SSM - Population Health 15 (2021) 100846

Contents lists available at ScienceDirect

SSM - Population Health

journal homepage: www.elsevier.com/locate/ssmph

Trajectories of unsecured debt and health at midlife

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ARTICLE INFO

Keywords:
Debt
Midlife
Pain
Longitudinal

ABSTRACT

Background: Unsecured debt — debt not tied to an asset — is a financial stressor that undermines health, but prior research has not investigated relationships between group-based trajectories of unsecured debt and pain and disability at midlife.
Methods: US respondents of the National Longitudinal Study of Youth-1979 cohort reported unsecured debt and income between ages 28–40. We used these measures to identify group-based trajectories of unsecured debt and unsecured debt-to-income ratio. We then used trajectory membership to predict three pain and disability-related health outcomes at age 50, adjusting for lagged health and other covariates.
Results: Group-based trajectory models divided the sample of 7850 respondents into 6 unsecured debt trajectories and 5 unsecured debt-to-income trajectories. In fully adjusted unsecured debt models, compared to people with constant low debt, those who paid down debt over time, carried constant debt, experienced debt cycling, or accumulated debt later in life were more likely to report pain interference with activities or joint pain or stiffness at age 50 (pain interference ORs ranging from 1.33 to 1.76; joint pain or stiffness ORs ranging from 1.27 to 1.45). In fully adjusted unsecured debt-to-income models, compared to those with constant low debt, those with constant high debt or accumulating debt later in life were more likely to report pain interference or joint pain or stiffness (pain interference ORs ranging from 1.30 to 1.91; joint pain or stiffness ORs ranging from 1.19 to 1.33).
Conclusion: The amount, timing, and duration of unsecured debt accumulation and repayment have important health implications and may exacerbate midlife health inequalities.

1. Introduction

Carrying high debt loads is detrimental for health (Boen et al., 2020; Drentea & Lavrakas, 2000; O'Rand & Hamil-Luker, 2020; Richardson et al., 2013; Sweet et al., 2013). The high cost of debts, and servicing these debts, increases stress (Drentea & Lavrakas, 2000; Sun & Houle, 2020) and leaves households with fewer resources to invest in protecting their health (Kalousova & Burgard, 2013). Unsecured debts are more stressful and burdensome than other forms of debt (Berger et al., 2016; Drentea & Lavrakas, 2000). These debts—including credit cards, payday loans, and money owed to businesses—are not tied to assets, have higher interest rates than secured debts, generally do not help families build wealth, and are more often borrowed under financial duress relative to other debt types (Berger et al., 2016; Drentea & Lavrakas, 2000).

Over the past several decades, unsecured debt has increased faster than income and has become more burdensome to repay (Board of Governors of the Federal Reserve System (US) (2020). This rise in unsecured debt has been accelerated by stagnating incomes, the weakening of the social safety net, and an increase in the supply of high cost credit that was spurred by the deregulation of credit markets (Campbell, 2010; Dwyer, 2018; Leicht & Fitzgerald, 2006; Prasad, 2012). Against this backdrop, it is increasingly important to understand linkages between unsecured debt and health. Debt burden is a plausible risk factor for poor health, but previous studies documenting health consequences of debt have had two primary limitations: measuring debt over a short time horizon, and analyzing a limited set of health outcomes. We use group-based developmental trajectories (Nagin, 2005) to identify patterns of unsecured debt accumulation and unsecured debt relative to household income from ages 28–40, and then estimate associations between unsecured debt trajectories and measures of pain and disability at age 50.

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https://doi.org/10.1016/j.ssmph.2021.100846
Received 18 March 2021; Received in revised form 9 June 2021; Accepted 10 June 2021
Available online 13 June 2021

1.1. Unsecured debt and health

Recent research conceptualizes debt as a financial stressor that, independent of coping resources, socioeconomic status, and other stressors, undermines physical and mental well-being (Drentea & Lavrakas, 2000; Drentea & Reynolds, 2012, 2015). Scholars have previously argued that indebtedness—especially unsecured debt—may undermine health for three reasons: 1) servicing high debt loads leaves fewer resources for purchasing goods and services that are protective of health—including but not limited to access to healthcare (Kalousova & Burgard, 2013); 2) indebtedness is a primary and secondary stressor that both causes and can be caused by stressful life events and chronic strains that undermine health (Drentea & Lavrakas, 2000; Sun & Houle, 2020); 3) the anxiety and mental health problems that arise from worries about repaying debts could, over time, take a toll on physical health (Drentea & Lavrakas, 2000; Drentea & Reynolds, 2012; Zurlo et al., 2014). Taken together, this theoretical argument implies that the effect of unsecured debt on health is primarily driven by the stress, strain, and reduced resources associated with debt repayment (rather than accumulation), and that these effects compound over time.

Consistent with these arguments, previous research demonstrates a negative association between absolute or relative unsecured debt and physical health. While absolute debt levels indicate the total amount of debt in a household, relative debt measures—such as the debt-to-income ratio—better capture the strain of debt repayment: a family that makes $100,000 per year likely has less difficulty paying down $5000 in credit card debt than a family that makes $25,000 per year. For example, Drentea and Lavrakas (2000) found that credit card debt relative to income was negatively associated with self-reported health and physical functioning in cross-sectional data; while Keese and Schmitz (2014) found that increases in unsecured debt repayments relative to income were associated with increases in health satisfaction in the following year in a longitudinal analysis.

