-6780; jboehm@chapman.edu.

confirm this. It is unclear why findings differed for physician-diagnosed versus study-screened diabetes.

Keywords

diabetes; chronic conditions; life satisfaction; emotional vitality; optimism; Whitehall II cohort

According to the World Health Organization, 347 million people worldwide have diabetes, which is a chronic disorder of hyperglycaemia ("Diabetes Fact Sheet," 2012). Moreover, Type 2 diabetes comprises 90% of those cases and deaths from diabetes are expected to increase by two thirds before the year 2030 ("Diabetes Fact Sheet," 2012). However, unlike related chronic conditions such as coronary heart disease, relatively little is known about the psychosocial factors that may influence risk of Type 2 diabetes, especially if there are attributes that may confer protective effects. Past findings indicate that depression (Knol et al., 2006; Mezuk, Eaton, Albrecht, & Golden, 2008) and job stress (Eriksson, van den Donk, Hilding, & Ostenson, 2013; Nyberg et al., 2014) may be associated with an increased risk of incident diabetes, but no work has considered whether positive psychological well-being – that is, the positive thoughts and feelings of well-functioning individuals – may reduce risk of diabetes.

Research regarding positive psychological well-being's association with glycosylated hemoglobin (a measure of average long-term glucose concentration) and cardiovascular-related outcomes hint that well-being may play a role in Type 2 diabetes. In one study of older women who were initially free from diabetes, greater positive emotions at baseline were associated with lower (i.e., more favorable) levels of glycosylated hemoglobin two years later, controlling for baseline levels of glycosylated hemoglobin, demographic characteristics, and health-related factors (Tsenkova, Dienberg Love, Singer, & Ryff, 2008). Moreover, higher baseline levels of positive psychological well-being were associated with lower levels of glycosylated hemoglobin one year later in men and women with diabetes (Yi, Vitaliano, Smith, Yi, & Weinger, 2008).

Although indicators of glycemic control are relevant for the management of diabetes, less is known about whether indicators of positive psychological well-being are associated with the likelihood of developing Type 2 diabetes in initially healthy individuals. Given that diabetes and coronary heart disease share common risk factors and antecedent pathways, additional evidence can be drawn from the relatively well-established literature regarding incident heart disease. A recent review indicated that positive psychological well-being is associated with a reduced risk of coronary heart disease, even when controlling for potential confounders (Boehm & Kubzansky, 2012). Furthermore, this association seems to be independent of the detrimental effects that psychological ill-being – including depression, anxiety, and hostility – seem to have on heart disease (e.g., Davidson, Mostofsky, & Whang, 2010; Kubzansky & Thurston, 2007). This suggests that positive psychological well-being does not simply mark the absence of depression or other psychological difficulties.

Thus, we sought to investigate whether positive psychological well-being would be associated with a reduced risk of incident diabetes using prospective data from the Whitehall II cohort, which is a sample of British civil servants. Past work with this cohort has reported inverse associations between coronary heart disease and three different indicators of positive psychological well-being: life satisfaction, emotional vitality, and optimism (Boehm, Peterson, Kivimaki, & Kubzansky, 2011a, 2011b). Life satisfaction can be defined as an overall evaluation of one's life (Pavot & Diener, 2008), emotional vitality can be defined as an enthusiasm for life and the ability to effectively regulate emotions (Kubzansky & Thurston, 2007), and optimism is the expectation that good things will happen in the future (Carver, Scheier, & Segerstrom, 2010). Although these three indicators all broadly fall under the umbrella of positive psychological well-being, they are most often investigated independently.

Among indicators of positive psychological well-being, emotional vitality and optimism seem to have particularly strong associations with the first occurrence of a cardiovascular event such that higher levels of emotional vitality and optimism are associated with a reduced risk of a cardiovascular event (Boehm & Kubzansky, 2012). This suggests that they may be similarly relevant for incident diabetes. Life satisfaction, emotional vitality, and optimism have also been theoretically linked with health and have viable means for influencing key pathways to health. For example, Chen and Miller (2012) suggest that being optimistic about the future and able to identify interesting and meaningful pursuits in life (and by extension being satisfied with life) enables individuals to deal effectively with challenges. This, in turn, may mitigate risk for diabetes by diminishing the harmful biological (e.g., activation of the hypothalamic-pituitary-adrenal axis and secretion of cortisol, which can interfere with blood glucose regulation) and behavioral effects (e.g., overeating, not getting enough exercise, consuming excessive amounts of alcohol) that stress exerts on the body (Chida & Hamer, 2008). Because optimistic people and those with greater positive psychological well-being expect and seek favorable outcomes, they are more likely to persist at their goals, use effective coping strategies, and recognize when to engage with attainable goals or disengage from unattainable goals (Rasmussen, Wrosch, Scheier, & Carver, 2006). In addition, positive emotions and cognitions (e.g., life satisfaction) may motivate short-term behaviors in the context of long-term goals or provide the willpower needed to maneuver between conflicting goals (DeSteno, 2009). Thus, we hypothesized that greater levels of life satisfaction, emotional vitality, and optimism would be associated with a reduced risk of incident diabetes.

