The prospective association between life satisfaction and physical pain: Evidence from longitudinal and cohort data

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Abstract

Life satisfaction and physical pain are key aspects of human wellbeing. Yet, evidence on the direction of their association and potential explanatory factors is relatively scarce. We address these questions across two studies. In Study 1, we explore the cross-lagged association between life satisfaction and physical pain using 22 waves from Australian longitudinal data (HILDA; N = 233,854), individual fixed effects regressions, and Random Intercept Cross-Lagged Panel Models (RI-CLPM). We found a bidirectional relationship between life satisfaction and pain which is virtually identical across both methods. In Study 2, we use data from the 1970 British Cohort Study (N = 4,002) and Ordinary Least Squares regressions with a wide set of covariates. We found that people who reported greater life satisfaction at age 26 (vs lower) reported lower physical pain at age 46. We document factors that partially explain this link including psychological distress and past unemployment.

Keywords: Physical pain, life satisfaction, psychological distress, longitudinal models.

Data and code availability

All data are publicly available. HILDA data can be accessed at https://melbourneinstitute.unimelb.edu.au/hilda. The BCS can be accessed at https://cls.ucl.ac.uk/cls-studies/1970-british-cohort-study/.

All analysis scripts are publicly available through the Open Science Framework (OSF) https://osf.io/zxpsm/?view_only=b5008e8cc23347bdb742e8586c3fd534

The authors declare no conflicts of interest.

Introduction

Life satisfaction is one of the most studied aspects of individuals' wellbeing. Since the 1970s researchers across the behavioural, economic, and psychological sciences have explored what makes people more satisfied with their lives (e.g., Clark et al., 2013; Di Tella et al., 2003; Easterlin, 1974; Jebb et al., 2020). At the same time, policymakers have used citizens' life satisfaction as an indicator of societal progress (Stiglitz et al., 2009). Recently, interdisciplinary researchers have examined the social determinants of physical pain opening up an avenue of research that highlights the value of pain as an indicator of individual's and national wellbeing (e.g., Case et al., 2020; Macchia, 2023; Zajacova et al., 2021). Life satisfaction and pain can have great impact on people's lives: while life satisfaction can shape given decisions like job change or hospital visits (Kaiser & Oswald, 2022), physical pain has been found to be strongly associated to harmful behaviours like drug use (McGreal, 2018), to job loss (Blanchflower & Bryson, 2022b), and to lower social connectedness (Baumgartner et al., 2023).

Given the importance of life satisfaction and pain for human wellbeing, our article aims to explore whether life satisfaction is associated with subsequent physical pain and the potential explanatory factors of this link. To address these questions, we conducted two studies. In study 1, we used longitudinal data from Australia to examine the link between life satisfaction and subsequent pain over time across 22 years. As the link between life satisfaction and pain can go in the opposite direction (i.e., pain linked to subsequent life satisfaction), we explored the cross-lagged association between these aspects. Study 1 is crucial to investigate both possibilities. In study 2, we used cohort data from the United Kingdom to explore whether life satisfaction in mid-life was associated with physical pain later in life as well as potential explanatory factors.

Prior work has shown that various aspects of positive wellbeing, including life satisfaction, can be linked to physical pain and potentially buffer the negative effects of pain.

Using Danish data, Santini et al. (2023) found that greater positive wellbeing, captured by The Warwick–Edinburgh Mental Well-being Scale (WEMWBS, a 14-item scale that includes items like feeling optimistic, useful, relaxed), was negatively associated with physical pain. Similarly, Karoly et al (2006) showed that resilience can help people with pain to develop coping strategies that result in lower levels of pain. Larsson et al. (2019) used Swedish longitudinal data with a follow-up of 2 years and showed that greater positive wellbeing at baseline, represented by the General Well-Being Scale (GWBS, a scale that includes aspects like anxiety, depression, positive well-being, self-control, vitality, and general health) and life satisfaction, was associated with lower pain severity at follow-up. Using cross-sectional data from Switzerland, Furrer et al. (2019) found that greater subjective wellbeing (i.e., a self-reported metric of individuals' wellbeing) was linked to lower physical pain and that pain catastrophizing mediated that association. Using data from the Midlife in the United States National Survey, Boring et al. (2022) showed that coherence, a component of meaning in life, was linked to lower likelihood of developing chronic pain and to lower headache, backache, joint, and extremities pain frequency.

Previous research has also examined the relevant link in the opposite direction investigating whether physical pain was associated to subsequent life satisfaction. For example, using panel data from Australia, one study found that chronic pain, measured by the pain that persisted past the normal time of healing or lasted longer than six months, was strongly negatively associated with life satisfaction (McNamee & Mendolia, 2014). Using data from the British National Child Development Study (NCDS), another study found that physical pain at age 44 was linked to lower life satisfaction at age 46 (Blanchflower & Bryson, 2022a).

