Preventive Medicine Reports 53 (2025) 103047

Contents lists available at ScienceDirect

Preventive Medicine Reports

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

Impact of a diabetes diagnosis on preventive care utilization among middle-life adults in the United States: A mediation analysis of depressive symptoms

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ARTICLE INFO

Keywords:
Diabetes diagnosis
Preventive care utilization
Depressive symptoms
Teachable moment
Mediation

ABSTRACT

Objective: To examine the association between diabetes diagnosis and preventive care utilization and whether depressive symptoms mediate this relationship.
Methods: The study used data from four waves of the National Longitudinal Survey of Youth gathered between 2006 and 2016 ($n = 6995$) in the United States. Logistic regression models were used to examine the relationship between a diabetes diagnosis and preventive care utilization and whether depressive symptoms mediated this relationship.
Results: After controlling for demographic, socioeconomic, and health variables, a diabetes diagnosis significantly increased preventive care utilization of blood pressure, cholesterol, blood sugar, electrocardiograph tests, and influenza vaccinations. Also, depressive symptoms mediated the association between a diabetes diagnosis and three preventive care service utilization types: influenza vaccinations, blood pressure, and electrocardiograph tests. Depressive symptoms decreased blood pressure tests and increased influenza vaccinations and electrocardiograph tests. Depressive symptoms did not mediate blood cholesterol or blood sugar tests.
Conclusions: Results indicated that a diagnosis of diabetes increases the use of preventative services, with the strongest effect on blood sugar tests. However, depressive symptoms slightly reduced the utilization of blood pressure testing. Future studies need to further examine the roles of doctor's recommendations and the roles of family members and familial care.

1. Introduction

Diabetes mellitus is a chronic disease linked to reduced quality of life, higher disability, and shorter life expectancy (Seuring et al., 2015). It is highly prevalent in the United States, affecting 14.6 % of adults aged 20 and older (Cheng et al., 2019). Approximately 31 million people aged 20–79 have diabetes, and projections estimate this number will rise to 36 million by 2045 (Saaedi et al., 2019). Type 2 diabetes constitutes 91.2 % of these cases (CDC, 2020). While evidence indicates a diabetes diagnosis prompts healthier behaviors such as increased physical activity, smoking cessation, and reduced alcohol consumption (Dontje et al., 2016; Xiang, 2016), scant research has examined whether it also increases the use of secondary preventive care services like blood sugar tests, blood pressure tests, and flu vaccinations. Yet, as secondary preventive care, regular monitoring of blood pressure and blood sugar after a diabetes diagnosis can help manage the progression of the disease (Fenton et al., 2016; Buse et al., 2007).

Depression may affect the relationship between a diabetes diagnosis and preventive care utilization. Depression is the most common mental health comorbidity of diabetes (de Alba et al., 2020). Individuals with type 2 diabetes are twice as likely to experience depression as those without diabetes (Aschner et al., 2021; Chireh et al., 2019). Previous studies have mixed findings regarding the direction of this relationship. One study attributed the link to the change in life routines and

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https://doi.org/10.1016/j.pmedr.2025.103047
Received 18 November 2024; Received in revised form 19 March 2025; Accepted 20 March 2025
Available online 25 March 2025

difficulties in adhering to various medical and behavioral regimens after the diabetes diagnosis (Aschner et al., 2021). Some studies, including systematic reviews, have shown that diabetes is an independent risk factor that increases the risk of depression with the psychological trauma following the diabetes diagnosis (Chireh et al., 2019). Other studies considered depression to be a risk factor that contributes to the development of diabetes (Knol et al., 2006; Golden et al., 2008). Most likely, the relationship between diabetes and depression is bidirectional (Beran et al., 2022). Understanding how depression affects the use of preventive care with the potential to improve the management of the disease among people with diabetes will add to our understanding of this relationship, as well as offer guidance for potential interventions to improve people's lives.

2. Theoretical frameworks and empirical evidence

The teachable moment concept suggests that health diagnoses can serve as wake-up calls for critical lifestyle changes (Newsom et al., 2012). A teachable moment occurs when individuals reevaluate their health choices and develop positive actions to improve health in response to a health event, typically one they perceive as negative (McBride et al., 2008). Research showing increased physical activity, smoking cessation, and reduced alcohol consumption in patients following diabetes diagnosis (Dontje et al., 2016; Xiang, 2016) suggests it constitutes a teachable moment. As such, a teachable moment is an appropriate theoretical framework to examine the utilization of secondary preventive care in response to diabetes diagnosis.

