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Happiness and Health

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Abstract

Research into the relationship between happiness and health is developing rapidly, exploring the possibility that impaired happiness is not only a consequence of ill-health but also a potential contributor to disease risk. Happiness encompasses several constructs, including affective well-being (feelings of joy and pleasure), eudaimonic well-being (sense of meaning and purpose in life), and evaluative well-being (life satisfaction). Happiness is generally associated with reduced mortality in prospective observational studies, albeit with several discrepant results. Confounding and reverse causation are major concerns. Associations with morbidity and disease prognosis have also been identified for a limited range of health conditions. The mechanisms potentially linking happiness with health include lifestyle factors, such as physical activity and dietary choice, and biological processes, involving neuroendocrine, inflammatory, and metabolic pathways. Interventions have yet to demonstrate substantial, sustained improvements in subjective well-being or direct impact on physical health outcomes. Nevertheless, this field shows great potential, with the promise of establishing a favorable effect on population health.

INTRODUCTION

Happiness, or more broadly subjective well-being, has become a major topic in public policy, economics, and psychology over the past decade. Ten years ago, the landmark Stiglitz-Sen-Fitousi Commission on the Measurement of Economic Performance and Social Progress was pivotal in bringing the issue of happiness to public attention (136). This inquiry, led by economists, cogently exposed the limitations of conventional indicators of economic performance as measures of social progress and argued that subjective well-being should be taken into account as well. The United Nations (UN) General Assembly resolved in 2011 to invite all member countries to measure happiness and use it to help guide public policy; the Assembly initiated the World Happiness Report, which provides an annual league table of happiness across countries and stimulates much competitive interest in national mass media (54). Positive psychology has become a recognized subdiscipline, with professional learned societies, journals, and postgraduate degrees from universities in the United States, the United Kingdom, Canada, Australia, Denmark, Singapore, and other countries. Numerous general interest books by economists and psychologists have extolled the value of happiness (33, 36, 48, 80, 84), and life coaching for happiness is a thriving industry. This attention has, in turn, led to skeptical reactions from many quarters (32, 41). Nowhere has the controversy been greater than in the health arena: Barbara Ehrenreich's *Bright-Sided. How the Relentless Promotion of Positive Thinking Has Undermined America* (tellingly retitled *Smile or Die* in the United Kingdom) took particular aim at claims that happiness is related to physical health (38).

Common experience tells us that when people suffer from a serious illness or are in pain, their capacity for happiness is impaired. But beyond this, why is it interesting or useful to study happiness and health? A substantial body of evidence relating depression and distress with ill-health already exists. Longitudinal population studies have documented associations between these negative psychological states and incident coronary heart disease (CHD) (24), stroke (82) and type 2 diabetes (50), whereas depression predicts increased mortality among people with documented chronic obstructive pulmonary disease, diabetes, CHD, stroke, and some cancers (3, 5, 89, 106, 109). If positive well-being merely reflects the absence of depression and distress, do studies of happiness break any new ground?

This review proposes two major reasons for taking happiness seriously in the context of health. The first reason is that the absence of negative states such as depression and distress does not mean that a person is happy. The individual might be in an affectively neutral state, perhaps not experiencing distress but not feeling particularly happy either. Additionally, moods fluctuate rapidly, and many experiences are bittersweet, eliciting both positive and negative feelings (78). Several studies have documented links between happiness and health that are maintained even after negative emotions are taken into account, which implies that associations between happiness and health may be distinctive.

The second reason for investigating happiness and health is because of the potential for intervention. Techniques are being developed to improve positive well-being and cultivate happiness that are different from those used to combat depression and distress. If happiness is protective, then interventions targeting well-being may have a favorable impact on public health.

This article summarizes the epidemiological evidence for the relationship between happiness and mortality and morbidity, focusing particularly on physical health outcomes. The behavioral and biological pathways that may link happiness with health are outlined, and interventions designed to promote happiness are reviewed. I argue that although the wilder claims of happiness gurus should be treated with suspicion, genuine associations between happiness and good health need to be unpacked and evaluated in the context of individual and population health.

Table 1 Taxonomy of subjective well-being[a]

Type	Description
Affective well-being	Experience of positive feelings such as happiness, joy, elation, vitality, pleasure, cheerfulness
Eudaimonic well-being	Evaluations of meaning and purpose in life, including flourishing, sense of autonomy, personal growth, environmental mastery, positive relations with others, and self-acceptance
Evaluative well-being	Appraisals of how satisfied people are with their quality of life

[a]Table adapted from Reference 128.