Building on this preliminary evidence, we explore the bidirectional link between pain and life satisfaction using longitudinal data spanning 22 waves, cohort data, and robust statistical methods that have not been employed in previous work.

To explore potential underlying factors in the link between pain and life satisfaction, we examined one aspect that has been found to be associated with both pain and life satisfaction, namely psychological distress. On one hand, prior work has shown that greater life satisfaction was associated with lower perceived stress, anxiety, and hopelessness in a German sample (Padmanabhanunni et al., 2023). A similar study has shown that lower levels of life satisfaction during the pandemic in India were strongly linked to greater distress (Kumar et al., 2021). On the other hand, a review of studies showed that experimentally induced negative mood can increase physical pain (Wiech & Tracey, 2009) and other studies have found a strong link between anxiety, depression, and physical pain (e.g., Achat et al., 2000). Bridging these two bodies of work, we explored the extent to which psychological distress can explain the association between life satisfaction and pain.

To shed further light on potential explanatory factors, we have considered aspects that have been found to be linked to both life satisfaction and pain: past unemployment, previous pain, general health status, and a large set of demographic characteristics including gender, childhood social disadvantage, education, employment, and income. For example, prior work has found that people with higher levels of past unemployment reported lower life satisfaction and greater pain than those with lower levels of past unemployment (Clark et al., 2001; Macchia et al., 2023). Episodes of pain and poor health tend to be linked to lower life satisfaction and greater general pain while demographic characteristics are linked to both pain and life satisfaction in various ways (Dolan et al., 2008; Macchia et al., 2025; McNamee & Mendolia, 2014).

The existing evidence would benefit from the use of rigorous statistical methods that can rule out potential confounding factors and establish a more robust understanding of the directional relationship between life satisfaction and physical pain. Our study contributes to this literature by leveraging longitudinal data from two countries and applying advanced

statistical techniques to disentangle the temporal associations between these key aspects of human wellbeing.

Study 1. Life satisfaction and physical pain over time - HILDA

Methods

Data

HILDA data can be accessed at https://melbourneinstitute.unimelb.edu.au/hilda. All analysis scripts are publicly available through the Open Science Framework (OSF) https://osf.io/zxpsm/?view_only=b5008e8cc23347bdb742e8586c3fd534

The goal of this study is to examine the cross-lagged association between life satisfaction and pain. To do so, we used 22 waves of data (2001-2022) from the Household, Income and Labour Dynamics of Australia Survey (HILDA). This is a representative longitudinal dataset from the Australian population over 14 years of age. Following up participants every year, the survey collects information about their wellbeing, health, labour market, and economic circumstances. The response rate is over 90% every year (Watson & Wooden, 2021). The sample used in this study includes 233,854 observations on 25,971 individuals (47% Male, Age range=14-101 years old, Mean age =45, SD = 18.63) and all variables used in this study were available in every survey year. Institutional ethical approval was not required because HILDA is a publicly available anonymized dataset.

Measures

In this study, we used the following variables:

Level of physical pain. Participants were asked about their level of physical pain with the following question: "How much bodily pain have you had during the past 4 weeks?" and could answer using a six-point scale ranging from 1 = "No bodily pain" to 6 = "Very severe."

Pain interference. Participants also answered a question about the impact of pain in

their daily lives. Participants were asked "During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?" and could answer using a five-point scale ranging from 1 = "Not at all" to 5 = "Extremely." Similar questions of pain have been used in prior work (e.g., Case et al., 2020; Chen et al., 2008; Franklin et al., 2013; Macchia et al., 2023).

Life satisfaction. Participants answered the following question "All things considered, how satisfied are you with your life? Pick a number between 0 and 10 to indicate how satisfied you are. The more satisfied you are, the higher the number you should pick."

These three variables were treated as continuous and used as dependent or independent variables depending on the analyses. For instance, when exploring whether lagged measures of physical pain were related to subsequent life satisfaction, we used life satisfaction as the dependent variable and lagged measures of physical pain as the independent variables.

