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# Positive life experiences and mortality: Examination of psychobiological pathways☆

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ABSTRACT

*Introduction and rationale:* Positive life experiences are potentially-rewarding events and behaviors, such as social and romantic interactions, experiences of relaxation and physical comfort, time spent in nature, and other leisure activities. To date, there is limited evidence linking positive life experiences to long-term health outcomes.
*Objective and methods:* The current study used data from N = 1243 participants in the Midlife Development in the US Study Biomarker Project to examine whether greater frequency of a range of different positive experiences and greater level of enjoyment of these experiences was linked to survival over a 12- to-16-year period in Cox proportional hazards models. The potential mediating roles of positive affect, depression, perceived stress, and an allostatic load index of physiological dysregulation in these associations were also examined.
*Results:* Greater frequency of positive experiences and greater enjoyment of positive experiences were both associated with a reduced hazard of mortality over the 12- to 16-year period. Models assessing a single mediator showed that both associations were mediated by decreased depression and decreased perceived stress, but not by positive affect or allostatic load. In supplementary multi-mediation models, depression was the only significant mediator of the frequency-survival and enjoyment-survival associations.
*Conclusions:* Positive life experiences may confer long-term survival benefits, partially through lessening depressive symptomatology.

## 1. Introduction

Positive life experiences are events and behaviors with the potential to be rewarding, such as social and romantic interactions, experiences of relaxation and physical comfort, time spent in nature, and other leisure activities. Individuals typically seek out positive experiences in an effort to enhance emotional, social, cognitive, and physical well-being (Crandall, 1980). In turn, these downstream correlates of positive experiences may promote survival. To date, there is limited evidence linking overall frequency and enjoyment of positive experiences to survival, but studies have linked specific positive experiences, such as taking vacations and engagement in leisure activities, including hobbies, cultural activities, and receptive art activities, to lower risk of mortality (Fancourt and Steptoe, 2019; Gump and Matthews, 2000; Lokken et al., 2020).

The aim of the current study was to examine whether greater frequency of a range of different positive experiences and the degree of enjoyment flowing from such experiences predict survival over a 12- to-16-year period. We also examined potential psychological and physiological pathways through which greater frequency of, and enjoyment from, positive experiences might be linked to survival. These include the potential role of positive affect, depression, perceived stress, and an allostatic load multisystem index of physiological dysregulation in mediating associations between positive experiences and survival.

### 1.1. Psychobiological pathways through which positive experiences may impact survival

Though much research has focused on the impact of adverse experiences on survival, fewer studies have examined the potentially

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beneficial impacts of positive life events. There is, however, evidence that positive experiences may promote better physiological and affective well-being and lessen stress (see Sin and Almeida, 2018), and may therefore impact survival. Hypothesized routes through which a greater frequency of positive experiences and associated enjoyment of such experiences may be linked to greater health and longevity include enhanced experience of positive affect, lesser experience of depressive symptomatology, lower perceived stress, and more favorable physiological well-being.

#### 1.1.1. Positive affect

Clark et al. (1989) defined high positive affect as a general mood factor that indicates an individual's level of pleasurable engagement in and passion for life, including feeling interested, energetic, joyful, alert, and enthusiastic. Positive affect can be experienced as a brief state and can also appear as a stable trait over time. Low positive affect does not automatically signify the presence of negative affect, which is a general factor of unpleasant engagement and subjective distress, though low positive affect is thought to be one of multiple dimensions of depression (Clark et al., 1989; Watson and Clark, 1991; see following section). Some prior studies indicate that positive events are more strongly linked to positive affective states and negative events are more strongly linked to negative affect (see Zautra, 2003; Zautra and Reich, 1983), highlighting the need to examine both positive and negative affective states as possible pathways linking positive experiences and health outcomes. Individuals who commonly experience positive events have been found to have higher overall levels of positive affect (Chen et al., 2022).

In turn, the enhanced general positive affect hypothesized to flow from greater frequency of positive experiences may be a key pathway to better health. Boehm and Kubzansky (2012) found a consistent association between positive psychological well-being and cardiovascular disease, though they noted that the studies examining positive affect specifically had mixed results. Pressman and Cohen (2005) reviewed literature showing that trait positive affect was associated with decreased morbidity and increased longevity and that both state and trait positive affect were associated with decreased symptoms and pain. Finally, meta-analyses by Chida and Steptoe (2008) showed that positive affect was associated with reduced mortality in studies of healthy but not diseased populations.

#### 1.1.2. Depressive symptomatology

A lesser experience of depressive symptomatology may be another route through which greater frequency of positive experiences may be linked to greater health and longevity. Depression is a multidimensional construct that includes affective (high negative, low positive), cognitive, somatic, and behavioral components (Radloff, 1977). There is evidence that those who experience more positive life events have lower depressive symptomatology (Blonski et al., 2016; Ferreira and Barham, 2018; Panaite et al., 2021; Rider et al., 2016; Riskind et al., 2013). These studies are in line with Lewinsohn's (1974) behavioral theory of depression, in which depression is linked to the number of experiences one might find pleasurable as they interact with their environment, the access they have to these experiences, and whether they are able to react to these experiences in a way that elicits positive reinforcement. Meta-analytic support indicates that behavioral activation interventions that focus on increasing positive life experiences are as effective in treating depression as cognitive behavioral therapy (Mazzucchelli et al., 2009), supporting a link between positive experience frequency and levels of depressive symptomatology.

A large literature indicates that subclinical and clinical depression is linked with the incidence and progression of a range of health conditions, including cardiovascular disease, metabolic conditions, and cancer, as well as disease-associated mortality (Nouwen et al., 2019; Pinquart and Duberstein, 2010; Vaccarino et al., 2020). In a study that focused on acute coronary syndrome patients, a path analysis showed that lack of obtained pleasure from positive experiences was one of a number of vulnerabilities associated with categories of depression trajectory, and depression trajectory was associated with an outcome variable that combined morbidity and mortality (Keegan et al., 2016). Thus, level of depressive symptomatology is a key pathway to examine in investigating potential associations between frequency of positive experiences and associated enjoyment and subsequent mortality risk.