Additional studies on unsecured debt and health confirm that absolute debts are associated with worse health after controlling for other socioeconomic factors. For example, recent research shows unsecured debts are associated with worse self-rated health (Sweet et al., 2013), heart attack risk (O'Rand & Hamil-Luker, 2020), and increased participation in risky health behaviors, such as excessive drinking, drug use and smoking (Richardson et al., 2013). Finally, Boen et al. (2020) find that total debts across all sources (unsecured debts, mortgages, student loans) are associated with a higher number of chronic conditions and disability risk, but this study does not directly examine unsecured debt.

A notable gap in existing research is how unsecured debts might be associated with pain and disability. The epidemiology of chronic pain is similar to the epidemiology of disability, with rapidly increasing prevalence around mid-life (Dahlhamer et al., 2018), a life course stage at which major health problems and disabling conditions tend to emerge (Ferraro & Shippee, 2009). The Global Burden of Disease study shows that pain and pain-related conditions are the single most common cause of disability world-wide (Mills et al., 2019). This strong correlation of pain with disability is thought to be mediated by processes of stress and inflammation, where increased activation of the stress response and inflammatory pathways by the pain condition results in greater disability (de Queiroz et al., 2016; Hall et al., 2011). Although no research to our knowledge has examined whether unsecured debt across the life course is associated with disability at midlife, previous research shows that income and other measures of socioeconomic status across the life course are associated with the risk of work-limiting disabilities (Boen et al., 2020; House et al., 1990), suggesting that financial strains—such as indebtedness—may increase the risk of a disabling health condition. Therefore, we posit that measures of disability or functional status and measures of chronic pain will be especially sensitive to the accumulating physiological harms of long-term indebtedness.

A further limitation of existing research is that it tends to examine the relationship between debt and health at a single point in time or over a short time horizon (e.g., 1–2 years). This limits our understanding of the link between debt and health in at least three ways. First, point-in-time estimates of debt are poor proxies for life-long debt burden (Houle & Berger, 2017; Sun & Houle, 2020), and processes of debt accumulation and repayment—or trajectories of debt over time—have not been measured in prior research on debt and health.

Second, theories about why debt may undermine health imply that the effects accumulate over time, as households struggle to repay debt (or not); and yet prior research has not explicitly examined how long term debt trajectories are associated with later health. This is a particularly relevant limitation when considering health conditions that may take several years to manifest as the result of ongoing financial strain (Herd et al., 2007). In addition, this omission also limits our ability to understand the causal ordering of debt and health. Because unsecured debt is especially likely to accumulate after a health shock, examining long-term trajectories of unsecured debt can help disentangle its roles as both a primary and secondary chronic stressor (Babiarz et al., 2013; Houle & Berger, 2017; Sullivan, 2008; Sullivan et al., 2001).

Third, research on debt accumulation and repayment suggests variation in trajectories of indebtedness over time that may have implications for health and well-being. Some scholars have argued that unsecured debt trajectories follow a life cycle model: that households accumulate debt when they are young in order to smooth income across the life course, and pay down that debt (while accumulating assets) as they age (Yilmazer & Devaney, 2005). However, recent studies suggest substantial heterogeneity in unsecured debt trajectories across the life course, such that only a minority of households follow a life cycle savings model of unsecured debt borrowing and repayment (Sun & Houle, 2020; Tippett, 2010). These studies reveal that many households hold chronically high debt levels, and cycle in and out of debt across the life course. Particularly, "debt traps"—whereby individuals cycle in and out of debt, or fail to pay off debts over time—are common among socioeconomically disadvantaged groups (Sullivan, 2008; Tach & Greene, 2014) and may represent a chronic stressor leading to worse health.

Drawing from research and theory on stress and the life course (Pearlin et al., 2005), we argue that both the *timing* and *duration* of unsecured debt exposure may have consequences for health at midlife. If the effects of chronic financial strains accumulate over time, we would expect those who are carrying high debt burdens across the life course, and those who are cycling in and out of high debt levels, to be at risk of experiencing poor health. Research in the life course perspective also suggests that the *timing* of stresses and strain has implications for the health, and that stressors that are "off-time" may have consequences for health (Pearlin et al., 2005). For example, those who are accumulating debt at older ages—a stage of life when we would anticipate households to be paying down debt (according to the life cycle savings hypothesis)—may have a high risk of poor health.

1.2. The present study

We advance research on indebtedness and physical health in two ways. First, we build upon previous research by moving beyond cross-sectional or short-term estimates of the association between debt and health. Our study draws upon repeated measures of unsecured debt between ages 28–40. Following prior research, we examine trajectories of both absolute (total unsecured debt) and debt relative to financial resources, measured as the unsecured debt-to-household income ratio (DTI). If the negative health consequences of debt are driven by ability to repay debt, it is plausible that relative debt trajectories will be more strongly associated with health outcomes than absolute debt trajectories. However, because debt trajectories capture accumulation and repayment patterns over time (rather than a single point in time), we might also expect to see similar findings for both absolute and relative debt measures (Sun & Houle, 2020). Although previous research has examined the link between absolute and relative unsecured debt trajectories across the life course and mental health at midlife (Sun &

Houle, 2020), no research to our knowledge has examined unsecured debt trajectories and physical health outcomes.

Our second contribution is to examine pain and disability as outcomes uniquely suited to capture the adverse effects of debt. Previous research on debt and physical health has typically focused on single-item measures of self-reported general physical health (Kyriopoulos et al., 2016). However, past middle age, self-rated health no longer tends to decline with age (Zheng et al., 2011), meaning that it may not adequately capture the accumulating effects of indebtedness over the life course. Other studies have included diverse measures of physical health, such as heart attack, body mass index, blood pressure, and chronic conditions, which may be more sensitive for identifying accumulation of wear and tear associated with indebtedness (Boen et al., 2020; O'Rand & Hamil-Luker, 2020; Sweet et al., 2013). To date, however, this literature has not considered measures of chronic pain or disability, which may be especially likely to reflect accumulating physical effects of indebtedness.

