



Changes in Precarious Employment and Health in the United States Amidst the COVID-19 Pandemic

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ABSTRACT

This study aimed to investigate the association between changes in employment precariousness and changes in health amidst the COVID-19 pandemic. We conducted an online survey of 623 U.S. adults at-risk for cardiovascular disease, which queried respondents on employment, food insecurity, and blood pressure measurements in the Fall of 2020 and retrospectively, in February 2020. Respondents were also queried on perceived stress in the Fall of 2020. We created a multidimensional precarious employment score (PES) using 13 survey indicators, that operationalized the following dimensions of employment precariousness (PES range: 0–13): material rewards, working time arrangements, employment stability, workers' rights, collective organization, interpersonal relations, and training opportunities. Using adjusted linear regression models, we investigated the association between a change in the PES and 1) change in systolic blood pressure, 2) change in pulse pressure, 3) change in food insecurity, and 4) perceived stress. Models controlled for race/ethnicity, age, gender, and education. Results indicated that employment precariousness was 13 % higher between February and Fall 2020, particularly among women and non-Hispanic Black respondents. A change in the PES was associated with a change in food insecurity (β : 0.02; 95 % CI: 0.01, 0.03) and higher perceived stress (β : 0.39; 95 % CI: 0.25, 0.53). The PES was not associated with a change in systolic blood pressure (β : -0.22; 95 % CI: -0.76, 0.32) nor in pulse pressure (β : -0.33; 95 % CI: -0.73, 0.07). Policy approaches to mitigate the growth in employment precariousness, and in turn food insecurity and stress, warrant consideration to prevent widening of health inequities.

1. Introduction

In March 2020, the U.S. began to impose stay-at-home orders to reduce COVID-19 incidence, which resulted in large-scale business closures and changes to the labor market that were often not coupled with an adequate government response. While closures were critical in the short-term, the unintended labor market consequences could affect cardiometabolic risk due to prolonged stress, which could induce a cortisol response, promoting the storage of abdominal fat (Björntorp, 2001), influence blood pressure regulation (Whitworth et al., 2005) and the development of insulin resistance (Phillips et al., 1998; Reynolds and Walker, 2003), as well as increase unfavorable lifestyle habits, such as an increased consumption of cheaper, unhealthful foods (Winkler et al., 2018; Zagorsky, 1997), lower leisure-time physical activity (Cook and Gazmararian, 2018; Antunes et al., 2010), and suboptimal sleep

duration (Winkler et al., 2018).

The changing macroeconomic conditions hit communities already disproportionately burdened by poor health outcomes the hardest. By April 2020, the U.S. unemployment rate hit 14.7 % (US Bureau of Labor Statistics, 2020) with Black women and low-wage workers facing the largest losses in employment (Cajner et al. 2021; Gould and Wilson, 2021). Additionally, for many people in the U.S., employment became more precarious (e.g., lower wages, longer hours, more limited benefits); among those who did not become unemployed, as many as 60 % of individuals reported pay cuts (Cajner et al. 2021). Those in precarious employment prior to the pandemic, were particularly affected by employment disruptions (Andrea et al., 2022; Parker et al., 2020). In a nationally representative sample of older adults, 15 % reported changes in their hours, 29 % reported decreased income, and relative to White men with higher education, Black and Hispanic women were 14 % and

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59 % more likely to report changes to their hours or days worked, respectively (Andrea et al., 2022). Moreover, these older workers who experienced some combination of decreases in income, schedule changes, and job loss were more likely to be engaged in precarious jobs prior to the pandemic (Andrea et al., 2022). In a second nationally representative sample, 44 % of Hispanic and 32 % of Black individuals reported that someone in their household had taken a pay cut because of the pandemic, compared to 29 % of White Americans (Parker et al., 2020). It is also plausible that with widespread business closures, individuals were pushed into employment with more limited benefits, compared to their employment pre-pandemic.