CONCEPTUALIZATION OF HAPPINESS

Happiness is used in the health literature to denote a number of different constructs (137). The distinction between affective well-being (the attainment of pleasure and avoidance of suffering) and eudaimonia or eudaimonic well-being (meaning and purpose in life) has been recognized since ancient times (116). In his *Nicomachean Ethics*, Aristotle favored eudaimonia, or living well and purposefully, over the vulgar pleasure seeking of hedonism. By contrast, the nineteenth-century utilitarians such as Jeremy Bentham argued that pleasure is intrinsically good and pain is bad and, therefore, that decisions about policy should be made on the basis of the greatest pleasure for the greatest number. More recent formulations have proposed the tripartite taxonomy outlined in **Table 1**. Affective (hedonic) well-being represents positive feelings and mood states such as happiness, joy, and elation, along with the avoidance of distress and depression. Eudaimonic well-being encompasses judgments about the realization of personal potential and the fulfillment of life goals. One influential taxonomy of eudaimonic well-being delineated several aspects that are detailed in **Table 1** (118). The third component is evaluative well-being, which reflects people's judgments about the quality and goodness of their lives and is often operationalized as satisfaction with life.

A construct that is related to subjective well-being is optimism, the general expectation of positive outcomes in life. A growing literature relates optimism with disease risk, prognosis, health behaviors, and biological processes (65, 85, 114). Unfortunately, space limitations prohibit discussion of optimism in this article.

Measurement is an important issue in health research. Affective well-being and positive feelings may fluctuate, and responses to simple questions such as "How happy are you?" are difficult to interpret because they are open to widely different interpretations. Simple ratings of happiness on a single occasion are the least robust, and associations with health outcomes have been inconsistent (83). Researchers have developed multi-item questionnaires that approach the concept with a range of wordings (137). But retrospective ratings may not accurately reflect actual experience because of failures in recall, recency biases, and other factors (62). Alternative methods based on ecological momentary assessment (EMA), diary methods, and the Day Reconstruction Method (a technique for measuring the moods associated with recent activities) have been applied in the health context (28, 133). Such methods have improved the precision of measuring affective well-being by asking people to report about brief recent periods, exploring emotional states directly without the overlay of retrospective evaluation (73).

The assessment of eudaimonic well-being requires more extensive cognitive processing than do ratings of current feelings and involves relatively complex introspection about attributes aggregated over time. The same applies to measures of evaluative well-being. Investigators have developed several questionnaire measures of these aspects of subjective well-being, some with fixed time frames (e.g., the past few weeks), whereas others are more open-ended (34, 118). It is

often difficult to know how respondents are interpreting these measures, for example, when asked about how satisfying one's life is, compared with what or with whom.

The different types of subjective well-being are positively intercorrelated on average (63), even though there appear to be many instances of people who have achieved meaning and fulfillment in their lives without being particularly joyful and vice versa. Some researchers argue that single measures, such as assessments of life satisfaction, are sufficient for the investigation of happiness (26, 80). However, there are potentially important differences in the biological correlates of the three dimensions of subjective well-being, and implications for intervention may also differ. So, in the context of health studies, consideration of distinct types of well-being may be important.

A wide array of factors appears to contribute to subjective well-being. Some of the principal elements that have been identified are summarized in **Figure 1**, and an extensive literature has been devoted to these associations (4, 26, 35). The various factors may not impact on the different types of well-being equally. For example, income and socioeconomic resources are strongly linked with evaluative well-being, but less so with affective well-being (60, 61). Pronounced variations have also been identified in the correlates of subjective well-being across the life course; social relationships figure more prominently for older individuals than for younger individuals (130). From the perspective of research on health, many of the factors listed in **Figure 1** are themselves related to health outcomes, which raises the question of whether links between happiness and health are independent of these factors or whether happiness is merely a convenient aggregate measure.

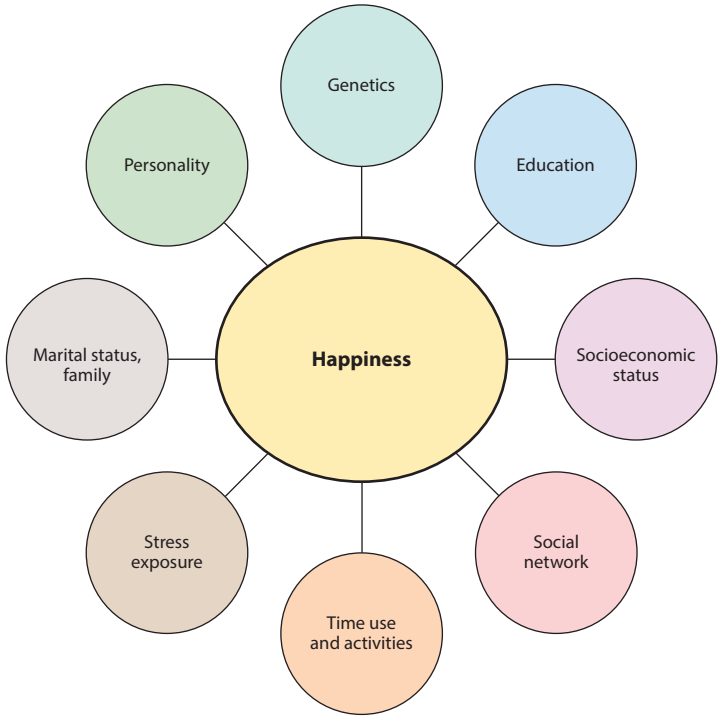

Figure 1

Summary of factors contributing to happiness.