Incident diabetes can be defined by self-reported doctor diagnoses of diabetes and use of diabetes medication, as well as by clinically-assessed glucose levels. Given that different correlates have emerged for diabetes when defined by self-reports of doctor diagnoses and medication use (i.e., diagnosed diabetes that is “known”) when compared with clinically-assessed or screen-detected glucose levels (i.e., undiagnosed diabetes; Kivimaki et al., 2011), we investigated each definition of diabetes separately. Various known diabetes risk factors – including ethnicity, employment grade, and blood pressure – were controlled to minimize confounding. Because health behaviors may also be confounders or serve as a pathway linking positive psychological well-being with reduced risk of incident diabetes and other health conditions (Steptoe, Dockray, & Wardle, 2009), the analyses additionally controlled for health behaviors such as physical activity, as well as body mass index (BMI), which stems in part from health behaviors. Depressive symptoms were also controlled because they are associated with increased risk of diabetes (Pan et al., 2010; Tabak, Akbaraly, Batty, & Kivimaki, 2014).

We performed exploratory analyses based on past work suggesting that associations with Type 2 diabetes may differ by gender or weight status. For example, the psychosocial factor of workplace stress is related to an increased risk of diabetes in women but not in men (Heraclides, Chandola, Witte, & Brunner, 2009, 2011), and other work has hinted that effects of psychosocial factors on chronic disease may be stronger in women than in men (Appleton, Loucks, Buka, Rimm, & Kubzansky, 2013; Low, Thurston, & Matthews, 2010). Moreover, overweight and obesity are strong risk factors for diabetes (Narayan, Boyle, Thompson, Gregg, & Williamson, 2007) and it is possible that if BMI does not mediate effects of optimism, it might either mask or modify the effects of well-being on diabetes development. We hypothesized that the relation of well-being with incident diabetes would be stronger among women, but based on relatively weak links between well-being and BMI to date (e.g., Korkeila, Kaprio, Rissanen, Koshenvuo, & Sorensen, 1998), associations would be similar across normal and overweight/obese individuals.

Research Design and Methods

Participants

The Whitehall II cohort initially began with 10,308 British civil servants examined during 1985-1988 (Phase 1; Marmot & Brunner, 2005). All three measures of positive psychological well-being were assessed in Phase 3 (1991-1994) and clinical assessments of glucose first occurred in Phase 3, so that time period serves as the baseline for the present study. Phase 3 participants included 8,815 men and women; 253 participants were excluded from the analysis because they had either self-reported or screen-detected diabetes at baseline. Eight additional participants were excluded because they were missing baseline diabetes information. The remaining sample of 8,554 was further reduced by 326 individuals who were missing diabetes information at all phases after the Phase 3 baseline and by 428 individuals who were missing one or more measures of positive psychological well-being (among whom 406 were missing all three positive psychological well-being measures). Thus, 7,800 participants comprised the analytic sample. All participants provided informed consent and human research ethics committees at participating institutions granted approval for the research.

Positive Psychological Well-Being Assessment

All three indicators of positive psychological well-being were self-reported by participants at Phase 3.

Life satisfaction—Participants indicated their satisfaction with seven domains in their lives: “marital or love relationship,” “leisure time activities,” “standard of living,” “job,” “family life,” “sex life,” and feelings “about yourself as a person” (referred to as self satisfaction). Each domain was rated on a scale ranging from 1 (*very dissatisfied*) to 7 (*very satisfied*) and ratings were averaged together to create an overall satisfaction score. Higher scores indicated more satisfaction and internal consistency reliability was good (α = 0.84).

