



Why does happiness matter? Understanding the relation between positive emotion and health outcomes



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High emotional well-being is commonly defined as frequent positive affect, infrequent negative affect, and a high level of life satisfaction in general (Diener et al., 2009). Despite the fact that both emotional well-being and good health are so important to individuals and societies and that they often coexist at individual and societal levels (De Neve et al., 2013; Steptoe et al., 2015; Helliwell et al., 2013), emotional wellbeing does not guarantee good health and vice versa. As a result, studies on the associations and the mechanisms that underlie the association of emotional wellbeing and health indicators are needed and have expanded in recent years. Ironson et al.'s (2017) recent study examined the associations between two indicators of emotional wellbeing (positive affect and life satisfaction) and clinically elevated inflammatory C-Reactive Protein (CRP \geq 3mg/dL), using linear and logistic regression analysis in a sample of 1979 respondents of a nationwide US survey and a chronic illness subgroup. CRP is a biomarker of chronic systemic inflammation shared by many non-communicable diseases. In the linear regression analysis, Ironson et al. found small, but statistically significant negative associations between the two

indicators of emotional wellbeing and CRP in the overall sample ($\beta = -0.049$ for positive emotion and $\beta = -0.074$ life-satisfaction, respectively) after controlling for sociodemographic factors and depression. However, after further adjusting the analysis for behavioral factors and BMI, these associations lost statistical significance, though satisfaction remained marginally associated with CRP ($\beta = -0.042$, $p = 0.078$). In the logistic regression analysis, only low life satisfaction, not low positive emotion, increased the chances of having elevated CRP in the fully adjusted analysis using the overall group (OR = 1.54; 95%CI: 1.20, 1.92). Similar results were observed for the chronic illness sub-group. The authors then employed the PROCESS macro for SPSS to verify whether the associations of the two measures of emotional wellbeing with CRP were mediated by behavioral factors (physical activity and smoking) and BMI. Two results of the mediation analysis are particularly interesting. First, while the two behavioral factors and BMI seemed to mediate the associations of positive affect and elevated CRP, only physical activity appeared as a mediator in the association between life satisfaction and elevated CRP. Second, BMI, which has very strong direct association with clinically elevated CRP (Yousuf et al., 2013), did not appear to be in the pathway of the association between life satisfaction and elevated CRP.

Statistical associations between any variable, including emotional wellbeing, and a chosen health outcome (such as elevated CRP) can arise when the variable is a cause of the health outcome or vice versa. Even if neither the variable nor the health outcome is the cause of the other, the two may still be statistically associated if they share some common cause such as a behavioral or contextual factor. Mediation analysis helps to identify intermediate variables that lie in the causal pathway between the exposure and the outcome (VanderWeele, 2016). Thus, an important focus of mediation analysis is on the estimation of the indirect effect of X on Y through an intermediary mediator variable M causally located between X and Y (i.e., a model of the form $X \rightarrow M \rightarrow Y$). Thus, understanding the mechanisms by which an effect operates goes beyond establishing that X affects Y.

The potential mediation roles played by common behavioral factors and BMI on the associations of emotional wellbeing with CRP call one to examine three questions. First, is reverse causality a plausible explanation for the cross-sectional association between emotional wellbeing and elevated CRP, or for the association

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between behavioral factors and emotional wellbeing? Second, if so, does reverse causality prevents the analysis of mediators in the relations between emotional well-being and health or between health behavior, such as physical activity, and emotional well-being? Third, are there common underlying determinants of emotional well-being (especially of life satisfaction) and health?

Although the two measures of emotional well-being analyzed by Ironson et al.'s (2017) study are highly correlated, they are not the same construct. Life satisfaction is regarded a more enduring measure of emotional well-being than positive affect is (Stepptoe et al., 2015), justifying the examination of each of them separately. According to DeNeve and Cooper (1998), life satisfaction refers to long-term states while positive and negative affects denote recent occurrences of specific positive and negative emotions. Following this reasoning, one would expect that life satisfaction is more likely to affect a chronic health outcome (such as elevated CRP) than is positive emotion. Studies on the variability of emotional wellbeing throughout the course of life are scarce. Fujita and Diener (2005) analyzed a large and nationally representative German 17-year-long panel study and found that less than one quarter (24%) of the respondents changed their life satisfaction significantly throughout time and that the endurance of life satisfaction declined as the period between measurements increased. The authors reported that the average life satisfaction rate during the first 5 years of follow up correlated 0.51 with the 5-year average of life satisfaction rate during the last 5 years, i.e., life satisfaction evaluation seems only moderately stable in the long term (Fujita and Diener, 2005). Clinically elevated CRP is a marker of chronic inflammation, indicative of prolonged low-grade dysregulation of the innate immune system, a major component of most chronic illness (Acabchuk et al., 2017). Temporality is important, though not sufficient, to postulate a potential direction in an association (what comes first), especially in a cross-sectional analysis such as the one carried out by Ironson et al. (2017). Thus, life satisfaction seems to be a stronger candidate in affecting the level of a chronic inflammatory marker like CRP than does positive emotion, which may explain why, in the study of Ironson et al. (2017), only life satisfaction remained associated with CRP when positive emotion and life satisfaction were entered into the same model.