HAPPINESS AND MORTALITY: LONGITUDINAL OBSERVATIONAL STUDIES

A substantial number of prospective observational studies have related subjective well-being to reduced mortality in both general populations and individuals with diagnosed illness at baseline (25). A meta-analysis in 2017 identified 62 general population studies involving more than 1,250,000 participants (87). After adjustment for confounders, these analyses showed a pooled hazard ratio (HR) of 0.920 [95% confidence interval (CI) 0.908–0.934] for people with higher subjective well-being at baseline, compared with those who were lower in well-being, indicating that happiness may be a protective force in relation to all-cause mortality. These results are corroborated by a separate meta-analysis of studies focused on purpose in life (27). Associations have been reported both in men and women and in samples recruited in the United States and Canada, in several countries in Europe, and in Pacific Asian countries, including Japan, South Korea, and Taiwan (29, 45, 70–72). Follow-up periods have ranged from 2 years to more than 20 years. Most mortality research has inevitably involved tracking middle-aged and older people; studies of younger individuals have limited power because of lower event rates. Some investigations have involved younger as well as older individuals, however, and have shown protective associations (55); effects are also present in the very old (39).

Many analyses have involved aggregate measures that incorporate different aspects of well-being (64, 74, 145), and few have directly contrasted different types of subjective well-being (45, 86). Nonetheless, associations with mortality have been observed with distinct measures of affective and evaluative well-being (17, 75, 125, 134) and with various aspects of eudaimonic well-being (55, 128, 139). Most researchers have assessed happiness by questionnaire, asking respondents about their experiences over the past week or month or more generally. Evidence has also indicated that more positive mood states measured through EMA are associated with reduced mortality (133). The vast majority of studies have assessed well-being on a single occasion, which could be affected by transient recent experiences. But duration of effects has been investigated as well: Individuals who report greater well-being on repeated measures over four years have lower mortality than do those who report greater well-being on only one occasion (149).

An important issue explored in some of these studies is whether the protective effect of greater subjective well-being is independent of negative emotional states of depression or distress. This concern has been addressed by adding baseline measures of depression or negative affect to the regression models to determine whether the strength of the association is diminished or disappears altogether. Although some studies indicate that depression appears to account for associations between well-being and survival (53), other studies have shown that depression and other negative states do not markedly alter the well-being/survival link (119, 134, 149). A particularly striking instance is the EMA study noted earlier, in which associations between repeated momentary assessments of positive affect and survival were independent of simultaneous assessments of negative affect (133).

INCONSISTENCIES AND EXPLANATIONS OF ASSOCIATIONS

Despite this extensive body of evidence, several large-scale studies have failed to confirm an association between happiness and survival (83, 104). Case ascertainment is unlikely to be an explanation of variations in results because most studies have used medical registers to measure mortality outcomes. Problems with the measurement of happiness may be relevant; however, publication bias has also been identified in this literature (25, 87), which suggests that analyses with null results are less likely to be published. Two other major threats to validity are confounding and reverse causation.

Although almost all investigations account for demographic factors, adjustment for baseline health status—both the presence of clinical disease and perceptions of ill-health—has been less consistent. The extent to which associations between subjective well-being and mortality disappear (72, 143), or survive after adjustment for covariates (19, 134), varies across analyses. In the 2017 meta-analysis (87), the relationship between greater subjective well-being and lower mortality in the studies with the lowest risk of bias (including adjustment for baseline health status) was slightly stronger (HR 0.881, 95% CI 0.829–0.936) than for studies with moderate or serious risk of bias (HR 0.928, 95% CI 0.913–0.944). However, confounding can seldom be completely eliminated, and unmeasured variables may contribute to greater subjective well-being predicting lower mortality. One study used a twin design to address potential confounding of subjective well-being and outcome by genes and environmental factors (119). Associations between affective and evaluative well-being and all-cause mortality over a median 9 years in nearly 4,000 twins were present not only in the complete sample but also in adjusted within-pair analyses of dizygotic and monozygotic twin pairs; this finding indicates that well-being was associated with mortality independently of genetic and shared environmental factors. But observational studies need to be complemented by other methodologies such as Mendelian randomization and regression discontinuity designs to strengthen causal inference.