Pearson *r* correlations among each of the domain satisfactions ranged from 0.27 to 0.73. Although participants also rated satisfaction with their health, it was not included in the overall score as it could be confounded with physical health.

Emotional vitality—Following previous work (Boehm, et al., 2011b; Kubzansky & Thurston, 2007), an emotional vitality composite was created from five items to represent the extent to which an individual was engaged with the world, effectively regulated feelings, and experienced overall well-being. Although emotional vitality shares some variance with other constructs such as positive affect, it is considered distinct. Two emotional vitality items were “I have a sense of direction and purpose in my life” (1 = *strongly disagree*, 6 = *strongly agree*) and “How often do you feel emotionally or mentally exhausted at the end of the day” (1 = *hardly ever/never*, 4 = *very often/always*; reverse scored). The other three emotional vitality items were drawn from the Short Form-36 (Ware & Sherbourne, 1992) and asked participants to indicate the amount of time during the past four weeks that they felt full of life, had a lot of energy, and had been a happy person (1 = *all of the time*, 6 = *none of the time*; reverse scored). Due to the different rating scales used across items, each item was standardized ($M = 0$, $SD = 1$) and then averaged together to create an overall score of emotional vitality where higher scores represented greater emotional vitality. Internal consistency reliability was good ($\alpha = 0.79$).

Optimism—A single item was used to assess optimism. The item asked participants to rate the statement “Over the next 5-10 years, I expect to have many more positive than negative experiences” using a 6-point Likert-type scale (1 = *strongly disagree*, 6 = *strongly agree*). This single optimism item is consistent with general definitions of optimism (Scheier & Carver, 1985) and has been used previously in research related to heart disease (Boehm, et al., 2011b).

Diabetes Assessment

Diabetic status was determined at Phase 3, Phase 4 (1995-1996), Phase 5 (1997-1999), Phase 6 (2001), and/or Phase 7 (2002-2004) in two ways. Participants had the opportunity to self-report at each of the phases whether a physician had diagnosed them with diabetes (e.g., “Has a doctor ever told you that you have diabetes?”) and whether they had used diabetes medication. Such self-reports tend to show strong agreement with reports directly from physicians or medical records (Okura, Urban, Mahoney, Jacobsen, & Rodeheffer, 2004; Pastorino et al., 2014). If participants received a diagnosis or used medication, they were classified as having physician-diagnosed diabetes. If participants did not report physician-diagnosed diabetes, they underwent a glucose screening at Phase 3, Phase 5 and/or Phase 7 (but not Phase 4 or 6) to assess undiagnosed diabetes. Screen-detected diabetes was established by a 2 hour glucose tolerance test level ≥ 11.1 mmol/l or a fasting glucose level ≥ 7.0 mmol/l. Consistent with past work, incident diabetes was defined by combining physician-diagnosed and screen-detected cases (Heraclides, et al., 2009; Kumari, Head, & Marmot, 2004), as well as by investigating physician-diagnosed diabetes and screen-detected diabetes separately (Kivimaki, et al., 2011). Analyses that used physician-diagnosed diabetes as the outcome were based on a sample size of 7,800 because all participants had at least one follow-up assessment of physician-diagnosed diabetes.

Analyses that used screened-detected diabetes were based on a sample size of 6,716 because 1,084 participants had no follow-up assessments of clinically-assessed glucose.

Covariate Assessment

Covariates included demographic characteristics, health behaviors, clinically-assessed factors, and depressive symptoms. Demographic characteristics considered as potential confounders included age (in years), gender (men, women), ethnicity (white, non-white), marital status (married/cohabitating, other), and grade of employment (clerical, professional, administrative [in order of increasing status]). Because health behaviors and clinically-assessed risk factors could be confounders or on the pathway linking positive psychological well-being and diabetes, these variables were also considered in analyses. Health behaviors 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]), physical activity (< 1.5 hours/week of moderate and vigorous exercise, ≥ 1.5 hours/week of moderate and vigorous exercise), and daily fruit and vegetable consumption (yes, no). Clinically-assessed factors included systolic blood pressure (SBP), diastolic blood pressure (DBP; both in mmHg), and BMI (in kg/m^2), which were measured according to standard operating protocols. Depressive symptoms were self-reported by participants using a four-item depression subscale from the General Health Questionnaire (Goldberg, 1972). Participants indicated on a scale ranging from 0-3 whether they were worthless, felt life was hopeless, felt life wasn't worth living, or couldn't do anything because of nerves. Following past work (Akbaraly et al., 2009), ratings for each of the four items were summed together for an overall score of depressive symptoms ranging from 0-12 (higher scores indicated more depressive symptoms). The internal consistency reliability for depressive symptoms was good ($\alpha = 0.87$). All covariates were measured at Phase 3 except for gender and ethnicity, which were measured at Phase 1.