Because Ironson et al.'s results (2017) do not establish causality from either of the two measures of emotional well-being to clinically elevated CRP, it is important to consider alternative interpretations for their findings. Causal models on emotional wellbeing and health outcomes (incidence of illness, survival, mortality) consider four main mechanisms by which emotional well-being (positive emotions, life satisfaction, happiness) can affect health outcomes: genetics, life style, resilience, and activation in neuroendocrine, autonomic, immune, and inflammatory systems (Stepptoe et al., 2009). Hence, Ironson et al.'s (2017) examined whether life style would also be in the pathway from emotional well-being to a subclinical marker of inflammation (CRP). They claimed that their results support the hypothesis that health behaviors are mediators in the association between emotional well-being and CRP more than they support the hypothesis that emotional wellbeing would mediate the association between health behavior and CRP. Emotional well-being has been linked, both cross-sectionally and longitudinally, to healthier lifestyle such as exercising regularly, better diet, and not smoking (Stepptoe et al., 2009). It is believed that positive emotions broaden cognitive capacity and attention, allowing individuals to engage in healthy behaviors and build skills associated with better health (Fredrickson and Branigan, 2005).

Yet, epidemiological evidences suggest a bidirectional relationship between these two variables. For example, healthy behaviors would promote emotional wellbeing and emotional wellbeing

would promote healthy behaviors in a sort of causal spiral (Fredrickson and Joiner, 2002), the same way that better sleep engenders positive affect and positive affect yields better sleep, and together they tend to promote better health (Stepptoe et al., 2008). Similarly, social connections have been robustly linked to positive emotions and positive emotions seem to improve social connections (Kok et al., 2013). There is no doubt that the dynamic and bidirectional relation between positive emotion and healthy behavior are likely to create an array that promotes good health, and in practical terms, it may not matter what comes first. Consequently, interventions to improve emotional well-being may foster healthy behaviors, as much as interventions to promote healthy behaviors might bolster emotional well-being.

Perhaps a deeper and more prominent question is to understand what promotes positive affect or life satisfaction. In an extensive meta-analysis, Lyubomirsky et al. (2005) found that people with high emotional well-being are healthier, show more adaptive health behavior, and are more productive at work. Prospective studies have shown that positive emotional well-being is associated with more social connections (Luhmann et al., 2013; Lyubomirsky et al., 2005), lower mortality (Chida and Steptoe, 2008), and healthier physical and cognitive ageing (Ostir et al., 2000; Gerstorff et al., 2007), even though results from the UK Million Women Prospective Study found no robust evidence that happiness itself reduces cardiac, cancer, or overall mortality (Liu et al., 2016). The 2017 World Happiness Report (Helliwell et al., 2017) shows that, on average, life satisfaction (or life evaluations) differs significantly and systematically from one country to another and that these differences are substantially explained by social and life circumstances. The top ten countries in the ranking of emotional wellbeing share the six factors that appear mostly related to happiness: income, healthy life expectancy, having someone to count on in times of trouble, generosity, freedom, and trust. Morrison et al.'s (2011) systematic review of the literature found evidence to support that the emotional wellbeing of populations increases with income per capita, although these gains are smaller in higher-income countries. Thus, at a societal level, health, emotional wellbeing and longevity seem to walk together. Poor countries and poor populations rank lower in the happiness scale. Richer nations tend to be happier, healthier, and have higher life expectancy (Helliwell et al., 2017). In addition, within the same country, richer people tend to report higher life satisfaction than poorer people (Ortiz-Ospina and Roser, 2017). In 2007, around 67% of Greeks reported to be satisfied with their lives, but five years later, after the financial crisis struck, the corresponding figure dropped to 32.4% (Ortiz-Ospina and Roser, 2017).

To the best of my knowledge, only one study has examined the covariation in socioeconomic determinants of health and happiness; it found that health and happiness correlated positively among individuals and communities, with education and income appearing as strong determinants of both (Subramanian et al., 2005). This latter result is to some extent in accordance with the findings of the World Happiness Report 2017 (Helliwell et al., 2017). Subramanian et al. (2005) also found that the covariation between poor health and unhappiness was positive and three times stronger at the community level, after taking into account individual data on demographic and socioeconomic factors.

Epidemiological methods can only identify causes that remain unchanged at the population level (Morabia, 2005). As De Neve et al. (2013) stated, "*Happiness is like any other factor that aids health and functioning; with all other things being equal, it is likely (but not guaranteed) to help*" (p. 2, emphasis added). Recipes and interventions to promote positive emotions or to achieve life satisfaction or happiness have become a profitable economic activity in recent years. Nonetheless, can we maintain that societies

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