The reverse causality argument is that individuals who are at greater risk of dying have preexisting health problems at the time of happiness assessment. These could contribute to lower levels of well-being, which may result in a spurious association between well-being and subsequent mortality. Statistical adjustment for ill-health at the time of the happiness assessment may be insufficient because such measures often do not take account of the severity of preexisting disease states or covert health problems. A strategy for addressing this issue is to exclude deaths occurring within a few years of baseline assessment, the rationale being that people with serious illness at baseline will not survive beyond a limited period.

The impact of these different factors is illustrated in **Table 2**, which summarizes the results of an analysis by Zaninotto and colleagues of sustained subjective well-being on survival (149). The exposure in this study was the number of reports of higher versus lower enjoyment of life on three occasions between 2002 and 2006 and mortality up to seven years later. Participants could report between zero and three instances of higher enjoyment. The HRs for two or three reports of higher enjoyment were 0.73 and 0.60, respectively, in the model adjusted for age and sex only. The HR moved toward 1 following adjustment for sociodemographic factors, baseline health, and baseline depression, though associations remained significant in the fully adjusted model. The covariates accounted for about 40% of the relationship between duration of enjoyment of life and survival. The lower section of **Table 2** indicates that patterns were little changed when deaths within two years of the last measure of enjoyment were excluded, suggesting that reverse causation was unlikely to be responsible for the findings.

HAPPINESS AND MORBIDITY

Research on happiness and survival has been complemented by work on the incidence and prognosis of a range of illnesses. Findings relating happiness with incident CHD are somewhat inconsistent (13, 37), but a number of studies from the United Kingdom, Canada, and Japan have shown associations for both hedonic and eudaimonic well-being and CHD incidence that were independent of covariates including health behaviors and negative affect (14, 31, 138). Some investigations have shown no association at all (42, 96), whereas others have observed relationships in simple analyses but not after covariates have been taken into account (101, 149). There may be varying associations for different manifestations of CHD. For example, an analysis of the Whitehall II

Table 2 Enjoyment of life over four years and subsequent mortality ($N = 9,365$)[a,b]

	Number of reports of high enjoyment of life between 2002 and 2006				
	None	One	Two	Three	Per 1 report increase
All-cause mortality: *N* (%)	400 (31%)	298 (23%)	283 (22%)	329 (25%)	
Statistical models					
Age, sex (model 1)	1 (ref)	0.87 (0.73, 1.03)	0.73 (0.62, 0.87)	0.60 (0.51, 0.70)	0.84 (0.80, 0.89)
+ baseline demographic factors[c] (model 2)	1 (ref)	0.88 (0.74, 1.05)	0.76 (0.64, 0.90)	0.64 (0.55, 0.75)	0.86 (0.82, 0.91)
+ baseline health indicators[d] (model 3)	1 (ref)	0.93 (0.78, 1.11)	0.83 (0.70, 0.99)	0.75 (0.64, 0.87)	0.91 (0.86, 0.95)
+ baseline depression[e] (model 4)	1 (ref)	0.89 (0.75, 1.06)	0.76 (0.64, 0.91)	0.63 (0.54, 0.74)	0.86 (0.82, 0.90)
Fully adjusted (model 5)	1 (ref)	0.93 (0.78, 1.12)	0.83 (0.70, 0.99)	0.76 (0.64, 0.89)	0.91 (0.86, 0.96)
Excluding deaths before 2008					
All-cause mortality: *N* (%)	355 (30%)	279 (24%)	262 (22%)	283 (24%)	
Fully adjusted (model 5)	1 (ref)	0.94 (0.78 to 1.13)	0.84 (0.70 to 1.01)	0.72 (0.61 to 0.86)	0.90 (0.85 to 0.95)

Abbreviation: ref, reference category.

[a]Hazard ratios with 95% confidence intervals.

[b]Results based on 10 imputed data sets.

[c]Wealth, education, ethnicity, marital status, employment.

[d]Fair/poor self-rated health, limiting long-standing illness, coronary heart disease, cancer, stroke, chronic lung disease, diabetes, arthritis, and impaired mobility and activities of daily living.

[e]Depressive illness and current symptoms of depression.

cohort showed stronger effects for angina incidence than for fatal CHD and nonfatal myocardial infarction, and the latter were not significant after health behaviors and cardiovascular risk factors had been taken into account (15).

Prospective studies indicate that emotional vitality (a combination of eudaimonic and affective components), positive affect, and purpose in life have all been associated with reduced risk of incident stroke independently of covariates, including sociodemographic factors, cardiovascular disease history, blood pressure, smoking and other health behaviors, and emotional distress (69, 76, 105). Studies of diabetes, cardiometabolic illness in general, and hypertension have also documented reduced incidence among people with greater well-being, though effects are attenuated after behaviors such as smoking, physical activity, and alcohol consumption are taken into account (12, 16, 140). The development of arthritis was inversely associated with eudaimonic well-being over a 9-year period in the Survey of Health and Retirement in Europe (SHARE), a study involving participants from 11 countries (100). Studies involving experimental administration of viruses indicate that greater positive affect predicts reduced vulnerability to the development of upper respiratory illness independently of relevant covariates (28).

In addition to investigations of chronic disease, research on physical capability and disability has been carried out. One study of affective well-being (enjoyment of life) showed that incident impaired activities of daily living (ADLs) over an eight-year period were reduced among those reporting greater enjoyment independently of sociodemographic factors, baseline health, mobility impairment, health behavior, and depressive symptoms (127). These findings were corroborated with objective measures of walking speed because the decrease in walking speed over years was smaller in people reporting greater well-being at baseline. Purpose in life was also protective against decline in walking speed over four years in the Health and Retirement Study

(66). Similarly, an analysis of the Rush Memory and Aging Project found that incident disability in basic and instrumental ADLs and mobility was reduced among older people who reported greater purpose in life at baseline, independently of cognitive factors, depressive symptoms, social networks, frailty, and vascular disease (21).

There is also much interest in whether subjective well-being predicts cognitive decline and dementia risk among older people. Studies in the United States and Singapore have suggested that reports of high eudaimonic and affective well-being predict reduced risk of dementia and mild cognitive impairment after controlling for relevant covariates (20, 115). In contrast, a 12-year follow-up of the Maastricht Aging Study showed no association between positive affect and decline in memory, executive function, or processing speed (8). These results are tantalizing, but more evidence is required before any firm conclusions can be drawn. The situation is further complicated by indications that cognitive decline in later life leads to reduced happiness and loss of purpose in life (144), implying that relationships are bidirectional.

Happiness may be relevant not only to the incidence of disease and disability, but also to prognosis. A substantial literature has related depression with poor prognosis for a number of serious illnesses (3, 5, 89, 106, 109), but evidence for the protective effect of subjective well-being is less clear. A meta-analysis of studies on a range of conditions, including spinal cord injury, coronary artery disease, and heart failure, documented a small protective effect of hedonic and eudaimonic well-being on recovery and survival (77). For example, an analysis of the National Health and Nutrition Epidemiologic Follow-Up Study found that enjoyment of life was associated with reduced all-cause mortality over 10 years among individuals with diabetes after adjusting for age, ethnicity, self-rated health, and physical activity (94). Nonetheless, prognostic studies are difficult to interpret in the absence of strong measures of baseline illness severity. Sicker people are more likely to have a poor prognosis and may also report less happiness, perhaps because they have more severe symptoms or have more pessimistic communication with health professionals. This scenario could lead to spurious associations between happiness and prognosis. Such processes are difficult to evaluate in the absence of detailed evidence of health status and patient perceptions.

PATHWAYS RELATING HAPPINESS WITH HEALTH

Assuming that robust links exist between happiness and health, two pathways have been proposed. The first is that habitual behavioral practices link the two and that people with greater subjective well-being have healthy lifestyles that reduce their risk of morbidity and premature mortality. The second is that biological correlates of happiness can mediate the association with health outcomes.

Behavioral Processes

As will be apparent from earlier sections, associations between happiness and health are frequently somewhat attenuated when health behaviors are taken into account, implying that these factors play an important mediating role. But how much evidence is there that favorable health behaviors are associated with happiness? One might imagine the opposite to be the case and that someone who eats and drinks to excess and does little exercise is happier than one who austerely maintains healthful habits.

The behavior that has been studied most extensively in this context is physical activity. The bidirectional association between physical inactivity and depression has been recognized for many years, and this literature has now been supplemented by work on subjective well-being. Cross-sectional analyses using objective indicators of activity (accelerometers) have shown positive associations between different indices of well-being and light and moderate/vigorous physical activity

among older adults (10, 23). The context of physical activity is relevant; a meta-analysis of nearly 100 studies found that mental health was positively associated with leisure time and transport physical activity but negatively related to occupational activity (142). Longitudinal studies assessing physical activity and subjective well-being over a number of years have shown both that greater well-being predicts maintained or increased activity over time (6, 67, 123), and that changes in leisure-time physical activity predict changes in happiness (141). Evidence also shows that physical activity mediates, in part, the association between positive affect and survival. A study from Denmark followed 607 patients with CHD over 5 years (57). Positive affect predicted lower all-cause mortality, as did greater physical activity. Positive affect was also associated with physical activity, and when activity was entered into the statistical models, the relationship between well-being and mortality was no longer significant. Similarly, an analysis of the Heart and Soul Study of patients with stable CHD found that greater positive affect was associated with reduced all-cause mortality over an average of seven years (56). This relationship remained significant after controlling for cardiac disease severity and depression but was eliminated by accounting for physical activity.

Links between diet and subjective well-being have also been explored, given longitudinal evidence that poor diets are associated with future depression (81). Intriguing associations between the consumption of fruit and vegetables and subjective well-being have been reported in both cross-sectional and longitudinal population studies (11, 95). But a short-term intervention trial of enhancing fruit and vegetable intake was inconclusive (30).