Covariates. In all the regression models we accounted for factors that might play a role in the link between physical pain and life satisfaction. Our analyses control for demographic characteristics like age (linear and squared), gender, marital status (single, married, cohabiting, separated, divorced, widowed), level of education (Year 11 or below, Year 12/completion of high school, Certificate level I/II, Certificate level III/IV, Diploma or Advanced Diploma, Bachelor degree, Graduate Certificate or Diploma, Postgraduate degree), personal income, and occupation (Managers, Professionals, Technicians and Trades Workers, Community and Personal Service Workers, Clerical and Administrative Workers, Sales Workers, Machinery Operators and Drivers, Labourers, see https://www.abs.gov.au/statistics/classifications/anzsco-australian-and-new-zealand-standard-classification-occupations/2021 for more information). Our models also included state and survey year fixed effects to account for the common aspects across states and years.

To account for the fact that physical pain might be a proxy for physical health

problems, we included a measure that captured whether the participant had long-term health conditions: “Do you have any long-term health condition, impairment or disability that restricts you in your everyday activities, and has lasted or is likely to last, for 6 months or more?” with yes or no answers.

Descriptive statistics for all the variables included in Study 1 can be found in Table S.1 in the Supplementary Materials.

Statistical analysis

In this study, we explored the longitudinal association between physical pain and life satisfaction. To do so, we used individual fixed effects regressions to account for the correlation of responses within participants over time. As participants were followed up every year, their responses might be correlated due to unobserved time-invariant characteristics (e.g. genetic variation, childhood environment, stable aspects of personality traits).

We lagged the independent variables by one, two, and three waves. This allowed us to explore the association between physical pain (or life satisfaction) in a given year and life satisfaction (or physical pain) years later. To account for potential confounding effects, our fixed-effects models included individual, state, year, and occupation fixed effects as well as a set of demographic characteristics: age (linear and squared), gender, level of education, marital status, and personal income and the presence of long-term health conditions. Occupation and long-term health conditions were lagged at the same level as the independent variable. These regression models were conducted using Stata 18.

To further explore the bidirectional relationship between physical pain and life satisfaction, we conducted Random Intercept Cross-Lagged Panel Models (RI-CLPM). To create this model we followed these steps: Created within-person centred variables for life satisfaction, created within-person centred variables for pain levels, constrained measurement error variances to 0, estimated lagged effects between within-person centred variables,

estimated the covariance between the within-person centred variables at the first wave, estimated covariance between random intercepts, estimated covariances between residuals of within-person components for each wave. These models allowed us to explore the cross-lagged link between pain and life satisfaction considering individual's stable traits as latent variables. These models were conducted using Mplus.

To allow for comparison across Study 1 and Study 2, we provide standardised estimates (β) for all the models.

Results

Table 1 shows individual fixed effects regressions with life satisfaction as the dependent variable and different lags of physical pain as the independent variables. Models show that level of physical pain at time t-1 was significantly negatively associated with life satisfaction at time t (b= -0.042, p < .001, 95%CI [-0.048, -0.036], β = -0.036, column 1) after controlling for demographic characteristics and whether the participant had long-term health conditions. This longitudinal association held using physical pain at time t-2 (b= -0.032, p < .001, 95%CI [-0.037, -0.025], β = -0.028, column 2) and time t-3 (b= -0.019, p < .001, 95%CI [-0.025, -0.013], β = -0.017, column 3). Similarly, this table shows that pain interference at time t-1 was significantly negatively associated with life satisfaction at time t (b= -0.067, p < .001, 95%CI [-0.074, -0.058], β = -0.047, column 4) after controlling for demographic characteristics and whether the participant had long-term health conditions. This longitudinal association also held using pain interference at time t-2 (b= -0.045, p < .001, 95%CI [-0.053, -0.036], β = -0.031, column 5) and time t-3 (b= -0.029, p < .001, 95%CI [-0.037, -0.021], β = -0.020, column 6).

Table 2 explores the reverse relationship and shows individual fixed effects regressions with physical pain and pain interference as the dependent variables and different lags of life satisfaction as the independent variables. Models show that life satisfaction at

time t-1 was significantly negatively associated with level of physical pain at time t (b= -0.030, p < .001, 95%CI [-0.034, -0.026], β = -0.035, column 1) after controlling for demographic characteristics and whether the participant had long-term health conditions. This longitudinal association held using life satisfaction at time t-2 (b= -0.020, p < .001, 95%CI [-0.024, -0.015], β = -0.023, column 2) and time t-3 (b= -0.014, p < .001, 95%CI [-0.018, -0.009], β = -0.016, column 3).

Similarly, our models show that life satisfaction at time t-1 was significantly negatively associated with pain interference at time t (b= -0.031, p < .001, 95%CI [-0.034, -0.027], β = -0.044, column 4) after controlling for demographic characteristics and whether the participant had long-term health conditions. This longitudinal association held using life satisfaction at time t-2 (b= -0.019, p < .001, 95%CI [-0.023, -0.015], β = -0.028, column 5) and time t-3 (b= -0.012, p < .001, 95%CI [-0.016, 0.008], β = -0.017, column 6). The standardised effect sizes for these models were rather small and in line with the findings from the RI-CLPM (see below).