Statistical Analyses

Statistical analyses were conducted with SAS 9.2. Potential univariate and multivariate outliers were investigated according to established guidelines (Tabachnick & Fidell, 2012), but because there were relatively few outliers and because their presence did not alter conclusions we did not exclude them. Multiple imputation procedures were used to impute missing values on covariates. Missing data were most common for the clinically-assessed risk factors (i,e., SBP, DBP, and BMI), although less than 5% of data were missing on those variables. Logistic regression models estimated the odds ratio (OR) and 95% confidence interval (CI) for the association between positive psychological well-being and incident diabetes. Four nested models were investigated: 1) minimally-adjusted model that accounted for the demographic characteristics of age, gender, ethnicity, marital status, and employment grade, 2) model that accounted for demographic characteristics and health behaviors, including cigarette smoking, alcohol consumption, physical activity, and fruit and vegetable consumption, 3) model that accounted for demographic characteristics, health behaviors, and the clinically-assessed factors (SBP, DBP, and BMI), and 4) model that accounted for demographic characteristics, health behaviors, clinically-assessed factors, and depressive symptoms. Each well-being indicator (satisfaction, vitality, optimism) was considered in relation to incident diabetes (physician-diagnosed, screen-detected, and combined) separately in the four models. In addition, for the combined diabetes outcome, each of the four primary models was stratified by gender to assess whether associations differed across men and women. Each model was also stratified by weight status (BMI < 25 versus BMI ≥ 25) for the combined diabetes outcome. Missing data on BMI were not imputed for the analyses that stratified by BMI, so the sample size for those analyses was slightly smaller (N = 7,424).

Results

Baseline Characteristics

The 7,800 participants were followed for an average of 10.65 years (SD = 2.53). Participants were comprised of more men (69%) than women and were on average 49.5 years old at baseline (SD = 6.06). The majority of participants were white (92%) and married (77%). At baseline, most participants engaged in physical activity (66%), consumed fruits and vegetables on a daily basis (62%), and had never smoked cigarettes (51%). However, the average participant tended to be slightly overweight (M = 25.23, SD = 3.65) at baseline.

Generally, participants reported moderately high levels of positive psychological well-being at baseline (life satisfaction: M = 5.33, SD = 1.18, minimum = 1, maximum = 7; emotional vitality: M = 0.0001, SD = 0.74, minimum = −2.54, maximum = 1.61; optimism: M = 4.64, SD = 1.16, minimum = 1, maximum = 6). Each positive psychological well-being indicator was correlated with the others. Emotional vitality showed the strongest correlations with life satisfaction (r = .58, $p < .0001$) and optimism (r = .51. $p < .0001$). Life satisfaction and optimism were moderately correlated (r = .38, $p < .0001$).

For the most part (and due to the large sample size), each indicator of well-being was significantly associated with or showed significant differences in the participant characteristics. The only exceptions were that life satisfaction did not differ significantly based on gender or ethnicity and optimism did not differ significantly by gender, alcohol consumption, SBP, or DBP. Correlation coefficients for positive psychological well-being's association with continuous participant characteristics included age ($r_{\text{life satisfaction}} = .12$, $p < .0001$; $r_{\text{emotional vitality}} = .16$, $p < .0001$; $r_{\text{optimism}} = .05$, $p < .0001$), SBP ($r_{\text{life satisfaction}} = .07$, $p < .0001$; $r_{\text{emotional vitality}} = .09$, $p < .0001$; $r_{\text{optimism}} = .02$, $p = .06$), DBP ($r_{\text{life satisfaction}} = .04$, $p = .001$; $r_{\text{emotional vitality}} = .05$, $p < .0001$; $r_{\text{optimism}} = .02$, $p = .11$), BMI ($r_{\text{life satisfaction}} = .02$, $p = .05$; $r_{\text{emotional vitality}} = .03$, $p < .05$; $r_{\text{optimism}} = .03$, $p < .01$), and depressive symptoms ($r_{\text{life satisfaction}} = -.44$, $p < .0001$; $r_{\text{emotional vitality}} = -.52$, $p < .0001$; $r_{\text{optimism}} = -.38$, $p < .0001$). Table 1 shows the relationship between positive psychological well-being and categorical participant characteristics at baseline.