There has also been work relating low life satisfaction to excessive alcohol consumption, smoking, and failure to use sun protection (49), though the importance of these associations to health outcomes is unclear. Another facet of health behavior that may be relevant is the use of preventive care services. An analysis of the Health and Retirement Study demonstrated that greater eudaimonia (purpose in life) was associated with an increased likelihood of having cholesterol tests, colonoscopy, mammograms, and Papanicolaou tests (women) and prostate examinations (men) (68). These associations were independent of age, ethnicity, marital status, education, wealth, insurance states, and chronic illness. Greater purpose in life was associated with fewer nights spent in the hospital as well. These findings point to potentially important ways in which the lifestyle correlates of subjective well-being may contribute to positive health outcomes.

Happiness and Biological Processes

Early studies relating happiness with biological processes relevant to health often involved college students and small sample sizes (112). **Table 3** summarizes evidence from population and community samples with at least 100 participants. It does not include experimental studies, within-person association studies of variations in mood and biology (1, 59, 121), studies of students (43, 126), work with chronic disease patients (9, 22), or reports that presented findings unadjusted for covariates (117). The most consistent evidence relates affective well-being with cortisol output, showing lower cortisol levels and steeper salivary decline over the day [a marker of reduced disease vulnerability (2)] in people reporting greater well-being. Associations have been observed using a variety of measures of affective well-being, including questionnaires and EMA, and these associations remain significant after statistical adjustment for covariates, including demographic factors, depression, and distress. Most studies have been cross-sectional, though one report showed that positive affect measured with EMA predicted lower cortisol output three years later (132).

Evidence relating happiness with lower inflammation has been less consistent. All three types of subjective well-being have been evaluated, but associations with C-reactive protein and interleukin 6 (IL-6) have varied across studies, some showing inverse relationships in men and others

Table 3 Associations between subjective well-being and biomarkers

Biomarker	Sample	Subjective well-being measure	Association with well-being	Adjustment
Neuroendocrine				
Cortisol	216 men and women, 45–59 years (135)	PA (EMA)	Output over the day inversely ∝ PA	Age, sex, SES, BMI, smoking, time of waking, distress
	334 men and women, 18–54 years (110)	PA (daily ratings)	Men: steeper decline over the day ∝ PA Women: flatter decline over the day ∝ PA	Age, ethnicity, time of year, time of waking
	4,474 men and women, 50–74 years (131)	PA (EMA)	Output over the day inversely ∝ PA	Age, sex, SES, ethnicity, BMI, waist/hip ratio, smoking, paid employment, time of waking, depression
	490 men and women, 30–54 years (91)	PA (questionnaire)	Steeper decline over the day ∝ PA	Age, sex, race
DHEAS	6,309 men and women, 50–90 years (129)	Affective and eudaimonic well-being (questionnaire)	Men: higher level ∝ affective and eudaimonic well-being Women: no association	Age, SES, marital status, smoking, chronic illness, depression
	1,040 men and women, mean 55 years (147)	PA (questionnaire)	No association	Age, sex, education, smoking, alcohol, waist/hip ratio, chronic illness, NA
Inflammation				
C-reactive protein	2,853 men and women, 50–74 years (131)	PA (EMA)	Women: levels inversely ∝ PA Men: no association	Age, SES, ethnicity, BMI, waist/hip ratio, smoking, paid employment, time of waking, depression
	797 men and women, mean 51 years (52)	Life satisfaction rating	Levels inversely ∝ life satisfaction, but not significant after adjustment for depression and anxiety	Age, sex, education, BMI, anxiety, and depressive symptoms
	6,335 men and women, 50–90 years (129)	Affective and eudaimonic well-being (questionnaire)	Men: no association Women: higher level inversely ∝ affective and eudaimonic well-being	Age, SES, marital status, smoking, chronic illness, depression
	1,946 men and women, 18–96 years (58)	PA and life satisfaction (questionnaire)	Levels inversely ∝ PA and life satisfaction after adjustment for demographics and depression, but not health behaviors. Physical activity particularly relevant	Age, sex, ethnicity, education, physical activity, smoking, alcohol, BMI, depression. C-reactive protein from dried blood spots

(*Continued*)

Table 3 (*Continued*)