2. Data and methods

2.1. Participants

We used data from the National Longitudinal Study of Youth, 1979 cohort, a survey sponsored and directed by the U.S. Bureau of Labor Statistics and managed by the Center for Human Resource Research (CHRR) at The Ohio State University. A nationally representative sample of respondents was first surveyed in 1979 when they were 14–21 years old, and were surveyed annually through 1994 and biennially in even-numbered years through 2018 (Bureau of Labor Statistics, U.S. Department of Labor, 2019). The NLSY79 data include time-varying measures of household financial resources, including both assets and debts, as well as two batteries of health assessments administered at ages 40 and 50. Our sample included 7850 respondents who participated in a health module administered from 2008 to 2016, when NLSY79 respondents were approximately 50 years old. This represented approximately 80% of original NLSY79 respondents who were not part of two oversamples excluded from follow-up after the 1984 and 1991 interviews. Men, Black respondents, and non-US natives were more likely to be lost to follow-up prior to age 50, and respondents whose mothers did not graduate high school (as a proxy for family of origin socioeconomic status) were less likely to be lost to attrition.

2.2. Missing data

Missing data for all variables were imputed using chained equations within the *mi impute* suite in Stata 16. Data on covariates were missing for 0.1%–14.5% of respondents, and data on unsecured debt were missing for 4.1%–8.3% of respondents. Missing values were imputed based on the group-based trajectory categories and all covariates listed in Table 1. We used the *how_many_imputations* command in Stata 16 (von Hippel, 2020) to ensure the replicability of point estimates and standard errors, and results were averaged across 60 imputed datasets. The results presented were consistent with those found using listwise deletion (non-imputed results available upon request).

2.3. Measures

2.3.1. Disability and pain measures

We included one measure of disability, and two measures of chronic pain or pain interference. All were measured at ages 40 (as a lagged indicator of health) and 50 (as outcome variables). Health-related work limitations (1 = yes) indicated whether the respondent had a health condition that limited the amount or type of work they could do and was used as an indicator of disability. Of the two measures of pain, the first asked whether the respondent experienced joint-related pain, swelling, or stiffness (1 = yes), and the second asked whether the respondent experienced pain in the last four weeks that interfered with housework or paid work (1 = Moderately, Quite a bit, Extremely; 0 = Not at all, A little bit).

Table 1
Descriptive statistics for all model variables, N = 7850.

	Mean (SD) or Percent
Dependent variables, age 50	
-Health limits type or amount of work	19%
-Joint pain, stiffness, or swelling	51%
-Pain interferes with paid or unpaid work	20%
Lagged health measures, age 40	
-Health limits type or amount of work	11%
-Joint pain, stiffness, or swelling	26%
-Pain interferes with paid or unpaid work	12%
Unsecured debt in 2013 dollars	
-Unsecured logged debt, age 28	3.35 (4.18)
-Unsecured logged debt, age 40	3.76 (3.47)
-Unsecured logged debt-to-income ratio, age 28	1.12 (1.54)
-Unsecured logged debt-to-income ratio, age 40	1.51 (1.72)
Covariates	
-Female	51%
-Latino	19%
-Black	31%
-Non Latino, non-Black	49%
-Non US-native	7%
-Mother did not graduate high school	45%
-Lived below poverty line, 1979	16%
-Educational attainment in years, age 25	11.36 (3.84)
-Unemployed 6+ months before age 28	29%
-Declared bankruptcy before age 28	1%
-Divorces before age 28	13%
-Lacks health insurance, age 50	17%
-BMI, age 50	29.22 (6.26)
-Smoker, age 50	25%
-Physically inactive, age 50	32%
-Binge drank <1time/week in last month (ref = did not binge drink)	7%
-Binge drank 1+ times/week in last month (ref = did not binge drink)	7%
-Hours of sleep on weekdays, age 50	6.61 (1.43)
-Mental health SF-12 score, age 50	52.83 (8.96)
Cumulative financial resources, ages 28–50	
-Ever owned home	84%
-Median household income in 1000s	63.44 (57.6)

Note: Means and standard deviations are calculated using the "misum" command in Stata 16.

2.3.2. Unsecured debt

Unsecured debt was assessed annually from 1985 to 1990 and 1992–1994, biennially from 1996 to 2000, and in 2004. We recoded these values to align with respondents' ages rather than the calendar years when they were measured, and measured unsecured debt and debt-to-income ratio for all respondents at or near ages 28, 30, 32, 34, 36, and 40 years. Unsecured debt included credit card debt; money owed to businesses, individuals, or banks; and medical debt. Credit card debt is differentiated from other types of unsecured debt beginning in 2004, and accounted for approximately two-thirds of all unsecured debt. Unfortunately, our data did not allow us to assess unsecured debt in other years in distinct categories. Following previous research (Berger et al., 2016; Berger & Houle, 2016; Houle & Berger, 2017) we applied a 98th percentile top-code to debt in each year, and adjusted for inflation, such that debt was measured in constant 2013 dollars. We then log-transformed unsecured debt (after adding a constant to account for zero debt values) because debt was highly right-skewed (Berger et al., 2016). We used this log-transformed debt measure to estimate group-based trajectories of unsecured debt. For unsecured debt-to-income ratio, the unsecured debt value was divided by household income for that calendar year, and then log-transformed. Households with no income were assigned an income of $500 to avoid dividing by zero.