Even prior to the COVID-19 pandemic, employment had become more precarious in the U.S. (Oddo et al., 2021), with women and people of color disproportionately experiencing employment precariousness (Andrea et al., 2021a,b; Eisenberg-Guyot et al., 2020; Oddo et al., 2021). These prior U.S.-based investigations suggest that employment precariousness is associated with worse mental and physical health (Andrea et al., 2021; Eisenberg-Guyot et al., 2020; Oddo et al., 2023; Peckham et al., 2019). Given the inequitable effects of the pandemic on the labor market, adverse changes in employment conditions stand to exacerbate existing inequities in cardiometabolic risk.

Notably, increases in blood pressure have been reported following the pandemic (Fosco et al., 2020; Laffin et al., 2022; Shah et al., 2022; Zhang et al., 2021). In the U.S., an analysis of home blood pressure data from 72,706 participants found that blood pressure rose modestly early in the pandemic (Shah et al., 2022). A second U.S.-based study found that among participants in an employer-sponsored wellness program, systolic and diastolic pressure increased between April to December 2020 (versus 2019) (Laffin et al., 2022). While these analyses provided initial insights into the cardiometabolic risk of Americans amidst the pandemic, prior studies used samples that were predominantly non-Hispanic White (or unknown), employed, and older and they did not measure the potential mechanisms through which the pandemic-induced labor market changes could affect blood pressure.

The objective of this paper was twofold. First, we described changes in employment precariousness over the initial course of the pandemic in a racially/ethnically diverse sample, at-risk for or diagnosed with hypertension. Second, we investigated the association between change in employment precariousness and health. We hypothesized that stay-at-home orders and the resultant labor market changes, would result in employment that is more precarious on average, which in turn, would be associated with higher perceived stress, food insecurity (a diet proxy), and blood pressure. Small increases in blood pressure are associated with an increased incidence of cardiovascular events, which is particularly concerning for people of color, who are already disproportionately at higher risk (Prospective Studies Collaboration, 2002). A better understanding of the association between employment precariousness and cardiometabolic health, amidst the COVID-19 pandemic, is important for informing interventions to mitigate any potential widening of health disparities.

2. Methods

2.1. Overview and data collection

We conducted an online survey of U.S. adults at-risk or diagnosed with for hypertension between August and October of 2020. Survey questions queried respondents on employment, perceived stress, food insecurity, and demographic characteristics. Because we were interested in understanding changes employment precariousness in relation to changes in health amidst the pandemic, we asked respondents already tracking their blood pressure to report systolic and diastolic blood pressure measurements. Individuals were recruited using 1) targeted banners in a blood pressure tracking application or 2) targeted social media ads on Facebook. Inclusion criteria included: being ≥ 18 years old, employed in February 2020, and ongoing home monitoring of blood pressure.

2.2. Survey Questions

Employment Precarity (measured Fall 2020 and recalled pre-COVID). Precarious employment is commonly characterized by a multitude of adverse employment conditions, including low wages, non-standard working hours (e.g., hours that are unpredictable, excessive, or inadequate), few fringe benefits and limited protections. Survey questions included indicators of employment precariousness pre-pandemic (February 2020) and in the Fall of 2020 and aimed to capture the following dimensions: material rewards, working time arrangements, employment stability, workers' rights, collective organization or empowerment, interpersonal relations, and training and employability opportunities (Julià et al., 2017). Questions were adapted from nationally representative surveys and designed to be consistent with prior literature (Andrea et al., 2021; Eisenberg-Guyot et al., 2020; Oddo et al., 2021; Peckham et al., 2019).

Questions are detailed in Table 1 and Supplemental File 1 and queried respondents on annual income from their job, employment type (e.g., contractor), having a second job, hours worked per week, fringe benefits, overtime pay, labor union participation, supervision of other employees, decision making freedom, chances for promotion, and paid training or education opportunities. We also asked respondents if they were able to work remotely in the Fall of 2020, whether they perceived that their employment conditions differed, and if they experienced job loss, furlough, or reduced hours.

Blood Pressure (measured Fall 2020 and pre-COVID). Study respondents were already tracking their blood pressure for the following reasons: having been diagnosed with high blood pressure; being

Table 1
Employment-Related Survey Questions.

