Full-Length Report

JHP

Journal of Health Psychology
1–24

DOI: 10.1177/13591053251329060
journals.sagepub.com/home/hpq
Sage

Positive life experiences and physical health: Associations and mediating pathways

Naomi Podber[1] and Tara L. Gruenewald[2]

Abstract

Engagement in positive experiences in everyday life has been associated with better long-term survival, but research assessing associations with other measures of long-term physical health is limited. In the current study, data collected from the Midlife in the US Study (N=1,182) in 2004-2017 were used to examine whether frequency of engagement in a range of positive experiences is associated with three domains of health (subjective, functional, and morbidity) over an average seven-year follow-up period. Potential cognitive-affective and physiological mediators of these associations were assessed. Greater positive experience frequency was associated with better self-rated health (SRH), less difficulty in performing basic activities of daily living (BADLs), and lower comorbidity (count of dichotomous indicators assessing history of lung-related, autoimmune, blood pressure, blood glucose, and neurological disorders). Cognitive-affective factors (positive affect, depression, and perceived stress) mediated the associations with SRH and BADLs. Positive experiences may impact long-term physical health and warrant further study.

Keywords

positive experiences, positive affect, depression, perceived stress, allostatic load, self-rated health, activities of daily living, comorbidity

Positive life experiences comprise the many potentially psychologically rewarding events, behaviors, and occurrences that we freely seek out on a daily basis. They include large and small social interactions with strangers, friends, or family (e.g. going to a get-together, being told you are loved, helping someone, or even simply smiling at someone), leisure activities that may be experienced alone or with others (e.g. going to a museum, spending time in nature, or reading a book), and mental and physical experiences of relaxation and contentment (e.g. the experience of having spare time or thinking about people one likes). Our research (Podber and Gruenewald, 2023a, 2023b) focuses on assessing links between overall, accumulated engagement in a variety of positive experiences and health and well-being. We posit that the seemingly disparate events that we refer to as positive life experiences add up in aggregate to define our lived experience and impact our well-being.

[1]State University of New York at Old Westbury, USA
[2]Chapman University, USA

Corresponding author:
Naomi Podber, Psychology Department, State University of New York at Old Westbury, 223 Store Hill Rd, Old Westbury, NY 11568, USA.
Email: podbern@oldwestbury.edu

Multidomain assessments of positive life experiences (MacPhillamy and Lewinsohn, 1982; Pressman et al., 2009) have been linked to physiological health and mortality (Moore et al., 2013; Podber and Gruenewald, 2023a, 2023b; Pressman et al., 2009; Sin et al., 2015; Sin et al., 2017).

Positive experiences and health

There is evidence that specific positive experiences may confer survival benefits—a lower risk of mortality has been observed in those who attend museums and concerts (Fancourt and Steptoe, 2019) and those who take more annual vacations (Gump and Matthews, 2000). Studies that have examined multidomain measures of positive experiences have identified physiological correlates of overall engagement in positive experiences. These include lower levels of inflammatory markers such as Interleukin-6 and C-reactive protein (Moore et al., 2013; Sin et al., 2015), both lower overall and steeper daily decline in cortisol (Pressman et al., 2009; Sin et al., 2017), and reduced mean arterial blood pressure and diastolic blood pressure over a 5-year period (Mausbach et al., 2017).

Health and well-being correlates of aggregate life experiences have primarily been assessed in the depression literature, and the Pleasant Events Schedule (PES; MacPhillamy and Lewinsohn, 1982) is a widely-used measure in this field. It assesses the frequency and derived pleasure of multiple positive experiences across different domains (e.g. social, recreation, relaxation, entertainment). Using data from the Midlife in the U.S. Study (MIDUS; http://midus.wisc.edu), we have found that overall engagement in positive life experiences, assessed using the PES, is cross-sectionally associated with better physiological well-being across multiple regulatory systems of the body (Podber and Gruenewald, 2023a). In an initial examination of long-term associations between overall engagement in positive experiences and survival (Podber and Gruenewald, 2023b) in MIDUS, we found that frequency of engagement in positive experiences was associated with decreased hazard of mortality over a 16-year span (2004–2020).

The current research expands on this study by using further MIDUS data to assess whether associations between positive life experiences and long-term physical health can be observed in three commonly-assessed domains of physical health: subjective health, functional health, and disease morbidity. These domains were chosen because they represent important aspects of health and functioning and are also robust predictors of longevity. A meta-analysis found that the commonly-measured self-rated health assessment composed of a single ordinal item is predictive of mortality (DeSalvo et al., 2006), and dependencies in both basic and intermediate activities of daily living are also predictive of mortality (Millán-Calenti et al., 2010). We measure the third domain, disease morbidity, with a count of comorbidities, since number of comorbidities is positively associated with risk of death (Nunes et al., 2016). We hypothesize that greater frequency of engagement in positive experiences will be associated with greater self-rated health, lower difficulty in performing both basic and intermediate activities of daily living, and lower comorbidity over a seven-year average follow-up period, while controlling for baseline levels of these health indicators.

Potential mechanisms linking positive experiences to health

The second aim of our research is to use additional MIDUS data to examine mechanisms through which frequency of positive experiences might be linked to these three forms of health and functioning. We focus on four potential mediators in the affective (positive affect, depression), cognitive (perceived stress), and physiological (allostatic load) domains, based on multiple frameworks. According to Lewinsohn and Graf's (1973) and Lewinsohn

and MacPhillamy's (1974) behavioral theory of depression, an increase in frequency of pleasant events is hypothesized to operate through positive reinforcement mechanisms to increase positive affect and positive cognitions and decrease negative affect and depression. In Sin and Almeida's (2018) conceptual model of pathways linking daily positive experiences and health, positive experiences are hypothesized to have direct effects on physiological well-being, including neuroendocrine activation, inflammation, and cardiac autonomic control, which then impact long-term health. Positive experiences are also expected to indirectly impact physiological well-being through decreased daily stress and psychological distress (such as depressive symptomatology), as well as to buffer against negative psychological and physiological stress sequelae. Sin and Almeida (2018) conceptualize these associations as bidirectional and note that while there have been studies examining individual direct pathways in their model, few studies have assessed its integrated pathways, such as mediation pathways. In line with these frameworks, Moore et al. (2013) assessed the efficacy of their Pleasant Events Program (a positive experiences intervention based on Lewinsohn's behavioral theory) using levels of positive affect, depressive symptomatology, negative affect, and individual biomarkers of physiological well-being (D-dimer and IL-6).

These frameworks suggest that people who have a greater overall day-to-day experience of what we might call "the good life" (assessed as overall frequency of engagement in positive experiences) will have better affective (including higher positive and lower negative affect and depression), cognitive (including lower perceived stress), and physiological (measured as lower physiological wear and tear, or allostatic load) well-being, and that these will in turn impact long-term health. Our aim is to provide initial evidence that these four mechanisms may underlie hypothesized associations between frequency of engagement in positive experiences and long-term physical health. Below we provide definitions for each mechanism, as well as further empirical evidence that each is associated with both positive experiences and the three health domains that are the focus of the current study.

Positive affect. Positive affect is a general mood factor that reflects the degree of passion for and enjoyment of life, including feelings of joy, interest, excitement, and enthusiasm (Clark et al., 1989). Positive experiences are thought to be pursued for their potential to enhance positive affect and enjoyment. In a recent study, Chen et al. (2022) found that greater frequency of leisure experiences was associated with higher mean levels of positive affect over a two-week period and with lower variability in levels of positive affect over time. Positive affect is, in turn, associated with health outcomes such as self-rated physical health (Winter et al., 2007), mobility and functional status over time (Ostir et al., 2000), gait speed in older individuals (Lord and Menz, 2002), and lower morbidity (Pressman and Cohen, 2005).

Perceived stress. Perceived stress is a cognitive state that occurs when individuals view aspects of their life as unpredictable, overwhelming, or uncontrollable, or when they perceive the demands of their environment as exceeding their coping capacity (Cohen et al., 1983; Richardson et al., 2012). Positive experiences may prevent or lessen perceived stress experience. Bono et al. (2013) found that positive events at work were associated with lower perceived stress both in the moment and later in the day. Li et al. (2021) found that positive events in high school students' daily lives were associated with lower stress and lower variability in stress over time. These decreases in stress are likely to confer health benefits, since there is strong evidence that links increased stress to worse health and mobility over time. Higher perceived stress has been found to be associated with lower self-rated physical health (Fatma

et al., 2013), and Kulmala et al. (2013) found that greater stress symptoms in midlife predicted increased disability severity as individuals aged into older adulthood. Perceived stress has been shown to predict onset of arthritis (Harris et al., 2013), as well as risk of asthma incidence (Rod et al., 2012) and coronary heart disease (Richardson et al., 2012).

Depression. Depression is multi-dimensional, including behavioral, somatic, affective (both low positive and high negative), and cognitive components (Radloff, 1977). Numerous studies have identified associations between increased positive experience frequency and decreased depressive symptomatology (Blonski et al., 2016; Ferreira and Barham, 2018; Panaite et al., 2021; Rider et al., 2016; Riskind et al., 2013). A meta-analysis indicated that interventions to increase positive experience frequency showed similar efficacy in treatment of depression to traditional cognitive-behavioral approaches (Mazzucchelli et al., 2009). In turn, depressive symptomatology is associated with poorer self-rated (Molarius and Janson, 2002; Mulsant et al., 1997) and functional health and increased morbidity. In a review of factors associated with mobility in older adults, Kalu et al. (2022) cite over 40 studies linking depression to mobility outcomes, including slow gait, balance, and mobility limitations. Birk et al. (2019) found in meta-analyses that depression was associated with subsequent incidence of diabetes and heart disease, and higher levels of depression have also been associated with a greater comorbidity count 10 years later (Poole and Steptoe, 2018).