Biomarker	Sample	Subjective well-being measure	Association with well-being	Adjustment
IL-6	146 men and women, 30–54 years (111)	PA (questionnaire)	Lipopolysaccharide -stimulated IL-6 inversely ∝ PA	Age, sex, race, BMI, white blood cell count
	2,519 men and women, 50–74 years (131)	PA (EMA)	Men: no association Women: levels inversely ∝ PA	Age, SES, ethnicity, BMI, waist/hip ratio, smoking, paid employment, time of waking, depression
	135 women, 61–91 years (44)	PA (questionnaire) Eudaimonic scales (questionnaire)	Levels inversely ∝ positive relationships, not any other scales	Age, education, SES, marital status, health, medication, smoking, alcohol, depression
Cardiovascular				
Blood pressure	162 men and women, 45–59 years (132)	PA (EMA)	Ambulatory systolic pressure measured 3 years later inversely ∝ PA	Age, sex, SES, paid employment, BMI, smoking, medication, distress
Heart rate	216 men and women, 45–59 years (135)	PA (EMA)	Men: ambulatory heart rate inversely ∝ PA Women: no association	Age, sex, SES, BMI, smoking, physical activity, distress
HRV	967 men and women, 34–83 years (124)	PA (questionnaire) Eudaimonic scales (questionnaire)	HRV not ∝ well-being in unadjusted or adjusted analyses	Age, sex, BMI, smoking, physical activity, chronic illness, medication, menstrual status
Metabolic				
HDL cholesterol	6,381 men and women, 50–90 years (129)	Affective and eudaimonic well-being (questionnaire)	Men: no association Women: higher level ∝ affective and eudaimonic well-being	Age, SES, marital status, smoking, chronic illness, depression
	1,017 American and 374 Japanese men and women, mean 54–55 years (146)	PA (questionnaire)	HDL positively ∝ PA in US but not Japanese sample	Age, sex, education, chronic illness, medication, NA
Triglycerides	6,386 men and women, 50–90 years (129)	Affective and eudaimonic well-being (questionnaire)	Higher level inversely ∝ affective and eudaimonic well-being	Age, sex, SES, marital status, smoking, chronic illness, depression
HbA1c	3,907 men and women, mean 67 years (51)	Purpose in life	Greater HbA1c measured four years later ∝ purpose in life	Age, sex, education, SES, marital status, BMI, physical activity, self-rated health, disability, baseline HbA1c, depression

(*Continued*)

Table 3 (*Continued*)

Biomarker	Sample	Subjective well-being measure	Association with well-being	Adjustment
General				
Allostatic load	45,225 men and women, mean 45 years (120)	PA (questionnaire)	Greater allostatic load inversely ∝ PA	Age, sex, smoking, physical activity, alcohol use, NA
	898 men and women, mean 46 years (150)	Purpose in life	Greater allostatic load measured 4 years later inversely ∝ purpose in life	Age, sex, ethnicity, education, PA, NA

Abbreviations: BMI, body mass index; DHEAS, dehydroepiandrosterone sulfate; EMA, ecological momentary assessment; HbA1c, glycated hemoglobin; HDL cholesterol, high-density lipoprotein cholesterol; HRV, heart rate variability; IL, interleukin; NA, negative affect; PA, positive affect; SES, socioeconomic status (income, wealth, occupational grade); ∝, significant association.

in women. Effects in some studies have become nonsignificant after health behaviors and distress are included as covariates, indicating confounding. Research on the cardiovascular correlates of affective well-being has also been inconclusive. There do, however, appear to be associations between different aspects of subjective well-being and metabolic parameters such as plasma cholesterol and glycated hemoglobin after controlling for a range of covariates, including adiposity and distress (51, 129). Additionally, two large-scale analyses of allostatic load, an aggregate measure of physiological dysfunction across multiple biological systems, have shown inverse associations with affective and eudaimonic well-being after controlling for age, sex, health behavior, and negative affect (120, 150). Greater subjective well-being has also been associated with better self-reported sleep (103).

There is a dearth of longitudinal research relating happiness with biological processes. Many associations may be bidirectional because inflammatory and neuroendocrine processes have an impact on subjective states (90). Additionally, few studies have yet established a link between happiness, biological dysfunction, and health. One exception is a study that investigated associations between eudaimonic well-being and arthritis incidence over a 10-year period in the English Longitudinal Study of Ageing (102). Greater well-being predicted reduced incidence of arthritis, whereas C-reactive protein measured two years later was also associated with increased risk of arthritis. Mediation analysis indicated that C-reactive protein accounted for a significant proportion of the association between well-being and arthritis incidence.

INTERVENTION STUDIES

Interventions that are potentially relevant to happiness and health are of two types. First are positive psychology interventions (PPI) that are focused directly on happiness. These include programs involving mindfulness, counting one's blessings, focusing on signature strengths, positive psychotherapy, savoring positive experiences, and other procedures (18, 122). Second are interventions that impact happiness but not necessarily as the primary outcome and that may have independent effects on health. Examples include enhancing physical activity or increasing social activity (40, 97). The issue of whether associations between happiness and health are independent of depression and distress is difficult to address in intervention studies because effective PPI and other interventions are likely to reduce depressive symptoms as well as enhance subjective well-being.

