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Positive emotional well-being, health Behaviors, and inflammation measured by C-Reactive protein

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ABSTRACT

Objective: There is a substantial body of literature describing the association between inflammatory biomarkers and negative emotional factors (i.e. depression). However, less is known about how they might be related to positive psychological variables. This study examined the association between positive emotional well-being (PEWB) and C-Reactive Protein (CRP), an inflammatory biomarker important for cardiovascular and other diseases.

Method: Data were analyzed from 1979 respondents to a nationwide survey in the U.S., which included a chronically ill subgroup. Two aspects of PEWB were assessed; positive affect and life satisfaction. CRP was analyzed via blood-spot from a finger-prick. The mediating role of health behaviors (i.e., smoking, alcohol, BMI, and moderate exercise) was also examined.

Results: Both positive affect and life satisfaction were significantly related to lower CRP even after controlling for demographics and depression, in both the overall sample and chronically ill group. Only life satisfaction remained significantly related to CRP when controlling for health behaviors. When both depression and health behaviors were controlled, neither positive affect nor life satisfaction was significantly related to CRP. Moderate exercise emerged as the strongest mediator, followed by BMI and smoking. Individuals with low positive affect or low life satisfaction were at increased odds (OR = 1.40 and OR = 1.54, respectively) of having clinically elevated (≥ 3 mg/L) CRP.

Conclusion: Our results add to a growing literature reporting an association between aspects of PEWB, especially life satisfaction, and a health-related biomarker of inflammation. Those with low positive affect or life satisfaction face increased risk of having clinically elevated CRP. Health behaviors, especially BMI and moderate exercise, account for some but not all of this relationship. Future studies should determine whether increasing life satisfaction and positive affect may contribute to improvements in health behaviors, inflammation, and better health outcomes.

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1. Introduction

Researchers have long been interested in how psychological factors affect physical health. While most studies have focused on the relationship between negative psychological states (e.g., depression, anxiety, and anger) and deleterious health outcomes (Das, 2016; Ironson and Fitch, 2016; Pratt et al., 2015), recent literature reflects a growing interest in positive psychological states and their potential impact on health (Seligman, 2008). These states, such as joy, happiness, and contentment, reflect a state of full

concentration and pleasurable engagement with the environment and have been associated with favorable health outcomes (Chida and Steptoe, 2008; Pressman and Cohen, 2005).

There are several possible mechanisms by which positive emotional well-being (PEWB) may be associated with health, including better engagement in healthy behaviors (Kassel et al., 2003; Peterson et al., 2013; Steptoe et al., 2005), strengthening of social ties and coping resources (Fredrickson, 2001), and regulation of emotion-responsive biological pathways such as the sympathetic nervous system (Steptoe et al., 2009), the hypothalamic-pituitary-adrenal-cortical axis (Steptoe et al., 2005), immune function (Marsland et al., 2007), and gene expression (Fredrickson et al., 2013). Importantly, each of these pathways has been shown to impact the body's inflammatory processes including

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proinflammatory cytokine and C-Reactive Protein production (Acabchuk et al., 2017; Albert et al., 2003; Fröhlich et al., 2003; Kiecolt-Glaser et al., 2010; Schneiderman et al., 2005; Visser et al., 1999; Woods et al., 2009). Therefore, in order to better understand the health benefits associated with PEWB, linkages between positive psychological factors and inflammation should be investigated.

C-Reactive Protein (CRP), a highly sensitive marker of systemic inflammation, has received much attention due to its association with coronary heart disease, metabolic syndrome, cancers, and mortality in the general population (Aggarwal and Gehlot, 2009; Casas et al., 2008; Park et al., 2009; Stork et al., 2006). CRP typically shows mild chronic elevations in conditions associated with mild chronic inflammation such as obesity, Type II diabetes, depression, and post-traumatic stress disorder (Segman and Stein, 2015). Release of CRP is mainly determined by Interleukin-6 (IL-6), a proinflammatory cytokine produced by the body's immune system in response to chronic inflammation (Stepptoe et al., 2007). While much research has examined the association of CRP with negative affect (Howren et al., 2009; Valkanova et al., 2013), emerging literature suggests that CRP may also be inversely associated with positive affect states.