Allostatic load. Indices of allostatic load assess physiological dysregulation across different biological regulatory systems (McEwen, 1998; McEwen, 2000; McEwen and Stellar, 1993; Seeman et al., 1997) and may allow for subclinical observation of physiological pathways that are associated with future health and morbidity (see Guidi et al., 2021). Allostatic load indices are constructed by first assessing whether each of a number of biomarker readings (commonly between 10 and 25 blood, urine, or other biomarkers) indicates physiological risk and then using these risk determinations to compute an index of overall physiological dysregulation throughout the body. Our research (Podber and Gruenewald, 2023a) has found that a lower frequency of positive experiences is linked to higher allostatic load. Higher allostatic load, in turn, is associated with faster decline in self-rated health (Barry et al., 2021), future disability and illness (Gallagher, 2021), and higher levels of frailty (Gruenewald et al., 2009; Szanton et al., 2009). In a review of over 250 articles, Guidi et al. (2021) found that allostatic load is consistently linked to poorer health outcomes, including cardiovascular disease, type 2 diabetes, lower bone mineral density, and periodontal disease.

The current study

We use survey and biomarker data from the MIDUS Study on frequency of positive experiences, positive affect, depression, perceived stress, and physiological health, along with baseline physical health data and physical health data spanning a 7-year average follow-up period to examine the hypotheses that (1) greater frequency of positive experiences is linked to better health across three domains, including better subjective health (higher self-rated health), better functional health (lower level of difficulty in performing basic and intermediate activities of daily living), and lower comorbidity count and (2) these associations are mediated by higher positive affect and lower perceived stress, depression, and allostatic load.

To our knowledge, this is the first investigation of long-term associations between any of these three domains of physical health and a comprehensive measure of frequency of engagement in a wide variety of positive experiences. An additional contribution is our

assessment of multiple pathways theorized to play a role in links between positive experiences and physical health.

Methods

MIDUS data and study design information, including the sites that obtained Institutional Review Board (IRB) approval for MIDUS data collection, are available at midus.wisc.edu. The present research was exempt from IRB review because the data were publicly available and de-identified. The pre-registration for this study can be viewed at https://osf.io/n834q/?view_only=aa3b057e3a8e4e43acc8693125979bd7. The code used to run the analyses is available at https://osf.io/d47rp/?view_only=2d14e388c0db4c978e2e24b7c0068de7.

Data and participants

The MIDUS Study was designed to collect data on social, behavioral, and psychological factors related to health and well-being in the US. There have been three main waves of survey data collection: M1 (1995–1997; participants were 24–75 years old), M2 (2004–2006), at which point a new subsample of Black participants from Milwaukee, WI was added, and M3 (2013–2017). The MIDUS Biomarker Project (2004–2009) collected additional data on a subsample of the M2 participants during an overnight visit to a clinical research center that included an additional survey and comprehensive biological assessment. All baseline health measures in the current study were assessed at M2. Frequency of positive experiences, positive affect, perceived stress, depression, and all biomarkers in the allostatic load index were assessed during the M2 Biomarker Project visit. All health outcomes were assessed at M3.

MIDUS recruitment included a random digit dial (RDD) of adults from the entire United States, but the MIDUS sample also includes a nation-wide subsample of twins, oversamples from specific urban cities, and the Milwaukee oversample of Black participants. In the current study, 50.4% of our analytic sample are from the RDD subsample (see Figure 1 for a detailed participant flow chart). Out of the 1,255 participants in the MIDUS Biomarker Project, 89% (n = 1,113) participated in M3. Out of the remaining 142 participants, 73 died before M3 data collection was completed and were excluded from the analyses, leaving a final analytic sample of N = 1,182.

Measures

Frequency of positive life experiences. This score was calculated as the mean of the non-missing values of 49 items (see Table 1; Podber and Gruenewald, 2023a) that assessed how frequently over the past month (0 - Never, 1 - 1 to 6 times, and 2 - 7 or more times (range: 0–2)) the participant engaged in different experiences relating to recreation, relaxation, achievement, solitude, physical comfort, nature, social interaction, intimacy, exercise, and entertainment. The majority of items in the MIDUS measure were from the mood-related subscale of the Pleasant Events Schedule (PES-MR; MacPhillamy and Lewinsohn, 1982).

Self-rated health. Self-rated health (see Krause and Jay, 1994) was assessed at M2 and M3 with a single item: "In general, would you say your physical health is excellent, very good, good, fair, or poor?" Given the lower number of respondents who selected "poor" or "fair," these two items were combined into one category. The responses were coded 1–4, with higher values reflecting better health.

Degree of difficulty in performing activities of daily living. At M2 and M3, participants were asked how much (1 - Not at all, 2 - A little, 3 - Some, 4 - A lot) their health limits them in performing different activities of daily living, using the 10 items on limitations in physical activities from the Medical Outcomes Study Short Form

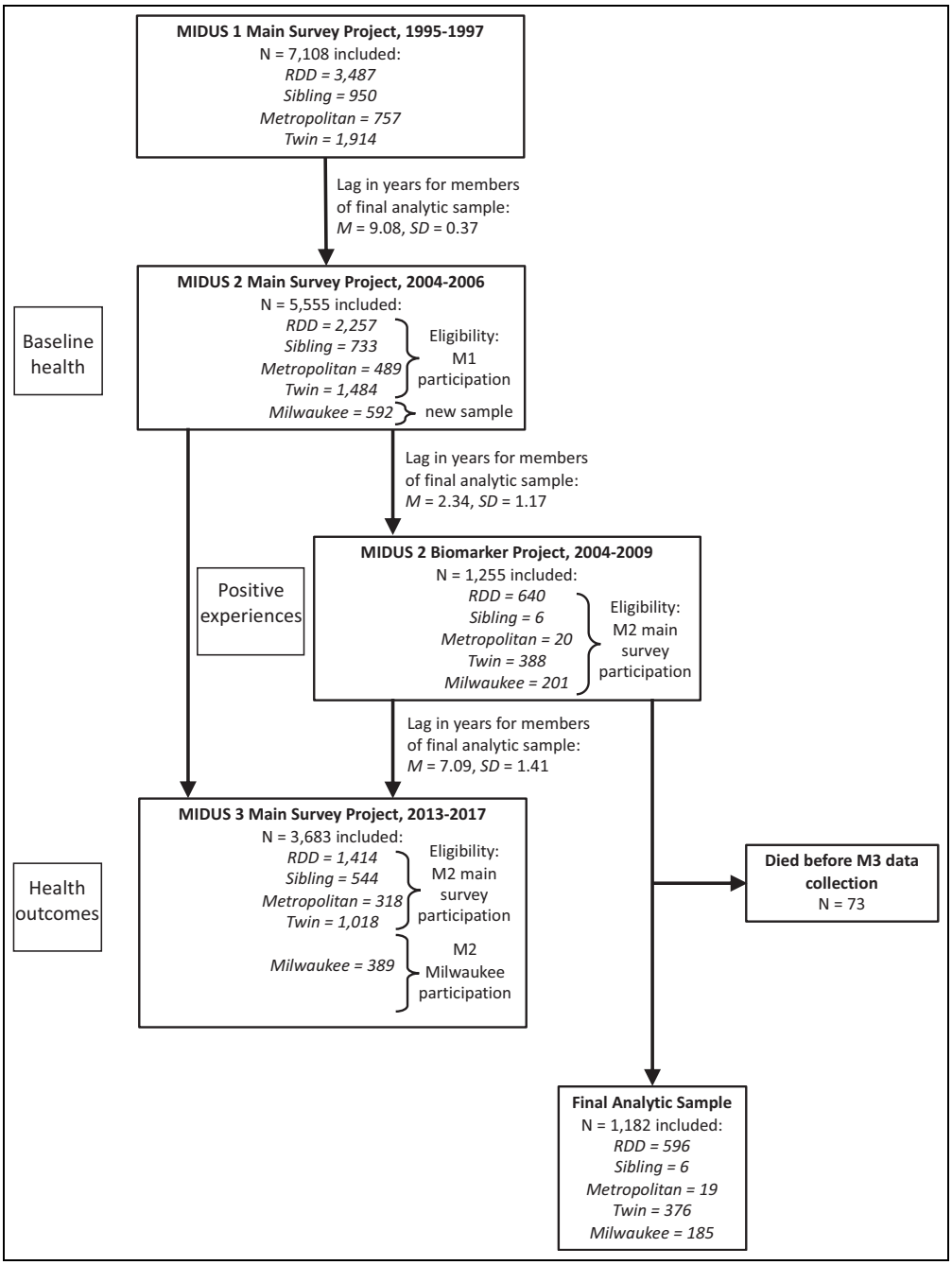

Figure 1. Participant flow chart.
RDD = Random digit dial.

Table 1. Items in the frequency of positive life experiences measure and missing data.