No happiness interventions have yet been shown to prevent illness onset or improve prognosis in people with existing physical illness in a scientifically robust study, but this field is relatively new. To have an impact on health, interventions likely need to increase happiness over a sustained period of months or years. To date, many PPI have focused on short-term effects. A meta-analysis in 2013 of 39 trials in which subjective well-being was monitored up to 6 months following intervention showed small but significant mean differences between individuals randomized to PPI and comparison conditions (18). Proyer et al. (113) evaluated changes in well-being up to 3.5 years after online PPI and found sustained effects, but only for individuals who liked the interventions to which they were assigned and continued to use them; loss to follow-up was more than 70%. Interventions have been tested in patients with a range of illnesses, focusing primarily on reducing psychological distress. An overview of more than 100 trials involving patients with cancer, cardiovascular disease, and other conditions concluded that mindfulness improved depressive symptoms, anxiety symptoms, and self-reported stress compared with control conditions, though with substantial heterogeneity and risk of publication bias (46). But results have been variable. For example, a five-session individually delivered intervention with people newly diagnosed as HIV positive showed no significant impact on the primary positive affect outcome (93). Several studies of mindfulness for patients with chronic pain have demonstrated favorable effects on distress and quality of life without reducing reports of pain (7).

The effects on happiness of a range of interventions that are not based on positive psychology have been examined as well. These include social activity and social support groups, memory training, exercise classes, and multicomponent programs. A meta-analysis of 44 trials involving participants aged 65 and older found beneficial effects on quality of life, positive mental health and life satisfaction, and reduced depressive symptoms, particularly with programs that lasted at least three months (40). Although significant, effects were generally small, and few studies involved follow-up measures.

It is not yet known whether the effects of either PPI or other interventions on happiness are large enough to impact physical health outcomes. But some evidence has indicated that happiness interventions can have an effect on behavioral and biological processes relevant to health. For example, a positive affect intervention involving self-affirmation and thinking about the good things in life led to greater self-reported physical activity at 12-month follow-up among patients who had undergone percutaneous coronary intervention, compared with patient education (108). A 12-week Web-based mindfulness intervention stimulated increased physical activity in heart disease patients, even though there were no significant effects on psychological well-being or physiological parameters (148). At 12 months, the physical activity differences were largely maintained, but there were still no differences from the comparison group in well-being or biology (47).

Several randomized controlled trials have also been conducted on the effects of PPI on inflammatory biomarkers. A meta-analysis of 19 trials involving mindfulness-based methods, cognitive-behavioral therapy, or relaxation reported significant reductions in C-reactive protein concentration when comparing levels before and after intervention, though differences were not sustained at follow-up (99). Effects were more marked among individuals who reported psychological distress at baseline. Results for other inflammatory biomarkers such as IL-6 were not significant. The effects of mindfulness interventions on cortisol have largely been negative to date (98), though other forms of meditation appear to lead to short-term reductions in cortisol and various cardiovascular parameters (107).

Work on interventions targeting happiness is evolving rapidly, and researchers can hope that larger, more rigorous studies that adhere to good trials practice will emerge in the future. But an issue of growing concern to many investigators is whether it is appropriate to encourage people to pursue happiness in order to improve health. There are, of course, many other motives that

stimulate the search for well-being, but placing a high value on happiness can have detrimental effects when experience does not match up to expectations (88). Even if happiness is beneficial for health, it is only one of many influences on disease incidence or prognosis and is almost certainly less important than other biological and behavioral processes. There is a risk that feelings of guilt and failure will arise when health deteriorates even in the presence of striving for happiness. A sense of proportion is needed when judging the benefits of enhancing happiness in the health context.

CONCLUSIONS

Many questions remain unresolved in this fast-moving field. Fully understanding the bidirectional associations between happiness and health involves the integration of epidemiological research with clinical, biobehavioral, and experimental work. Research on health outcomes has been dominated by observational epidemiological studies, and these can never convincingly establish causality, even when multiple covariates are taken into account. This limitation to observational studies is particularly relevant for happiness, which is embedded in a matrix of other health-related phenomena (**Figure 1**). Firm conclusions would be strengthened by controlled intervention studies demonstrating that changes in happiness result in changes in health, but such a program would require longitudinal trials involving robust methods of modifying subjective well-being over prolonged periods. In the meantime, research on causality has not yet exploited methods such as instrumental variable approaches, natural experiments, and negative control studies that might produce more compelling findings than those emerging from observational work (79). New discoveries, such as the influence of the gut microbiome on brain function and emotional states, are also likely to be relevant (92). Issues that are not yet settled include, among others, the extent to which variability in happiness levels needs to be addressed (17) and how best to disentangle low happiness from negative affective states (78). Interventions in the health arena depend on devising generalizable and cost-effective methods of inducing sustained improvements in subjective well-being so that impacts on healthy populations and people with chronic illness can be assessed. Enhancing the well-being of the population is a laudable societal aim; whether this translates into improvements in health has yet to be proven.

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