The Cognitive Model of Depression (CMD) points to a mechanism that may disrupt the teachable moment in patients with depression. According to CMD, individuals with cognitive distortion tend to result in negative self-perceptions and exacerbate depressive symptoms (Gautam et al., 2020). As a result of depression, individuals tend to engage in less healthy behaviors, such as riskier behaviors and poorer medical adherence (Can Gür and Okanli, 2019). Thus, the link between depression and diabetes may disrupt the valuable relationship between diabetes diagnosis and the screenings that these patients need.

3. The present study

Combining the two conceptual/theoretical frameworks, we hypothesize, first, that a diabetes diagnosis increases the likelihood of preventive care utilization. Second, depression mediates the relationship between a diabetes diagnosis and preventive care utilization. Thus, we hypothesize that a diabetes diagnosis increases depressive symptoms and, in turn, depressive symptoms decrease preventive care utilization. Depressive symptoms, then, act as a mediator that is positively related to a diabetes diagnosis but negatively related to preventive care utilization.

As we hypothesize that depressive symptoms are positively related to a diabetes diagnosis and negatively related to preventive care utilization, we use the *inconsistent mediation* model to test these opposing relationships of mediation. Inconsistent mediation refers to the mediation effect when the mediated and direct effects have opposite signs (MacKinnon et al., 2000; Wang and Shen, 2017). Such opposite effects can cancel each other and thus make the total effect close to zero or insignificant. Therefore, using inconsistent mediation enables us to examine depressive symptoms as being positively related to a diabetes diagnosis and negatively associated with preventive care utilization.

The hypotheses for the study are as follows:

- **H1**: A diabetes diagnosis is positively associated with the utilization of preventive care services.
- **H2.1**: A diabetes diagnosis is positively associated with depressive symptoms.
- **H2.2**: Depressive symptoms are negatively associated with preventive care utilization.

4. Methods

4.1. Data and sample

The National Longitudinal Survey of Youth 1979 (NLSY79) provides a nationally representative sample of individuals aged 14 to 22 at their initial interview in 1979, with an original sample size of 12,686. Participants were interviewed annually until 1994 and biannually after that (Rothstein et al., 2019). The final sample comprised 6995 participants. Since this study uses publicly available NLSY79 data, it is exempted from the institutional review by University of Illinois at Urbana-Champaign and Southern Illinois University Carbondale.

4.2. Measures

4.2.1. Dependent variables

Preventive health care services utilization. Participants were asked, "During the past 24 months, have you had any of the following medical tests or procedures?" Five variables were selected when participants turned 52, which occurred throughout four waves (2010–2016). The five preventive health care services used for examining preventive care utilization are blood pressure, cholesterol, blood sugar tests, electrocardiogram (ECG), and influenza vaccinations.

Previous studies suggest that disease diagnoses influence related preventive service use (Xiang, 2016). The selection of these five preventive health services aligns with secondary prevention strategies for diabetes management. Blood sugar testing directly monitors diabetes progression, while blood pressure and cholesterol checks help manage cardiovascular risks, given the high prevalence of hypertension and dyslipidemia among diabetics (Jia and Sowers, 2021). ECG detects cardiac issues, including silent ischemia (Stern and Sclarowsky, 2009). Lastly, since diabetes weakens the immune system, flu vaccination is crucial to prevent severe complications (Dicembrini et al., 2023).

4.2.2. Diabetes diagnosis

Diabetes diagnosis. The diabetes diagnosis was based on responses to the question, "Has a doctor ever told you that you had diabetes or high blood sugar?" with a binary (no vs. yes) answer. Diabetes diagnoses that occurred before the age of 31 and after 49 were excluded from this study to ensure the time intervals necessary for mediation modeling.

4.2.3. Depressive symptoms

Depressive symptoms. The 7-item CES-D short form assessed depressive symptoms at age 50 (2008–2014), with a Cronbach's alpha of 0.80 or higher (Kohout et al., 1993). Depressive symptoms included loss of appetite, trouble concentrating, depression, fatigue, disturbed sleep, sadness, and lack of motivation, with the total score ranging from 1 to 21 (Castro et al., 2012). While many studies use CES-D cutoff points, treating it as a continuous variable preserves variability, better reflects symptom severity, and reduces misclassification risk. NLSY79 created this variable by collecting data from respondents as they turned 50 over multiple years (NLSY79, 2024).

4.2.4. Control variables

Categorical demographic variables included sex (male vs. female), race/ethnicity (Hispanic, Black, and Non-Black-and-Non-Hispanic), education (less than high school, high school, some college, college graduate or higher), marital status (married, divorced, never married), and health insurance (no vs. yes). Reference categories were male, Hispanic, less than high school, married, and no health insurance. Family net income was used as a continuous variable. Health covariate variables included heart problems (no vs. yes) and hypertension (no vs. yes). The samples with pre-1996 diagnoses of either comorbidities or diabetes were excluded from the study to ensure that the disease before age 31 did not complicate the analyses.

4.2.5. Data analysis plan

After descriptive analysis, logistic regression models were used to test the total effect, starting with a basic model that included only diabetes diagnosis and one of five preventive services. Covariates were then added in different combinations to identify the best-fitting model. Next, the total effect was decomposed into (1) the direct effect of diabetes on preventive care use and (2) the indirect effect via depressive symptoms. The product of indirect effects was compared to the direct and total effects. Each preventive service was analyzed separately using mediation models, with the best-fitting model determined by AIC and BIC scores. Indirect effects were computed as the product of ORs for both pathways –diabetes to depressive symptoms and depressive symptoms to preventive care use. All analyses were conducted using R statistical software (v4.3.0; R Core Team, 2023).

5. Results

As shown in Table 1, data for diabetes diagnoses and depressive symptoms were derived from the NLSY79 Health 50+ module, which was collected across four waves when respondents turned 50, namely, 2008 (n = 1531), 2010 (n = 1794), 2012 (n = 1945), and 2014 (n = 1725). With control variables created at age 48 and dependent variables created at age 52, such a data organization maintains a two-year interval for temporal separation. To focus on middle-life diagnoses, we excluded 129 respondents diagnosed with hypertension, diabetes, or heart problems before 30 or after 49. Table 2 presents the descriptive statistics of the distribution of preventive care utilization by types of diagnosis.

Table 3 presents how a diabetes diagnosis influences preventive care utilization, with the basic and best-fit models reported. The best-fit model included race, gender, education, marital status, health insurance, hypertension, and heart disease as control variables.

The results showed that diabetes diagnosis increases the odds for all five preventive care service utilization types: blood sugar tests (OR = 6.85, 95 % CI [4.60, 10.67]), cholesterol (OR = 2.95, 95 % CI [2.11, 4.20]), blood pressure (OR = 2.56, 95 % CI [1.46, 4.94]), influenza vaccinations (OR = 1.85, 95 % CI [1.47, 2.32]), and ECGs (OR = 1.71, 95 % CI [1.36, 2.15]).

Table 4 presents the best-fitted mediation results. Depressive symptoms mediate the association between diabetes and influenza vaccinations, blood pressure, and ECG tests. However, for blood pressure tests, depressive symptoms acted as an inconsistent mediator. Thus, the result of path c when unmediated was a smaller value than that of path c', suggesting that path c was a suppressed result. This suppressed result is typical when inconsistent mediations exist (MacKinnon et al., 2000). As the total effect between a diabetes diagnosis and the blood pressure test, the odds ratio (OR = 2.56) resulted from depression counteracting the total effect. By contrast, mediations between a diabetes diagnosis and ECG tests, as well as influenza vaccinations, are supported in both cases. Paths c' to both ECG tests and influenza vaccinations are smaller than their respective paths c, showing partial strengths of the total effects have been mediated through their respective paths of mediation.

Depressive symptoms are a partial mediator with a significant indirect effect for influenza vaccinations (OR = 1.40), ECG tests (OR = 1.41), and blood pressure tests (OR = 1.34). Thus, a diabetes diagnosis is associated with an increase of 40 % in influenza vaccinations, 41 % in ECG tests, and 34 % in blood pressure tests after depressive symptoms. Depressive symptoms form a regular mediation relationship with influenza vaccinations and ECG tests.

The mediation effect of depressive symptoms on the relationship between a diabetes diagnosis and blood pressure tests is classified as inconsistent mediation. While a diabetes diagnosis increases the likelihood of depression by 37 % (OR = 1.37, 95 % CI [1.32–1.43]), each unit increase in depression decreases the likelihood of utilizing blood pressure tests by 3.84 %. This inconsistent mediation helps explain why the direct effect of a diabetes diagnosis on blood pressure test utilization (OR = 2.60, 95 % CI [1.48–5.04]) is slightly larger than the total effect (OR = 2.56, 95 % CI [1.46–4.94]).

The effect sizes of the mediation are small according to Cohen's d cutoff standards (Preacher and Kelley, 2011), with the effect size of the mediation effect for influenza vaccination being 0.03 and 0.04 for ECG tests. Even though a one-point increase in depressive symptoms raises the odds of ECG tests by 1.03, a score of 7 (compared to 0) increases the odds by 1.23, assuming all other predictor variables remain constant.

6. Discussion

This study uses mediation analysis to examine the relationship between a diabetes diagnosis and the utilization of five types of preventive care services, with depressive symptoms as a possible mediator. With the benefit of the longitudinal data, the study investigated the total effect of a diabetes diagnosis on preventive care utilization and the mediating effect of depressive symptoms. Results confirmed the primary hypothesis that a diabetes diagnosis positively impacts all five types of preventive care utilization, which supports the theoretical teachable moments framework.

In addition, the study partially supported the Cognitive Model of Depression in that a diabetes diagnosis tends to increase the likelihood of depressive symptoms. Contrary to the expectations model, however, depressive symptoms did not reduce the use of all five types of preventive care services. Instead, depressive symptoms only lowered the likelihood of blood pressure testing—the reasons why depressive symptoms led to increased use of influenza vaccination and ECG tests remain unclear.

Previous studies have shown that people are more likely to change behaviors directly related to their specific diagnosis. For example, Xiang (2015) found that people with lung diseases are more likely to reduce smoking than alcohol consumption. Our research findings align with this: a diabetes diagnosis has a far greater impact on the likelihood of blood sugar tests (OR = 6.85, 95 % CI [4.60–10.67]) than on ECG tests (OR = 1.71, 95 % CI [1.36–2.15]). Such varying strengths of associations have important implications for predicting the types of preventive care utilization behaviors associated with different diagnoses.

Factors not explored in this study, such as an increase in doctors' recommendations or family members' suggestions for patients with depressive symptoms, could explain the increased use of preventive care services in the cases of influenza vaccinations and ECG tests. Future studies should investigate such explanations.

Table 1
Timeline of data collection and sample sizes for control variables, diabetes diagnosis, depressive symptoms, and outcomes among midlife adults in the United States (2006–2016).

Year of Variables Collected (Wave)	Control Variables (n)	Diabetes Diagnosis (n)	Depressive symptoms (n)	Outcomes (n)
2006	1531	–	–	–
2008	1794	1531	1531	–
2010	1945	1794	1794	1531
2012	1725	1945	1945	1794
2014	–	1725	1725	1945
2016	–	–	–	1725
Total sample size of the present study	6995	6995	6995	6995

Note. a. Final data excluded those diagnosed with diabetes, hypertension, and heart problems before 1996. A total of 119 participants were excluded from the baseline to ensure all respondents were above 30 years and free from heart problems, diabetes, and hypertension.
b. "-" means the years when data was not collected. To create temporal separation, control variables were drawn from 2006 to 2012, depressive symptoms (mediating variable) from 2008 to 2014, and outcome variables from 2010 to 2016. See text for more details on sample selection.

Table 2
Descriptive statistics of preventive care utilization and health conditions of midlife adults ($n = 6995$) in the United States (2006–2016) (Percentages in Parentheses).