Item	% Missing	Never*	1-6 Times*	7+ Times*	Item	% Missing	Never*	1-6 Times*	7+ Times*
Appreciate nature	0.5%	5.1%	48.0%	46.9%	Noticed as sexually attractive	1.0%	40.2%	51.7%	8.1%
Meet someone new	0.6%	13.4%	74.6%	12.0%	Learning to do something new	0.8%	25.3%	67.4%	7.3%
Plan trips or vacations	0.8%	16.7%	77.8%	5.5%	Complimenting someone	0.5%	3.5%	56.5%	40.0%
Reading	0.5%	24.1%	47.2%	28.7%	Thinking about people I like	0.9%	2.0%	40.1%	57.8%
Helping someone	0.6%	2.3%	56.9%	40.9%	Kissing	0.9%	18.8%	33.9%	47.3%
Breathing clean air	0.8%	6.7%	27.2%	66.0%	Praying or meditating	0.4%	14.3%	29.9%	55.8%
Saying something clearly	1.9%	5.1%	42.9%	52.0%	Doing a project my own way	1.3%	13.1%	62.4%	24.5%
Thinking about good in future	0.8%	2.0%	47.7%	50.3%	Having peace and quiet	0.7%	4.2%	49.5%	46.3%
Laughing	1.0%	0.9%	22.1%	76.9%	Being relaxed	1.1%	2.9%	46.8%	50.3%
Being with animals	0.9%	23.8%	30.1%	46.1%	Sleeping soundly at night	0.7%	8.1%	39.9%	52.0%
Having an open conversation	0.7%	6.3%	64.0%	29.7%	Having a good fitness workout	0.9%	36.0%	35.7%	28.4%
Going to a party	0.5%	39.2%	57.9%	2.9%	Amusing people	0.7%	18.1%	62.3%	19.6%
Giving thanks for daily life	0.8%	7.9%	27.3%	64.8%	Being with someone I love	0.8%	5.8%	19.0%	75.2%
Being with friends	0.6%	2.8%	46.0%	51.2%	Having sexual relations with partner	0.9%	38.8%	43.5%	17.8%
Being popular at a gathering	0.8%	34.3%	58.1%	7.7%	Watching sports	0.7%	30.7%	45.9%	23.3%
Enjoying TV or movies	0.7%	1.9%	34.9%	63.2%	Being with happy people	0.5%	2.0%	44.7%	53.3%
Sitting in the sun	0.8%	38.1%	48.6%	13.3%	Smiling at people	0.7%	1.0%	23.2%	75.8%
Seeing good happen to family/friend	0.8%	5.5%	67.7%	26.8%	Being with spouse/partner	1.3%	22.9%	10.3%	66.8%
Planning something	0.8%	11.4%	66.9%	21.7%	Teaching or advising someone	0.8%	9.7%	61.9%	28.3%
Having a lively talk	0.8%	7.0%	63.2%	29.8%	Being complimented	1.0%	7.4%	73.9%	18.7%
Being with family	0.8%	4.1%	31.7%	64.2%	Being told I am loved	1.1%	8.2%	36.7%	55.1%
Taking a relaxing bath	0.8%	49.0%	30.3%	20.7%	Seeing old friends	1.0%	22.0%	65.0%	13.0%
Seeing beautiful scenery	0.9%	5.6%	51.9%	42.5%	Shopping	1.0%	10.3%	69.5%	20.3%
Eating good meals	0.8%	1.0%	33.0%	66.0%	Feeling no pain	0.8%	19.2%	33.5%	47.3%
Having spare time	0.8%	7.6%	56.0%	36.4%					

Note. The frequency of positive life experiences predictor variable was constructed from these 49 items, which assessed how frequently over the past month the participant had experienced each. The response options were 0 - Never, 1 - 1 to 6 times, and 2 - 7 or more times. The final score was constructed by calculating the mean of the non-missing values (range: 0–2).

*Percentages shown for each response option are out of the total non-missing values.

Health Survey (SF-36; Ware and Sherbourne, 1992). Consistent with prior use of this measure in MIDUS (Friedman et al., 2015), three items were used to construct a scale of difficulty in performing basic activities of daily living (BADLs; bathing or dressing, climbing one flight of stairs, walking one block) and seven items were used to form a scale of difficulty in performing intermediate activities of daily living (IADLs; e.g. lifting or carrying groceries, moderate activities, such as pushing a vacuum cleaner). A mean score of the non-missing values was calculated for the BADL and IADL items (range: 1–4).

Comorbidity count. At M2 and M3, participants self-reported whether they had specific medical conditions over the past 12 months (1 - Yes, 0 - No). The M3 comorbidity outcome was a count variable computed as the sum of indicators for five conditions (range: 0–5): lung-related conditions, autoimmune disease, high blood pressure or hypertension, diabetes or high blood sugar, and neurological disorders. In addition to the M2 items, the baseline control variable also incorporated additional self-report items that were available in the M2 Biomarker assessment on whether the participant had any history of the five conditions and on four additional conditions (AIDS or HIV, stroke, cancer, and heart trouble). The sum of these nine conditions was calculated and winsorized at 99% (range: 1–4). In sensitivity analyses, we used the exact M2 version of the M3 comorbidity measure as the baseline variable.

Positive affect. The 14-item positive affect subscale of the Mood and Symptom Questionnaire (MASQ; Watson and Clark, 1991; Watson et al., 1995) was used to assess positive affect. The items measured how much (1 - Not at all, 2 - A little bit, 3 - Moderately, 4 - Quite a bit, 5 - Extremely) participants experienced different positive feelings over the past week (e.g. "Felt cheerful," "Felt optimistic"). Positive affect was computed as the mean of the non-missing items multiplied by 14.

Depression. The 20-item Center for Epidemiological Studies Depression Inventory (CES-D; Radloff, 1977) was used to assess depression. The items measured how often (0 - Rarely or none of the time, 1 - Some or a little of the time, 2 - Occasionally or moderate amount of the time, 3 - Most or all of the time) participants experienced different psychological and somatic symptoms of depression over the past week (e.g. "I was bothered by things that usually don't bother me," "I did not feel like eating; my appetite was poor"). Four items were reverse scored, and then depression was computed as the mean of the non-missing items multiplied by 20, with higher values reflecting greater levels of depressive symptomatology.

Perceived stress. The 10-item Perceived Stress Scale (PSS; Cohen et al., 1983) was used to assess perceived stress. The items measured how often (1 - Never, 2 - Almost never, 3 - Sometimes, 4 - Fairly often, 5 - Very often) participants experienced different feelings of stress over the past month (e.g. "Found that you could not cope with all the things that you had to do," "Felt that you were unable to control the important things in your life"). Four items were reverse scored, and then perceived stress was calculated as the mean of the non-missing items multiplied by 10, with higher values reflecting greater levels of perceived stress.

Allostatic load (AL). AL was computed as a multisystem risk score (see Gruenewald et al., 2012), using 24 biomarkers representing seven biological systems: the cardiovascular system, lipids and general metabolic activity, glucose metabolism, the HPA axis, the inflammatory system, the sympathetic nervous system, and the parasympathetic nervous system. Table 2 shows the biomarkers used to assess each biological system. High-risk quartile cutoffs were calculated for each

Table 2. Biomarkers used in calculating the allostatic load score.

System	Biomarkers
Cardiovascular system	Resting pulse
	Systolic blood pressure (average of three readings)
	Diastolic blood pressure (average of three readings)
Lipids and general metabolic activity	Body mass index
	Waist-hip ratio
	Triglycerides (mg/dL)
	High-density lipoprotein cholesterol (mg/dL)
	Low-density lipoprotein cholesterol (mg/dL)
Glucose metabolism	Glycated hemoglobin
	Fasting glucose (mg/dL)
	Homeostasis model of insulin resistance (HOMA-IR)
HPA axis	Overnight urinary cortisol, adjusted for urinary creatinine (ug/g)
	Dehydroepiandrosterone-sulfate (DHEA-S; ug/dL)
Inflammatory system	Interleukin-6 (pg/mL)
	Fibrinogen (mg/dL)
	C-reactive protein (ug/mL)
	e-Selectin (ng/mL)
	Soluble intercellular adhesion molecule 1 (ICAM-1; ng/mL)
Sympathetic nervous system	Overnight urinary norepinephrine, adjusted for urinary creatinine (ug/g)
	Overnight urinary epinephrine, adjusted for urinary creatinine (ug/g)
Parasympathetic nervous system*	Low-frequency (0.04–0.15 Hz) spectral power (average of 2 readings)
	High-frequency (0.15–0.50 Hz) spectral power (average of 2 readings)
	Standard deviation of R-R intervals (SDRR; in milliseconds; average of 2 readings)
	Root mean square of successive differences (RMSSD; average of 2 readings)

Note: The highest-risk quartile was defined as the lowest quartile for HDL cholesterol, DHEA-S, and all PNS measures and the highest quartile for all other biomarkers.

*The parasympathetic nervous system (PNS) was assessed using 4 measures of heart-rate variability.

biomarker (without the Milwaukee subsample, since these participants may not have been representative of the national population). All participants (including Milwaukee participants) who fell in the highest-risk quartile on each biomarker were assigned 1 on a risk indicator variable for that biomarker and 0 otherwise. A risk proportion score was calculated for each biological system, for participants who were not missing more than half of the indicators within a system, by averaging the indicators. AL was computed as the mean of the risk proportion scores multiplied by 7, for participants who were not missing more than 1 of the risk proportion scores (range: 0–7).

Covariates. Cumulative life socioeconomic advantage (range: 0–16; see Table 3 for items and score calculation), age in years, race (white [referent], Black, other), gender (assessed as male or female [referent] in MIDUS), and lag time (in months) between the M2 Biomarker survey and M3 survey were used as covariates.