Table 3 shows the results from the Random Intercept Cross-Lagged Panel Models (RI-CLPM) of life satisfaction and level of physical pain. This model shows that there was a bidirectional relationship between level of physical pain and life satisfaction over time yielding coefficients that are virtually identical to the ones obtained in the individual fixed effects regression analyses. Specifically, the RI-CLPM showed that there was a significantly negative association when using level of physical pain as the independent variable and life satisfaction as the dependent variable (b= -0.041, p < .001. The corresponding b estimate from the individual fixed effects models is -0.042 which is shown in column 1 of Table 1) as well as when using life satisfaction as the independent variable and physical pain as the dependent variable (b= -0.029, p < .001. The corresponding b estimate from the individual fixed effects models is -0.030 which is shown in column 1 of Table 2).

It is worth noting that while the lagged parameters were constrained to be equal over time, the standardised parameters may change over time as their calculation considers the standard deviations of the independent and dependent variable which do vary over time. The standardised estimate (β) for the association between pain as the independent variable and life satisfaction as the dependent variable ranges from -0.032 to -0.035 and for the association between life satisfaction as the independent variable and pain as the dependent variable ranges from -0.035 to -0.042. Following the guidelines from Orth et al (2024) that classifies an effect of 0.03 as small, 0.07 as medium, and 0.12 as large, the effects of the RI-CLPM are rather small. All estimates can be found in the output which is available through the Open Science Framework (OSF) https://osf.io/zxpsm/?view_only=b5008e8cc23347bdb742e8586c3fd534.

Other parameters of the RI-CLPM include covariance between random intercepts of life satisfaction and pain (-0.327, p <.001), model fit represented by Akaike Information Criteria (AIC, 1785148.347) and Bayesian Information Criteria (BIC, 1786092.823), Chi-Square Test of model fit (X^2= 11036.861, p <.001). Other parameters like covariance coverage of the main variables across the 22 waves can be found in the output available through the OSF.

Study 2. Life satisfaction and subsequent physical pain – 1970 British Cohort Study

Methods

Data

The BCS can be accessed at https://cls.ucl.ac.uk/cls-studies/1970-british-cohort-study/.

All analysis scripts are publicly available through the Open Science Framework (OSF) https://osf.io/zxpsm/?view_only=b5008e8cc23347bdb742e8586c3fd534

This study used data from the 1970 British Cohort Study (BCS; Elliott & Shepherd, 2006) which is a representative cohort study that follows up people born in England the first week of April 1970. In the first waves, the survey gathered information about participants' birth situation, family circumstances including socioeconomic status, health, and educational aspects. As participants were growing up, information related to labour market outcomes, relationships, parenting, and social attitudes was also gathered. At age 46, the study collected biomedical information including cholesterol levels, heart rate, among others.

To date, the BCS consists of 11 waves which were collected at different time intervals. Our sample consists of 4,161 individuals who are 54 years of age today (44% male). Our relevant measures were collected at age 26, 46, and during participants' childhood reported by their parents.

Anonymized data from all waves are publicly available in the U.K. Data Service website, thus, institutional ethical approval was not required.

Measures

This study used the following variables:

Physical pain at age 46. At age 46, participants answered the SF-36 Health Survey (Ware, 2000) which includes a question about whether they were experiencing bodily pain. This measure ranges from 0 (very severe and extremely limiting pain) to 100 (no pain or limitations due to pain). For this study, this variable was reversed coded to represent greater pain with a higher number and used as the dependent variable.

Life satisfaction at age 26. At age 26, participants were asked "Here is a scale from 0 to 10. On it, "0" means that you are completely dissatisfied and "10" means that you are completely satisfied. Please tick the box with the number above it which shows how dissatisfied or satisfied you are about the way your life has turned out so far." This was our independent variable and was used as continuous in our analyses.

Our models included the following covariates:

Psychological distress at age 26. We measured psychological distress with the nine items drawn from the Malaise Inventory (Rutter et al., 1970) asked at age 46. These nine items were yes/no self-completion questions that were part of the psychological subscale. For example, the scale included the following questions: 1) "Do you feel tired most of the time?", 2) "Do you often feel depressed?", 3) "Do you often get worried about things?", 4) "Do you often get into a violent rage?", 5) "Do you often suddenly become scared for no good reason?", 6) "Are you easily upset or irritated?", 7) "Are you constantly keyed up and jittery?", 8) "Does every little thing get on your nerves and wear you out?", 9) "Does your heart often race like mad?." These items were averaged yielding a measure that ranged from 0 to 9. The Malaise Inventory has acceptable internal consistency and validity (Rodgers et al., 1999) and good psychometric properties (McGee et al., 1986). For this study, the resulting measure was internally reliable with a Cronbach's alpha of .71.