#### 1.1.3. Perceived stress

Perceived stress is postulated to occur when individuals perceive characteristics of their life experiences as uncontrollable, unpredictable, or overburdening, or when environmental demands surpass perceived coping capacity (Cohen et al., 1983; Richardson et al., 2012). Positive life events may lower perceived stress. In a workplace study, naturally-occurring positive events at work were associated with both a reduction in perceived level of stress and better health (Bono et al., 2013). A study of over 27,000 social media posts by 500 Chinese high school students found that report of positive experiences was linked to lower linguistic expressions of stress (e.g., few stress-related words in postings) and less stress expression surrounding scheduled exams in the student cohort (Li et al., 2021). Monfort et al. (2015) found that simply anticipating a positive event resulted in more adaptive thoughts while experiencing a social stressor and also resulted in greater mood elevation after the stressor.

Stress is, in turn, linked to mortality. Arnold et al. (2012) found that acute myocardial infarction patients with moderate or high perceived stress levels had greater 2-year mortality risk than those with low levels of perceived stress. A meta-analysis found that perceived stress is associated with a moderate increase in the risk of coronary heart disease (Richardson et al., 2012), and a follow-up meta-analysis found that perceived stress also increases the risk of coronary heart disease mortality (Vahedian-Azimi and Moayed, 2019).

#### 1.1.4. Biomarkers and allostatic load

There is increasing evidence that positive life experiences may be associated with lower levels of physiological dysregulation. Greater levels of positive daily experiences have been linked to higher levels of post-antigen secretory immunoglobulin A (Stone et al., 1994), and greater frequency of positive social interactions with family, friends, and intimate others has been linked with lower levels of interleukin-6 (Bajaj et al., 2016) and lower cortisol (Ditzen et al., 2008). Studies of dementia caregivers have shown lower blood pressure in those with higher frequency of positive experiences and higher obtained pleasure from positive experiences (Mausbach et al., 2018; Vara-García et al., 2022). An intervention to increase the frequency of positive life experiences in a similar population of caregivers resulted in lower Interleukin-6 (Moore et al., 2013). Leisure activities have also been associated with lower waist circumference and body mass index, in addition to lower cortisol and blood pressure (Pressman et al., 2009).

Podber and Gruenewald (2023) found that greater frequency of positive experiences was associated with lower allostatic load, particularly in those of lower socioeconomic status. Allostatic load indices assess physiological dysregulation across multiple systems of the body (Gruenewald et al., 2012; McEwen, 2000; Seeman et al., 1997), and such dysregulation has been found to prospectively predict the risk of mortality (Karlamangla et al., 2006; Milot et al., 2014; see Beckie, 2012). A recent meta-analysis found that higher allostatic load was associated with a 22% increase in risk of all-cause mortality and 31% increase in risk of cardiovascular disease mortality (Parker et al., 2022).

### 1.2. The current study

The current study used data from the Midlife Development in the United States (MIDUS) Study (http://midus.wisc.edu) on frequency of positive experiences, derived enjoyment from positive experiences, positive affect, depression, perceived stress, and an allostatic load index of multi-system physiological dysregulation, along with associated

mortality data spanning a 12- to 16-year follow-up period, to examine (1) whether greater frequency of positive experiences and greater level of enjoyment from these experiences are linked to lower hazard of mortality, and (2) whether levels of positive affect, depression, perceived stress, and allostatic load play a role in these hypothesized links.

To our knowledge, the present analyses represent the first investigation of long-term mortality hazard associated with a comprehensive assessment of the frequency of a range of positive experiences and the reported enjoyment flowing from such experiences. Although it is hypothesized that individuals seek out positive experiences and may derive benefit from them due to the experienced pleasure associated with such events, individuals may differ in their level of experience-associated enjoyment and this aspect of positive experiences may be differentially linked to mortality risk. An additional contribution of the current analysis is the examination of multiple factors – positive affect, depression, perceived stress, and allostatic load – that may play a role in hypothesized links between greater frequency of positive experiences and associated enjoyment and lower hazard of mortality over time. We hypothesized that each would mediate the positive experiences-mortality association, such that greater frequency and enjoyment of positive events would be associated with higher positive affect and lower depression, perceived stress, and allostatic load, and that these would each be associated with a lower hazard of mortality.

## 2. Methods

The data used in the current research are from the longitudinal Midlife in the United States (MIDUS) Study (http://midus.wisc.edu). The data, instruments, and documentation 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 and the MIDUS Portal at https://midus.colectica.org. The study was pre-registered at OSF and can be viewed at https://osf.io/tkn85/registrations. Stata 17 (StataCorp, 2021) was used for all analyses, and the code used to construct variables and run all analyses, as well as the analysis results, can be found at https://osf.io/tkn85/files/osfstorage.

The MIDUS Study was approved by the Health Sciences Institutional Review Boards of the University of Wisconsin-Madison, University of California, Los Angeles, and Georgetown University. Informed written consent was obtained from all study participants. The current study used de-identified, publicly-available data and was determined to be exempt from human subjects IRB review.

### 2.1. Data and participants

The MIDUS Study is a multi-wave longitudinal study of the demographic, behavioral, social, and psychological factors associated with health and well-being over time in a national sample of Americans. Detailed sample and sampling descriptions are available on the MIDUS website (http://midus.wisc.edu). The longitudinal study consists of multiple waves of phone and mail surveys of an initial cohort of 7108 individuals aged 24–75 (M1, 1995–1997) drawn from a national probability sample (n = 3487), siblings of those in the national probability sample (n = 950), oversamples from 5 metropolitan areas (n = 757), and a national probability sample of twin pairs (n = 1914). A second wave, M2, took place in 2004–2006 and included 4963 M1 participants and an additional oversample of 592 African American participants from Milwaukee, WI.