Analyses

Descriptive statistics and correlations were examined for model variables. Then unadjusted and adjusted models were run to assess the association between frequency of positive life experiences and each of the 4 M3 outcomes: (1) M3 self-rated health (odds ratio (OR) from ordinal logistic regression); (2) M3 BADL difficulty (linear regression); (3) M3 IADL difficulty (linear regression); and (4) M3 comorbidity count (incidence rate ratio (IRR) from Poisson regression). Adjusted models included the positive

Table 3. Items used in calculating the cumulative life socioeconomic advantage measure.

Life course phase	Items	Response options
Childhood advantage items	Self-assessment of participant's financial level in childhood relative to others	0 - worse off than others 1 - same as others 2 - better off than others
	Parents' highest level of education	0 - less than high school 1 - high school/GED 2 - some college or greater
	Whether the family ever received governmental welfare	0 - yes 2 - no
Adult advantage items	Self-assessment of current financial level	0 - worst possible 1 - average 2 - best possible
	Self-assessment of whether the participant has enough money for basic needs	0 - not enough 1 - just enough 2 - more than enough
	Self-assessment of difficulty of paying bills	0 - very or somewhat difficult 1 - not very difficult 2 - not difficult at all
	Level of education	0 - high school/GED 1 - some college/associate's degree 2 - college degree or greater
	Household-adjusted income-to-poverty ratio (IPR)	0 - less than 300% 1 - 300-599% 2 - greater than or equal to 600%

Note. For the IPR calculation, US Census Bureau poverty thresholds were assigned based on household size, household composition, and survey year.
Cumulative life socioeconomic advantage was calculated by summing the eight items (range: 0–16) for participants who were missing no more than one childhood measure and one adult measure. When a childhood measure was missing, it was set as the mean of the two other childhood measures rounded to the nearest integer, and when an adult measure was missing, it was set as the rounded mean of the four other adult measures.

experiences predictor, M2 baseline for the outcome variable, and all five covariates. Each model was run with cluster robust standard errors to account for the presence of siblings in the dataset.

Positive affect, depression, perceived stress, and AL were each examined one at a time as mediators of each association. Each mediation model included a linear regression to predict the mediator, with positive experiences, the baseline M2 measure for the outcome being assessed, and the four sociodemographic covariates as predictors, and a regression (ordinal logistic for self-rated health, linear for BADL and IADL, and Poisson for comorbidity) to predict the outcome, with positive experiences, the mediator, the baseline M2 measure, the sociodemographic covariates, and months between the M2 Biomarker and M3 surveys as predictors. Each model was run with cluster robust standard errors to account for family relations. Bootstrap tests of the linear indirect and total effects, with 5,000 replications, were calculated for each model. Supplementary multiple mediation models were run to assess all four mediators together.

The proportion of missing data was less than 1% for positive experiences, all baseline measures, all mediators, and all sociodemographic covariates. The proportion of missing scores was 5.8% for self-rated health (this was the portion of the missing data due to attrition, as all M3 participants filled out self-rated health), 9.8% for BADL and IADL, and 10.9% for comorbidity. Multiple imputation by chained

equations (MICE; White et al., 2011) was used to impute the missing data in 10 datasets. All 1,255 M2 Biomarker participants were included in the imputation models, but after imputation, the 73 participants who died before the end of M3 data collection were excluded from the primary analyses. For calculating bootstrap tests of the indirect and total effects, bootstrapping was carried out within each imputed dataset, and then the bootstrap estimates were combined (see Method 2 in Schomaker and Heumann, 2018).

All analyses were run in Stata 17 (StataCorp, 2021). Positive experiences, BADL, IADL, the four mediators, and the socioeconomic advantage scores were standardized in the models. Proportional odds and distributional assumptions were assessed. In order to assess whether the analytic decision to combine two response categories on the self-rated health measure changed the findings, additional supplementary analyses were run in which the primary analyses were replicated using the original measure with five response categories.

Results

Descriptive analyses

The mean follow-up time from the M2 Biomarker lab visit to the M3 survey was 7.09 years (*Min* = 4.17, *Max* = 10.42). There were 1,031 families represented in the data. Table 4 shows univariate descriptive statistics, and Table 5 is a correlation matrix of the study variables. Positive experiences were weakly correlated with all four outcomes, and each of the mediators was weakly-to-moderately correlated with all four outcomes. Each baseline measure was strongly correlated with its associated outcome, with M2 and M3 IADL showing the strongest correlation.

Primary analyses

Table 6 shows the results for unadjusted and adjusted models assessing associations between positive experiences and physical health. A higher frequency of engagement in positive experiences at M2 Biomarker was associated with better self-rated health, lower BADL difficulty, and lower comorbidity count at M3 in both unadjusted and covariate-adjusted models. More frequent engagement in positive experiences at M2 Biomarker was also associated with lower IADL difficulty at M3, but this association was not significant in the fully adjusted model.

Table 7 shows the three paths in each of the mediation analyses, as well as bootstrap tests of the indirect and total effects. Indirect effect tests showed that positive affect significantly mediated the positive experiences-self-rated health and positive experiences-BADL associations, but not the positive experiences-comorbidity association. In these path models, higher frequency of positive experiences was significantly associated with higher positive affect (Path A), and higher positive affect was associated with higher self-rated health and lower BADL difficulty (Path B), but the path from positive affect to comorbidity was not significant. The direct paths from positive experiences to self-rated health, BADL, and comorbidity were not significant.

Similarly, bootstrap tests of the indirect effects through depression and perceived stress showed that both significantly mediated the positive experiences-self-rated health and positive experiences-BADL associations, but neither mediated the positive experiences-comorbidity association. In these path models, higher positive experience frequency was significantly associated with lower depression and lower perceived stress (Path A), and lower depression and lower perceived stress were both associated with higher self-rated health and lower BADL difficulty (Path B), but the paths from depression and perceived stress to comorbidity were not significant. The direct paths from positive experiences to self-rated health, BADL, and comorbidity were not significant in these models either, with the exception of the direct path from positive experiences to self-rated health in the model with perceived stress as the mediator.

Table 4. Univariate descriptive statistics for variables in the study.

Variable	*n*	% or *M* (SD)
Predictors		
Frequency of positive life experiences	1,177	1.25 (0.26)
Mediators		
Positive affect	1,180	44.63 (10.15)
Perceived stress	1,178	22.15 (6.37)
Depression	1,178	8.60 (8.20)
Allostatic load	1,171	1.80 (1.05)
Covariates		
Gender	1,182	
Female (ref)	679	57.5%
Male	503	42.6%
Race/ethnicity	1,178	
White (ref)	923	78.4%
Black	210	17.8%
Other	45	3.8%
Age	1,182	56.72 (11.18)
Cumulative SES Advantage	1,173	9.32 (3.49)
Baseline		
M2 self-rated health	1,182	2.65 (0.92)
M2 difficulty in performing basic activities of daily living	1,179	1.27 (0.59)
M2 difficulty in performing intermediate activities of daily living	1,180	1.71 (0.84)
M2 comorbidity	1,182	1.14 (1.09)
Outcomes		
M3 self-rated health	1,113	2.46 (0.97)
M3 difficulty in performing basic activities of daily living	1,066	1.44 (0.73)
M3 difficulty in performing intermediate activities of daily living	1,066	1.99 (0.94)
M3 comorbidity	1,053	0.74 (0.84)

Finally, bootstrap tests of the indirect effect showed that AL did not mediate the association between positive experiences and any of the M3 outcomes. Positive experiences were not significantly associated with AL in the path models (Path A), but greater AL was associated with lower self-rated health, higher BADL difficulty, and higher comorbidity (Path B). AL was the only mediator associated with the comorbidity outcome.

Though the effect of positive experiences on IADL difficulty was non-significant, indirect effects tests for this outcome mirrored the results for self-rated health and BADL. A significant indirect effect was found for the paths through positive affect, perceived stress, and depression.

In total, significant indirect effects through positive affect, depression, and perceived stress were found for the associations between positive experiences and self-rated health, positive experiences and BADL difficulty, and the non-significant association between positive experiences and IADL difficulty. No significant mediation was found in the association between positive experiences and comorbidity. AL did not mediate any of the associations between positive experiences and physical health.

Supplementary analyses

Our primary analyses examined each potential mediator separately, given the strong intercorrelation among mediating variables (see Table 5). In supplementary analyses, we ran additional models with all four mediators in the model together. Variance inflation

Table 5. Correlations between variables in the study.