2.3.3. Covariates

We controlled for variables that had known associations with health and were measured prior to the start of measuring trajectories in order to clarify causal order between independent and dependent variables (Brown, 2018; Rogers et al., 2010). These included gender, race-ethnicity (Latino [reference], Black, Non-Latino non-Black), US nativity (1 = non US native), maternal education (1 = mother did not graduate high school), baseline poverty status (1 = lived below the poverty line in the baseline 1979 interview), and educational attainment in years at age 25. We also controlled for long-term unemployment (>6 months in a calendar year), bankruptcy, and divorce (Addo, 2017; Frech & Damaske, 2012; Sullivan et al., 2001) when they occurred prior to the start of measuring trajectories (i.e, before age 28).

At age 50, we adjusted for health behaviors and other variables that likely influenced midlife health, including whether the respondent lacked health insurance, their body mass index (BMI), whether the respondent smoked, was physically inactive, or binge drank (6 or more drinks on at least one occasion in the last month), hours of sleep on a typical weeknight, and mental health score at age 50, using the Mental Component Summary (MCS) calculated from the Short Form Health Survey (SF-12) health index, where higher scores on a scale from 0 to 100 indicated better mental health (Brazier et al., 1992; Gandek et al., 1998; Rogers et al., 2010; Sun & Houle, 2020).

Because financial resources other than unsecured debt are associated with midlife health (Boen et al., 2020; Frech & Damaske, 2019), our final models also adjusted for median income from ages 28–50 in the log-transformed debt trajectory models (but not the debt-to-income ratio models as income is included in the denominator), as well as whether the respondent ever owned a home between ages 28–50.

2.4. Analytic methods

Group-based trajectories of unsecured debt and unsecured debt-to-income ratio were identified using group-based trajectory models (Nagin, 2005). Group-based trajectories are finite-mixture models that identify groups of respondents following similar trajectories of change or stability over time. Unlike growth curve models, which focus on individual change over time, group-based trajectory models use maximum likelihood to identify shared trajectories across groups of like individuals, and assigns individuals to trajectories with a known probability of correct placement. The average probability of correct placement, or APP, should be at least 0.70 for each group, and is one indicator that individuals are assigned to the correct group. Bayesian Information Criterion (BIC) statistics, prior research, and substantive fit are used to determine the correct number and shape (polynomial order) of trajectories. Following identification of group-based trajectories of unsecured debt and unsecured debt-to-income ratio, we used trajectory membership as a predictor of health at age 50 in separate logistic regressions predicting each outcome variable.

3. Results

3.1. Sample characteristics

Table 1 provides descriptive statistics for all model variables. At age 50, 19% of respondents reported health limitations to the type or amount of work they could do, just over half (51%) reported joint pain or stiffness, and 20% reported pain that interfered with paid or unpaid work.[1] At age 40, when we control for lagged health, fewer respondents reported these issues: 11% reported work-limiting health conditions, 26% reported joint pain or stiffness, and 12% reported pain interference. Across the sample, unsecured debt and unsecured debt-to-income ratio increased with time, with average logged unsecured debt increasing from 3.35 at age 28 to 3.76 at age 40, and average logged unsecured debt-to-income ratio increasing from 1.12 at age 28 to 1.51 at age 40.

3.2. Group-based trajectories

Our first aim was to identify group-based trajectories of unsecured debt and unsecured debt-to income ratio between ages 28–40. We identified six group-based, cubic polynomial trajectories of logged unsecured debt from ages 28–40. The 6-trajectory cubic model was selected after reviewing BIC statistics for persons (N = 7850) and person-years (53,807), as well as reviewing average probability of correct placement (APP) for each group, and substantive fit with prior research on debt trajectories. Measures of model fit are shown in Table 2. The three, four, and five group models were not selected because BIC statistics continued to increase as the number of trajectories increased from the three-group model through the seven-group model. APPs were also high and well above the threshold of 0.70 recommended by Nagin (2005) for three groups through seven groups. However, the seven-group model was not used because it created an empty trajectory containing no respondents. We allowed for a cubic polynomial for all groups because the linear and quadratic forms were all significant across the six groups, and the cubic polynomial was significant for four of the six groups. Results remained the same when quadratic forms were used for the two groups that were not significant at the cubic level.

Fig. 1 depicts unsecured debt trajectories in logged 2013 dollars from ages 28–40. The Constant high group was largest, including 35% of respondents, followed by Constant low/no debt (18%), Low-to-stable mid (17%), Debt cycling (14%), Mid-to-low (12%), Low-to-high late (4%).

We next identified 5 cubic group-based trajectories of logged, unsecured debt-to-income ratio between ages 28–40. As with absolute unsecured debt trajectories, we relied on measures of model fit as well as prior research and whether substantive differences existed across groups. As shown in Table 2, beginning with the four-group model, a small group including 1% of respondents emerged, and we selected the

Table 2
Measures of model fit for selection of group-based trajectories.