Survey Questions	Values ¹
1. What was your annual income from this job before taxes (e.g., \$25,000 - \$34,999, \$35,000 - \$49,999)?	1 = < \$75,000
2. In addition to income/wages, were you eligible to receive: health insurance (y/n)?	1 = no health insurance
3. In addition to income/wages, were you eligible to receive: pension/retirement plan (y/n)?	1 = no retirement plan
4. In addition to income/wages were you eligible to receive paid vacation (y/n)?	1 = no paid vacation
5. How many hours a week did you usually work, at all jobs (e.g., 20-30 h/week, 30-40 h/week, 40-50 h/week)?	1 = <30 hr or >50 hr week
6. Did you work at more than one job (y/n)?	1 = >1 job
7. How would you describe your work arrangement in your main job (e.g. consultant, permanent employee, on call)?	1 = non-permanent employee (e.g. independent contractor, on call, temp)
8. If you were to work more hours than usual during some week, would you: get paid for those extra hours, get time off later, get no compensation for the extra hours?	1 = no compensation
9. Did you belong to a labor union?	1 = no labor union
10. As an official part of your main job, did you supervise the work of other employees or tell other employees what work to do (y/n)?	1 = does not supervise
11. Did your job allow you to take part in making decisions that affect your work (e.g., your schedule) (y/n)?	1 = does not make decisions
12. In addition to income/wages were you eligible to receive training or education (y/n)?	1 = no training
13. For your main job, were the chances for promotion good (y/n)?	1 = no chances for promotion

¹ The precarious employment score ranged from 0 to 13, with 13 indicating the most precarity.

monitored for high blood pressure; were pregnant; having been diagnosed with type 2 diabetes; or other (e.g., family history of hypertension). Respondents reported systolic and diastolic readings from their tracking system on February 15th (or nearest measurement) and August 15th (or nearest measurement).

Food Insecurity (measured Fall 2020 and recalled pre-COVID). Because food insecurity is correlated with diet quality (Hanson and Connor, 2014) and retrospective dietary recall would not be reliable, we use food insecurity as a proxy indicator of diet quality. Responses to food insecurity include changes in the types of foods purchased and consumed (Kendall et al., 1996; Tarasuk and Beaton, 1999). Variety may decrease and the consumption of energy-dense foods may increase, as energy-dense foods are less expensive calorie-for-calorie (Drewnowski and Darmon, 2005; Monsivais and Drewnowski, 2007). Relatedly, prior studies suggest food insecurity is associated with hypertension (Seligman et al., 2010). We used the USDA two-question food security screener questionnaire (Hager et al., 2010). Using a Likert scale (often, sometimes, never), respondents were asked if they were 1) “worried whether food would run out before we got money to buy more” (in last month) or that 2) “the food that we bought just didn’t last, and we didn’t have money to get more” (in last month). Respondents were considered food insecure if they responded in the affirmative (often, sometimes) to either question.

Perceived Stress (measured Fall 2020). We asked respondents about perceived stress at the Fall 2020 timepoint, using the 10-question Perceived Stress Scale (PSS). Respondents were asked how often they felt or thought a certain way using a Likert scale (0 = never, 4 = very often) (range 0 to 40) (Cohen et al., 1994).

Demographics. We collected information on age (18–30, 31–40, 41–50, 51–64, ≥ 65), gender, race/ethnicity (non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, non-Hispanic Native Hawaiian, non-Hispanic American Indian/Alaska Native, Hispanic), educational attainment (≤ highschool, some college, associates, bachelors, graduate), household size, and zipcode.

2.3. Description of key variables

Independent variable. Our primary independent variable was change in employment precariousity. We created the precarious employment score (PES) for each respondent at each timepoint. Similar to prior literature (Oddo et al., 2021), each item was assigned a 1 (versus 0) indicating more precarious employment (Table 1). We summed scores for each survey item, which were equally weighted, and yielded a maximum score of 13 (most precarious). We assigned unemployed individuals a PES of 13, because individuals in more precarious employment often cycle into and out of unemployment (Benach and Muntaner, 2007). We calculated the change in the PES between February and Fall 2020.