Past unemployment until age 26. Participants were asked "Since you were 16, what is the length of the longest single period when you were unemployed and seeking work?" and could answer never unemployed, 3 months or less, 4-6 months, 7-11 months, 1-2 years, more than 2 years. We used this variable as categorical with 'Never unemployed' as the reference category.

Persistent joint or back pain at age 26. Participants were asked whether they have suffered from persistent joint or back pain since they were 16. This is a binary variable which represents persistent joint or back pain with 1 and otherwise with 0.

General health status at age 26. Participants were asked "How would you describe your general health?" and could answer Excellent, Good, Fair, or Poor. We used this variable as categorical, using 'Excellent' as the reference category.

Gender. This variable captured participant's gender (men, women).

Childhood social disadvantage index. Following prior work (Bridger & Daly, 2017), we created this measure with the following variables: a) social class based on the father's occupation at birth; b) social class in early childhood, both measured by using the Registrar General's Social Class scheme (I= professional occupations, II=managerial or technical occupations, III= skilled workers, IV=semiskilled workers, V=unskilled workers; Office of Population Census and Surveys, 1980); c) the age at which the participant's father left education (1= >22 years, 2= 19-21 (2), 3= 16-18, 4= 14-15, 5= <14 years); d) the age at which the participant's mother left education (1= >22 years, 2= 19-21 (2), 3= 16-18, 4= 14-15, 5= <14 years); e) parental housing tenure in early childhood (1= owner occupied or being bought, 2= private rented furnished or unfurnished, 3= council rented, 4= tied to occupation); and f) persons per room in early childhood. Each item was standardized to have a mean of 0 and standard deviation of 1, averaged, and re-standardized in an index of childhood social disadvantage. The resulting measure was internally reliable with a Cronbach's alpha of .74.

Highest qualification at age 26. At age 26, participants were asked to report their highest level of education: No qualification, CSE 2-5, O Level, A Level, higher qualification, and higher degree. We used this measure as continuous representing a higher level of education with a higher number.

Employment status at age 26. Participants were asked "Which of the following best describes what you are currently doing?" and could answer employed full-time for an employer (30 or more hours a week), employed part-time for an employer (under 30 hours a week), self-employed full-time, self-employed part-time, unemployed and seeking work, full-time education, temporarily sick/disabled (less than 6 months), long-term sick/disabled (6 months or longer), looking after home/family, on a training scheme. We included each answer as a dummy variable (0-1).

Marital status at age 26. Participants were asked "What is your current legal marital status?" and could answer single, married, separated, divorced, or widowed. We used this variable as categorical with 'single' as the reference category.

Personal income at age 26. Participants were asked "What is your usual take home pay (after deductions but including any bonuses or overtime)?" and provided an amount in British Pounds. They were also asked the period that the amount covered including hour, day, week, month, or year. We converted each amount to represent an annual figure to make the income variable comparable across participants.

Descriptive statistics of all the variables used in Study 2 can be found in Table S.2 in the Supplementary Materials.

Statistical analysis

To explore the association between life satisfaction at age 26 and physical pain at age 46, we conducted Ordinary Least Squares regressions with standard errors clustered at the individual level to account for the correlation of the responses of the same person at the two time points. We controlled for factors that have been used in prior related work (Bridger & Daly, 2017) and that could influence the main relationship including psychological distress at age 26, past unemployment until age 26, back or joint pain at age 26, general health status at age 26, gender, childhood social disadvantage index, highest qualification at age 26, employment status at age 26, marital status at age 26, and personal income at age 26. We used multiple imputation to treat missing values in the covariates with larger number of missing values like childhood disadvantage, highest qualification, psychological distress, and personal income. All analyses for Study 2 were conducted using Stata 18.

To allow for comparison across Study 1 and Study 2, we provide standardised estimates (β) for all the models.