Variables	Influenza Vaccination		Cholesterol Test		Blood Pressure Test		Blood Sugar Test		Electrocardiograph Test		
	NO *n (%)*	YES *n (%)*	NO *n (%)*	YES *n (%)*	NO *n (%)*	YES *n (%)*	NO *n (%)*	YES *n (%)*	NO *n (%)*	YES *n (%)*	Missing *n (%)*
Depressive symptoms											70 (1.0)
Mean	3.7 (4.4)	4.0 (4.6)	3.8 (4.5)	3.9 (4.5)	3.7 (4.4)	3.9 (4.5)	4.2 (4.9)	3.8 (4.4)	3.6 (4.3)	4.3 (4.8)	
Hypertension											1172 (16.8)
No	2520 (77.0)	1815 (71.7)	1390 (84.2)	2937 (70.9)	1636 (84.1)	2661 (69.8)	466 (88.3)	3868 (73.3)	2963 (79.1)	1361 (66.6)	
Yes	754 (23.0)	717 (28.3)	261 (15.8)	1206 (29.1)	309 (15.9)	1149 (30.2)	62 (11.7)	1410 (26.7)	782 (20.9)	684 (33.4)	
Heart problem											13 (0.2)
No	3658 (94.7)	2873 (92.6)	1775 (96.2)	4745 (93.0)	2065 (95.4)	4408 (93.1)	553 (96.2)	5978 (93.6)	4218 (97.3)	2296 (88.0)	
Yes	204 (5.3)	228 (7.4)	70 (3.8)	358 (7.0)	100 (4.6)	329 (6.9)	22 (3.8)	410 (6.4)	117 (2.7)	313 (12.0)	
Diabetes											360 (5.1)
No	3448 (92.5)	2543 (88.0)	1719 (95.9)	4259 (88.6)	2083 (97.8)	3849 (87.0)	539 (95.7)	5452 (90.1)	3855 (92.6)	2122 (87.1)	
Yes	279 (7.5)	346 (12.0)	74 (4.1)	550 (11.4)	47 (2.2)	576 (13.0)	24 (4.3)	601 (9.9)	308 (7.4)	313 (12.9)	
Missing n (%)	19 (0.3)		34 (0.5)		19 (0.3)		81 (1.2)		39 (0.6)		

Table 3
Logistic regression results examining the association between diabetes diagnosis and preventive care utilization of midlife adults in the United States (2006 to 2016).

	Influenza Vaccination	Cholesterol Test	Blood Pressure Test	Blood Sugar Test	Electrocardiograph Test
	OR (CI 95 %)				
Basic Model: Diabetes	1.68 (1.43–1.99)	3.00 (2.35–3.88)	2.48 (1.67–3.86)	6.63 (4.96–9.09)	1.85 (1.56–2.18)
Best Model: Diabetes	1.85 (1.47–2.32)	2.95 (2.11–4.20)	2.56 (1.46–4.94)	6.85 (4.60–10.67)	1.71 (1.36–2.15)

Note. Model comparison information: Basic Model: unadjusted model, with each preventive care utilization regressed on the diabetes diagnosis. The best model with the lowest AIC and BIC included all the variables: age, sex, race/ethnicity, education, marital status, health insurance, family net income, heart problems and hypertension.

Table 4
Mediated and total effects of diabetes diagnosis on preventive care utilization among midlife adults in the United States (2006–2016).

	Influenza Vaccination	Cholesterol Test	Blood Pressure Test	Blood Sugar Test	Electrocardiograph Test
OR (95 % CI)					
Indirect Path a	1.37 (1.32–1.43)				
Indirect Path b	1.02 (1.00–1.03)	0.99 (0.98–1.01)	0.98 (0.95–1.00)	1.00 (0.98–1.02)	1.03 (1.02–1.05)
Direct Effect	1.80 (1.43–2.26)	2.94 (2.11–4.20)	2.60 (1.48–5.04)	6.81 (4.57–10.61)	1.65 (1.31–2.08)
Total Effect	1.85 (1.47–2.32)	2.95 (2.11–4.20)	2.56 (1.46–4.94)	6.85 (4.60–10.67)	1.71 (1.36–2.15)

Note. Indirect Path a refers to the relationship between diabetes diagnosis and depressive symptoms. Indirect Path b refers to the relationship between depressive symptoms in each one of the five preventive care utilization. The direct effect is the effect of a diabetes diagnosis on preventive care utilization, with depression added on as the mediator. The total effect was the effect of a diabetes diagnosis on preventive care utilization without depression as the mediator. Odds Ratios (OR) of the total effects and each path are reported.