Variable	FREQ	M3 SRH	M3 BADL	M3 IADL	M3 CMB	PA	PS	DEP	AL	M2 SRH	M2 BADL	M2 IADL	M2 CMB	Male	Black	Other	Age	SES
FREQ	1																	
M3 SRH	**0.21**	1																
M3 BADL	**−0.15**	**−0.48**	1															
M3 IADL	**−0.15**	**−0.56**	**0.84**	1														
M3 CMB	**−0.12**	**−0.40**	**0.37**	**0.40**	1													
PA	**0.50**	**0.28**	**−0.17**	**−0.19**	**−0.09**	1												
PS	**−0.33**	**−0.28**	**0.21**	**0.24**	**0.13**	**−0.57**	1											
DEP	**−0.40**	**−0.35**	**0.28**	**0.29**	**0.17**	**−0.64**	**0.75**	1										
AL	**−0.07**	**−0.24**	**0.29**	**0.33**	**0.38**	−0.02	0.06	**0.08**	1									
M2 SRH	**0.21**	**0.53**	**−0.36**	**−0.42**	**−0.35**	**0.29**	**−0.27**	**−0.35**	**−0.26**	1								
M2 BADL	**−0.14**	**−0.33**	**0.52**	**0.49**	**0.34**	**−0.15**	**0.21**	**0.28**	**0.24**	**−0.44**	1							
M2 IADL	**−0.18**	**−0.40**	**0.56**	**0.63**	**0.38**	**−0.19**	**0.22**	**0.28**	**0.30**	**−0.51**	**0.81**	1						
M2 CMB	−0.05	**−0.34**	**0.34**	**0.39**	**0.57**	−0.05	**0.07**	**0.15**	**0.35**	**−0.41**	**0.33**	**0.39**	1					
Male	−0.06	0.02	**−0.13**	**−0.15**	−0.05	−0.05	**−0.07**	−0.05	−0.02	0.02	**−0.12**	**−0.17**	−0.05	1				
Black	**−0.15**	**−0.28**	**0.18**	**0.17**	**0.22**	**−0.07**	**0.19**	**0.20**	**0.08**	**−0.26**	**0.14**	**0.15**	**0.12**	**−0.09**	1			
Other	**−0.06**	**−0.07**	−0.01	−0.02	−0.03	−0.05	**0.06**	0.05	0.01	**−0.08**	0.01	0.02	0.00	0.01	**−0.09**	1		
Age	**0.06**	0.02	**0.13**	**0.23**	**0.13**	**0.15**	**−0.20**	**−0.17**	**0.30**	0.02	**0.08**	**0.19**	**0.30**	0.03	**−0.14**	**−0.07**	1	
SES	**0.24**	**0.38**	**−0.31**	**−0.32**	**−0.18**	**0.23**	**−0.32**	**−0.34**	**−0.18**	**0.35**	**−0.28**	**−0.31**	**−0.13**	**0.13**	**−0.37**	**−0.08**	**0.08**	1

Note. FREQ: frequency of positive life experiences; PA: positive affect; PS: perceived stress; DEP: depression; AL: allostatic load; SRH: self-rated health; BADL: difficulty in performing basic activities of daily living; IADL: difficulty in performing intermediate activities of daily living; CMB: comorbidity.
Bold type denotes statistical significance at the $p < 0.05$ level.

Table 6. Unadjusted and adjusted models for positive experiences predicting each outcome.

Model	Predictor	Outcome: SRH OR (95% CI)	Outcome: BADL *b* (95% CI)	Outcome: IADL *b* (95% CI)	Outcome: CMB IRR (95% CI)
Unadjusted	FREQ	1.54 (1.37, 1.72)***	−0.16 (−0.23, −0.09)***	−0.16 (−0.23, −0.10)***	0.87 (0.80, 0.94)***
Adjusted	FREQ	1.21 (1.07, 1.37)**	−0.06 (−0.12, −0.002)*	−0.04 (−0.09, 0.01)	0.92 (0.86, 0.99)*
	Cum. SES Adv.	1.50 (1.31, 1.70)***	−0.14 (−0.20, −0.08)***	−0.15 (−0.20, −0.09)***	0.96 (0.90, 1.02)
	Age	1.00 (0.99, 1.01)	0.01 (0.01, 0.02)***	0.01 (0.01, 0.02)***	1.00 (0.99, 1.01)
	Male (vs. Female)	0.97 (0.78, 1.21)	−0.10 (−0.21,0.00)	−0.07 (−0.17, 0.02)	0.97 (0.85, 1.10)
	Race				
	Black (vs. White)	0.67 (0.47, 0.96)*	0.07 (−0.10, 0.23)	0.03 (−0.12, 0.17)	1.23 (1.03, 1.47)*
	Other (vs. White)	0.81 (0.46, 1.42)	−0.12 (−0.37, 0.14)	−0.25 (−0.44, −0.06)*	0.83 (0.58, 1.21)
	Follow-up	0.99 (0.98, 0.9975)**	0.005 (0.001, 0.01)**	0.004 (0.001, 0.01)*	1.00 (1.00, 1.01)
	M2 SRH	3.07 (2.60, 3.62)***			
	M2 BADL		0.49 (0.42, 0.56)***		
	M2 IADL			0.56 (0.51, 0.62)***	
	M2 CMB				1.60 (1.52, 1.69)***

Note. FREQ: frequency of positive life experiences; SRH: self-rated health; BADL: difficulty in performing basic activities of daily living; IADL: difficulty in performing intermediate activities of daily living; CMB: comorbidity; OR: odds ratio; IRR: incidence rate ratio.
*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

Table 7. Linear coefficients for paths A, B, and C' in the mediation models and bootstrap tests of the indirect and total effects, with 95% CIs.

Path or Effect	Outcome: SRH *b* or Effect (95% CI)	Outcome: BADL *b* or Effect (95% CI)	Outcome: IADL *b* or Effect (95% CI)	Outcome: CMB *b* or Effect (95% CI)
FREQ-PA (path A)	0.45 (0.40, 0.50)***	0.46 (0.41, 0.52)***	0.45 (0.40, 0.51)***	0.47 (0.42, 0.52)***
PA-outcome (path B)	0.27 (0.13, 0.41)***	−0.08 (−0.15, −0.02)*	−0.09 (−0.15, −0.03)**	−0.04 (−0.11, 0.04)
Direct effect (path C')	0.07 (−0.06, 0.21)	−0.02 (−0.09, 0.04)	0.004 (−0.05, 0.06)	−0.07 (−0.15, 0.02)
Indirect effect†	0.12 (0.06, 0.18)***	−0.04 (−0.07, −0.01)*	−0.04 (−0.07, -0.01)**	−0.02 (−0.05, 0.02)
Total effect†	0.19 (0.06, 0.32)**	−0.06 (−0.12, −0.002)*	−0.04 (−0.09, 0.01)	−0.08 (−0.16, −0.01)*
FREQ-PS (path A)	−0.25 (−0.30, −0.19)***	−0.26 (−0.31, −0.20)***	−0.25 (−0.30, −0.19)***	−0.26 (−0.32, −0.21)***
PS-outcome (path B)	−0.24 (−0.37, −0.11)***	0.09 (0.03, 0.14)**	0.11 (0.06, 0.16)***	0.03 (−0.04, 0.10)
Direct effect (path C')	0.13 (0.0001, 0.26)*	−0.04 (−0.10, 0.02)	−0.01 (−0.06, 0.04)	−0.07 (−0.15, −0.0005)*
Indirect effect†	0.06 (0.02, 0.10)***	−0.02 (−0.04, −0.01)**	−0.03(−0.04, −0.01)***	−0.01(−0.03, 0.01)
Total effect†	0.19 (0.06, 0.32)**	−0.06 (−0.12, −0.002)*	−0.04 (−0.09, 0.01)	−0.08 (−0.16, −0.01)*
FREQ-DEP (path A)	−0.31 (−0.36, −0.25)***	−0.32 (−0.38, −0.26)***	−0.31 (−0.37, −0.25)***	−0.33 (−0.39, −0.27)***
DEP-outcome (path B)	−0.38 (−0.53, −0.23)***	0.13 (0.06, 0.20)***	0.13 (0.08, 0.19)***	0.02 (−0.05, 0.10)
Direct effect (path C')	0.08 (−0.05, 0.22)	−0.02 (−0.08, 0.04)	0.004 (−0.05, 0.06)	−0.07 (−0.15, 0.00)
Indirect effect†	0.12 (0.07, 0.17)***	−0.04 (−0.06, −0.02)***	−0.04 (−0.06, −0.02)***	−0.01 (−0.03, 0.02)
Total effect†	0.20 (0.07, 0.33)**	−0.06 (−0.12, −0.002)*	−0.04 (−0.09, 0.01)	−0.08 (−0.15, −0.01)*
FREQ-AL (path A)	−0.01 (−0.07, 0.04)	−0.02 (−0.08, 0.03)	−0.01 (−0.07, 0.04)	−0.03 (−0.09, 0.02)
AL-outcome (path B)	−0.26 (−0.38, −0.14)***	0.15 (0.09, 0.21)***	0.12 (0.07, 0.17)***	0.21 (0.14, 0.28)***
Direct effect (path C')	0.19 (0.07, 0.32)**	−0.06 (−0.12, 0.00)	−0.04 (−0.08, 0.01)	−0.07 (−0.14, 0.00)
Indirect effect†	0.00 (−0.01, 0.02)	−0.003 (−0.01, 0.00)	−0.001 (−0.01, 0.01)	−0.01 (−0.02, 0.00)
Total effect†	0.19 (0.07, 0.32)**	−0.06 (−0.12, −0.002)*	−0.04 (-0.09, 0.01)	−0.08 (−0.15, −0.003)*

FREQ: Frequency of positive life experiences; PA: positive affect; PS: perceived stress; DEP: depression; AL: allostatic load; SRH: self-rated health; BADL: difficulty in performing basic activities of daily living; CMB: comorbidity.

*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

†Bootstrap tests based on 5,000 replications.

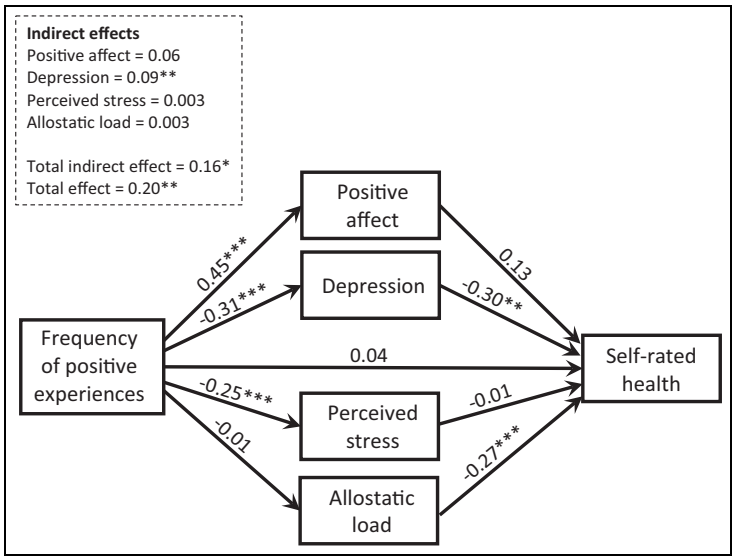

Figure 2. Model assessing mediating pathways in the association between frequency of positive life experiences and self-rated physical health, with unstandardized linear coefficients, indirect effects, and total effect.

Not shown: Regressions predicting the mediators controlled for gender, race, age, socioeconomic status, and baseline M2 self-rated physical health. Regressions predicting the M3 self-rated physical health outcome controlled for gender, race, age, socioeconomic status, baseline M2 self-rated physical health, and time between the M2 Biomarker Project survey and M3 survey.

Significance of indirect and total effects based on 5,000 bootstrap samples.

*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

factors (VIF) indicated that multicollinearity was not a significant concern. The highest VIF values were 2.8 for depression and 2.4 for perceived stress, whereas values above 5 have typically been interpreted as indicating a potential issue with multicollinearity (O'Brien, 2007). These models, with path coefficients, indirect effects, total indirect effects, and total effects, are presented in Figures 2 (self-rated health), 3 (BADL), 4 (IADL), and 5 (comorbidity). As shown in the figures, bootstrap tests of the indirect effects showed that only depression was a significant mediator of the positive experiences-self-rated health association (Figure 2), positive experiences-BADL association (Figure 3), and non-significant positive experiences-IADL association (Figure 4). Paralleling the single mediator analyses, none of the examined variables mediated the association between positive experience frequency and comorbidity (Figure 5).

Using a baseline comorbidity variable that was the exact 5-item M2 version of the M3 comorbidity outcome did not impact the analyses. Positive experience frequency still predicted M3 comorbidity in the adjusted model, $IRR = 0.925$, $p = 0.039$, 95% CI[0.859, 0.996]. The results of Paths A and B in each mediation model remained unchanged, and none of the mediators significantly mediated the association between positive experience frequency and comorbidity. Using the original self-rated health measure with five response options similarly resulted in only minimal changes to coefficients. The coefficient for positive experiences

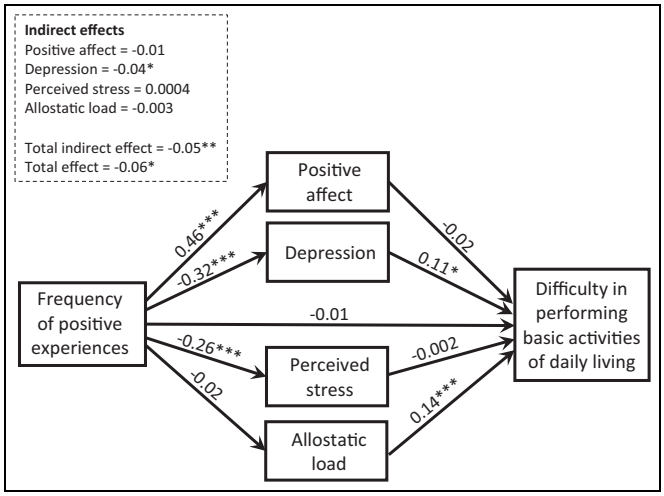

Figure 3. Model assessing mediating pathways in the association between frequency of positive life experiences and difficulty in performing basic activities of daily living, with unstandardized linear coefficients, indirect effects, and total effect.

Not shown: Regressions predicting the mediators controlled for gender, race, age, socioeconomic status, and baseline M2 difficulty in performing basic activities of daily living. Regressions predicting the M3 difficulty in performing basic activities of daily living outcome controlled for gender, race, age, socioeconomic status, baseline M2 difficulty in performing basic activities of daily living, and time between the M2 Biomarker Project survey and M3 survey. Significance of indirect and total effects based on 5,000 bootstrap samples.

*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

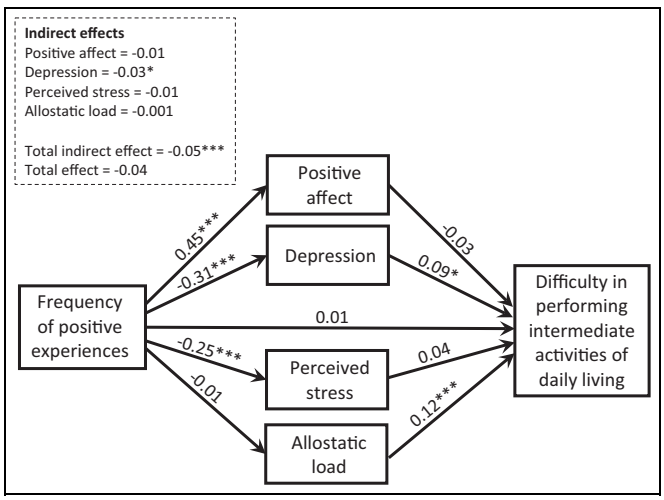

Figure 4. Model assessing mediating pathways in the association between frequency of positive life experiences and difficulty in performing intermediate activities of daily living, with unstandardized linear coefficients, indirect effects, and total effect.

Not shown: Regressions predicting the mediators controlled for gender, race, age, socioeconomic status, and baseline M2 difficulty in performing intermediate activities of daily living. Regressions predicting the M3 difficulty in performing intermediate activities of daily living outcome controlled for gender, race, age, socioeconomic status, baseline M2 difficulty in performing intermediate activities of daily living, and time between the M2 Biomarker Project survey and M3 survey. Significance of indirect and total effects based on 5,000 bootstrap samples.

*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

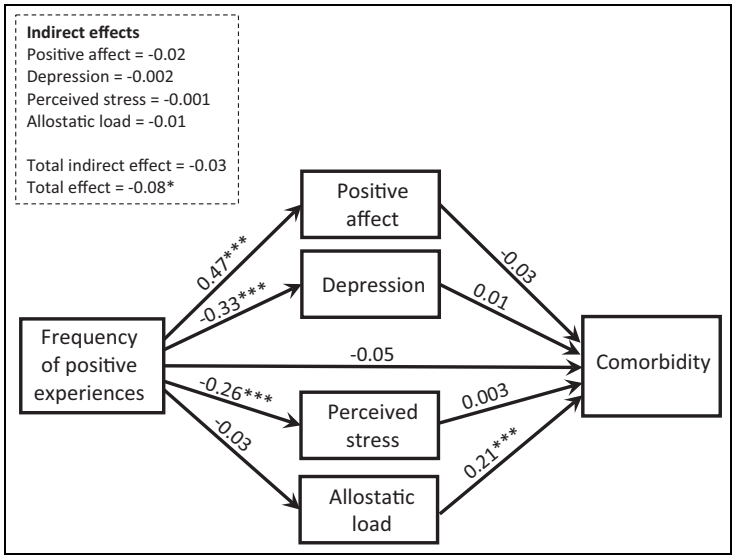

Figure 5. Model assessing mediating pathways in the association between frequency of positive life experiences and comorbidity, with unstandardized linear coefficients, indirect effects, and total effect.
Not shown: Regressions predicting the mediators controlled for gender, race, age, socioeconomic status, and baseline M2 comorbidity. Regressions predicting the M3 comorbidity outcome controlled for gender, race, age, socioeconomic status, baseline M2 comorbidity, and time between the M2 Biomarker Project survey and M3 survey.
Significance of indirect and total effects based on 5,000 bootstrap samples.
$^{*}p < 0.05$. $^{**}p < 0.01$. $^{***}p < 0.001$.

predicting self-rated health changed from $OR = 1.54$ to $OR = 1.53$ in the unadjusted model and from $OR = 1.21$ to $OR = 1.19$ in the adjusted model, and the mediation models followed similar patterns (see Table 8 for the full results).

Discussion

We found an association between greater frequency of engagement in positive life experiences and health outcomes assessed approximately 7 years later across three domains of physical health: subjective health, functional health, and disease morbidity. The associations between positive experiences and self-rated health, BADL difficulty, and comorbidity count remained significant after adjustment for health at baseline and covariates. These results are consistent with prior research that links positive experiences to better sleep (e.g. Tighe et al., 2016) and lower risk of mortality (e.g. Gump and Matthews, 2000), and they suggest that engagement in a greater frequency of positive experiences may have a positive impact on both subjective and objective physical health.

Our mediation analyses showed that associations between positive experiences and both self-rated health and BADL difficulty were mediated by higher positive affect, decreased perceived stress, and decreased depression. In supplementary analyses that assessed all mediators in tandem, only depression remained significant as a mediator of both associations. These results are in line with a large body of research that links positive experiences to depression and depression to multiple health outcomes (see Depression subsection in the Introduction). More research is needed to understand why

Table 8. Replication of the primary analyses using the original 5-category self-rated health measure.

Unadjusted and adjusted models for positive experiences predicting self-rated health		
Model	Predictor	OR (95% CI)
Unadjusted	FREQ	1.53 (1.36, 1.71)***
Adjusted	FREQ	1.19 (1.04, 1.35)**
	Cum. SES Adv.	1.46 (1.28, 1.66)***
	Age	1.00 (0.99, 1.01)
	Male (vs. Female)	0.94 (0.75, 1.18)
	Race	
	Black (vs. White)	0.73 (0.52, 1.03)
	Other (vs. White)	0.75 (0.41, 1.38)
	Follow-up	0.99 (0.98, 0.998)*
	M2 SRH	3.12 (2.67, 3.64)***

Linear coefficients for paths A, B, and C' in the self-rated health mediation model, and bootstrap tests of the indirect and total effects, with 95% CIs	
Path or Effect	Outcome: SRH
	b or Effect (95% CI)
FREQ-PA (path A)	0.45 (0.39, 0.50)***
PA-outcome (path B)	0.27 (0.13, 0.41)***
Direct effect (path C')	0.05 (−0.09, 0.19)
Indirect effect†	0.12 (0.06, 0.18)***
Total effect†	0.17 (0.04, 0.30)*
FREQ-PS (path A)	−0.24 (−0.30, −0.19)***
PS-outcome (path B)	−0.23 (−0.36, −0.11)***
Direct effect (path C')	0.11 (−0.02, 0.25)
Indirect effect†	0.06 (0.02, 0.09)***
Total effect†	0.17 (0.04, 0.30)*
FREQ-DEP (path A)	−0.30 (−0.36, −0.25)***
DEP-outcome (path B)	−0.36 (−0.50, −0.22)***
Direct effect (path C')	0.06 (−0.07, 0.20)
Indirect effect†	0.11 (0.06, 0.16)***
Total effect†	0.17 (0.04, 0.30)*
FREQ-AL (path A)	−0.01 (−0.07, 0.04)
AL-outcome (path B)	−0.25 (−0.37, −0.13)***
Direct effect (path C')	0.17 (0.04, 0.30)**
Indirect effect†	0.00 (−0.01, 0.02)
Total effect†	0.17 (0.04, 0.30)**

Note. FREQ: Frequency of positive life experiences; OR: odds ratio; PA: positive affect; PS: perceived stress; DEP: depression; AL: allostatic load; SRH: self-rated health.
Path A is the path from the predictor to the mediator, Path B is the path from the mediator to the outcome, and Path C' is the direct effect from the predictor to the outcome.
*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.
†Bootstrap tests based on 5,000 replications.

depression emerged as the dominant mediator in multi-mediation models, but depression may be an overarching construct that captures elements of low positive affect (as is the case with the depression measure utilized in the present study), as well as perceptions typically

captured in measures of perceived stress, such as feelings of overwhelm, uncontrollability, and unpredictability. Overall, our results suggest that frequency of positive experiences, which include experiences of social interaction, recreation, relaxation, and entertainment, may have long-term impacts on physical health and that there may be psychological pathways underlying these associations.

In our mediation analyses, allostatic load was not a significant mediator of any associations between positive experiences and health. Though allostatic load strongly predicted each of the health outcomes in the mediation analyses, in line with prior research (e.g. Guidi et al., 2021), frequency of positive experiences did not predict allostatic load in our analytic sample. In contrast, Podber and Gruenewald (2023a) found an overall association between positive experience frequency and allostatic load in a sample that included MIDUS data from the current study and also a newer cohort (with only one wave of survey data). One possibility is that the expanded sample examined in the prior study, which was 77.3% larger than our current sample, was large enough to pick up a weak association that was not observable in our current sample.

For a 1-standard deviation increase in positive experience frequency in our adjusted models, the odds of being in a better category of self-rated health were predicted to increase by 21%, and the comorbidity count was predicted to decrease by 8%. For the same increase in positive experience frequency, difficulty in performing BADLs was predicted to be 0.06 standard deviations lower, which is analogous to the decrease expected for a person who was 6 years younger. Although these variations in health as a function of increased positive experience frequency are small to moderate, it is likely that frequency of engagement in positive experiences is one of many factors that, together, impact our subjective and objective physical health to larger and smaller degrees.

Limitations

Positive experiences and the four mediators were all measured during the same time frame. Although there is prior evidence that positive experiences impact positive affect, depression, perceived stress, and physiological health (Bono et al., 2013; Chen et al., 2022; Mazzucchelli et al., 2009; Moore et al., 2013), and although we controlled for prior health, the associations between positive experiences and our mediators may be bidirectional. While we controlled for length of follow-up period in our analyses, our follow-up periods had a large range (from 4 to 10 years) due to the long period of data collection for each MIDUS survey wave. We examined our four outcomes separately, but they may also be causally related (e.g. comorbidity may lead to difficulty in performing activities of daily living). Finally, there also may be factors that remain unaccounted for in our analyses that impact physical health or that moderate the associations we examined.

The results are not necessarily generalizable to the US population. The MIDUS Biomarker subsample is sociodemographically similar to the larger MIDUS sample (Love et al., 2010), but there may be other particular characteristics among those who can agree to travel to one of three national sites for a 2-day visit that may impact generalizability. In the Biomarker data, 97.9% of white participants are from national samples, but 85.7% of Black participants are from the Milwaukee, WI oversample. For this reason, all race coefficients should be interpreted with caution. In addition, the results may not generalize to other time periods, given that the data were collected prior to the COVID pandemic, or to locations with different healthcare distribution systems than the US.

Our analyses were carried out using a measure that combines 49 positive behaviors, events, and experiences. Although a strength of this measure is that it assesses the frequency of positive experiences across a wide variety of experience types, the cross-domain averaging may obscure associations between different

types of positive experiences and different health outcomes. Such examinations are beyond the scope of the present analysis but may be a fruitful avenue of future research.

Future research

Future research should assess whether different domains of positive experiences each show similar associations with health, as well as how the presence and severity of individual morbidities are associated with positive experiences. As evidence accumulates, additional complex associations can be assessed, such as which sociodemographic, psychosocial, and individual difference factors may strengthen or weaken the observed associations between positive experiences and physical health, as well as whether level of engagement in positive experiences moderates (i.e. buffers against) associations between stress and physical health.

Conclusion

We found that greater frequency of positive life experiences was associated with better self-rated health, lower difficulty in performing basic activities of daily living, and lower comorbidity over a seven-year average follow-up period. We also found that associations between positive experiences and both self-rated health and difficulty in performing activities of daily living were mediated by higher positive affect, lower perceived stress, and lower depression, but that in multi-mediator models, only depression remained a significant mediator. Positive experiences may impact long-term physical health, particularly through psychological pathways such as depression, and warrant further study.

Data sharing statement

Data and materials are available via the University of Michigan Inter-university Consortium of Political and Social Research at https://www.icpsr.umich.edu/web/pages/NACDA/midus.html. The pre-registration can be viewed at https://osf.io/n834q/?view_only=aa3b057e3a8e4e43acc8693125979bd7. Analysis code is provided at https://osf.io/d47rp/?view_only=2d14e388c0db4c978e2e24b7c0068de7.

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Publicly-available data from the MIDUS Study were used for this research. Since 1995, the MIDUS study has been funded by the John D. and Catherine T. MacArthur Foundation Research Network, National Institute on Aging (P01-AG020166), and National Institute on Aging (U19-AG051426). Naomi Podber received funding as a Postdoctoral Researcher from the Chapman University Crean College of Health and Behavioral Sciences.

Ethics approval

The Institutional Review Boards (IRB) of the University of Wisconsin-Madison, University of California, Los Angeles, and Georgetown University approved the MIDUS Study. The present research was exempt from IRB review because all data were publicly available and de-identified.

ORCID iD

Naomi Podber https://orcid.org/0009-0007-0243-6755

Tara L. Gruenewald https://orcid.org/0000-0002-3783-9171

References

Barry LE, O'Neill S, Heaney LG, et al. (2021) Stress-related health depreciation: Using allostatic load to predict self-rated health. *Social Science & Medicine* 283: 114170.

Birk JL, Kronish IM, Moise N, et al. (2019) Depression and multimorbidity: Considering temporal characteristics of the associations between depression and multiple chronic diseases. *Health Psychology* 38(9): 802.

Blonski SC, Conradi HJ, Oldehinkel AJ, et al. (2016) Associations between negative and positive life events and the course of depression: A detailed repeated-assessments study. *The Journal of Nervous and Mental Disease* 204(3): 175–180.

Bono JE, Glomb TM, Shen W, et al. (2013) Building positive resources: Effects of positive events and positive reflection on work stress and health. *Academy of Management Journal* 56(6): 1601–1627.

Chen ST, Hyun J, Graefe AR, et al. (2022) The influence of leisure engagement on daily emotional well-being. *Leisure Sciences* 44(7): 995–1012.

Clark LA, Watson D and Leeka J (1989) Diurnal variation in the positive affects. *Motivation and Emotion* 13: 205–234.

Cohen S, Kamarck T and Mermelstein R (1983) A global measure of perceived stress. *Journal of Health and Social Behavior* 24(4): 385–396.

DeSalvo KB, Bloser N, Reynolds K, et al. (2006) Mortality prediction with a single general self-rated health question: A meta-analysis. *Journal of General Internal Medicine* 21: 267–275.

Fancourt D and Steptoe A (2019) The art of life and death: 14-year follow-up analyses of associations between arts engagement and mortality in the English Longitudinal Study of Ageing. *British Medical Journal* 367(10): Article l6377.

Fatma HG, Joan VA, Ajabshir S, et al. (2013) Perceived stress and self-rated health of Haitian and African Americans with and without Type 2 diabetes. *Journal of Research in Medical Sciences: The Official Journal of Isfahan University of Medical Sciences* 18(3): 198–204.

Ferreira HG and Barham EJ (2018) Relações entre Atividades Prazerosas, Depressão, Funcionalidade e Variáveis Sociodemográficas em Idosos. *Paidéia (Ribeirão Preto)* 28: 25. SciELO Brasil.