Association between Positive Psychological Well-Being and Incident Diabetes

Combined physician-diagnosed and screen-detected diabetes—There were 562 cases of incident diabetes when both physician-diagnosed and screen-detected cases of diabetes were combined into one outcome. As shown in Table 2, no measure of positive psychological well-being was associated with the risk of incident diabetes for this combined outcome. This was true regardless of which covariates were adjusted.

Physician-diagnosed diabetes—There were 288 cases of incident diabetes when diabetes was defined by self-reported diagnosis from a doctor or use of diabetes medication (Table 3). Life satisfaction was significantly associated with diabetes such that for every standard deviation unit increase in life satisfaction, there was a 13-17% decrease in the odds of having physician-diagnosed diabetes. Odds ratios were similar when accounting for demographic characteristics, health behaviors, clinically-assessed factors, and depressive symptoms. The pattern of findings was consistent for emotional vitality. For every standard deviation increase in vitality, there was a 9-15% decrease in the odds of having physician-diagnosed diabetes. However, findings for emotional vitality were attenuated when depressive symptoms was included in the final model. By contrast, optimism was not significantly associated with physician-diagnosed diabetes in any of the models.

Screen-detected diabetes—There were 414 cases of incident diabetes when diabetes was defined by screen-detected glucose levels (Table 4). Similar to findings with the combined diabetes outcome, none of the positive psychological well-being indicators were associated with screen-detected diabetes.

Stratified analyses—When the primary models for the combined diabetes outcome were stratified by gender, the pattern of findings was similar across men and women. Indeed, the interaction terms between gender and each indicator of well-being failed to reach conventional levels of significance ($p > .19$), suggesting that gender was not a significant moderator of the relationship between well-being and incident diabetes. In addition, the interaction terms between weight status and each indicator of well-being failed to reach conventional levels of significance ($p > .35$). This indicates that weight status did not modify the association between well-being and incident diabetes when considering physician-diagnosed and screen-detected diabetes combined.

Discussion

This research sought to investigate the prospective association between positive psychological well-being – assessed by life satisfaction, emotional vitality, and optimism – and incident diabetes. Given past work showing that greater positive emotions are associated with healthier levels of glycosylated hemoglobin (Tsenkova, et al., 2008) and reduced risk of coronary heart disease (Davidson, et al., 2010), an inverse association between positive psychological well-being and diabetes was expected. However, none of the three measures of well-being were significantly related to incident diabetes when both physician-diagnosed diabetes and screen-detected diabetes were combined (even when stratifying by gender and weight status), nor when screen-detected diabetes was investigated separately. Nonetheless, our hypothesis was confirmed for self-reported physician-diagnosis of diabetes or use of diabetes medication. That is, individuals with greater levels of life satisfaction and emotional vitality were less likely to report physician-diagnosed diabetes than individuals with lower levels. Optimism was not significantly related to the odds of physician-diagnosed diabetes in any model, which could be due to the single item measure that was used. Recent work with the Whitehall II cohort has similarly failed to find an association between this measure of optimism and incident hypertension (Trudel-Fitzgerald, Boehm, Kivimaki, & Kubzansky, 2014).

The null findings for the combined outcome are likely due to the fact that associations between well-being and screen-detected diabetes – one part of the combined outcome – were null. This still leaves the question of why well-being was not associated with screen-detected diabetes. In light of previous findings regarding the inverse association between psychological well-being and heart disease (Boehm, et al., 2011a, 2011b), the less consistent results reported here with diabetes are somewhat unexpected, particularly given that many risk factors for diabetes and cardiovascular disease are similar (e.g., physical inactivity, poor diet, cigarette smoking, obesity, hypertension) and that diabetes is itself a risk factor for cardiovascular disease ("Diabetes mellitus: a major risk factor for cardiovascular disease. A joint editorial statement by the American Diabetes Association; The National Heart, Lung, and Blood Institute; The Juvenile Diabetes Foundation International; The National Institute of Diabetes and Digestive and Kidney Diseases; and The American Heart Association," 1999). Although a definitive explanation for the findings in this study is not possible, it is worth noting that other work in the Whitehall II cohort has not always found robust associations between psychosocial factors (e.g., work demands) and incident diabetes when physician-diagnosed and screen-detected cases are combined (Kumari, et al., 2004). Moreover, prior work in this cohort has similarly reported differing results depending on whether diabetes is defined according to physician diagnosis or glucose screening levels. For example, use of anti-depressants was associated with an increased risk of physician-diagnosed diabetes, but not with screen-detected diabetes (Kivimaki, et al., 2011). It may be that the screening tests used to detect diabetes have somewhat lower specificity for actual disease relative to doctor diagnoses for which more tests may be conducted to confirm a diagnosis, and that the increased noise in the screening measure makes it difficult to detect what may be a somewhat L effect.

To date, the most commonly considered psychological risk factor in relation to diabetes is depression. While some work has suggested depression is associated with higher risk of developing diabetes, other work has offered a more nuanced picture, suggesting a modest bidirectional association between diabetes and psychological distress (Pan, et al., 2010). Such bidirectionality may also be at play in the relationship between well-being and diabetes. Although data to examine this were not available in the current study, it may be that bidirectionality in the association between well-being and diabetes could obscure associations, particularly if repeated measures of both well-being and diabetes are not available. Thus, exploring bidirectionality in future studies could add insight.

In addition, well-being's association with Type 2 diabetes may be less strong than well-being's association with cardiovascular disease because the importance of risk factors differ between the two diseases, and so too does well-being's relationship with the risk factors. For example, being overweight or obese is one of the strongest risk factors for diabetes whereas other risk factors (e.g., cigarette smoking) confer substantial risk for cardiovascular disease. Moreover, diabetes is more strongly associated with problems of insulin production or ineffective use of insulin than cardiovascular disease. If well-being is less strongly associated with dysregulated insulin or the risk of being overweight or obese, this may partly account for a weaker association with diabetes than with cardiovascular disease. The lack of a substantial association between any measure of positive psychological well-being and BMI in this sample (rs ranged between .02 and .03) is notable. Some prior cross-sectional studies have shown that positive psychological well-being is associated with healthier weight status (Kelloniemi, Ek, & Laitinen, 2005; Saloumi & Plourde, 2010), whereas others have reported a weak or null association (e.g., Sutin, 2013). There is also inconsistent support for an association between well-being and weight status in the limited longitudinal studies that have been conducted to date. For example, one longitudinal study reported that less life satisfaction was associated with weight gain in older women, but not younger women or men (Korkeila, et al., 1998). While the reasons for the inconsistencies in a protective effect of well-being in relation to weight status are not clear, other apparently positive psychosocial factors (e.g., marital satisfaction) are associated with weight gain over time (Meltzer, Novak, McNulty, Butler, & Karney, 2013). Thus, effects of psychological factors (positive or negative) are clearly not monolithic and more work is needed to understand the range of effects across outcomes.

Notably, the inverse associations that both life satisfaction and emotional vitality had with physician-diagnosed diabetes persisted even after adjusting for typical sociodemographic confounders (e.g., employment grade) as well as health behaviors and clinically-assessed blood pressure and BMI. Past work suggests that positive psychological well-being is likely to influence health through a behavioral pathway (Steptoe, et al., 2009). For example, healthy behaviors such as eating fruits and vegetables or being physically active are strongly associated with improved glycemic control and reduced risk for diabetes (Hu et al., 2001). These same healthy behaviors have also been positively linked with psychological well-being (Boehm, Vie, & Kubzansky, 2012). However, in the present study, health behaviors did not operate strongly on the pathway linking well-being with incident diabetes. Similarly, past research has also found that behaviors often do not explain associations between well-being and incident heart disease as strongly as anticipated (Boehm, et al., 2011b; Kubzansky & Thurston, 2007; Tindle et al., 2009).

The association of life satisfaction and emotional vitality with reduced risk of incident diabetes remained after controlling for relevant covariates and, in the case of life satisfaction, depressive symptoms. Failure to attenuate the association between life satisfaction and incident diabetes after adjusting for potential explanatory variables could be due to imprecision in the measurement of behavioral pathways and clinically-assessed risk factors (e.g., health behaviors were self-reported and could be subject to measurement error). However, all covariates have been used previously and are associated in expected directions with other factors (e.g., occupational status). Moreover, trained medical professionals conducted the clinical assessments using standardized procedures. Thus, it is possible that other, unmeasured factors lie on the pathway linking life satisfaction and emotional vitality with physician-diagnosed diabetes. For example, additional endocrine-based mechanisms like effective cortisol regulation, reduced inflammation, or psychosocial mechanisms like social support may be on the pathway. Future research is needed to address these speculations.

One limitation of the current research is the lack of diversity in the participants. The Whitehall II cohort includes mostly white participants who were all employed in the civil service. In addition, positive psychological well-being was subjectively assessed at a single point in time, which may be subject to biases such as the social desirability bias. Report of diabetes diagnoses also did not discriminate between Type I and II diabetes, which may lead to misclassification (although Type I diabetes is usually diagnosed in individuals younger than the typical Whitehall II participant). Unmeasured third variables such as common genetic pathways may also confound the relationship between positive psychological well-being and diabetes. However, these limitations are balanced by numerous strengths including a prospective design in which all people with physician-diagnosed and clinically-assessed diabetes at baseline were excluded from analyses. Moreover, members of the cohort had adequate access to medical care and were followed for more than a decade. In addition, three different types of positive psychological well-being were examined in relation to incident diabetes, which has never been done before.

In summary, life satisfaction and emotional vitality were each robustly associated with reduced odds of incident diabetes as diagnosed by a doctor. This is consistent with the broader literature linking positive psychological well-being with greater longevity and reduced risk of incident coronary heart disease (Boehm, et al., 2011a; Chida & Steptoe, 2008; Diener & Chan, 2011). However, examining incident diabetes also provided some novel findings less apparent in work on longevity and coronary heart disease – namely, effects do not appear to be carried through potential health enhancing effects of health behaviors or weight status. There was no association between positive psychological well-being and incident diabetes when defined by physician diagnosis combined with a clinical screening or by clinical screening alone, however. It may be helpful to assess these relationships in a more diverse population to see if they are replicated or if population characteristics contribute to shaping associations. If findings in relation to physician-diagnosed diabetes hold across other studies, this research suggests that clinicians treating individuals at high risk for diabetes may want to evaluate patient levels of positive psychological well-being to assess additional risk and ultimately target positive psychological well-being in interventions for high risk individuals. In the meantime, this is one of the first studies to identify potentially important linkages between positive psychological functioning and incident diabetes, a highly prevalent disease that imposes significant population burden. Initial evidence of an association within this large population-based cohort suggests that further examination of this relationship is warranted and may lead to important insights for improving prevention outcomes.

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Abbreviations

BMI	body mass index

SBP	systolic blood pressure
DBP	diastolic blood pressure
OR	odds ratio
CI	confidence interval

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Table 1

Relationship between positive psychological well-being and participant characteristics.

Characteristic	Mean (Standard Deviation)		
	Life Satisfaction	Emotional Vitality	Optimism
Gender			
Male	5.33 (1.18)	0.03 (0.72)***	4.63 (1.14)
Female	5.33 (1.17)	−0.07 (0.77)	4.64 (1.19)
Ethnicity			
White	5.33 (1.17)	−0.02 (0.74)***	4.63 (1.15)*
Non-white	5.34 (1.25)	0.21 (0.69)	4.73 (1.21)
Marital status			
Married or cohabitating	5.51 (1.11)***	0.06 (0.71)***	4.69 (1.12)***
Other	4.73 (1.20)	−0.19 (0.79)	4.45 (1.26)
Grade of employment			
Administrative	5.43 (1.10)***	0.01 (0.71)***	4.70 (1.11)***
Professional	5.24 (1.21)	−0.03 (0.76)	4.62 (1.17)
Clerical	5.34 (1.24)	0.06 (0.74)	4.51 (1.23)
Smoking status			
Never smoker	5.38 (1.16)***	0.03 (0.74)***	4.65 (1.16)***
Former smoker	5.35 (1.16)	0.006 (0.73)	4.67 (1.13)
Current smoker	5.11 (1.26)	−0.11 (0.75)	4.47 (1.19)
Alcohol consumption			
Low or moderate	5.35 (1.18)**	0.008 (0.74)*	4.64 (1.15)
High	5.25 (1.17)	−0.04 (0.73)	4.63 (1.17)
Moderate and vigorous exercise			
< 1.5 hours/week	5.16 (1.24)***	−0.16 (0.79)***	4.46 (1.23)***
≥ 1.5 hours/week	5.41 (1.14)	0.08 (0.70)	4.72 (1.11)
Fruit and vegetable consumption			
Yes	5.41 (1.14)***	0.04 (0.73)***	4.70 (1.13)***
No	5.20 (1.23)	−0.07 (0.74)	4.53 (1.19)

* $p < .05$

** $p < .01$

*** $p < .001$

Table 2

Odds Ratios (95% Confidence Intervals) for the Association between One Standard Deviation Increase in Life Satisfaction, Emotional Vitality, or Optimism and Incident Diabetes (Physician-diagnosed and Screen-detected Diabetes Combined)[a]

	Model			
Positive Psychological Well-Being	**Model 1**[b]	**Model 2**[c]	**Model 3**[d]	**Model 4**[e]
Life Satisfaction				
Odds Ratio (95% Confidence Interval)	0.98 (0.89-1.07)	0.99 (0.91-1.09)	0.98 (0.89-1.07)	0.99 (0.90-1.10)
Emotional Vitality				
Odds Ratio (95% Confidence Interval)	0.96 (0.88-1.05)	0.98 (0.90-1.08)	0.97 (0.88-1.06)	0.98 (0.88-1.10)
Optimism				
Odds Ratio (95% Confidence Interval)	1.00 (0.92-1.09)	1.02 (0.94-1.11)	1.00 (0.91-1.09)	1.02 (0.92-1.12)

[a]There were 7,800 participants and 562 cases in each model

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

[c]Adjusted for covariates in Model 1 and health behaviors (smoking status, alcohol consumption, physical activity, fruit and vegetable consumption)

[d]Adjusted for covariates in Model 2 and clinically-assessed variables (systolic and diastolic blood pressure, body mass index)

[e]Adjusted for covariates in Model 3 and depressive symptoms

Table 3

Odds Ratios (95% Confidence Intervals) for the Association between One Standard Deviation Increase in Life Satisfaction, Emotional Vitality, or Optimism and Physician-diagnosed Diabetes[a]

	Model			
Positive Psychological Well-Being	**Model 1[b]**	**Model 2[c]**	**Model 3[d]**	**Model 4[e]**
Life Satisfaction				
Odds Ratio (95% Confidence Interval)	0.85** (0.76-0.95)	0.86** (0.77-0.97)	0.83** (0.74-0.93)	0.87* (0.76-1.00)
Emotional Vitality				
Odds Ratio (95% Confidence Interval)	0.86* (0.77-0.97)	0.88* (0.78-0.99)	0.85** (0.75-0.96)	0.91 (0.78-1.06)
Optimism				
Odds Ratio (95% Confidence Interval)	0.94 (0.84-1.05)	0.95 (0.84-1.06)	0.91 (0.81-1.03)	0.96 (0.85-1.10)

[a]There were 7,800 participants and 288 cases in each model

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

[c]Adjusted for covariates in Model 1 and health behaviors (smoking status, alcohol consumption, physical activity, fruit and vegetable consumption)

[d]Adjusted for covariates in Model 2 and clinically-assessed variables (systolic and diastolic blood pressure, body mass index)

[e]Adjusted for covariates in Model 3 and depressive symptoms

*$p \leq .05$

**$p \leq .01$

Table 4

Odds Ratios (95% Confidence Intervals) for the Association between One Standard Deviation Increase in Life Satisfaction, Emotional Vitality, or Optimism and Screen-detected Diabetes[a]

	Model			
Positive Psychological Well-Being	**Model 1[b]**	**Model 2[c]**	**Model 3[d]**	**Model 4[e]**
Life Satisfaction				
Odds Ratio (95% Confidence Interval)	1.04 (0.93-1.15)	1.07 (0.96-1.19)	1.05 (0.95-1.17)	1.05 (0.94-1.19)
Emotional Vitality				
Odds Ratio (95% Confidence Interval)	1.04 (0.93-1.15)	1.08 (0.97-1.20)	1.07 (0.96-1.19)	1.08 (0.95-1.22)
Optimism				
Odds Ratio (95% Confidence Interval)	1.05 (0.95-1.17)	1.08 (0.97-1.20)	1.06 (0.96-1.18)	1.07 (0.95-1.19)

[a] There were 6,716 participants and 414 cases in each model

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

[c] Adjusted for covariates in Model 1 and health behaviors (smoking status, alcohol consumption, physical activity, fruit and vegetable consumption)

[d] Adjusted for covariates in Model 2 and clinically-assessed variables (systolic and diastolic blood pressure, body mass index)

[e] Adjusted for covariates in Model 3 and depressive symptoms