Dependent variables. Dependent variables included: 1) change in systolic blood pressure, because it is a reliable indicator of psychological stress (Szanton et al., 2005), 2) change in pulse pressure (systolic - diastolic pressure), 3) change in food insecurity status, and 4) perceived stress.

Confounders and Effect Modifiers. Plausible confounding variables were identified using a directed acyclic graph and included: race/ethnicity, age, gender, and education. Women and people of color are disproportionately burdened by precarious employment (Andrea et al., 2021a,b; Eisenberg-Guyot et al., 2020; Oddo et al., 2021). Therefore, we also investigated variation in the associations by gender and race/ethnicity using interaction terms for each dependent variable.

2.4. Analytic sample

A total of 1,739 participants were initially recruited using a health application (N = 544) and on Facebook (N = 1,195). Individuals were first excluded if they did not meet inclusion criteria (N = 288). Because

surveys shared on social media can be prone to fraud, we included additional consistency checks for those recruited through Facebook; we asked respondents about their zipcode, age, employment status, and income in multiple places and excluded all participants that did not supply consistent responses (N = 724). We additionally excluded 3 individuals who that gave inconsistent answers to employment questions, 12 individuals with implausible blood pressure values, and “don’t know” responses were coded as missing (N = 89). The final analytic sample was 623 individuals.

2.5. Statistical analysis

We estimated descriptive statistics for the overall sample and stratified by gender and race/ethnicity. We employed adjusted linear regression models, with state-clustered standard errors, to estimate whether change in the PES was associated with 1) change in systolic blood pressure, 2) change in pulse pressure, 3) change in food insecurity status, and 4) perceived stress. Our primary models controlled for race/ethnicity, age, gender, and education.

Secondarily, we investigated variation in the associations by race/ethnicity and gender using an interaction term. The interaction term was only statistically significant for the association between employment precariousity and perceived stress by race/ethnicity; therefore, we also present the results for the PES-stress association stratified by race/ethnicity.

We tested the robustness of our primary results when also controlling for state fixed-effects, recruitment strategy, and household size. In our main analyses, we assumed that being unemployed was equivalent to having the most precarious employment because individuals in the most precarious employment often cycle into and out of unemployment; however, it is possible that this assumption over-estimates their level of precariousness and/or unemployment has its own distinct health effects. Thus, we also tested the association when excluding unemployed individuals. We investigated the association between change in the PES and change in systolic blood pressure and pulse pressure when excluding those on antihypertensive medications, as the inclusion of these individuals could attenuate estimates. Finally, we examined change in high blood pressure as a dependent variable (systolic pressure > 130 and/or diastolic pressure > 80 and/or taking an anti-hypertensive medicine) and the cross-sectional association between employment precariousity and outcomes in Fall 2020.

Statistical analyses were performed using Stata 16.1 (StataCorp LP, College Station). Alpha was set to 0.05. The University of Washington Institutional Review Board determined that this study was exempt from review.

3. Results

3.1. Descriptive results

Half of the sample (53 %) were male, 60 % were aged 41 or older, and half had a bachelors (27 %) or graduate (24 %) degree (Table 2). About 60 % of respondents were non-Hispanic White, 25 % were non-Hispanic Black, 11 % were Hispanic, and 6 % were non-Hispanic of another race. Approximately 60 % of the sample earned less than \$100,000, annually. Trends were generally similar by gender and race/ethnicity (Supplemental Table 1) and participation was geographically diverse (Supplemental Table 2).

The average PES was 6.1 (Standard Error [SE]: 0.1) in February 2020, compared to 6.9 (SE: 0.1) in the Fall 2020, indicating more precarious employment overtime (Table 3). At both timepoints the PES was higher among women. In February 2020, non-Hispanic White (PES: 6.2, SE: 0.1) and non-Hispanic Black respondents (PES: 6.2, SE: 0.1) had higher employment precariousity versus Hispanic respondents (PES: 5.9, SE: 0.2) and respondents that were non-Hispanic of another race (PES: 5.2, SE: 0.4). In Fall 2020, the PES was highest among non-Hispanic Black

Table 2
Respondent Characteristics.