1.1. Positive emotional well-being and CRP

Positive emotional well-being is defined as the presence of high positive affect and life satisfaction, together with an absence of depression (Snyder et al., 2010). A meta-analysis of 70 prospective observational cohort studies indicated that PEWB is associated with enhanced longevity in healthy and chronic disease populations (Chida and Steptoe, 2008). Recent evidence also suggests that positive affect and life satisfaction may both be inversely related to lower levels of systemic inflammation measured by circulating inflammatory markers such as IL-6 (Stellar et al., 2015), TNF- α (Brouwers et al., 2013), and CRP (Stepptoe et al., 2008). For example, Steptoe et al. (2008) showed that higher ecological momentary assessment ratings of positive affect throughout the day were associated with lower plasma levels of both IL-6 and CRP in women but not in men in a large population-based study (i.e., the Whitehall II study). Similarly, Friedman and Ryff (2012) found that positive affect was marginally inversely related to plasma levels of IL-6 and CRP in a national sample of middle-aged men and women. More recently, Brouwers et al. (2013) reported that positive affect measured by the PANAS was inversely related to IL-6 and TNF- α serum levels (but not to CRP) in a sample of patients with chronic heart-failure.

Fewer studies have examined life satisfaction as a correlate of CRP, and those have yielded mixed results. Hamer and Chida (2011) found a significant relationship between life satisfaction and lower CRP when controlling for demographic variables and health behaviors, which reduced to a trend after controlling for negative affect. In contrast, neither Carpenter et al. (2012) nor Friedman and Ryff (2012) found a significant relationship between life satisfaction and CRP after controlling for only demographic factors. These findings reflect uncertainty as to whether life satisfaction relates to CRP, and whether the relationship exists independent of health behaviors and/or depressed mood.

1.2. Health behaviors as potential mediators

Several lines of evidence indicate that PEWB is related to healthier behaviors, and that health behaviors are in turn related to inflammation. For example, higher PEWB has been associated with better adherence to medication (Gonzalez et al., 2004), greater likelihood of achieving exercise recommendations (Peterson et al.,

2013), moderate alcohol consumption (Dear et al., 2002), reduced smoking (Kassel et al., 2003), and lower BMI (Stepptoe et al., 2005). In addition, there is evidence that some health behaviors, such as exercise (Woods et al., 2009) and moderate alcohol consumption (Albert et al., 2003), are linked to lower inflammation. Conversely, smoking (Fröhlich et al., 2003) and being overweight (Visser et al., 1999) are associated with higher inflammation. Thus, health behaviors may in part help to explain the association of PEWB with inflammation.

However, there is also evidence suggesting that certain health behaviors may influence PEWB. Exercise programs have been associated with improvements in emotional well-being (Penedo and Dahn, 2005), while obesity has been associated with less frequent positive affect (Carr et al., 2007). Similarly, smoking cessation has been shown to predict improvements in PEWB (Piper et al., 2012), and heavy alcohol use is associated with lower psychological well-being (Dear et al., 2002).

1.3. Objectives

While the handful of studies addressing the PEWB and CRP relationship are suggestive, they have yielded mixed findings. Specifically, the strength of the associations between positive affect and life satisfaction with CRP above depression and health behaviors remains unclear. The first aim of this study was to evaluate, in a large national sample, whether two primary components of PEWB, positive affect and life satisfaction, were associated with lower CRP levels controlling for demographics followed by depression. The second aim was to determine whether these effects would persist after controlling for health behaviors collectively. Third, if we found support for the second aim, we would then examine the extent to which each specific health behavior (i.e., BMI, smoking, alcohol, and exercise) mediated the relationship between positive affect or life satisfaction and CRP. Fourth, this study aimed to examine these relationships in a subgroup of individuals with chronic illnesses.

2. Method

The present study was conducted as part of the Landmark Spirituality and Health Survey (LSHS) conducted in 2014 among a sample of 3010 adults, representative of the adult U.S. population. Data collection for this nationwide, face-to-face survey, was conducted by the National Opinion Research Center (NORC) using clustered random household sampling from 44 national frame areas representing the continental US. The response rate was 50%. The IRB at NORC approved this study. Additional information can be obtained from the LSHS website (<http://landmarkspirituality.sph.umich.edu/>).

The overall sample for this paper consisted of 1979 participants who were in the nationwide Landmark survey and consented to a finger prick for blood-spot analysis of CRP. These participants had a mean age of 51.93, $SD = 19.23$ (range 18–96) years. More participants were female (58.1%) and the majority completed some college ($M_{\text{education}} = 13.41$, $SD = 3.21$ years). The sample was approximately 67% Euro-American, 13% African American, and 2% Asians, with 16.1% identifying as Latino distributed across racial categories. Those who provided a blood-spot for CRP were more likely to have a chronic illness (67.0%) than those who did not provide a blood spot (58.6%), $\chi^2(1) = 20.874$, $p < 0.001$, and less likely to be African American or Asian (African Americans: 12.9% vs 15.6%, $\chi^2(1) = 4.362$, $p = 0.037$; Asians: 1.9% vs 3.1%, $\chi^2(1) = 4.650$, $p = 0.031$). The chronic illness subgroup consisted of a subset of 1326 participants who self-reported at least one current chronic illness. Means and standard deviations of demographic variables for both groups appear in Table 1.

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