Results

Table 4 presents Ordinary Least Squares regressions with life satisfaction at age 26 as the independent variable and physical pain at age 46 as the dependent variable. Column 1 shows a negative association between these two variables when no controls are included in the model (b= -1.764, p < .001, 95%CI [-2.195, -1.332], β = -0.143). This negative association held after controlling for psychological distress at age 26 (b= -1.078, p < .001, 95%CI [-1.517, -0.638], β = -0.087, column 2), past unemployment until age 26 (b = -1.415, p < .001, 95%CI [-1.858, -0.972], β = -0.115, column 3), persistent joint or back pain at age 26 (b = -1.584, p < .001, 95%CI [-2.007, -1.161], β = -0.129, column 4), health status at age 26 (b = -0.972 p < .001, 95%CI [-1.404, -0.539], β = -0.079, column 5), and demographic characteristics including gender, social disadvantage during childhood, highest qualification at age 26, employment status at age 26, marital status at age 26, and personal income at age 26 (b = -1.524, p < .001, 95%CI [-1.965, -1.082], β = -0.124, column 6). However, when including all the covariates in the same model the relationship between life satisfaction and pain becomes statistically insignificant (b = -0.428, p = .063, 95%CI [-0.879, 0.024], β = -0.035, column 7) highlighting the potential explanatory role of a broad set of life circumstances.

Among the factors explored here, health status at age 26 explains the largest proportion of the association between life satisfaction and pain (45%), followed by psychological distress at age 26 (39%), past unemployment until age 26 (20%), demographic factors (14%), and back or joint pain at age 26 (10%).

Discussion

Physical pain is an important problem: it has been rising all over the world with more than 30% of people in pain (Macchia, 2022) and has detrimental impact on people's quality of life (Breivik et al., 2013). Under these circumstances, uncovering the aspects that are

strongly linked to pain is of crucial importance. However, most of the scientific evidence to date focused on the biological or chemical mechanisms that can ease physical pain. In this article, we conducted two studies using longitudinal and cohort data to explore the association between life satisfaction and physical pain as well as potential explanatory factors.

In Study 1, we used longitudinal data from the Household, Income and Labour Dynamics of Australia Survey (HILDA), individual fixed effects regressions and Random Intercept Cross-Lagged Panel Models (RI-CLPM) to explore the cross-lagged association between life satisfaction and physical pain over 22 waves of data. We found a bidirectional link between life satisfaction and physical pain: While life satisfaction in a given year was significantly negatively associated with pain years later, physical pain in a given year was significantly negatively associated with life satisfaction years later. Most importantly, the magnitude of the links was virtually identical across both statistical methods. While the RI-CLPM accounts for trait-like stability by separating within-person and between-person variance and the fixed effect model eliminates all time-invariant confounders, the identical results across models might support the possibility that the associations can be driven by within-person changes rather than pre-existing individual differences. Since both methods control for stable individual characteristics but do so differently, the consistency in results suggests that the relationship between life satisfaction and pain is not an artifact of a particular analytical approach.

In Study 2, we used data from the 1970 British cohort Study and Ordinary Least Squares regressions with a wide set of control variables and standard errors clustered at the individual level to examine the association between life satisfaction at age 26 and physical pain at age 46. We found that people who reported greater life satisfaction at age 26 (vs lower) experienced lower pain at age 46. We also found that health status at age 26 explained 45% of the relationship between life satisfaction and level of physical pain, and

psychological distress at age 26 explained 39% of that link. However, other factors explained a smaller proportion: past unemployment until age 26 explained 20%, demographic characteristics 14%, and the existence of back or joint pain at age 26 10%. These findings suggest that various life circumstances and psychological aspects can play a substantial role in the link between life satisfaction and pain. These findings are consistent with prior research that showed a negative link between life satisfaction and pain (e.g., Furrer et al., 2019; Larsson et al., 2019; McNamee & Mendolia, 2014; Santini et al., 2023), as well as a positive association between distress and pain (Price, 2000).

The negative association between life satisfaction and physical pain can also be explained by other aspects. For example, greater positive wellbeing can lead to aspects that can reduce people's pain like greater social connections and greater ability to engage in prosocial behaviour (Helliwell & Aknin, 2018) as well as a healthy lifestyle (Trudel-fitzgerald et al., 2019). Future research should explore these possibilities.

It is worth noting that despite using different statistical techniques, both Study 1 and Study 2 yielded consistent effect sizes, suggesting that the findings are not sensitive to the statistical method used. Although effect sizes were rather small, they were aligned with findings in the social and psychological sciences.

Our findings have relevant practical implications as they highlight the importance of interventions that can help to increase life satisfaction and reduce pain levels. These interventions can involve physical activity (Yoshimoto et al., 2021), social inclusion programmes (MacDonald & Leary, 2005) and involvement in community services like gardening or art activities as suggested by the new research on social prescribing (Pilkington et al., 2025).

Our analyses have some limitations. First, although we used longitudinal and cohort data which allowed us to reduce the possibility of reverse causality, we certainly cannot establish causality. Mediation analyses using a longitudinal design (i.e., time elapsing

between the independent variable and the mediator and the mediator and the dependent variable) and controlling for prior levels of the mediator and the dependent variable can shed light on causal effects (see Maxwell & Cole, 2007). Second, the pain variable in the 1970 British Cohort Study was asked at age 46. Future research should explore whether the negative link between mid-life life satisfaction and later pain persists after age 46. Third, as our studies used data from Australia and the United Kingdom, we cannot generalise these findings to other countries and regions. Fourth, in Study 2, we controlled for pain using a binary item about the presence or absence of joint or back pain which differs from the continuous outcome measure of pain. Future research should consider using the same measures of pain at different time points and stratifying the sample into prior pain/no pain groups. Omitted variable bias should also be considered as life satisfaction might proxy aspects that were not available in the datasets. However, the use of 22 waves of longitudinal data and several years of cohort data, the various validated pain measures, the rigorous statistical methods, and the important practical implications can offset these limitations providing valuable information for the scientific community.

Overall, we document the first longitudinal evidence of the bidirectional link between life satisfaction and pain as well as potential explanatory factors. Our studies show a significantly negative association between life satisfaction and physical pain which is partially explained by prior health status and psychological distress and to a lesser extent by past unemployment, prior back or joint pain and a set of demographic factors like education, income, and employment status. Our study provides valuable information for wellbeing policymaking.

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Tables

Table 1: Study 1. Life satisfaction as a function of level of physical pain and pain interference. Fixed effects regressions, 2001-2022, HILDA.

	Dependent variable: Life satisfaction (0-10)					
	(1)	(2)	(3)	(4)	(5)	(6)
Level of physical pain at t-1	-0.042***	-	-	-	-	-
	(0.003)					
Level of physical pain at t-2	-	-0.032***	-	-	-	-
		(0.003)				
Level of physical pain at t-3	-	-	-0.019***	-	-	-
			(0.003)			
Pain interference at t-1	-	-	-	-0.067***	-	-
				(0.004)		
Pain interference at t-2	-		-	-	-0.045***	-
					(0.004)	
Pain interference at t-3	-	-	-	-	-	-0.029***
						(0.004)
Long-term health condition at t-1 -Yes	-0.096***	-	-	-0.089***	-	-
	(0.008)			(0.008)		
Long-term health condition at t-2 -Yes	-	-0.057***	-	-	-0.054***	-
		(0.009)			(0.008)	
Long-term health condition at t-3 -Yes	-	-	-0.029**	-	-	-0.027**
			(0.009)			(0.009)
Constant	8.450***	8.555***	8.291***	8.496***	8.578***	8.308***
	(0.072)	(0.078)	(0.087)	(0.072)	(0.078)	(0.087)
N of observations	233,854	210,337	189,899	233,854	210,337	189,899
R^2	0.014	0.012	0.010	0.015	0.013	0.010

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Models show coefficients from fixed effects regressions. Standard errors in parentheses. All models include state, wave, and occupation code fixed effects. Personal characteristics: Age, age squared, gender, marital status, employment status, level of education, and income. Full models can be found in Table S.3 in the Supplementary Materials.

Table 2: Study 1.Level of physical pain and pain interference as a function of life satisfaction. Fixed effects regressions, 2001-2022, HILDA.

	Dependent variables					
	Level of physical pain (1-5)			Pain interference (1-6)		
	(1)	(2)	(3)	(4)	(5)	(6)
Life satisfaction at t-1	-0.030***	-	-	-0.031***	-	-
	(0.002)			(0.002)		
Life satisfaction at t-2	-	-0.020***	-	-	-0.019***	-
		(0.002)			(0.002)	
Life satisfaction at t-3	-	-	-0.014***	-	-	-0.012***
			(0.002)			(0.002)
Long-term health condition at t-1 -Yes	0.171***	-	-	0.154***	-	-
	(0.007)			(0.006)		
Long-term health condition at t-2 -Yes	-	0.097***	-	-	0.097***	-
		(0.007)			(0.006)	
Long-term health condition at t-3 -Yes	-	-	0.060***	-	-	0.059***
			(0.008)			(0.007)
Constant	1.871***	1.955***	1.667***	1.499***	1.603***	1.410***
	(0.059)	(0.065)	(0.073)	(0.048)	(0.054)	(0.060)
N of observations	233,854	210,337	189,899	233,854	210,337	189,899
R^2	0.030	0.026	0.024	0.028	0.023	0.021

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Models show coefficients from fixed effects regressions. Standard errors in parentheses. All models include state, wave, and occupation code fixed effects. Personal characteristics: Age, age squared, gender, marital status, employment status, level of education, and income. Full models can be found in Table S.4 in the Supplementary Materials.