	N (%) or Mean (SE) N = 623
Males	333 (53 %)
Age	
18–30	92 (15 %)
31–40	157 (25 %)
41–50	200 (32 %)
51–64	156 (25 %)
65+	18 (3 %)
Race/Ethnicity	
Non-Hispanic White	354 (57 %)
Non-Hispanic Black	158 (25 %)
Hispanic	71 (11 %)
Non-Hispanic Other	40 (6 %)
Education	
≤ High school	91 (15 %)
Some college	101 (16 %)
Associates degree	111 (18 %)
Bachelors degree	171 (27 %)
Graduate degree	149 (24 %)
Household Income	
< \$34,999	19 (3 %)
\$35,000 - \$49,999	88 (14 %)
\$50,000 - \$74,999	101 (16 %)
\$75,000 - \$99,999	152 (25 %)
\$100,000 - \$149,999	118 (19 %)
\$150,000 - \$199,999	87 (14 %)
\$200,000+	55 (9 %)
Mean Household Size	3.4 (0.1)

SE = standard error.

respondents (PES: 7.5, SE: 0.3). About 12 % of the sample became unemployed during the pandemic; higher proportions of females (15 %) versus males (10 %) and non-Hispanic Black (22 %) versus non-Hispanic White (10 %) respondents reported unemployment.

In February 2020, the mean systolic blood pressure was 131 mm Hg

Table 3
Descriptive Employment and Health Outcomes for Full Sample and by Gender and Race.

	All (N = 623)	Males (N = 333)	Females (N = 290)	NH-White (N = 354)	NH-Black (N = 158)	Hispanic (N = 71)	NH-Other (N = 40)
Employment Characteristics							
Mean PES February ¹	6.1 (0.1)	6.0 (0.1)	6.3 (0.1)	6.2 (0.1)	6.2 (0.1)	5.9 (0.2)	5.2 (0.4)
Mean PES Fall ¹	6.9 (0.1)	6.7 (0.2)	7.2 (0.2)	6.9 (0.2)	7.5 (0.3)	6.0 (0.3)	5.5 (0.5)
Able to Work Remote ⁶	269 (49 %)	144 (48 %)	125 (51 %)	182 (51 %)	56 (35 %)	16 (23 %)	15 (38 %)
Self-Perceived EQ Change	308 (49 %)	160 (48 %)	148 (51 %)	143 (40 %)	95 (60 %)	50 (70 %)	20 (50 %)
Became Unemployed	77 (12 %)	34 (10 %)	43 (15 %)	36 (10 %)	34 (22 %)	4 (6 %)	3 (8 %)
Health Outcomes							
Mean Pulse Pressure²							
February 2020	46 (0.7)	47 (0.9)	45 (1.0)	45 (0.9)	42 (1.2)	55 (2.0)	53 (3.0)
Fall 2020	46 (0.7)	48 (0.9)	45 (1.0)	45 (0.9)	43 (1.2)	56 (2.1)	51 (2.7)
Mean Systolic Blood Pressure							
February 2020	131 (0.7)	131 (0.9)	130 (1.0)	130 (0.9)	126 (1.2)	138 (2.4)	139 (4.2)
Fall 2020	130 (0.7)	131 (1.1)	128 (1.0)	129 (0.9)	127 (1.3)	140 (2.9)	133 (3.3)
High Blood Pressure³							
February 2020	546 (88 %)	293 (88 %)	253 (87 %)	308 (87 %)	144 (91 %)	61 (86 %)	33 (83 %)
Fall 2020	570 (91 %)	299 (90 %)	271 (93 %)	317 (90 %)	155 (98 %)	64 (90 %)	34 (85 %)
Perceived Stress⁴							
Mean PSS Fall 2020	19 (0.2)	18 (0.3)	19 (0.3)	18 (0.3)	19 (0.4)	19 (0.8)	20 (0.8)
Food Insecure⁵							
February 2020	143 (23 %)	72 (22 %)	71 (24 %)	72 (20 %)	23 (15 %)	36 (51 %)	12 (30 %)
Fall 2020	152 (24 %)	81 (24 %)	71 (24 %)	65 (18 %)	26 (16 %)	41 (58 %)	20 (50 %)

NH = non-Hispanic; PES = precarious employment score; PSS = Perceived Stress Scale; SE = standard error.

¹ Range: 0–13, with 13 indicating the highest employment precarity.

² Defined as systolic - diastolic pressure.

³ Defined as systolic pressure \geq 130 and/or diastolic pressure \geq 80 or taking an anti-hypertensive medicine.

⁴ Measured using the 10-question perceived stress scale (range 0–40).

⁵ Answered in the affirmative to either: 1) we worried whether food would run out before we got money to buy more (in last month) or 2) the food that we bought just didn't last, and we didn't have money to get more (in last month).

⁶ Missing Values N = 77

(SE: 0.7) in the full sample and was slightly lower (130 mm Hg, SE: 0.7) in Fall 2020. In February of 2020, 88 % of the full sample had high blood pressure and the prevalence of high blood pressure was somewhat higher (91 %) in the Fall of 2020. The prevalence of high blood pressure was highest among non-Hispanic Black respondents at both timepoints.

The average perceived stress score was 19 (out of 40) among the full sample, and similar by gender and race/ethnicity. One-quarter of the full sample were food insecure at both timepoints. Food insecurity was higher among Hispanic versus non-Hispanic White respondents.

3.2. Regression-based results

A change in the PES was not associated with a change in systolic blood pressure (β : -0.22; 95 % Confidence Interval [CI]: -0.76, 0.32) nor a change in pulse pressure (β : -0.33; 95 % CI: -0.73, 0.07) in adjusted models (Table 4). However, a change in the PES was associated with a change in food insecurity (β : 0.02; 95 % CI: 0.01, 0.03) and higher levels of perceived stress (β : 0.39; 95 % CI: 0.25, 0.53).

The PES-stress association was of similar magnitude and statistical significance among non-Hispanic White (β : 0.37; 95 % CI: 0.12, 0.61) and non-Hispanic Black (β : 0.37; 95 % CI: 0.17, 0.60) respondents (Supplemental Table 3). The association between change in the PES and perceived stress among Hispanic respondents was higher (β : 1.16; 95 % CI: 0.63, 1.69).

Sensitivities. Unlike our primary results, the PES was negatively associated with pulse pressure in cross-sectional models (β : -0.69; 95 % CI: -1.20, -0.21) (Supplemental Table 4). Results for change in food insecurity and perceived stress were robust in magnitude and statistical significance to the various sensitivity specifications (Table 4). Results were unchanged and not significant when excluding individuals on anti-hypertensive medications. The association between employment precarity and high blood pressure was small in magnitude and not statistically significant (data not shown).

Table 4
Association between Change in Employment Precarity and Health Outcomes¹.

	N	β (95 % Confidence Interval)			
		Change in Systolic Pressure	Change in Pulse Pressure	Perceived Stress Scale ²	Change in Food Insecurity ³
Change in PES	623	-0.22 (-0.76, 0.32)	-0.33 (-0.73, 0.07)	0.39 (0.25, 0.53) *	0.02 (0.01, 0.03) *
Sensitivities					
Controlling for state fixed-effects	623	-0.36 (-0.94, 0.21)	-0.36 (-0.81, 0.08)	0.40 (0.21, 0.59)*	0.02 (0.01, 0.03) *
Controlling for recruitment method	623	-0.23 (-0.78, 0.32)	-0.32 (-0.72, 0.08)	0.37 (0.23, 0.51)*	0.02 (0.01, 0.03) *
Controlling for household size	623	-0.23 (-0.76, 0.32)	-0.33 (-0.73, 0.07)	0.39 (0.23, 0.55)*	0.02 (0.01, 0.03) *
Without unemployed	546	-0.26 (-1.20, 0.70)	-0.26 (-1.22, 0.70)	0.38 (0.05, 0.72) *	0.03 (0.01, 0.05) *
Excluding those on anti-hypertensive medication	298	-0.43 (-1.09, 0.23)	-0.33 (-0.84, 0.18)	—	—

PES = precarious employment score.

*p < 0.05.

¹ PES (range: 0–13) measured in February 2020 and Fall 2020. Estimated using linear models with state-clustered standard errors, controlling for race/ethnicity, age, gender, and education.

² Measured using the 10-question perceived stress scale (range 0–40).

³ Answered in the affirmative to either: 1) we worried whether food would run out before we got money to buy more (in last month) or 2) the food that we bought just didn't last, and we didn't have money to get more (in last month).

4. Discussion

We described changes in employment precarity over the initial course of the pandemic, among a sample of people at-risk for or diagnosed with hypertension, as well as investigated the association between changes in employment precarity and health. Employment precarity was 13 % higher in the Fall of 2020, compared to February 2020 (PES changed from 6.1 to 6.9). In particular, the change in employment precarity was 14 % higher among women and 21 % higher among non-Hispanic Black respondents. Notably, higher employment precarity could stem from a change in quality in the same job and/or changing jobs. Compared to pre-pandemic, the prevalence of high blood pressure was 3.5 % higher in the Fall of 2020 in the sample overall (88 % to 91 %), and ~ 7 % higher among women (87 % to 93 %) and non-Hispanic Black (91 % to 98 %) respondents; however, results relating changes in employment precarity to changes in blood pressure were not significant. We did consistently find that a change in employment precarity was associated with a change in food insecurity and higher levels of perceived stress, which may have important implications for chronic-disease related health.

Our findings that employment became more precarious overall, and particularly among women and non-Hispanic Black respondents, are consistent with prior surveys reporting that people of color and women faced the largest losses in employment and a slower job recovery, (Center on Budget and Policy Priorities, 2020; Gould and Wilson, 2021) as well as data indicating that Black Americans were more likely to take a pay cut during the pandemic (Parker et al., 2020). They are also generally consistent with one prior study finding that older adults of color were more likely to experience adverse COVID-19-related changes in employment conditions (e.g., changes to their hours) (Andrea et al., 2022). Black and female workers likely experienced larger layoffs and pay cuts from the stay-at-home measures, in part, because of long-

standing occupational segregation in the U.S., where people of color and women are over-represented in occupations like food service and transportation, which could not be done remotely and were especially impacted by lockdowns (e.g., restaurant closures). At the same time, unexpectedly, non-Hispanic White individuals experienced higher employment precarity than Hispanic individuals; this may be due to the overrepresentation of high-income and high education among Hispanic individuals in this sample (Supplemental Table 1).

Additionally, our findings are consistent with those from Andrea and colleagues who reported that older adults who experienced job loss with decreased income or continued in-person employment with decreased income had a greater prevalence of food insecurity (Andrea et al., 2022). Decreased or lower-income, a characteristic of precarious employment, is a driver of food insecurity. As of April 2020, national estimates of food insecurity more than tripled to 38 % (Fitzpatrick et al., 2020). Household responses to food insecurity could include changes in diet quality, including reduced intake of fruits and vegetables, which tend to be higher in cost, and increased intake of lower-cost energy-dense foods (Kendall et al., 1996; Tarasuk and Beaton, 1999; Monsivais and Drewnowski, 2007; Drewnowski and Darmon, 2005). Food insecurity is also a stressor (Laraia et al., 2006), which could also result in worsening of diet quality (Khaled et al., 2020). Diet quality is strongly associated with cardiometabolic health (Schwingshackl et al., 2018).

Higher employment precarity was also associated with higher levels of perceived stress. Literature on the association between employment precarity and stress is limited. However, these findings are generally aligned with prior U.S.-based investigations that find that precarious employment is associated with poorer mental health (Andrea et al., 2021; Eisenberg-Guyot et al., 2020; Peckham et al., 2019) and one study from Spain reporting that precarious employment is associated with higher levels of perceived stress (Belvis et al., 2022). Additionally, perceived job insecurity and temporary employment (Bartoll et al., 2019; Ferrie et al., 2005), characteristics of precarious employment, have been associated with perceived stress.