Further, the inconsistent mediation of depressive symptoms and the relationship between diabetes diagnosis and blood pressure tests raises questions about the multiple mechanisms that might hide under the surface. People with depressive symptoms may engage less in healthy behaviors, such as preventive care, and different severity levels of their depressive symptoms likely influence these behaviors differently. Furthermore, interactions between depressive symptoms and a diabetes diagnosis may function differently across various levels of depressive symptoms. If such interactions help explain the differing mediation effects, then the potential moderating role of depressive symptoms warrants further examination. Moreover, the observed mediation effects may vary by depressive symptoms severity or result from interactions with diabetes, leading to combined effects.

Despite the small effect sizes of the mediation efforts of depressive symptoms for three types of preventive care utilization, the main relationship remains significant. This implies that the impact of a diabetes diagnosis on preventive care prevails despite the impact of depressive symptoms. The finding suggests that interventions may focus more on strengthening the impact of a teachable moment on a diagnosis. Results regarding doctor-patient communication also support this implication for interventions, as past research shows that doctors' recommendations can positively affect patients' health behaviors (Stange, 2018).

Given the small effect size of depressive symptoms as a mediator, future studies should consider how doctor-patient relationships, patients' other social relationships, and the traceable "teachings" or "learning" moments that health professionals recommended to patients or that patients adapted to cope with their newly diagnosed health conditions can strengthen teachable moments.

This study has several limitations. This study focused on depressive symptoms as the sole mediator, though its small effect size suggests other mediators, such as self-efficacy and mastery, should be explored. The CES—D, a screening tool rather than a diagnostic instrument, identifies depressive symptoms but does not confirm clinical depression. Therefore, we use "depressive symptoms" rather than "depression," and

interpretations should not extend to major depressive disorders. Additionally, measuring depressive symptoms only at age 50 limited the use of advanced modeling techniques.

The study also faced limitations due to the NLSY79 dataset. Key preventive services, such as kidney function tests and diabetic retinopathy screenings, were unavailable, restricting the scope of analysis. Self-reported data on preventive care and diabetes diagnosis introduced recall and social desirability biases, potentially misestimating associations. Future research should incorporate clinical measures (e.g., HbA1c or medical records) to validate self-reported diabetes status. Furthermore, the dataset did not distinguish between diabetes types or high blood sugar levels, leading to potential misclassification and bias in estimating the relationship between diabetes and preventive care use.

Despite these limitations, this study offers key strengths. Its open framework allows for examining multiple mediators and outcomes, advancing comparative research in preventive care utilization. The use of longitudinal data strengthens causal inferences compared to cross-sectional studies. Additionally, applying inconsistent mediation expands mediation research and aligns with the Teachable Moments framework and the Cognitive Model of Depression. By differentiating five types of preventive services, this study highlights the value of a comparative approach, providing insights for targeted interventions and future research.

7. Conclusions

By employing an inconsistent mediation framework, this study accounts for the possibility that the mediator (depressive symptoms) has divergent effects on the relationships between the independent variable (diabetes diagnosis) and the dependent variables (preventive care utilization). The study shows that diabetes diagnosis impacts the utilization of five types of preventive care services. In that sense, it acts as a teachable moment. However, depressive symptoms do not act as a mediator in all the ways hypothesized. It lowers the likelihood of blood sugar and cholesterol tests, which are closely related to diabetes. In contrast, people with depressive symptoms appear to be more likely to receive ECG tests and influenza vaccinations. Future studies should investigate whether these unexpected results might be due to different recommendations and prescriptions from doctors as they consider necessary or important for people with diabetes to use. More studies can also replicate studies on different data sets to illuminate the complex relationship that depressive symptoms play in the ultimate well-being of a vulnerable and growing population.

CRediT authorship contribution statement

Kang Sun: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Min Zhan:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Conceptualization. **Flavia Cristina Drumond Andrade:** Writing – review & editing, Validation, Supervision, Methodology, Investigation, Conceptualization.

Funding information

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The National Longitudinal Survey of Youth 1979 is publically available dataset.

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