Table 3: Study 1. Random Intercept Cross-Lagged Panel Models (RI-CLPM) of life satisfaction and level of physical pain. 2001-2022, HILDA.

	Dependent variable: Life satisfaction (0-10)
Life satisfaction	0.251***
	(0.002)
Level of physical pain	-0.041***
	(0.003)
	Dependent variable: Level of physical pain (0-5)
Life satisfaction	-0.029***
	(0.002)
Level of physical pain	0.188***
	(0.002)

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Models show coefficients from Random Intercept Cross-Lagged Panel Models (RI-CLPM) with constraints over time. Standard errors in parentheses.

Table 4: Study 2. Physical pain at age 46 as a function life satisfaction at age 26. British Cohort Study.

	Dependent variable: Physical pain at age 46 (0-100)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Life satisfaction at age 26	-1.764***	-1.078***	-1.415***	-1.584***	-0.972***	-1.524***	-0.428
	(0.220)	(0.224)	(0.226)	(0.216)	(0.221)	(0.225)	(0.230)
Psychological distress at age 26	-	2.368***	-	-	-	-	1.244***
		(0.234)					(0.238)
Past unemployment *(Ref.: Never unemployed)*							
3 months or less	-	-	1.790*	-	-	-	1.859*
			(0.842)				(0.807)
4-6 months	-	-	4.172***	-	-	-	3.633**
			(1.218)				(1.175)
7-11 months	-	-	5.451***	-	-	-	4.108*
			(1.655)				(1.612)
1-2 years	-	-	7.362***	-	-	-	4.674**
			(1.821)				(1.786)
More than 2 years	-	-	9.924***	-	-	-	4.096
			(2.583)				(2.546)
Persistent joint or back pain at age 26 - Yes	-	-	-	11.224***	-	-	8.285***
				(0.960)			(0.957)
Health status at age 26 *(Ref.: Excellent)*							
Good	-	-	-	-	6.322***	-	4.006***
					(0.698)		(0.696)
Fair	-	-	-	-	16.630***	-	10.603***
					(1.694)		(1.706)
Poor	-	-	-	-	29.813***	-	15.157**
					(5.510)		(5.468)
Male	-	-	-	-	-	-1.338	-0.421
						(0.733)	(0.734)
Childhood social disadvantage index	-	-	-	-	-	0.836*	0.668
						(0.424)	(0.408)
Highest qualification at age 26	-	-	-	-	-	-1.368***	-1.130***
						(0.281)	(0.274)
Employment status at age 26							
Employed full time for an employer	-	-	-	-	-	-5.053**	-4.372*
						(1.756)	(1.717)
Employed part time for an employer	-	-	-	-	-	-1.731	-2.021
						(1.762)	(1.684)
Self-employed full time	-	-	-	-	-	-5.354*	-5.569**
						(2.105)	(2.076)
Self-employed part time	-	-	-	-	-	-1.300	-2.048
						(3.022)	(2.938)
Unemployed	-	-	-	-	-	-1.369	-3.281
						(2.709)	(2.652)
Full time education	-	-	-	-	-	-1.816	-3.243

						(2.626)	(2.501)
Temporarily sick or disabled	-	-	-	-	-	24.489*	15.241
						(10.307)	(10.600)
Long-term sick or disabled	-	-	-	-	-	20.372***	10.165
						(5.558)	(5.678)
At home	-	-	-	-	-	-0.140	-2.205
						(1.952)	(1.874)
In training scheme	-	-	-	-	-	-0.773	-2.787
						(7.440)	(7.949)
Marital status at age 26 *(Ref.: Single)*							
Married	-	-	-	-	-	1.580	1.493
						(0.828)	(0.798)
Separated	-	-	-	-	-	-5.087	-3.355
						(3.037)	(3.042)
Divorced	-	-	-	-	-	7.284*	7.049*
						(3.341)	(3.170)
Widowed	-	-	-	-	-	-15.808***	-8.571***
						(2.226)	(2.223)
Personal income at age 26	-	-	-	-	-	0.002	0.001
						(0.005)	(0.005)
Constant	33.365***	24.411***	28.812***	29.753***	22.606***	39.248***	21.749***
	(1.694)	(1.827)	(1.843)	(1.682)	(1.799)	(2.474)	(2.691)
N of obs.	4,002	4,002	4,002	4,002	4,002	4,002	4,002

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Models show coefficients from Ordinary Least Squares regressions with standard errors clustered at the individual level in parentheses. Annual income was expressed in British Pounds and rescaled by 10,000.