Although we find that employment became more precarious, and this change was associated with changes in food insecurity and perceived stress, in most specifications, changes in employment precarity were not associated with changes in blood pressure. This is somewhat inconsistent with studies reporting both short-term increases (Fosco et al., 2020; Laffin et al., 2022; Shah et al., 2022; Zhang et al., 2021) and decreases (Pengo et al., 2022; Girerd et al., 2022; Feitosa et al., 2022) in blood pressure levels following the pandemic. It is possible that this group of at-risk individuals, already monitoring their blood pressure, would be more likely to make adjustments (e.g., diet, physical activity) or begin taking anti-hypertensive medication if their blood pressure started to increase. Consistent with this explanation, 25 % of respondents reported that they started an anti-hypertensive between February and Fall 2020. It is also plausible that there was some protective effect of expanded unemployment insurance and stimulus payments. While evidence has consistently found associations between employment precarity and mental health in the U.S., (Andrea et al., 2021; Eisenberg-Guyot et al., 2020; Peckham et al., 2019) the investigations between employment precarity and physical health (Oddo et al., 2023) are more limited and it is possible that we were not able to capture changes in physical health over the period of observation or in a relatively small sample. Moreover, with retrospective data of blood pressure measurements, we could not account for the variation in blood pressure throughout the day nor seasonal variation, both of which could contribute to null results.

Nevertheless, findings suggest that the pandemic-related increases in employment precarity could further widen health disparities in the U.S., given that we observed increases in employment precariousness among women and non-Hispanic Black respondents, groups already over-represented in precarious employment, and that employment precarity is associated with adverse health (Andrea et al., 2021; Eisenberg-Guyot et al., 2020; Oddo et al., 2023; Peckham et al., 2019). Additionally, over

the longer-term food insecurity is associated with markers of chronic disease risk, including hypertension, hyperlipidemia and poor glycemic control and perceived stress is also associated with a higher risk of coronary heart disease (Richardson et al., 2012). While both food insecurity and perceived stress could affect lifestyle behaviors, it is also well-established that stressors, like employment precarity, activate the hypothalamic–pituitary–adrenal axis (cortisol) and inflammatory cytokines (Segerstrom and Miller, 2004; Won and Kim, 2016; Miller et al., 2007), which promotes the storage of abdominal fat (Björntorp, 2001) and influences blood pressure regulation (Whitworth et al., 2005) and the development of insulin resistance (Phillips et al., 1998; Reynolds and Walker, 2003).

This study has limitations. First, these analyses used observational data and we are not able to espouse causality to any reported associations. Second, it was a convenience sample drawn from a population at risk for or diagnosed with hypertension. While respondents are geographically and racially/ethnically diverse, the sample is not representative by geography, race/ethnicity, or other demographic characteristics. Moreover, these data are subject to selection bias, in that those who choose to participate are likely different from those who do not participate (e.g., those with lower levels of education or in the most precarious employment). Third, we asked participants to look at their recorded blood pressure measurements and report the measurements taken on specific dates; because these were retrospective measurements, we could not specify the time of day of collection (or account for that variation between respondents), nor account for seasonable variation in blood pressure measurement, and their self-reporting of measurements may be prone to error. Fourth, the survey relies on retrospective recall of employment conditions, which may be subject to recall bias. Fifth, the PSS asks respondents about the prior 30 days; we did not think that people would be able to accurately recall pre-pandemic stress levels. Despite limitations, this study provided new insights into changes in employment precarity, using a multidimensional indicator, and whether changes in employment precarity were associated with health during COVID-19 pandemic.

5. Conclusions

In this sample, employment precarity increased during the pandemic, particularly among women and non-Hispanic Black respondents. We also found that changes in employment precarity were associated with a change in food insecurity and higher levels of perceived stress, which could adversely affect health. It will be important to consider policy approaches to mitigate the potential growth in employment precarity, and in turn, food insecurity and stress, to prevent further widening of health inequities.

CRedit authorship contribution statement

Vanessa M. Oddo: Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Jessica C. Jones-Smith:** Methodology, Writing – review & editing. **Melissa A. Knox:** Data curation, Formal analysis, Methodology, Writing – review & editing.

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

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.pmedr.2023.102113>.

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