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BRIEF REPORT

The Great Recession and Allostatic Load in the United States

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Generally, recessions are negatively associated with health-related outcomes. This study extends these findings by testing the association between self-reported economic hardships during the Great Recession of 2007–2009 and allostatic load. The recessionary hardships are measured using an index of 17 negative economic events experienced during the 2007–2009 recessionary period and reported in the Midlife in the United States Refresher Survey during 2012–2015. Allostatic load, or physical wear and tear manifested in biomarkers, is measured using 23 biomarkers collected during 2013–2016 in the Midlife in the United States Refresher Biomarker data. Controlling for prerecession satisfaction with life, pre- and postrecession household income, education, demographic and psychological characteristics, the results show a positive association between the index of recessionary hardships and allostatic load. A least absolute shrinkage and selection operator regression is used to assess the relative importance of predictors in explaining allostatic load. Because age is strongly correlated with allostatic load, as expected, age was the most important predictor of allostatic load, followed by the index of recessionary hardships. The dose–response analysis further shows that above the mean of the index of recessionary hardships the association is nonlinear and increasing. The findings indicate that the Great Recession may have contributed to a higher allostatic load among the participants in our sample. Future research investigating underlying mechanisms driving the proposed association is warranted.

Keywords: recession, allostatic load, economic crisis, physical wear and tear

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Over the past decade, studies have increasingly focused on the association between recession and health outcomes (Basu, Carney, & Kenworthy, 2017; Burgard & Kalousova, 2015; Ruhm, 2016). Past research has focused on the influence of recession on health at the multiple levels of analyses. At the individual level, recession influences uptake and intensity of smoking and drinking (Golden & Perreira, 2015; Jofre-Bonet, Serra-Sastre, & Vandoros, 2018), physical activity (Colman & Dave, 2013), subjective well-being (Kirsch & Ryff, 2016), and body mass index (Latif, 2014; Nizalova & Norton, 2017). Recessions are also associated with higher rates of traffic fatalities, homicides, and suicides (He, 2016; Ruhm, 2016; Strumpf, Charters, Harper, & Nandi, 2017). At the county level, studies have found that higher unemployment during a recession is associated higher poverty, crime, and mortality (Sameem & Sylwester, 2017). The country-level studies have also reached somewhat similar inferences (Chang, Stuckler, Yip, & Gunnell, 2013). At the macroeconomic level, studies have found support for a procyclical association between economic conditions and mortality (Ruhm, 2015); however, in recent years, due to the countercyclical increase in cancer and accidental poisoning incidences, there is growing evidence that the shift is acyclical. Reviewing this large body of literature, Ruhm (2015, 2016) concluded that the direction of effect of recessions on a variety of health outcomes remains mixed.

Although the literature has focused on outcomes ranging from smoking and exercise to mortality and morbidities, the association between recession and allostatic load remains unexplored. Allostatic load is a physiological index of wear and tear (McEwen, 1998, 2004, 2007; Seeman et al., 2008) resulting from chronic psychosocial stress that results in "temporal cascade of multi-systemic [neuroendocrine, immune, metabolic, and cardiovascular systems] physiological dysregulations" (Juster, McEwen, & Lupien, 2010, p. 2). A review of past studies on allostatic load is beyond the scope of this work. For a review of the theoretical basis of allostatic load, we refer readers to Juster et al. (2010), and for a review of the empirical operationalizations of allostatic load, we refer readers to Johnson, Cavallaro, and Leon (2017).

Kirsch and Ryff (2016) using Midlife in the United States (MIDUS) Refresher Survey data (2012–2015),[1] found that recessionary hardships were positively related to self-reported chronic conditions, physical health, acute somatic symptoms, and waist circumfer-

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[1] We use MIDUS Refresher Survey data (2012–2015) and MIDUS Refresher biomarker study (2013–2016) in this study.

ence. Building on their work, and drawing on the accumulation of risk model (Cable, 2014; Gruenewald et al., 2012), in this brief report, we hypothesize that the economic hardships experienced during the Great Recession (2007–2009) would be positively associated with allostatic load measured in the mid-2010s. Psychosocial stress from recessionary hardships could accumulate and cumulate to negatively influence a variety of physiological systems, resulting in a higher allostatic load. The allostatic load may, therefore, provide a "better picture of the physiological toll" that recessionary hardships may have on the body (Gruenewald et al., 2012, p. 2). In the following text, we discuss the rationale for the proposed positive association between recessionary hardships during the Great Recession and the postrecession allostatic load.

Considered as the deepest economic crisis since the Great Depression of the 1930s, the Great Recession of 2007–2009 significantly increased economic hardships ranging from home foreclosures and higher debt to job insecurity and unemployment (Ruhm, 2015, 2016). The recession led to the collapse of housing market, mass layoffs, and reduction in work hours. The Dow Jones Industrial Average declined by 53.8% (Grusky, Western, & Wimer, 2011), and the household wealth declined by $17 trillion (Emmons & Noeth, 2013). Officially, the Great Recession started in December 2007 and ended in early 2009; however, exposure to the recession was long-lasting. The economic recovery after the recession was slow (Cynamon & Fazzari, 2016); only 40% of the loss in household wealth was recovered by 2012, and the unemployment rate did not return to prerecession levels until August 2015. For those experiencing recessionary hardships, this long-term exposure to the Great Recession may have increased the psychosocial stress that in turn may have cascaded into physiological wear and tear.

Experiences of hardships such as unemployment, layoffs, job insecurity, and foreclosures are found to influence physical and mental health during the recession. Althouse, Allem, Childers, Dredze, and Ayers (2014) found that for every 1% increase in home foreclosures in a prior month during the Great Recession, Google queries for psychological distress increased by 16%. Yilmazer, Babiarz, and Liu (2015) found that decline in household wealth and difficulties with mortgage payments during the Great Recession were associated with psychological distress and depression. In a sample of European Community Household Panel (1996–2001), Böckerman and Ilmakunnas (2009) found that those becoming unemployed had lower health status than those remaining continually unemployed. Increased job insecurity and financial uncertainty could translate to a variety of health problems, including musculoskeletal disorders, cardiovascular disease, and distress (Caroli & Godard, 2016). The Great Recession is also associated with poor health (Frone, 2018) and chronic health problems (Downing et al., 2017; Niedzwiedz, Katikireddi, Reeves, McKee, & Stuckler, 2017; Seeman et al., 2018). Closely related to this study, using a longitudinal data of elderly participants between 50 and 91 with an average age of 66.7 years in the Multi-Ethnic Study of Atherosclerosis, Seeman et al. (2018) found that economic and social stressors during the Great Recession were associated with an increase in blood pressure and glucose levels.

Indeed, the aforementioned conditions of poorer health and well-being (Juster et al., 2010), stress (McEwen & Seeman, 1999), and socioeconomic risk (Dowd, Simanek, & Aiello, 2009) during the recession are antecedents to allostatic load. Cascading and cumulative experiences of these psychosocial stressors (Burgard & Kalousova, 2015) and the mounting evidence of negative physical and mental health outcomes from the 2007–2009 recession (Mucci, Giorgi, Roncaioli, Fiz Perez, & Arcangeli, 2016), call for testing of the association between recessionary hardships and allostatic load.

We aim to make the following contributions. First, using a comprehensive set of 23 biomarkers and three different operationalizations of allostatic load, we are one of the first to test for this less explored, yet an important, association. The index of 17 recession-related experiences—ranging from losing a job to starting a new job below education/experience to cutting back on spending and from experiencing foreclosure to missing a credit card payment to moving in with family/friends—provides a more comprehensive assessment of multidimensional spillovers from economic hardships during the recession (Kirsch & Ryff, 2016). By using allostatic load as an outcome, we extend previous studies on the effects of recessionary hardships on health and well-being (Kirsch & Ryff, 2016; Seeman et al., 2018).

Second, although previous studies focus on more immediate outcomes following a recession, the current study provides a medium-term assessment, about 4–7 years, after the official end of the recession in early 2009.[2] Due to a slow recovery, the effects of recession continued until 2015. Therefore, its impact on medium-term physiological outcomes is also an important extension of previous work. The association between recessionary hardships and allostatic load could be particularly salient to further understand the "getting under the skin" effects of the recession.

The article is structured as follows. Section 2 presents the data and the variables used in the analyses. Section 3 presents the results, and Section 4 concludes with the discussion of results and limitations.

Data and Method

We draw on the MIDUS Refresher's survey and biomarker data to test for the proposed association (Ryff & Lachman, 2017; Weinstein, Ryff, & Seeman, 2017). MIDUS Refresher is a part of the MIDUS (http://midus.wisc.edu) study. MIDUS I was conducted in 1995, and the participants from MIDUS I were followed in MIDUS II (2000–2006). In 2012, additional participants were recruited as an augmented sample, MIDUS Refresher. One of the purposes of MIDUS Refresher was to collect data on negative economic experiences during 2008 economic recession. The study also collected data from the survey, daily diaries, cognitive and psychological assessments, biomarker and neuroscience data. A detailed description of this rich data set is available in Ryff & Lachman (2017) and Weinstein et al. (2017). The survey data were collected from 3,577 respondents between 2012 and 2015, and the biomarker data were collected from 863 respondents between 2013 and 2016. After merging the two data sets and based on casewise deletion, our final sample includes 526 participants.

[2] MIDUS Refresher Survey conducted between 2012 and 2015 (n = 3,577) includes self-reported negative recession experiences and the biomarker data collected between 2013 and 2016 (n = 863; http://midus.wisc.edu/data/timeline.php). