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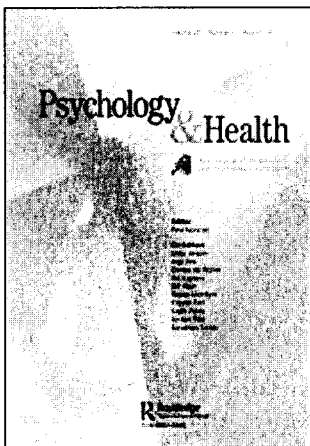
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The relationship between mental vitality and cardiovascular health

Laura Smart Richman^{a*}, Laura D. Kubzansky^b, Joanna Maselko^c, Leland K. Ackerson^d and Mark Bauer^c

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Past measurement of vitality has included both emotional and physical components. Since aspects of physical vitality such as fatigue can be indicative of physical illness, the usefulness of existing measures of vitality to predict health is limited. This research was designed to examine the psychometric properties of a new Mental Vitality Scale and to test its associations with measures of cardiovascular health over the course of 2 years. The measure of mental vitality was administered in a two-part study using three different samples. In part 1, the reliability and validity of the scale was assessed with a student and a clinic sample. In part 2, medical data on mental and physical health were abstracted over a two-year period from 1041 patient records from a multi-specialty medical practice, and mental vitality assessed through a mailed questionnaire. The findings indicate that the Mental Vitality Scale is a valid and reliable questionnaire for measuring this construct. Mental vitality was also associated with reduced odds of several cardiovascular outcomes and prospective analyses suggest that mental vitality may serve a protective function in the development of cardiovascular disease. The results lend support for the importance of mental vitality as a construct that may be relevant for considering resilience in relation to cardiovascular disease.

Keywords: positive emotion; vitality; cardiovascular health

Introduction

Whether positive emotions have a protective effect on physical health has received an increasing amount of attention on research. In a comprehensive review of the literature on trait positive affect – a term used interchangeably to refer to affect, mood or emotion – Pressman and Cohen (2005) find that it is associated with lower morbidity, decreased symptoms and pain and increased longevity for older community-dwelling individuals. In attempting to understand the aspects of positive emotion that make it protective for health, the present research examines how a theoretically derived composite of positive emotion, mental vitality, is related to health outcomes.

Vitality has been identified as a key component in a model of healthy psychological functioning (Rozanski & Kubzansky, 2005). This model highlights the importance of

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flexibility and identifies three inter-related components of healthy psychological functioning: vitality, coping flexibility (the ability to adjust and implement effective coping strategies according to the nature of the problem) and emotional flexibility (the ability to flexibly regulate emotions across a wide range of situations). According to this model, vitality is a composite of positive emotions that provides energy for managing negative emotions and solving problems effectively. This relationship is proposed to be bidirectional, with effective emotional regulatory processes and coping skills also helping to preserve vitality by diminishing the frequency of energy-depleting negative emotions and/or taxing life problems. This type of psychological vitality may also lead to more effective physiological regulation, and therefore, may be associated with better physical health.

The current study seeks to develop a valid measure of mental vitality derived from this model. Mental vitality, as conceptualised here, would also be expected to predict health outcomes. Prior work has suggested that mental vitality may protect health because it limits psychological and physiological reactivity to chronic stress and hyper arousal, which may be related to the development and acceleration of coronary artery disease (Rozanski & Kubzansky, 2005; Ryff & Singer, 1998). Thus, building on previous work by identifying an important role for psychological factors in cardiovascular health, we also test the hypothesis that high levels of mental vitality are associated with better cardiovascular health as measured by the prevalence and incidence of several cardiovascular outcomes over the course of 2 years.

Preliminary evidence points to a relationship between various aspects of vitality and health outcomes. The Profile of Mood States (POMS; McNair, Lorr, & Doppleman, 1971) is a widely used measure that contains a factor closely related to vitality, labelled 'vigour/activity'. The vigour factor has been negatively related to tension, depression, anger, fatigue and confusion in validity studies. A more extensively used measure of vitality is the vitality subscale in the short form (SF-36) of the health status survey of the Medical Outcomes Study (MOS; McHorney, Ware, & Raczek, 1993). This is a four-item scale that measures physical energy and has been associated with fewer chronic physical conditions (Lerner, Levine, Malspeis, & D'Agostino, 1994). Another study defined subjective vitality as the conscious experience of possessing energy and aliveness (Ryan & Frederick, 1997). Here, vitality was positively associated with several indices of psychological well-being and inversely associated with somatic factors such as physical symptoms and poor perceived body functioning. In a study of nursing home residents, Kasser and Ryan (1999) found this same measure of vitality was also positively correlated with perceived health, well-being and satisfaction. Among disabled older women, Penninx et al. (2000) found that a measure of emotional vitality protected against progression of disability and mortality. These findings suggest that vitality, broadly defined, may serve to protect or maintain good health.

Although relationships between the construct of vitality and health outcomes have been found in past research, one limitation of this work is the inconsistency in how vitality is defined. Vitality has been referred to as the presence of energy, enthusiasm, and in general, aliveness (Ryan & Frederick, 1997). While 'energy' seems to be a defining feature of vitality in previous studies (e.g. Kasser & Ryan, 1999), what is meant by 'energy' is unclear. For example, Selye's (1956) theory of stress refers to 'adaptation energy' synonymously with vitality and describes it as a protective mechanism in response to stress – a sort of 'hidden reserve of adaptability energy in ourselves throughout the body'. (p. 65) However, a clear definition of such energy has not been proposed. Perhaps as a result, measures of vitality have varied widely, from measuring primarily physical levels of energy

(McHorney, Ware, & Raczek, 1993) to capturing more psychological aspects of feeling alive and engaged (e.g. Kasser & Ryan, 1999).

This inclusion of both emotional and physical components in the definition of vitality is highly problematic for studies seeking to examine the links between vitality and physical health. A close examination of items from existing vitality or vitality-related scales finds that such physical energy items are almost always present. For example, Ryan and Frederick's subjective vitality measure includes items such as 'I nearly always feel alert and awake' and 'I feel energised'. The trait version of this measure asks respondents to indicate the degree to which each statement is true for them, in general, in their life, but it is difficult to distinguish subjective perceptions of health, such as somatic complaints, from trait-like perceptions of feeling alert and awake. In fact, questions about alertness or fatigue are often used to assess somatic complaints and can even be indicators of physical illness. Similarly, the vitality subscale of the SF-36, contains the items, 'Did you feel full of pep?' 'Did you have a lot of energy?' These somatic complaints comprise the majority of items for these scales, so using either of these scales with the somatic items removed are not viable options; the subjective vitality measure would only have three items remaining and the SF-36 subscale would have none. Another scale created by Penninx et al. (1998) defines emotional vitality in yet a different way: an index of a high sense of personal mastery, high happiness and low depressive symptomatology and anxiety scores.

In the present research, we sought to validate a measure of mental vitality that is comprised of items that represent a combination of hopefulness and mental vigour (i.e. interest). These components are derived from both theoretical and empirical work on mental vitality and relevant positive emotions, and measure positive affect about both present and future experiences. Hopefulness and engagement with the social environment have been identified as key components of the flexibility and adaptability that is associated with how mental vitality may serve as a protective function for health outcomes (Deci, 1992; Fredrickson, 1998; Izard & Ackerman, 1995; Rozanski & Kubzansky, 2005). Although, existing scales of related constructs may include some of these elements, we consider a measure that captures vitality-related psychological processes more uniquely, and which may also be appropriate for use in studies exploring the relationship between mental vitality and physical health.

Study overview

This study consisted of two parts. First, we examined the psychometric properties of the mental vitality instrument, using data from study participants who completed the mental vitality measure along with several other questionnaires predicted to be either positively or negatively related to mental vitality. We hypothesised that mental vitality would be positively associated with positive affect, well-being, dispositional optimism and mastery. Conversely, we expect mental vitality to be negatively associated with negative affect and hopelessness and unrelated to social desirability. We also expected mental vitality to be a relatively stable trait. To assess this, we examined the stability of our measure of mental vitality over time by evaluating test-retest reliability with assessments separated by 2 weeks. In a separate study population, we subsequently tested the hypothesis that mental vitality would be associated with better cardiovascular health. The primary research question concerned whether levels of mental vitality were related to reduced prevalence and likelihood of developing (incidence of) adverse cardiovascular risk factors and adverse outcomes. In this population, data on mental health diagnoses were also available.

Thus, we took the opportunity to examine whether mental vitality was negatively associated with mental illness as another check on the validity of the measure. Although mental illness is typically under-diagnosed in primary care practice (Kessler et al., 1994), it may still be a useful indicator of the quality of our mental vitality measure.

Data for this study comes from three sources: (1) a survey conducted in a student population – used for psychometric and validation analyses; (2) a survey conducted in a general medical practice with a clinic population – used for psychometric and validation analyses; (3) survey and medical record abstraction with patients affiliated with a multi-specialty medical practice – used for cardiovascular outcomes analyses. The identical surveys were used with the first two independent samples to provide further validation of our measure.

Method

Study populations and procedure

Psychometric and validation analyses

Two samples were used: graduate students ($n=68$) and general medicine patients ($n=106$). For the student sample, a table was set-up outside of large lecture class, where students were asked whether they would like to complete several questionnaires for a survey study. They were then given the survey to complete in an empty classroom. They were also asked to provide their contact information so that they could be sent the mental vitality measure 2 weeks later. Those who returned their questionnaires were entered in a raffle to win a gift bag of coffee-related products worth $\approx \$50$, and the response rate for completing the second survey was 79%. For the clinic sample, people were approached in the waiting rooms of two outpatient general health clinics and were asked to complete some questionnaires. After completing the measures, participants were offered \$5.00 Starbucks gift cards as compensation. In the sample of graduate student, ages ranged from 22 to 57 with a mean age of 33, and $\approx 68\%$ were female and 53% were Caucasian. In the sample of general medicine patients, ages ranged from 23 to 76 with a mean age of 43, and $\approx 71\%$ were female and 70% were Caucasian.

Cardiovascular outcomes analyses

The cardiovascular outcomes sample was randomly selected from 5500 patients aged 55–69 from the database of a multi-specialty practice caring for 180,000 adults in urban and suburban settings. We contacted each patient's primary care physician and requested permission to recruit the patients. Several of the physicians did not grant consent, so 4027 received the mailed questionnaire. All patients had HMO-type coverage and had relatively low co-payments for office visits. A total of 1041 patients completed the questionnaire and gave permission to access their records, yielding a response rate of 27%. Participants were not compensated and this response rate is typical of surveys that do not include a financial incentive (Tedin & Hofstetter, 1982). There were no significant differences in response rates across gender and age. The questionnaire assessed trait emotions, health behaviours and demographic information. More than a year after the questionnaire was returned, data were abstracted from the computerised medical record system, focusing on the year *before* the administration of the questionnaire (pre-baseline) and the year *after* the administration of the questionnaire (post-baseline). Medical record information was recorded at each outpatient visit by the examining clinician, who entered diagnoses using

the International Classification of Disease (ICD-9) codes. Records were 99.9% complete. Data for the cardiovascular outcomes analyses were drawn from linked survey responses and medical records abstracted for patients in the multi-specialty practice. The distribution of men and women was similar to that of the overall practice patient base of 55% women and 45% men. The mean age was 61.8 years ($SD = 4.5$ years, range = 55–70 years).

Measures

Mental vitality

Participants in all three samples responded to seven items that measure emotional traits related to aspects of mental vitality. They were asked to respond according to the extent to which they generally feel on a Likert-type scale ranging from *strongly disagree* (1) to *strongly agree* (4). Items were derived from existing measures of hope (Ellsworth & Smith, 1988) and curiosity (Spielberger, 1998) tapping into aspects of hopefulness and engagement with the social environment that underlie the mental vitality construct. These seven items included, 'I feel hopeful', 'I feel challenged', 'I feel confident', 'I feel bored', (reverse coded) 'I feel stimulated', 'I feel mentally active', and 'I feel disinterested'¹ (reverse coded).

Measures to assess validity (student and clinic samples)

Affect was measured using the 20-item Positive and Negative Affect Schedule (PANAS; Watson & Tellegen, 1988) and the POMS scale, which measures seven aspects of affect (friendliness, anxiety, depression, anger, vigour, fatigue and confusion) using 65 adjectives that can be ranked on a five-point scale (McNair et al., 1971). Well-being was measured by the Satisfaction with Life scale (Diener, Emmons, Larsen, & Griffin, 1985). Dispositional optimism was measured by the Life Orientation Test (LOT; Scheier, Carver, & Bridges, 1994). The LOT is a 10-item scale with two filler items, four positively-worded items and four reverse-coded items scored on a five-point scale ranging from *strongly disagree* (1) to *strongly agree* (5). To measure psychological coping resources, we included two items scored on a four-point scale from Pearlin's Mastery subscale (Pearlin & Schooler, 1978). Hopelessness was assessed using the Beck Hopelessness Scale (Beck, Rush, Shaw, & Emery, 1979). Physical vitality was assessed using items from the vitality subscale in the short form (SF-36) of the health status survey of the MOS (McHorney, Ware, & Raczek, 1993). We also included the Social Desirability Scale (Crowne & Marlowe, 1960), which uses 33 true/false questions to measure tendency of individuals to project favourable images of themselves during social interaction. All of these measures have been shown to be valid and reliable in numerous populations.

Assessment of health outcomes (patient sample)

Medical records were abstracted for diagnoses related to cardiovascular outcomes and mental health diagnoses. To increase power and because case counts were small for some diagnoses, we combined related diagnoses into broader categories. Three cardiovascular-related outcomes were considered: coronary heart disease (CHD)/cerebral vascular disease (CVD), hypertension and high cholesterol/lipid metabolism problems. Mental illness included any diagnosis of psychoses, depression and anxiety. Two physicians, in concordance, established these domains of classification prior to data analysis. All diagnoses were identifiable in patient records via ICD-9 codes. The physicians

reviewed the list of diagnoses occurring in the two-year study period and assigned relevant diagnoses (based on their ICD-9 codes and diagnostic criteria) to the outcomes of interest. Because the physicians worked in concert to develop these categories, inter-rater reliability information is unavailable. All outcomes were coded for prevalence and incidence. Prevalent cases were coded yes/no according to whether patients received a diagnosis in the two-year time frame. Incident cases were coded yes/no according to whether patients received a diagnosis in the year after baseline, *but did not* have the diagnosis in the year prior to emotional assessment (pre-baseline). We note that in some cases, power for these analyses is extremely limited. For example, we have only 25 incident cases of CHD/CVD. Thus, analyses with these outcomes are considered more exploratory, and should be viewed cautiously. Physicians did not have access to the patients' mental vitality scores or demographic information.

For the analysis of cardiovascular health outcomes, covariates included gender, age, marital status, smoking status, alcohol consumption, physical activity and two measures of negative affect. Information on gender, age and marital status were self-reported. Measures of smoking status and alcohol consumption (Cheng, Kawachi, Coakley, Schwartz, & Colditz, 2000), and physical activity (Chasan-Taber et al., 1996) were also based on self-report using standardised and validated scales. Trait anxiety and trait anger were assessed using the trait measures of the Spielberger State-Trait Personality Inventory (Spielberger, 1998). Trait anxiety reflects stable individual differences in the frequency and intensity with which anxiety states have been manifested in the past and in the probability that anxiety will be experienced in the future (Spielberger & Gorsuch, 1983). The anxiety subscale includes 10 items and has an internal consistency reliability coefficient of $\alpha = 0.84$. Trait anger is defined as the disposition to perceive situations as annoying or frustrating, and the tendency to respond to such situations with more frequent elevations in state anger (Spielberger, 1996). The anger subscale includes 10 items and has an internal consistency reliability coefficient of $\alpha = 0.81$.

Statistical analyses

We used confirmatory Factor Analysis (CFA) techniques to evaluate the construct validity of a theoretically-derived Mental Vitality Scale using the items available. We specified the items that we hypothesised would comprise aspects of mental vitality and used CFA to match the observed and theoretical factor structures and then determine the goodness-of-fit of the predetermined factor model. We used several standard goodness-of-fit statistics to determine the fit of our model including: chi-square to degrees of freedom ratio, Non-Normed Fit Index (NNFI; Bentler & Bonett, 1980), and the Comparative Fit Index (CFI; Bentler, 1990). We applied the criteria of a chi-square to degrees of freedom ratio of 2:1 or lower, and a NNFI or CFI of 0.90 or better as indicative of an acceptable model fit (Bagozzi & Youjae, 1988). Additional analyses included assessing reliability through internal consistency coefficient alphas and test-retest correlations, as well as determining convergent and discriminant validity using the various measures of affect, well-being and personality. We initially conducted analyses separately in the student and clinic populations. However, because findings were virtually identical, for parsimony, we combined the samples for presentation here.

To assess relations with cardiovascular health, we used the CFA results from the students and the clinic samples and applied the modified Mental Vitality Scale to examine health outcomes in the multi-specialty practice patient sample. We then used

logistic regression analysis to examine whether levels of mental vitality (as a continuous variable) were associated with the dichotomous outcomes of diagnosis of disease (yes/no) for the three cardiovascular outcomes as well as mental illness diagnosis. Basic models controlled for age and gender only. Multivariable models subsequently included a broader array of potential confounders. These models controlled for age, gender, marital status and health-related behaviours including smoking, exercise and alcohol intake. In addition, given other research that has suggested negative emotions are risk factors for a variety of diseases, we considered whether our results might be a function of the inverse relationship between mental vitality and negative emotions. For each disease outcome, we separately ran the multivariable models with and without anger and anxiety to assess whether mental vitality had effects over and above those negative emotions. Findings were similar when negative emotions were included. Thus, we report only the models with anger and anxiety, since the results were largely unchanged from the models without them.

Results

Psychometric assessment of mental vitality

Construct validity

The initial CFA analyses included seven items theoretically posited to assess aspects of mental vitality. In order to increase power for the CFA analyses, we combined the student and clinic samples. The chi-square fit was unsatisfactory for the full set of seven items as were the NNFI and CFI fit indices. Since one item, 'bored', had a low factor loading (0.31 in the combined sample), we removed this item and then refitted the model. The modified scale without the bored item suggested a single factor model with a chi-square to degrees of freedom ratio of 2:1, the NNFI of 0.95 and the CFI of 0.97, all indicating acceptable model fit.

Reliability analyses

Reliability for the refined Mental Vitality Scale was measured via Cronbach's internal consistency coefficient alpha (Cronbach, 1951) in the student and clinic samples separately, and via test-retest correlations for the student sample. The coefficient alpha for each sample was strong, 0.78 for the student sample and 0.81 for the clinic sample. We estimated test-retest reliability for the mental vitality instrument by correlating scores obtained from the student sample in the first rating session with the scores obtained in a second rating session, ≈ 2 weeks later. The total N for test-retest correlations was 54 and the coefficient was modest ($r = 0.54$, $p < 0.0001$).

Convergent and discriminant validity

As predicted, mental vitality was related to various aspects of well-being. For both the student and clinic samples, mental vitality was positively and significantly related to the PANAS positive affect scale, well-being, mastery and dispositional optimism (Table 1). It was positively related to the 'friendly' component of the POMS scale. The magnitude of the associations across the two samples varied somewhat, but the direction and significance of effects were consistent. Importantly, associations with measures of physical vitality/vigour were modest in size; correlations ranged from 0.29 to 0.45, indicating that our new mental vitality measure converged with, but did not duplicate, these physical aspects of vitality.

Table 1. Convergent and discriminant relations to other constructs.

	Student	Clinic
<i>Convergent validity</i>		
PANAS positive affect	0.61*	0.44*
Well-being	0.38*	0.37*
POMS friendly	0.28*	0.34*
POMS vigour	0.45*	0.36*
Mastery	0.42*	0.32*
Optimism	0.58*	0.25*
Physical vitality	0.36*	0.29*
<i>Discriminant validity</i>		
PANAS negative affect	-0.36*	-0.33*
POMS fatigue	-0.2	-0.23*
Social desirability	-0.37*	-0.02
POMS anxiety	-0.19	-0.31*
POMS anger	-0.38*	-0.25*
POMS depression	-0.43*	-0.44*
POMS confusion	-0.43*	-0.34*
Hopelessness	-0.37*	-0.19

Note: Pearson correlation coefficients reported.

* $p < 0.05$.

As shown in Table 2, mental vitality was negatively related to the POMS depression, confusion and anger scales, and the PANAS negative affect scale. Though the associations were all in the same direction, there were some differences in the magnitude of these associations across the student and clinic samples. The POMS fatigue and POMS anxiety scales were negatively related to mental vitality in the clinic sample, but non-significant in the student sample. Hopelessness and social desirability were negatively related to mental vitality in the student sample but were unrelated in the clinic sample.

We explored the possibility that there may be differences between the student and the clinic sample on levels of fatigue, potentially limiting our ability to compare the samples. We created a 'tired' variable based on 19 items selected for their reflection of physical tiredness: 2 from the PANAS scale, 13 from the POMS scale and 4 from the SF-36. Each of the selected items was considered to indicate feeling tired if it was a PANAS score in the highest two-response categories, a POMS score in the highest two-response categories or a SF-36 score in the highest three-response categories. Participants were characterised as tired if they gave responses indicating tiredness to at least 51% of the 19 selected items. On this basis, 86% of the sample was coded as not tired and 14% was coded as tired. Mean levels of tiredness were not significantly related to sample ($p = 0.13$), and being tired did not substantially change the relationship between sample and mental vitality ($p = 0.45$). As a result, we were somewhat reassured that any greater fatigue in the clinic sample would not alter the interpretation of our findings.

Mental vitality and cardiovascular health

Descriptive statistics

We examined the distribution of potential risk factors for disease across our sample (Table 2). There were approximately equal numbers of men and women and the

Table 2. Sample characteristics ($N = 1036$).

Sample characteristics (%)		
Sex (men)	44.8	
Current smoker	7.8	
Married	69.2	
	Mean	SD
Age	61.8	4.4
Activity level (MET's per week)	26.1	53.9
Alcohol consumption (servings per week)	5.4	8.4
Vitality	3.15	0.58

Table 3. Association between vitality and two-year prevalence and incidence of cardiovascular outcomes.

CV outcomes	Prevalence		Incidence	
	Age and sex	Multivariable	Age and sex	Multivariable
	OR (95% CI)		OR (95% CI)	
CHD/CVD	0.59** (0.43–0.80)	0.55** (0.36–0.84)	0.45* (0.24–0.86)	0.52 (0.27–1.03)
Hypertension	0.70** (0.56–0.87)	0.58** (0.43–0.79)	0.64* (0.43–0.94)	0.65 (0.37–1.14)
High cholesterol	0.74** (0.60–0.92)	0.57** (0.43–0.78)	0.72 (0.52–1.00)	0.51** (0.31–0.82)

Note: Multivariable models adjusted for age, gender, smoking, exercise, alcohol intake, marital status, anger and anxiety.

* $p < 0.05$; ** $p < 0.01$.

majority of the sample was married (69.2%). Participants were on average moderate drinkers and there were relatively few smokers. As expected, controlling for age and gender, mental vitality was significantly inversely associated with having a diagnosis of mental illness (prevalence Odds Ratio (OR)=0.48, 95% confidence interval (CI):0.37, 0.63), $p < 0.0001$). Mental vitality was also strongly associated with obtaining a diagnosis of mental illness in Year 2. The OR was 0.53 (95% CI: 0.32, 0.87), $p < 0.05$ indicating that a one unit (one point on a 1–4 scale) increase in mental vitality was associated with a 47% decreased likelihood of getting diagnosed with mental illness in the year following the survey.

Mental vitality and CHD/CVD

Mental vitality was significantly associated with a decreased likelihood of having a diagnosis of CHD/CVD (prevalence; OR = 0.59, 95% CI 0.43, 0.80, $p < 0.01$), controlling for age and gender (Table 3). This association was maintained in the full multivariable model with a 45% reduction in odds (OR = 0.55; 95% CI 0.36, 0.84, $p < 0.01$). Mental vitality was also significantly associated with incident CHD/CVD, demonstrating a protective association of mental vitality with the development of CHD/CVD in Year 2. In the basic model controlling for age and gender (OR = 0.45, 95% CI: 0.24, 0.86, $p < 0.05$),

for each one-unit increase in mental vitality over the one-year follow-up there was a 55% decrease in odds of getting a diagnosis of CHD/CVD. The association of mental vitality with incident CHD/CVD in the full multivariate model was substantially attenuated, but effect estimates were in the expected direction.

Hypertension

Mental vitality was significantly associated with having a diagnosis of hypertension (prevalence; OR = 0.70, 95% CI 0.56, 0.87, $p < 0.01$), controlling for age and gender (Table 3) and this association was maintained in the full multivariable model with a 42% reduction in odds of diagnosis (OR = 0.58; 95% CI 0.43, 0.79, $p < 0.0001$). Mental vitality was also significantly associated with incident cases of hypertension, OR = 0.64 (95% CI: 0.43, 0.94), $p < 0.05$ controlling for age and gender, with a 46% decrease in odds of getting a diagnosis of hypertension for each one-unit increase in mental vitality over the one-year follow-up. This effect was similar but attenuated in the multivariable model, OR = 0.65 (95% CI: 0.37, 1.14), $p = 0.13$.

High cholesterol

Mental vitality was significantly associated with prevalent high cholesterol, OR = 0.74, 95% CI: 0.60, 0.92, $p < 0.01$ controlling for age and gender and in the full multivariate model, OR = 0.57, 95% CI: 0.43, 0.78, $p < 0.001$. Mental vitality was marginally significantly associated with incident cholesterol in the basic models, OR = 0.72, 95% CI: 0.52, 1.00, $p = 0.05$ and the association reached significance in the full multivariable model, OR = 0.51, 95% CI: 0.31, 0.82, $p < 0.01$, indicating that there was a 49% reduction in the odds of being diagnosed with high cholesterol for each one-unit increase in mental vitality over the one-year follow-up.

Discussion

In this research, we examined the reliability and validity of our mental vitality construct and examined its pattern of associations with measures of psychological and physical health. The results lend support for the importance of mental vitality as a valid and reliable construct that may be relevant for health and more specifically for considering resilience in relation to CVD. Our measure of mental vitality was administered in three samples and demonstrated high validity and reliability on multiple indicators. The convergent validity findings indicate that, as expected, people with high levels of mental vitality tended to have more psychological resources such as more positive affect, higher well-being, higher mastery, higher optimism and more sociability. Although there are some shared components between these measures and mental vitality, as indicated by the correlations, they are clearly measuring separate constructs. Importantly, we note that mental vitality was related to but not redundant with, aspects of physical vitality/vigour, suggesting that this measure is tapping a unique aspect of vitality that may have important protective elements for health. We note that although we did find some differences between the clinic and the student samples on demographics, level of tiredness, mastery and hopelessness (data not shown), these differences do not seem to influence the relationships between mental vitality and various constructs used to assess convergent and discriminant validity. Finally, we found some evidence to suggest that mental vitality may be associated with reduced likelihood of several cardiovascular health outcomes and effects were maintained

after controlling for a variety of potential confounders. Moreover, even with the small number of cases in this sample, the prospective analyses suggest the possibility of a protective role for mental vitality in the development of CVD.

Although the scale we developed has similar components to other measures of subjective, emotional or physical vitality, our scale is distinguishable from the previous measures in important ways. Prior measurements of vitality included components of physical vitality (e.g. Kubzansky & Thurston, 2007; McHorney, Ware, & Raczek, 1993; Ryan & Frederick, 1997), in addition to emotional aspects of vitality. The inclusion of both physical and psychological aspects of vitality in one measure limits how such scales can be applied in examining health-related outcomes. Aspects of physical vitality are often used as indicators of illness such as fatigue and lack of alertness, which are also symptoms of many illnesses. Thus, an association between such measures of vitality and specific disease outcomes may be inflated by overlap across these symptoms. In focusing on just the mental element of vitality, we were able to reduce this potential confound and increase our confidence that positive psychological functioning *per se* could influence physical health outcomes. Other related constructs to vitality are also in the literature, such as Jamison's (2005) concept of exuberance, which shares some similarities with our measure of vitality. She defines exuberance as a temperament and comprised of enthusiasm. Although our measure does not directly measure enthusiasm, it is likely that individuals who are exuberant or enthusiastic are likely also vitally engaged with their social environment. However, Jamison (2004) does not typically measure or quantify exuberance, so a direct comparison with vitality is not possible.

A great deal of the literature linking positive emotional states to health also suffer from the methodological limitation of relying upon self-reports of physical symptoms and pain. Such self-reports may be subject to cognitive biases in perceiving, reporting and acting on physical sensations rather than actual physical illness (Pressman & Cohen, 2005). High positive affect is associated with reporting fewer and less severe symptoms when objective markers of disease are held constant (Cohen, Doyle, Turner, Alper, & Skoner, 2003). A strength of the present study was the use of self-report methodology to assess emotions and physician diagnosis to determine health outcomes. In addition, some of the outcomes measured did not depend on reports of pain or symptoms, including hypertension and high cholesterol, thus, allowing for a less biased assessment of whether mental vitality was associated with health outcomes.

Our research did not examine specific mechanisms underlying the relationship between mental vitality and cardiovascular health, but possible pathways are suggested in the vitality model proposed by Rozanski and Kubzansky (2005). This model proposes that vitality is instrumental in regulating emotion and coping with stress. This is important because cumulative stress has been implicated in physiologic wear and tear on the body due to the chronic over- or under-activity of allostatic systems to produce allostatic load (e.g. Seeman, Singer, Rowe, Horwitz, & McEwen, 1997). Of particular relevance to the present research, evidence supports a causal relationship between the chronic stress and the development of coronary artery disease most likely through a mechanism involving excessive sympathetic nervous system activation (Rozanski, Blumenthal & Kaplan, 1999; Strike & Steptoe, 2004). Sympathetic nervous system hyper-responsivity has been linked to accelerated development of carotid atherosclerosis in human subjects and to exacerbated coronary and carotid atherosclerosis in monkeys (Rozanski et al., 1999). Such findings have led to recognition of the importance of behavioural interventions that might promote more positive ways of responding to life stressors, and thus, reduce the impact on health outcomes. Psychosocial skills training that focuses on anger management and developing

better social relationships (Williams & Williams, 1993) has been shown to reduce cardiovascular reactivity to stress (Bishop et al., 2005) and recent work on meditation (Fredrickson, Cohn, Coffrey, Pek, & Finkel, 2007) finds that it is associated with increases in daily experiences of positive emotion, which were related to decreases in illness symptom reporting.

The aspects of vitality involved with emotion regulation and coping, therefore, may also be related to more effective physiological regulation. Evidence suggests that positive emotions may speed internal homeostatic processes, specifically for cardiovascular functioning (Fredrickson & Levenson, 1998). Fredrickson and Levenson found that after participants viewed a fear-inducing film, a subsequent induction of positive emotion shortened the duration of cardiovascular arousal produced by the fear film as compared to those who had a sad or neutral mood induction. In this way, positive emotions may reduce stress on the cardiovascular system in the face of negative life events. As suggested by Fredrickson and Levenson (1998) and Rozanski and Kubzansky (2005), trait levels of positive emotion (and vitality specifically) may enable people to cope with stressful experiences with a confidence about the future, thus, muting potential adverse effects.

Several limitations of this study deserve mention. Although we do find that mental vitality is associated with CHD/CVD and hypertension in the models that only controlled for age and gender, the results were only marginally significant for the full models. This was likely due to low power since we had only a small number of cases for these analyses. We were unable to assess the influence of unmeasured potential confounds such as socioeconomic status and body mass index that may have been related to tendencies to experience mental vitality and cardiovascular health. Unfortunately, we could not examine the specific influence of depression in our models since depression was not measured in the larger study, however, in all the multivariable models we did include a measure of anxiety. Given the high rates of comorbidity of anxiety and depression, we think the inclusion of anxiety adjusts for a large amount of the potential effect of depression. Another limitation is that the response rate to the survey in the multi-specialty practice sample was low. The response rate (27%) in our survey is not atypical of surveys in the general population that do not offer a financial incentive, but caution is nevertheless warranted in generalising our results to the general population of patients. On the other hand, a low-response rate does not necessarily affect the internal validity of our findings. The stability of our measure over time was moderate and future research with larger sample sizes should investigate the extent to which mental vitality is capturing a stable individual difference. In addition, although we measured physician diagnosis rather than symptom reporting, which eliminates some potential sources of bias, the possibility remains that our findings may be due to an increased motivation to seek medical care or sensitivity to symptoms. Whether mental vitality may be related to such tendencies is unknown at this point.

Conclusions

Our measure of mental vitality was found to be psychometrically sound and was associated with a reduced likelihood of several cardiovascular outcomes. This research lends support to the future use of this measure to examine how mental vitality may function to provide 'adaptation energy' for managing psychological and physiological reactivity to stressors. A strong measure of mental vitality is essential to examine such questions.

Note

1. This is the US meaning of this word, which is most commonly defined as 'not interested' or 'indifferent' rather than the British meaning of 'impartial'.

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