	BIC (persons)	BIC (person-years)	Average APP	Lowest APP	% in smallest group
Logged unsecured debt in 2013 dollars					
3 group	−96016.87	−96031.31	.917	.841	20%
4 group	−95381.05	−95400.30	.897	.851	18%
5 group	−95070.36	−95094.41	.890	.746	10%
6 group	**−94939.19**	**−94968.06**	**.868**	**.756**	**4%**
7 group	−94871.32	−94905.01	.866	.758	0%
Unsecured debt-to-income ratio in 2013 dollars, logged					
3 group	−100083.80	−100098.40	.932	.835	10%
4 group	−99305.16	−99324.61	.916	.814	1%
5 group	**−98656.11**	**−98680.43**	**.882**	**.805**	**1%**
6 group	−98431.43	−98460.61	.879	.777	1%
7 group	−98106.65	−98140.71	.849	.728	1%

Note: n = 7850 persons with 53,807 person-year observations. BIC = Bayesian information criterion; APP = Average probability of correct placement.

[1] Supplemental analyses (available upon request) indicate some overlap between groups; almost all who report pain interference at age 50 also report a work-limiting health condition or pain and stiffness, and 58% of respondents with pain and stiffness also report pain interference or a work-limiting health condition.

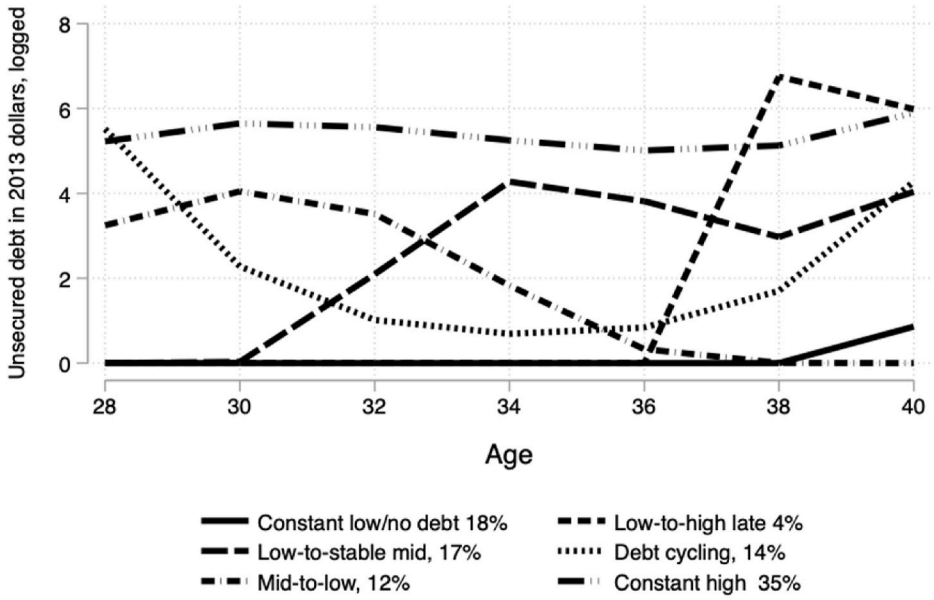

Fig. 1. Group-based trajectories of unsecured debt in logged 2013 dollars, N = 7850.

5-group model as the model of best fit, which limited the number of groups including <5% of the sample, while preserving group APPs of greater than 0.70. We allowed for a cubic polynomial for all five groups because all linear, quadratic, and cubic terms were significant, but quartic forms were not, across the five group-based trajectories.

Fig. 2 shows logged unsecured debt-to-income ratio group-based trajectories across the life course. Most respondents (62%) reported Constant low debt relative to household income. Other groups demonstrated Low-to-high (18%), Mid-to-low (14%), Constant high (5%), and Low-to-highest (1%) trajectories of unsecured debt relative to income.

Across both debt outcomes, group-based trajectory models revealed patterns that were not evident from examining mean values of unsecured debt over time. Rather than most people experiencing increasing unsecured debt (as indicated by the mean unsecured debt values listed in Table 1), or a life cycle model of unsecured debt (with higher debt at younger ages and decreasing thereafter), unsecured debt trajectories were highly variable, with groups of stable unsecured debt, cycling debt, increasing debt, or decreasing debt with age.

3.3. Unsecured debt trajectories and health at age 50

To answer our main research questions, we used debt trajectory membership as a predictor of midlife health in a series of logistic regression models. In the first set of results, we regressed three health outcomes (work-limiting health conditions, self-reported pain and stiffness, and self-reported pain interference) separately on the unsecured debt trajectories shown in Fig. 1. Model 1 of Table 3 also adjusts for lagged (age 40) health outcomes, as well as pre-trajectory variables associated with midlife health, including gender, race-ethnicity, US nativity, educational attainment, maternal education, poverty status at the baseline (1979) interview, and divorce, bankruptcy, or long-term (>6 months) unemployment when they occurred before age 28. Model 2 of Table 3 adjusted for Model 1 variables as well as variables measured at age 50 that may be associated with midlife health, including health