Friedman EM, Christ SL and Mroczek DK (2015) Inflammation partially mediates the association of multimorbidity and functional limitations in a national sample of middle-aged and older adults: The MIDUS study. *Journal of Aging and Health* 27(5): 843–863.

Gallagher S (2021) Caregiving and allostatic load predict future illness and disability: A population-based study. *Brain, Behavior, & Immunity-Health* 16: 100295.

Gruenewald TL, Karlamangla AS, Hu P, et al. (2012) History of socioeconomic disadvantage and allostatic load in later life. *Social Science & Medicine* 74(1): 75–83.

Gruenewald TL, Seeman TE, et al. (2009) Allostatic load and frailty in older adults. *Journal of the American Geriatrics Society* 57(9): 1525–1531.

Guidi J, Lucente M, Sonino N, et al. (2021) Allostatic load and its impact on health: A systematic review. *Psychotherapy and Psychosomatics* 90(1): 11–27.

Gump BB and Matthews KA (2000) Are vacations good for your health? The 9-year mortality experience after the multiple risk factor intervention trial. *Psychosomatic Medicine* 62(5): 608–612.

Harris ML, Loxton D, Sibbritt DW, et al. (2013) The influence of perceived stress on the onset of arthritis in women: Findings from the Australian Longitudinal Study on women's health. *Annals of Behavioral Medicine* 46(1): 9–18.

Kalu ME, Bello-Haas VD, Griffin M, et al. (2022) Cognitive, psychological and social factors associated with older adults' mobility: A scoping review of self-report and performance-based measures. *Psychogeriatrics* 22(4): 553–573.

Krause NM and Jay GM (1994) What do global self-rated health items measure? *Medical Care* 32(9): 930–942.

Kulmala J, von Bonsdorff MB, Stenholm S, et al. (2013) Perceived stress symptoms in midlife predict disability in old age: A 28-year prospective cohort study. *Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences* 68(8): 984–991.

Lewinsohn PM and Graf M (1973) Pleasant activities and depression. *Journal of Consulting and Clinical Psychology* 41(2): 261–268.

Lewinsohn PM and MacPhillamy DJ (1974) The relationship between age and engagement in pleasant activities. *Journal of Gerontology* 29(3): 290–294.

Li Q, Zhao L, Xue Y, et al. (2021) Stress-buffering pattern of positive events on adolescents: An exploratory study based on social networks. *Computers in Human Behavior* 114: 106565.

Lord SR and Menz HB (2002) Physiologic, psychologic, and health predictors of 6-minute walk performance in older people. *Archives of Physical Medicine and Rehabilitation* 83(7): 907–911.

MacPhillamy DJ and Lewinsohn PM (1982) The Pleasant Events Schedule: Studies on reliability, validity, and scale intercorrelation. *Journal of*

Consulting and Clinical Psychology 50(3): 363–380.

Mausbach BT, Romero-Moreno R, Bos T, et al. (2017) Engagement in pleasant leisure activities and blood pressure: A 5-year longitudinal study in Alzheimer's caregivers. *Psychosomatic Medicine* 79(7): 735–741.

Mazzucchelli T, Kane R and Rees C (2009) Behavioral activation treatments for depression in adults: A meta-analysis and review. *Clinical Psychology: Science and Practice* 16(4): 383–411.

McEwen BS (1998) Stress, adaptation, and disease: Allostatis and allostatic load. *Annals of the New York Academy of Sciences* 840: 33e44.

McEwen BS (2000) Allostasis and allostatic load: Implications for neuropsychopharmacology. *Neuropsychopharmacology* 22(2): 108–124.

McEwen BS and Stellar E (1993) Stress and the individual: Mechanisms leading to disease. *Archives of Internal Medicine* 153(18): 2093e2101.

Millán-Calenti JC, Tubío J, Pita-Fernández S, et al. (2010) Prevalence of functional disability in activities of daily living (ADL), instrumental activities of daily living (IADL) and associated factors, as predictors of morbidity and mortality. *Archives of Gerontology and Geriatrics* 50(3): 306–310.

Molarius A and Janson S (2002) Self-rated health, chronic diseases, and symptoms among middle-aged and elderly men and women. *Journal of Clinical Epidemiology* 55(4): 364–370.

Moore RC, Chattillion EA, Ceglowski J, et al. (2013) A randomized clinical trial of Behavioral Activation (BA) therapy for improving psychological and physical health in dementia caregivers: Results of the pleasant events program (PEP). *Behaviour Research and Therapy* 51(10): 623–632.

Mulsant BH, Ganguli M and Seaberg EC (1997) The relationship between self-rated health and depressive symptoms in an epidemiological sample of community-dwelling older adults. *Journal of the American Geriatrics Society* 45(8): 954–958.

Nunes BP, Flores TR, Mielke GI, et al. (2016) Multimorbidity and mortality in older adults: A systematic review and meta-analysis. *Archives of Gerontology and Geriatrics* 67: 130–138.

O'Brien RM (2007) A caution regarding rules of thumb for variance inflation factors. *Quality & Quantity* 41: 673–690.

Ostir GV, Markides KS, Black SA, et al. (2000) Emotional well-being predicts subsequent functional independence and survival. *Journal of the American Geriatrics Society* 48(5): 473–478.

Panaite V, Devendorf AR, Kashdan TB, et al. (2021) Daily life positive events predict well-being among depressed adults 10 years later. *Clinical Psychological Science* 9(2): Los Angeles, CA: 222–235.

Podber N and Gruenewald TL (2023a) Socioeconomic status, positive experiences, and allostatic load. *Health Psychology* 42(2): 82–91.

Podber N and Gruenewald TL (2023b) Positive life experiences and mortality: Examination of psychobiological pathways. *Social Science & Medicine* 335: 116192.

Poole L and Steptoe A (2018) Depressive symptoms predict incident chronic disease burden 10 years later: Findings from the English Longitudinal Study of Ageing (ELSA). *Journal of Psychosomatic Research* 113: 30–36.

Pressman SD and Cohen S (2005) Does positive affect influence health? *Psychological Bulletin* 131(6): 925–971.

Pressman SD, Matthews KA, Cohen S, et al. (2009) Association of enjoyable leisure activities with psychological and physical well-being. *Psychosomatic Medicine* 71(7): 725.

Radloff LS (1977) The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement* 1(3): Thousand Oaks, CA: 385–401.

Richardson S, Shaffer JA, Falzon L, et al. (2012) Meta-analysis of perceived stress and its association with incident coronary heart disease. *The American Journal of Cardiology* 110(12): 1711–1716.

Rider KL, Thompson LW and Gallagher-Thompson D (2016) California Older Persons Pleasant Events Scale: A tool to help older adults increase positive experiences. *Clinical Gerontologist* 39(1): 64–83.

Riskind JH, Kleiman EM and Schafer KE (2013) "Undoing" effects of positive affect: Does it buffer the effects of negative affect in predicting changes in depression? *Journal of Social and Clinical Psychology* 32(4): 363–380.

Rod NH, Kristensen TS, Lange P, et al. (2012) Perceived stress and risk of adult-onset asthma and

other atopic disorders: A longitudinal cohort study. *Allergy* 67(11): 1408–1414.

Schomaker M and Heumann C (2018) Bootstrap inference when using multiple imputation. *Statistics in Medicine* 37(14): 2252–2266.

Seeman TE, Singer BH, Rowe JW, et al. (1997) Price of adaptation—allostatic load and its health consequences: MacArthur studies of successful aging. *Archives of Internal Medicine* 157(19): 2259–2268.

Sin NL and Almeida DM (2018) Daily positive experiences and health: Biobehavioral pathways and resilience to daily stress. In: Ryff CD and Krueger RF (eds) *Oxford Handbook of Integrative Health Science*. New York: Oxford University Press, pp. 155–172.

Sin NL, Graham-Engeland JE and Almeida DM (2015) Daily positive events and inflammation: Findings from the National Study of Daily Experiences. *Brain, Behavior, and Immunity* 43: 130–138.

Sin NL, Ong AD, Stawski RS, et al. (2017) Daily positive events and diurnal cortisol rhythms: Examination of between-person differences and within-person variation. *Psychoneuroendocrinology* 83: 91–100.

StataCorp LLC (2021) *STATA Statistical Software: Release 17*. StataCorp LLC.

Szanton SL, Allen JK, Seplaki CL, et al. (2009) Allostatic load and frailty in the women's health and aging studies. *Biological Research for Nursing* 10(3): 248–256.

Tighe CA, Shoji KD, Dautovich ND, et al. (2016) Affective mediators of the association between pleasant events and global sleep quality in community-dwelling adults. *Journal of Behavioral Medicine* 39: 170–177.

Ware JE Jr and Sherbourne CD (1992) The MOS 36-item short-form health survey (SF-36): I. Conceptual framework and item selection. *Medical Care* 30(6): 473–483.

Watson D and Clark LA (1991) *Mood and Anxiety Symptom Questionnaire*. Unpublished manuscript, University of Iowa, Department of Psychology, Iowa City.

Watson D, Weber K, Assenheimer JS, et al. (1995) Testing a tripartite model: I. Evaluating the convergent and discriminant validity of anxiety and depression symptom scales. *Journal of Abnormal Psychology* 104(1): 3–14.

White IR, Royston P and Wood AM (2011) Multiple imputation using chained equations: Issues and guidance for practice. *Statistics in Medicine* 30(4): 377–399.

Winter L, Lawton MP, Langston CA, et al. (2007) Symptoms, affects, and self-rated health: Evidence for a subjective trajectory of health. *Journal of Aging and Health* 19(3): 453–469.