For the present study, data on positive experiences and potential mediators come from the M2 Biomarker Project, with additional information on sociodemographic and health conditions derived from the main M2 surveys. N = 1255 individuals from the M2 cohort (666 from the probability sample, 388 from the twin sample, and 201 from the Milwaukee sample) were selected to participate in the Biomarker Project (2004–2009; time from M2 phone survey to M2 Biomarker completion: $M = 2.32$ years, $SD = 1.17$). Biomarker Project participants attended one of three clinical research centers for an overnight visit that included a self-administered survey and a comprehensive biological assessment. Out of the 1255 participants in the M2 Biomarker Project, 12 died of external injuries and were excluded from the current analyses. The final sample is composed of the remaining 1243 M2 Biomarker participants.

### 2.2. Measures

#### 2.2.1. Survival

Mortality occurrence was ascertained from the National Death Index (NDI), other online tracing resources, mortality closeout interviews during survey fielding, and routine sample maintenance for MIDUS participants. Survival time was measured as months between M2 Biomarker Project completion and date of death or censoring. Date of censoring was set to December 2020 for all participants not marked as deceased, since the MIDUS mortality dataset included complete NDI data up to this date.

#### 2.2.2. Frequency of positive life experiences (POSFR)

A set of 49 items, most of which were from the Pleasant Events Schedule (PES; MacPhillamy and Lewinsohn, 1982) were used to measure the first predictor variable, frequency of positive life experiences. POSFR was assessed in a survey given to participants during their M2 Biomarker Project visit. Each item assessed how frequently over the past month the participant engaged in one of a variety of experiences involving relaxation, recreation, entertainment, green spaces, social engagement, intimacy, achievement, exercise, and physical comfort. There were 3 response categories: 0 - Never, 1 - 1 to 6 times, and 2 - 7 or more times. POSFR was calculated as the mean of the non-missing scores on the 49 items (range: 0–2).

#### 2.2.3. Enjoyment of positive life experiences (POSEN)

The second predictor variable was enjoyment of positive life events. For each of the 49 positive life experiences discussed above, participants who had engaged in the experience 1 or more times over the past month were asked the degree to which they found it to be pleasant, enjoyable, or rewarding. There were 3 response categories: 0 - Neutral or unpleasant, 1 - Somewhat pleasant, and 2 - Very pleasant. POSEN was calculated as the mean of the non-missing scores on the 49 items, so that scores represented the average pleasantness rating given to the experiences the participant had engaged in over the past month.

#### 2.2.4. Positive affect

The first mediator, positive affect, was measured using the positive affect subscale of the Mood and Symptom Questionnaire (MASQ; Watson and Clark, 1991; Watson et al., 1995). The 14 items ask participants how much (1 - Not at all to 5 - Extremely) they experienced happy, hopeful, energetic, and positive feelings during the past week (e.g., "Felt cheerful," "Felt optimistic," "Looked forward with enjoyment"). A scale score was computed as the average of the non-missing items multiplied by the total number of scale items. The scale exhibited high internal consistency (Cronbach's $\alpha = 0.93$) in the sample.

#### 2.2.5. Center for Epidemiological Studies Depression Inventory

The second mediator, depression, was measured using the widely-used Center for Epidemiological Studies Depression Inventory (CES-D; Radloff, 1977). The CES-D contains 20 items assessing frequency (0 - Rarely or none of the time to 3 - Most or all of the time) of psychological and somatic symptoms of depression (e.g., "I was bothered by things that usually don't bother me," "I did not feel like eating; my appetite was poor") over the past week. After recoding the 4 reverse-scored items, a score was computed as the average of the non-missing items multiplied by the total number of scale items. The scale exhibited high internal consistency ($\alpha = 0.90$) in the sample.

#### 2.2.6. Perceived Stress Scale

The third mediator, perceived stress, was measured using the Perceived Stress Scale (PSS; Cohen et al., 1983). The PSS contains 10 items assessing frequency (1 - Never to 5 - Very often) of feelings of stress (e.g., "been upset because of something that happened unexpectedly," "felt that you were unable to control the important things in your life") over the past month. After recoding the 4 reverse-scored items, a perceived stress score was constructed as the average of the non-missing items multiplied by the total number of scale items. The PSS exhibited good internal consistency ($\alpha = 0.86$) in the sample.

#### 2.2.7. Allostatic load (AL)

The fourth mediator, AL, was computed using 24 biomarkers to create proportion of risk scores for 7 physiological systems: the cardiovascular system, lipids and the general metabolic system, activity of the HPA axis, the inflammatory system, the sympathetic nervous system, and the parasympathetic nervous system (see Gruenewald et al., 2012). Supplemental Table 1S shows the biomarkers used to assess each physiological system. For each of the biomarkers, a dichotomous risk indicator was created in which participants were assigned a 1 if their score fell within the highest-risk quartile and 0 otherwise. M2 Milwaukee participants were excluded from the calculation of high-risk quartile cutoffs, since participants in this sample were recruited based on geographical location and racial identity and may have been less representative of the U.S. population as a whole, but were assigned values on the risk indicators after cutoffs were determined. The risk indicators within each system were averaged, for participants with data on at last half of the indicators in that system, to create system risk proportion scores. These scores were then averaged and multiplied by 7, for participants with data on at least 6 out of the 7 system risk scores, to create the final AL score (range: 0–7). This construction ensured that all biological systems carried equal weight in the measure.

#### 2.2.8. Sociodemographic and health burden covariates

Gender, age and race were entered into the model as covariates. Gender was assessed in MIDUS as male or female (referent). Age was assessed in years. Race was entered as white (referent), Black, or other.

Cumulative life socioeconomic advantage was assessed with a measure modeled from previous MIDUS investigations (Gruenewald et al., 2012; Podber and Gruenewald, 2023) that incorporated reported socioeconomic conditions in childhood (parent education level, whether the family ever received governmental welfare, and self-assessment of childhood financial level) and adulthood (participant education level, self-assessment of current financial level, availability of money for basic needs, difficulty of paying bills, and household-adjusted income-to-poverty ratio). Supplemental Table 2S shows the response options and assigned values for each item used to construct the composite score (possible range: 0 to 16).

Chronic health burden was computed as the sum of indicators for the presence of 9 types of chronic conditions (lung-related conditions, AIDS or HIV, autoimmune disease, high blood pressure or hypertension, diabetes or high blood sugar, neurological disorders, stroke, cancer, and heart trouble). These conditions were assessed in 20 items from the M2 main survey study and the M2 Biomarker Project, and participants were given a 1 on an indicator if they reported having that condition on any of the items assessing it. The variable was winsorized at 99% (range:1–4).

### 2.3. Analyses

Descriptive univariate and bivariate statistics (by mortality status) were examined for model variables and power analyses were carried out. In order to determine whether frequency of positive life events was associated with survival in the M2 Biomarker sample, an unadjusted Cox proportional hazards model was run, followed by an adjusted model with gender, age, race, cumulative life socioeconomic advantage, and chronic health burden added as covariates. Then analogous unadjusted and adjusted models were run to assess the association between enjoyment of positive life events and survival. All models used cluster robust standard errors to account for correlated errors among sibling groups (n = 308 participants were in groups of 2–4 siblings). Since the mediation analyses described in the next paragraph were carried out using parametric survival models with a Weibull distribution, the unadjusted and adjusted models were also run as parametric models with a Weibull distribution in order to determine whether the results deviated from the Cox results.

In a set of 4 mediation models, positive affect, depression, perceived stress, and allostatic load were each examined one at a time as mediators of the POSFR-survival association. Then analogous models were run to assess mediation of the POSEN-survival association. Each mediation model included 2 regressions - one linear regression to predict the mediator, using the positive life experiences predictor and all 5 covariates, and one parametric survival model using a Weibull distribution, with the positive life experiences predictor, the mediator being tested, and the 5 covariates entered into the model. Two exploratory multiple mediation models were then run to assess all 4 mediators together in the POSFR-survival association and the POSEN-survival association. As before, all models were run with cluster robust standard errors. Linear indirect and total effects were calculated for each mediation model, and a bootstrap test of each indirect effect, with 5000 replications, was carried out.

The proportion of missing data was less than 1% for each variable (see Table 1 for frequency and percent of missing data by variable). AL had the highest proportion of missing data at 0.9%. Missing data were initially imputed into 5 datasets using multiple imputation by chained equations (MICE; White et al., 2011) and all analyses were run with these 5 imputed datasets. To determine whether additional imputations were necessary in order to obtain replicable SE estimates, the quadratic rule (Von Hippel, 2020) was applied to each analysis. In this approach, the required number of imputations is approximated as a quadratic function of the fraction of missing information (FMI) from each analysis (see Equations 1 and 2 in Von Hippel, 2020). The imputation equations included the predictors, mediators, covariates, M2 biomarker date, and the outcome as a dichotomous decedent status variable and the Nelson-Aalen cumulative hazard function (see White and Royston, 2009). Continuous variables were imputed using linear regression and nominal variables were imputed using multinomial logistic regression. Indirect and total effects were tested by bootstrapping within each imputed dataset and then combining the bootstrap estimates (see Method 2 in Schomaker and Heumann, 2018) using Stata's -mi estimate- command.

All analyses were run in Stata 17, and all primary analyses were run using the -mi estimate- command. Power analyses were carried out with the -power cox- command. Survival time was set using the -mi stset- command. POSFR, POSEN, the 4 mediators, and the cumulative life socioeconomic advantage scores were standardized in the models. The Cox proportional hazards models were run using the -stcox- commands, and the Breslow method was used to handle ties. Weibull models were run using the -streg- command. The mediation analyses were run using -gsem- in Stata. The proportional hazards assumption was assessed globally and for each model variable in each imputed dataset, using hypothesis tests of the coefficients for the scaled Schoenfeld residuals on log time. Probability plots of the survival data against a Weibull distribution were examined.

## 3. Results

### 3.1. Descriptive analyses

Out of the 1243 participants in the sample, 205 were deceased. The follow-up time ranged from 11.6 years to 16.4 years, with an average of 14.1 years. The dates of death ranged from 2007 to 2021, and the average survival time among the deceased was 9.2 years (SD = 3.8).

**Table 1**
Descriptive statistics for study variables.

| | n | Missing [Frequency(%)] | % or M(SD) | Survived (n = 1038) | Died (n = 205) | *t* or $X^2$ |
|---|---|---|---|---|---|---|
| **Predictors** | | | | | | |
| POSFR | 1238 | 5(0.4) | 1.24(.26) | 1.25(.25) | 1.19(.29) | $t = 3.07^{**}$ |
| POSEN | 1237 | 6(0.5) | 1.60(.27) | 1.60(27) | 1.58(.27) | $t = 1.09$ |
| **Mediators** | | | | | | |
| PA | 1241 | 2(0.2) | 44.48(10.23) | 44.71(10.05) | 43.33(11.04) | $t = 1.78$ |
| DEP | 1239 | 4(0.3) | 8.75(8.26) | 8.47(8.12) | 10.20(8.81) | $t = -2.74^{**}$ |
| PS | 1239 | 4(0.3) | 22.24(6.35) | 22.13(6.40) | 22.81(6.05) | $t = -1.39$ |
| AL | 1232 | 11(0.9) | 1.83(1.06) | 1.71(1.03) | 2.42(1.00) | $t = -8.98^{***}$ |
| **Covariates** | | | | | | |
| Gender | 1243 | 0(0) | | | | $X^2 = 6.56^{**}$ |
| Female (ref) | 707 | – | 56.9% | 58.5% | 48.8% | |
| Male | 536 | – | 43.1% | 41.5% | 51.2% | |
| Race/ethnicity | 1239 | 4(0.3) | | | | $X^2 = 0.93$ |
| White (ref) | 966 | – | 78.0% | 77.5% | 80.5% | |
| Black | 223 | – | 18.0% | 18.4% | 16.1% | |
| Other | 50 | – | 4.0% | 4.2% | 3.4% | |
| Age | 1243 | 0(0) | 57.22(11.47) | 55.24(10.26) | 67.20(12.05) | $t = -14.78^{***}$ |
| Cum. SES Adv. | 1233 | 10(0.8) | 9.25(3.49) | 9.37(3.50) | 8.66(3.39) | $t = 2.63^{**}$ |
| Health burden | 1243 | 0(0) | 1.18(1.11) | 1.07(1.06) | 1.74(1.19) | $t = -8.14^{***}$ |
| Died over follow-up | 205 | 0(0) | 16.5% | – | – | |

POSFR = Frequency of positive life experiences, POSEN = Enjoyment of positive life experiences, PA = positive affect, DEP = depression, PS = perceived stress, AL = allostatic load.
*p < 0.05; **p < 0.01; ***p < 0.001.

Descriptive statistics by mortality status for study variables prior to imputation are provided in Tables 1 and 3S in the supplement (for individual socioeconomic items). POSFR was associated with mortality before covariate adjustment, but POSEN was not. AL and depression were both associated with mortality status.

### 3.2. Power, imputation, and assumption assessment

A power analysis showed that with our sample size of N = 1243, the distribution of standardized scores for the positive experience frequency and enjoyment predictors, power = .80, α = .05, and after adjusting for associations between positive experiences and the model covariates, we would be able to detect a very small hazard ratio of 0.92 for both positive experience frequency and enjoyment. Use of the quadratic rule (Von Hippel, 2020) showed that 5 imputations were enough to obtain replicable SE estimates for all analyses except those involving the CES-D measure, for which 8 imputations were required, and we added 3 additional imputations when running these models. The tests of the scaled Schoenfeld residuals did not indicate that the proportional hazards assumption had been violated.

### 3.3. Primary analyses

Table 2 shows the results for the adjusted Cox models. In the unadjusted model, an increase in POSFR was associated with a reduced hazard of mortality (HR = 0.79, $p = .001$, 95% CI [0.69, 0.91]), and this association remained significant after adjustment (HR = 0.80, $p = .004$, 95% CI [0.69, 0.93]). POSEN was not associated with survival before adjustment (HR = 0.92, $p = .232$, 95% CI [0.81, 1.05]), but an increase in POSEN was associated with a reduced hazard of mortality after adjustment (HR = 0.83, $p = .010$, 95% CI [0.72, 0.96]). When these models were run as parametric Weibull survival models, the results were the same, and all hazard ratios for POSFR and POSEN deviated from the Cox results by no more than 0.01.

**Table 2**
Adjusted Cox proportional hazard models for positive experience frequency and enjoyment predicting survival.

| | POSFR Model | | POSEN Model | |
|---|---|---|---|---|
| Predictor | *HR* (95% CI) | *p* | *HR* (95% CI) | *p* |
| POSFR or POSEN | 0.80 (0.69, 0.93) | .004 | 0.83 (0.72, 0.96) | .010 |
| Cum. SES Adv. | 0.78 (0.67, 0.92) | .003 | 0.76 (0.65, 0.89) | <.001 |
| Age | 1.09 (1.07, 1.10) | <.001 | 1.09 (1.07, 1.10) | <.001 |
| Male (vs. Female) | 1.47 (1.11, 1.96) | .008 | 1.44 (1.07, 1.92) | .015 |
| Race | | | | |
| Black (vs. White) | 0.90 (0.58, 1.40) | .645 | 0.91 (0.58, 1.43) | .685 |
| Other (vs. White) | 0.97 (0.41, 2.31) | .948 | 1.07 (0.47, 2.45) | .864 |
| Health burden | 1.26 (1.13, 1.41) | <.001 | 1.27 (1.13, 1.42) | <.001 |

Table 3 shows the 3 paths in the mediation models for POSFR and POSEN, as well as the bootstrap tests of the indirect and total effects. In the path models examining positive affect as a mediator, both greater frequency and greater enjoyment of positive experiences were associated with higher levels of positive affect, but positive affect was not associated with survival. Neither positive experiences predictor was significantly associated with AL in the models, but greater AL was associated with greater hazard of mortality. As outlined in the table, neither positive affect nor allostatic load mediated the associations between POSFR and survival or POSEN and survival.

In the models examining depression as a mediator, greater frequency and enjoyment of positive experiences were both associated with lower levels of depression, and higher levels of depression were associated with greater hazard of mortality. In the models examining perceived stress as a mediator, greater frequency and enjoyment of positive experiences were both associated with lower levels of perceived stress, and higher levels of perceived stress were associated with greater hazard of mortality. As shown in Table 3, the bootstrap tests of the indirect effects through both perceived stress and depression were significant, indicating that both depression and perceived stress mediated the association between POSFR and survival, as well as the association between POSEN and survival.

### 3.4. Exploratory analyses

Fig. 1 presents an exploratory multiple mediation model examining the association between frequency of positive life experiences and survival with all four potential mediators. In this model, bootstrap tests indicated non-significant indirect effects through positive affect (*Indirect effect* = 0.001, $p = .975$, 95% CI = (−0.09, 0.09)), perceived stress (*Indirect effect* = −0.02, $p = .484$, 95% CI = (−0.07, 0.03)), and allostatic load (*Indirect effect* = −0.01, $p = .179$, 95% CI = (−0.03, 0.01)). Only depression was a significant mediator of the association between frequency of positive life experiences and hazard of mortality (*Indirect*

**Table 3**
Linear coefficients for paths A, B, and C' in the mediation models and bootstrap tests of the indirect and total effects.

| | POSFR Models | | POSEN Models | |
|---|---|---|---|---|
| | *b* or Effect (95% CI) | *p* | *b* or Effect (95% CI) | *p* |
| POS-PA (path A) | 0.48 (0.43, 0.53) | <.001 | 0.45 (0.40, 0.50) | <.001 |
| PA-survival (path B) | −0.14 (−0.31, 0.03) | .097 | −0.16 (−0.33, 0.01) | .068 |
| Direct effect (path C′) | −0.15 (−0.32, 0.02) | .080 | −0.11 (−0.27, 0.06) | .203 |
| Indirect effect[a] | −0.07 (−0.15, 0.02) | .113 | −0.07 (−0.15, 0.01) | .080 |
| Total effect[a] | −0.22 (−0.37, −0.06) | .005 | −0.18 (−0.32, −0.04) | .014 |
| POS-DEP (path A) | −0.34 (−0.40, −0.28) | <.001 | −0.36 (−0.41, −0.30) | <.001 |
| DEP-survival (path B) | 0.26 (0.12, 0.40) | <.001 | 0.27 (0.12, 0.43) | <.001 |
| Direct effect (path C′) | −0.13 (−0.28, 0.03) | .107 | −0.08 (−0.24, 0.08) | .325 |
| Indirect effect[a] | −0.09 (−0.14, −0.04) | .001 | −0.10 (−0.15, −0.04) | .001 |
| Total effect[a] | −0.21 (−0.36, −0.06) | .006 | −0.18 (−0.32, −0.03) | .016 |
| POS-PS (path A) | −0.27 (−0.32, −0.21) | <.001 | −0.32 (−0.38, −0.27) | <.001 |
| PS-survival (path B) | 0.22 (0.07, 0.37) | .005 | 0.22 (0.06, 0.39) | .007 |
| Direct effect (path C′) | −0.16 (−0.32, −0.01) | .038 | −0.11 (−0.27, 0.04) | .152 |
| Indirect effect[a] | −0.06 (−0.10, −0.02) | .007 | −0.07 (−0.13, −0.02) | .008 |
| Total effect[a] | −0.22 (−0.37, −0.07) | .005 | −0.19 (−0.33, −0.04) | .012 |
| POS-AL (path A) | −0.04 (−0.09, 0.01) | .139 | −0.01 (−0.06, 0.05) | .813 |
| AL-survival (path B) | 0.30 (0.14, 0.45) | <.001 | 0.32 (0.17, 0.47) | <.001 |
| Direct effect (path C′) | −0.21 (−0.35, −0.06) | .005 | −0.21 (−0.35, −0.07) | .004 |
| Indirect effect[a] | −0.01 (−0.03, 0.01) | .183 | −0.002 (−0.02, 0.02) | .820 |
| Total effect[a] | −0.22 (−0.37, −0.06) | .005 | −0.21 (−0.35, −0.07) | .004 |

Note: 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.

[a] Bootstrap tests based on 5000 replications.

*effect* = −0.07, $p$ = .048, 95% CI = (−0.15, −0.001)), and both the total indirect effect (*Indirect effect* = −0.10, $p$ = .014, 95% CI = (−0.18, −0.02)) and the total effect (*Total effect* = −0.22, $p$ = .005, 95% CI = (−0.37, −0.06)) were significant.

Fig. 2 presents the multiple mediation model for the association between enjoyment of positive life experiences and survival. Bootstrap tests again indicated non-significant indirect effects through positive affect (*Indirect effect* = −0.004, $p$ = .934, 95% CI = (−0.09, 0.09)), perceived stress (*Indirect effect* = −0.02, $p$ = .603, 95% CI = (−0.09, 0.05)), and allostatic load (*Indirect effect* = −0.002, $p$ = .805, 95% CI = (−0.02, 0.02)). As in the model for frequency, only depression was a significant mediator of the association between enjoyment of positive life experiences and hazard of mortality (*Indirect effect* = −0.08, $p$ = .037, 95% CI = (−0.16, −0.005)), and the total indirect effect (*Indirect effect* = −0.10, $p$ = .017, 95% CI = (−0.19, −0.02)) and the total effect (*Total effect* = −0.20, $p$ = .008, 95% CI = (−0.34, −0.05)) were significant.

## 4. Discussion

Consistent with prior research linking leisure activities to lower risk of mortality, we found a direct association between a multi-domain measure of positive life experiences and hazard of mortality, such that higher frequency of positive experiences and higher enjoyment of positive experiences were both associated with a lower hazard of mortality over a 12- to 16-year follow-up period. Our mediation analyses suggest that these associations are mediated by lower depression and perceived stress, but not by higher positive affect or lower allostatic load. Supplementary analyses showed that depression was the strongest mediator of the associations between positive life experiences and hazard of mortality and the only significant mediator in the multiple mediation model. This result is in line with prior findings that link positive life experiences to depression (e.g., Ferreira and Barham, 2018; Rider et al., 2016) and depression to mortality (e.g., Pinquart and Duberstein, 2010). Overall, our results suggest that both the frequency and level of enjoyment derived from positive life experiences, which include experiences of relaxation, social interaction, intimacy, entertainment, nature, and physical comfort, may have long-term associations with survival, and that depression may be an important pathway underlying these associations.

Positive affect did not mediate positive experiences-survival associations in our analyses, though prior research has identified links between positive experiences and positive affect (e.g., Chen et al., 2022), as well as positive affect and mortality (e.g., Chida and Steptoe, 2008). Our analyses showed an association between positive experiences and positive affect – in fact, this association was stronger than the associations between positive experiences and any of the other hypothesized mediators – but we did not find an association between positive affect and survival. In their meta-analyses, Chida and Steptoe (2008) found that positive affect was only associated with reduced mortality in in studies of healthy, not diseased, populations. If this means, as they suggest, that positive affect may have a stronger impact on those in earlier stages of illness, then our follow-up period may not have been long enough to fully capture the association between positive affect and mortality. Only 16.5% of our sample had died by the end of our 12- to 16-year follow-up period, and those with chronic disease burden were over-represented in this group at the time that positive affect was assessed. Though we controlled for chronic illness burden in our analyses, it is possible that after a longer-follow-up period, positive affect could emerge as a significant mediator of the associations between positive experiences and survival. Another possibility is that positive affect may not be consistently associated with survival. Pressman and Cohen (2005) found that the literature on positive affect and serious illness was inconsistent.

Allostatic load also did not mediate the associations between positive experiences and survival in our analyses. In line with prior research (e.g., Beckie, 2012; Parker et al., 2022), we found an association between allostatic load and mortality – one that was stronger than the association between any of the other hypothesized mediators and survival – but neither frequency nor enjoyment of positive experiences was associated with allostatic load in our sample. While, in a previous study with an expanded MIDUS sample, Podber and Gruenewald (2023) did find an

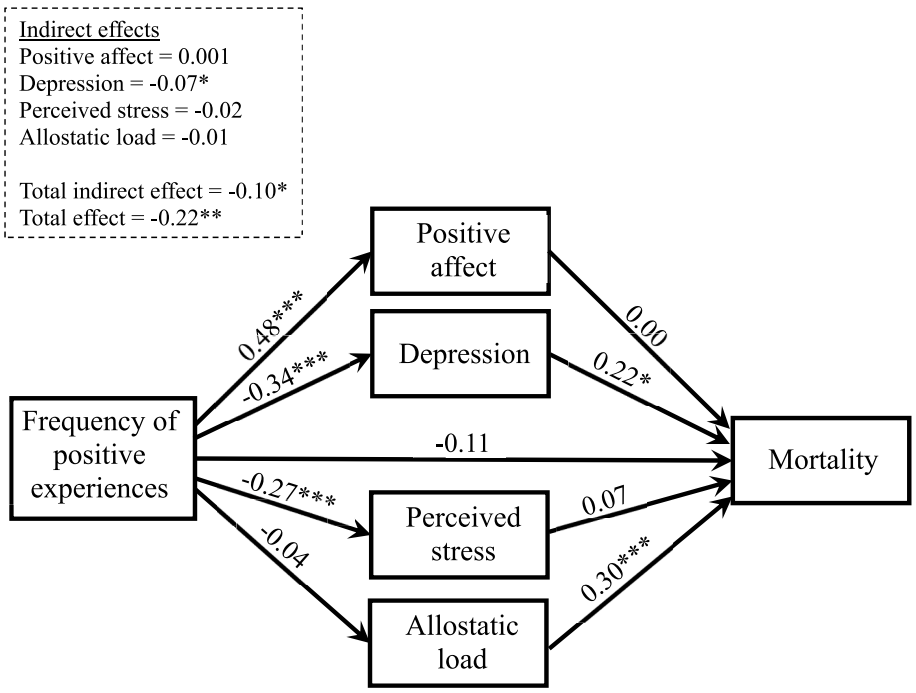


**Fig. 1.** Model assessing mediating pathways in the association between frequency of positive life experiences and hazard of mortality, with unstandardized coefficients, indirect effects, and total effect.
Not shown: This model controlled for gender, race, age, socioeconomic status, and chronic health conditions.
Significance of indirect and total effects based on 5000 bootstrap samples.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

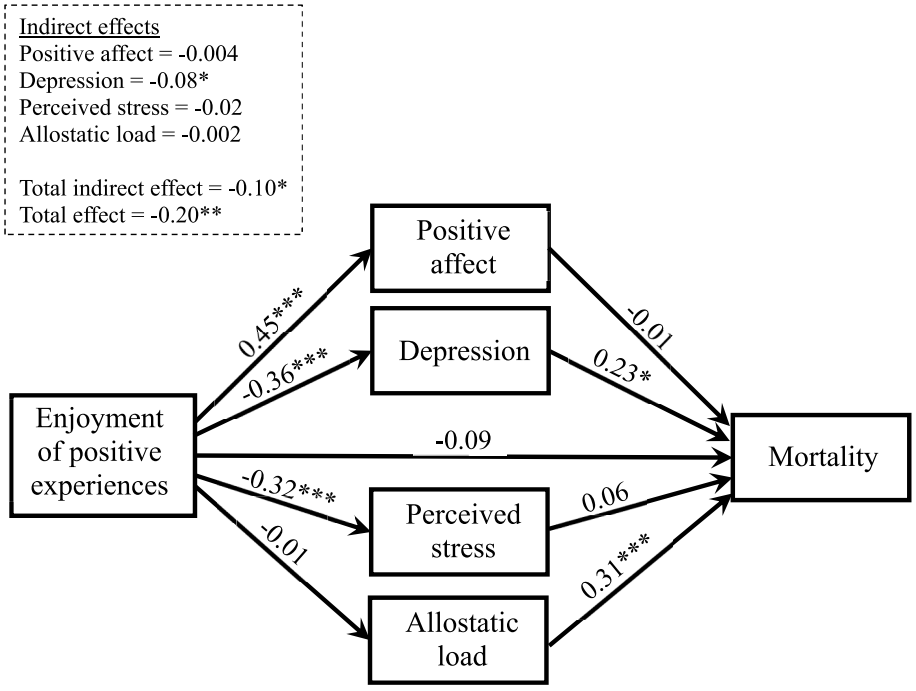


**Fig. 2.** Model assessing mediating pathways in the association between enjoyment of positive life experiences and hazard of mortality, with unstandardized coefficients, indirect effects, and total effect.
Not shown: This model controlled for gender, race, age, socioeconomic status, and chronic health conditions.
Significance of indirect and total effects based on 5000 bootstrap samples.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

overall association between frequency of positive experiences and allostatic load, they also found that this association was stronger in those of lower socioeconomic status and non-significant at higher levels of socioeconomic status. Those of lower socioeconomic status experience more stressful life events (Brady and Matthews, 2002), and early positive experiences researchers (Cohen and Hoberman, 1983) found that greater frequency of positive events was associated with fewer physical symptoms, but only for those categorized as high stress, not for those categorized as low stress. If positive experiences function as a stress-buffering mechanism, it is possible that the association between positive experiences and allostatic load is stronger in those with higher levels of stress, and that allostatic load may only mediate the association between positive experiences and survival for those who have higher levels of stress. Future investigations with samples that can support the examination of such moderated mediation are needed to clarify our understanding of the potential interactions of these factors in linking positive experiences and mortality risk.

The effect size for the association between positive experiences and mortality was modest – in our model, an increase of 1 standard deviation of frequency of positive life experiences was associated with a predicted reduction in the hazard of mortality of 20%, which was the reduction in hazard of mortality associated with a 2.7-year age gap. Similarly, an

increase of 1 standard deviation of enjoyment of positive life experiences was associated with a predicted reduction in the hazard of mortality of 17%, which was the reduction in hazard of mortality associated with a 2.2-year age gap. Though these are small effects (Azuero, 2016), our analyses illuminate one of many factors that, together, account for disparities in mortality. Positive life experiences would not be expected to have as strong an impact on mortality as basic material needs such as access to quality health care, but they are a potential resilience factor and warrant further study.

Though positive life experiences may be a modifiable factor associated with greater survival, this does not mean that a top-down positive experiences intervention would necessarily provide benefits to survival. Our analyses examined positive experiences in which individuals freely engaged, and our research cannot speak to whether there may be associations between prescribed positive experiences and survival. Hopper and Iwasaki (2017) argue that artificially imposing positive experiences interventions on members of vulnerable groups may actually be detrimental, and they recommend a bottom-up, participant-led approach. In the Intergenerational Change Initiative's 2021 survey of urban youth in New York City, the top responses when asked what would make their neighborhoods better, other than basic needs (jobs and affordable housing), were community events, green spaces, and public art (Zeller-Berkman et al., 2021). The most meaningful way to modify the frequency of positive experiences may be to ensure that individuals have the time, money, and access necessary to be able to freely choose to engage in a variety of positive experiences.

### 4.1. Limitations

In the MIDUS study, participants were asked to report on their positive experiences over the previous month, but this was measured during the same time frame as the 4 mediators. In reliability tests, the Pleasant Events Scale had a test-retest reliability higher than 0.7 for a 2-month period and higher than 0.6 for a 2-to-3-year period (MacPhillamy and Lewinsohn, 1976), so responses likely represent a longer-term pattern of behavior. It is possible, however, that although the literature suggests that leisure and other positive experiences may impact positive affect (Chen et al., 2022), depression (Mazzucchelli et al., 2009), perceived stress (Bono et al., 2013), and physiological well-being (Moore et al., 2013), these relationships are bidirectional. Individuals with higher positive affect, lower depression, and lower perceived stress may engage in more positive activities or recall them as more enjoyable. Similarly, though we controlled for chronic health burden in our models, it is possible that those with higher allostatic load but who have not yet accumulated a clinical chronic health burden may not feel as well in general and may not be able to engage in as many activities or enjoy them as much as those with lower allostatic load.

Our results may not be generalizable to the larger national population. Though Love et al. (2010) found that the MIDUS Biomarker Project sample had similar demographic and socioeconomic characteristics to the main MIDUS survey sample, and though our sample was diverse in terms of socioeconomic status and health, those who are able to volunteer to travel to one of 3 national clinics for a 2-day visit may have specific characteristics that impact generalizability. In addition, while the majority of participants in the MIDUS Biomarker Project were recruited using a national random-digit-dialing approach, some were recruited from targeted oversamples of both specific cities and Black individuals from Milwaukee, WI. These geographically- and racially-specific samples may not be representative of the larger population. In our sample, 59.6% of the white participants were recruited from the national population through random digit dialing, and another 38.3% were recruited from the national population of twins through random digit dialing. In contrast, only 13.5% of the Black participants in our sample belonged to these 2 sampling groups, and 85.7% were from the Milwaukee, WI oversample of Black individuals. Our race coefficients may not be indicative of national racial differences in mortality.

Our positive experiences measure pools together diverse behaviors, events, and experiences, including social events, relaxation behaviors, and nature experiences, which may each have different impacts on survival. Our research identifies an overall association between positive life experiences and survival, but it does not assess whether certain positive life experiences are more strongly associated with survival. This is an important avenue for future research that is beyond the scope of the current paper. Finally, while we controlled for sociodemographic characteristics and chronic health burden, there are likely many factors that impact survival or that impact the associations between positive life experiences and survival that we did not account for in our analyses.

### 4.2. Future research

Given the observed link between positive life experiences and mortality, future longitudinal research can examine whether positive life experiences may be associated over time with multiple measures of physical well-being, such as disability and chronic disease burden. Future designs with repeated assessments of positive experiences and the psychological and physiological states hypothesized to flow from these experiences would also permit examination of potential bidirectional associations amongst these factors and their relation to health. Further studies can examine different positive life experiences separately, to examine whether they may confer different survival benefits. Finally, stressful life experiences and socioeconomic disadvantage should also be examined as possible moderators of the associations between positive life experiences and physical health, as well as the mediating pathways through which these associations take place.

## 5. Conclusion

We found that greater frequency and enjoyment of positive life experiences were each associated with a lower hazard of mortality over a 12- to 16-year follow-up period, and that these associations were mediated by decreases in depression and perceived stress. If such potentially rewarding experiences impact long-term survival, then their role throughout the life course, as well as the level of access that individuals have to them throughout the life course, warrant further study.

## Data availability

MIDUS data access: https://www.icpsr.umich.edu/web/pages/NACDA/midus.html & https://midus.colectica.org. Analysis code access: https://osf.io/tkn85/files/osfstorage.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2023.116192.

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