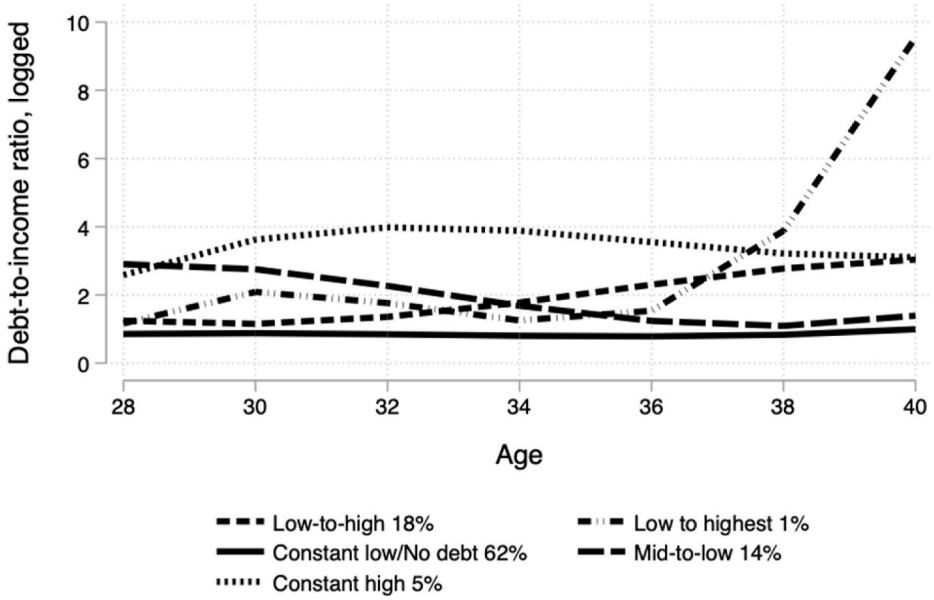

Fig. 2. Group-based trajectories of unsecured debt-to-income ratio in logged 2013 dollars, N = 7850.

Table 3
Logistic regressions of relationships between unsecured debt trajectories and health at age 50, Odds ratios, (95% CI) N = 7850.

Outcome	Trajectory group	Model 1	Model 2
Work-limiting health conditions	Constant low/no debt	Referent	Referent
	Low-to-high late	**1.39 (1.00–1.95)**	1.42 (.99–2.04)
	Low-to-stable mid	1.05 (.85–1.30)	1.11 (.88–1.40)
	Debt cycling	0.98 (.78–1.27)	1.06 (.82–1.40)
	Mid-to-low	1.11 (.87–1.42)	1.21 (.93–1.57)
	Constant high	1.02 (.84–1.24)	1.05 (.85–1.31)
Pain/stiffness	Constant low/no debt	Referent	Referent
	Low-to-high late	1.18 (.92–1.52)	1.10 (.84–1.43)
	Low-to-stable mid	**1.40 (1.21–1.64)**	**1.30 (1.11–1.53)**
	Debt cycling	**1.25 (1.06–1.49)**	1.17 (.98–1.40)
	Mid-to-low	**1.33 (1.13–1.59)**	**1.27 (1.07–1.52)**
	Constant high	**1.65 (1.44–1.88)**	**1.45 (1.25–1.67)**
Pain interference	Constant low/no debt	Referent	Referent
	Low-to-high late	**1.66 (1.21–2.27)**	**1.67 (1.19–2.35)**
	Low-to-stable mid	**1.45 (1.19–1.78)**	**1.53 (1.23–1.91)**
	Debt cycling	**1.27 (1.01–1.60)**	**1.33 (1.03–1.71)**
	Mid-to-low	**1.40 (1.12–1.77)**	**1.49 (1.17–1.91)**
	Constant high	**1.76 (1.47–2.11)**	**1.76 (1.45–2.15)**

Notes: Bolded items are significant at p < .05. Results are averaged across 60 imputed datasets using *mi estimate* in Stata 16. Model 1 controls for lagged health outcome at age 40, gender, race-ethnicity, US nativity, educational attainment, maternal education, poverty status at baseline interview, divorce before age 28, unemployment >6 months before age 28, and bankruptcy before age 28. Model 2 controls for Model 1 + health insurance, smoking, binge drinking, physical inactivity, BMI, hours of sleep, and mental health SF-12 score, all measured at age 50, as well as ever owned a home between ages 28–50 and median income from ages 28–50.

insurance, smoking, binge drinking, physical inactivity, BMI, hours of sleep, and mental health SF-12 score. We also adjusted for two cumulative measures of financial stability in Model 2, including whether the respondent ever owned a home between ages 28–50, and median household income from ages 28–50. In all models, Constant low/No debt was the reference debt trajectory.

Overall, we found that unsecured debt trajectories were more strongly associated with our pain related outcomes than our measure of disability. As shown in Models 1 and 2 of Table 3, unsecured debt trajectories were not associated with work-limiting health conditions at age 50 after full multivariable adjustment. When predicting pain and stiffness, compared to those with Constant low debt, respondents in the Low-to-stable mid, Mid-to-low, and Constant high trajectories had greater odds of pain and stiffness at age 50 in the fully adjusted model (OR: 1.30 [95% CI: 1.11, 1.53], OR: 1.27 [95% CI: 1.07, 1.52], and OR: 1.45 [95% CI: 1.25, 1.67], respectively). For pain interference, all five debt trajectories were associated with greater odds of pain interference relative to the reference group of Constant low/no debt. In the fully adjusted model, Constant high (OR: 1.76; 95% CI: 1.45, 2.15) and Low-to-high late (OR: 1.67; 95% CI: 1.19, 2.35) debt trajectories were associated with the highest odds of pain interference among the debt trajectory groups. In sum, we found that respondents who held unsecured debt during the course of their life reported greater pain than those who did not hold debt, and that this association was strongest for those with a longer duration of debt (Constant high), and those with "off time" debts later in life (Low to high late).

3.4. Unsecured debt-to-income trajectories and health at age 50

Next, in Table 4, we examined the associations between relative unsecured debt trajectories (debt-to-income) and health conditions at age 50. The model progression for Table 4 is the same as Table 3, but we did not control for median income from ages 28–50 in Model 2 of Table 4 because income is included in the denominator of the DTI trajectory. Similar to the results for absolute debt, we found little evidence that relative debt trajectories were associated with work-limiting health conditions at age 50 net of all covariates, with one exception: in Model 2, only Low-to-high (OR: 2.12; 95% CI: 1.27, 3.53) was associated with greater odds of a work-limiting health condition.

We found more evidence for an association between relative debt trajectories and (a) pain and stiffness, and (b) pain interference. When predicting pain and stiffness in Model 1 of Table 4, the Low-to-highest and Constant high had greater odds of pain and stiffness at age 50 relative to the Constant low/no debt trajectory. In Model 2, Low-to-highest (OR: 1.19; 95% CI: 1.05, 1.36) and Constant high (OR: 1.33; 95% CI 1.05, 1.68) remained associated with greater odds of pain and stiffness.

When predicting pain interference in the fully adjusted model, relative to those with Constant low/no debt, Low-to-high, Low-to-highest, and Constant high trajectories remained associated with greater odds of pain interference at midlife (OR: 1.91 [95% CI: 1.17, 3.10], OR: 1.30 [95% CI: 1.10, 1.53], and OR: 1.46 [95% CI: 1.11, 1.91], respectively). Similar to the results for absolute debt trajectories, we found that respondents who were indebted for a longer duration, or who experienced an "off time" increase in debt in mid-life, were at the highest risk

Table 4
Logistic regressions of relationships between unsecured debt-to-income ratio trajectories and health at age 50, Odds ratios. N = 7851.

Outcome	Trajectory group	Model 1	Model 2
Work-limiting health conditions	Constant low/no debt	Referent	Referent
	Low-to-high	**2.18 (1.36–3.47)**	**2.12 (1.27–3.53)**
	Low-to-highest	**1.28 (1.08–1.52)**	1.11 (.92–1.33)
	Mid-to-low	1.19 (.97–1.45)	1.07 (.87–1.33)
	Constant high	**1.72 (1.30–2.28)**	1.23 (.91–1.67)
Pain/stiffness	Constant low/no debt	Referent	Referent
	Low-to-high	1.15 (.78–1.73)	1.11 (.73–1.67)
	Low-to-highest	**1.29 (1.13–1.46)**	**1.19 (1.05–1.36)**
	Mid-to-low	1.13 (.98–1.31)	1.05 (.90–1.21)
	Constant high	**1.61 (1.27–2.00)**	**1.33 (1.05–1.68)**
Pain interference	Constant low/no debt	Referent	Referent
	Low-to-high	**2.04 (1.32–3.17)**	**1.91 (1.17–3.10)**
	Low-to-highest	**1.48 (1.27–1.73)**	**1.30 (1.10–1.53)**
	Mid-to-low	**1.28 (1.07–1.53)**	1.13 (.93–1.37)
	Constant high	**2.06 (1.61–2.64)**	**1.46 (1.11–1.91)**

Notes: Bolded items are significant at p < .05. Results are averaged across 60 imputed datasets using *mi estimate* in Stata 16. Model 1 controls for lagged health outcome at age 40, gender, race-ethnicity, US nativity, educational attainment, maternal education, poverty status at baseline interview, divorce before age 28, unemployment >6 months before age 28, and bankruptcy before age 28. Model 2 controls for Model 1 + health insurance, smoking, binge drinking, physical inactivity, BMI, hours of sleep, and mental health SF-12 score, all measured at age 50, as well as ever owned a home between ages 28–50.

for reporting pain-related health problems.

4. Discussion

Our findings demonstrated adverse associations between several trajectories of growing or sustained unsecured debt between ages 28–40, and poor physical health at midlife. Because debt is a chronic stressor, we focused on health outcomes that reflected the cumulative wear and tear of the stress of debt repayment over time, including health conditions that limited the ability to work, joint pain or stiffness, and pain that interfered with daily activities. Prior studies on the health consequences of debt had subsumed these outcomes within a general measure of self-rated health, or have not considered the relationship between debt and physical health problems that worsen at midlife, such as chronic pain. Consistent with prior research on mental health (Sun & Houle, 2020), we found that some respondents experienced chronically high levels of unsecured debt, while others experienced low or no debt, or debt that fluctuated with age. We found that holding persistent high debt over time was associated with worse health than other groups. Similarly, those with low debt early in life tended to remain low as they entered midlife, indicating the ability to save and grow wealth with time, contributing to better health outcomes. Nevertheless, even respondents who had paid down debt over time reported worse health than those who remained at relatively low levels of debt, demonstrating that the lasting strain of unsecured debt for midlife health. Therefore, future research should more closely examine the contribution of indebtedness to onset and persistence of chronic pain problems (Warth et al., 2019), including specific pain problems that might reflect cumulative stress burden at midlife, such as migraine, lower back pain, and complex regional pain syndrome (CRPS) (Goebel, 2011; Shmagel et al., 2016; Victor et al., 2010).

Although prior research tends to show that relative debt measures have a stronger relationship with health than absolute debt (Drentea & Lavrakas, 2000), we found similar results across both types of debt measures. This might be because our trajectory approach better captured processes of accumulation and repayment than single point-in-time estimates of debt (Sun & Houle, 2020). For both absolute and relative debt measures, respondents who held chronically high debt or accumulated debt late in life were more likely to report pain, suggesting a continuing cycle of worsening finances and well-being as they enter their fifties and sixties.

We did find a few key differences in the statistical significance of coefficients across relative and absolute debt models. For example, we found that the Low-to-high relative debt trajectory was associated with work-limiting disability, but the Low-to-high late absolute debt trajectory was not. Similarly, respondents in the Mid-to-low absolute debt trajectory reported significantly higher levels of pain interference than the reference group, but those in the Mid-to-low relative debt trajectory did not. While it is possible that these differences represent meaningful variation in the impact of indebtedness on health, we would caution against over interpreting these differences for at least two reasons. First, the coefficients in question are similar in size and direction, and even though one is statistically significant and another is not, this difference between these coefficients is not statistically significant (Gelman & Stern, 2006). Second, the reference groups in the absolute and relative debt models (Constant low/no debt) are named similarly, but do not represent the same group of respondents, which limits the comparability of these coefficients.

Our focus on midlife health reveals how associations between unsecured debt exposure and health appear to vary according to both the *timing* and *duration* of this exposure. Our findings are consistent in showing that the *timing* of indebtedness may be consequential for health. Recent debt accumulation, and not debt at younger ages, was most associated with declining health at midlife. Debt scholars have long argued that unsecured debt is age-graded: younger individuals take on debt when young to invest in the future and smooth income, and pay down that debt as they age (Yilmazer & Devaney, 2005). Rising debt in middle-age may therefore be indicative of an "off-time" or non-normative life course event that creates stress and undermines health (Pearlin et al., 2005).

Our findings also suggest that the *duration* of exposure to debt may also undermine health. Those with chronic debt, and especially chronically high debt, reported worse health than those with persistently low debt. We also found that respondents who were in debt for a moderate time length (e.g., Low to stable mid; Moderate to low groups) were also at a moderate risk of experiencing poor health relative to those with no debt and those with chronically high debt, further suggesting that the duration or length of exposure to the chronic strain of debt may be consequential for health. For those with high debt levels across the life course, debt may represent a chronic or enduring financial stressor—rather than a passing financial stressor or worry—that deteriorates health (Pearlin et al., 2005). Future research can expand on these findings by examining how debt affects health, especially past retirement, when income decreases while health problems and expenses continue to increase.

4.1. Limitations

A significant limitation of our study is attrition in the NLSY79 data. By the time NLSY79 respondents turn 50, about 20% have exited the study. This limits the generalizability of our findings among respondents who were most likely to attrit, including men, Black respondents, and non-US natives. Our debt trajectories are also limited in that they end at or near age 40, which falls during calendar years 1996–2004, depending on respondents' year of birth. This period ends prior to the Great Recession and the financial crises brought on by the SARS-CoV-2 pandemic, which have likely increased financial insecurity among many in our sample. Future research should consider more recent measures of unsecured debt, especially as they relate to recent financial crises.

A second limitation relates to our use of group-based trajectory models. The advantage of this approach was the ability to reveal underlying patterns of unsecured debt accumulation and repayment that were not evident when examining the overall trends in debt by age (which suggested rising debt in Table 1) or when considering prevailing theories of debt across the life course (which suggested declining debt with age). However, the disadvantage of group-based trajectory models is the uncertainty surrounding the relationship between individuals' trajectories of debt and the group-based trajectory to which they are assigned. Although individuals are assigned to a group-based trajectory with a known probability of correct placement, it remains the case that individuals' personal trajectories of unsecured debt may not align precisely with the group to which they were assigned, and some experiences of unsecured debt may not be captured in the models we present. Future research should continue to investigate individual-level variation in unsecured debt across the life course.

Although we control for lagged measures of health, selection remains a limitation in this study. For example, because we are unable to distinguish between different types of unsecured debts, it is possible that chronically ill respondents are more likely to accumulate (and have difficulty repaying) medical debt. But while health selection – poorer health causing higher unsecured debt – is a concern for our study, our findings are somewhat inconsistent with a health selection hypothesis. For example, prior research using the NLSY79 shows that work-limiting health conditions are strongly associated with later debt accumulation and repayment (Houle & Berger, 2017), but we found little evidence that debt trajectories were associated with work-limiting health conditions later in life. Were our findings biased by health selection, we would have expected debt trajectories to be strongly predictive of later work-limiting health conditions. That unsecured debt is not strongly associated with midlife health provides some evidence that our findings are not biased by health selection.

Finally, while we focus on unsecured debt in this study because it is considered more financially stressful than other forms of debt (Drentea & Lavrakas, 2000; Sun & Houle, 2020), future research might consider the association between other forms of debt and health, such as home mortgage or student loan debt. For example, recent research suggests that many college-going young adults are having difficulty repaying their student loans well into their 30's and 40's (Houle & Addo, 2019), which may have consequences for health later in life (Walsemann et al., 2015).

4.2. Conclusion

At a time of increasing financial insecurity due to the ongoing SARS-CoV-2 pandemic, the present study demonstrates the long-term physical health consequences associated with the accumulation and persistence of unsecured debt. These results suggest that helping families avoid indebtedness or pay off existing debts during early adulthood could help protect health and functional status in midlife. The especially strong association between debt trajectories and measures of chronic pain also reveals the importance of considering unsecured debt as a key social determinant of pain problems common among middle-aged adults. Future research should consider how this association extends to later stages of the life course, and how debt influences the clinical course of specific physical health problems and chronic conditions.

Financial disclosure statement

No funding was received.

Compliance with Ethical Standards

The study protocol has been approved by the Institutional review broad of the University of Missouri. This study uses publicly available and de-identified data.

CRediT authorship contribution statement

Adrianne Frech: Conceptualization, Methodology, Software, Formal analysis, Writing – original draft, Writing – review & editing. **Jason Houle:** Conceptualization, Methodology, Software, Writing – original draft, Writing – review & editing. **Dmitry Tumin:** Writing – original draft, Writing – review & editing.

Declaration of competing interest

None to disclose.

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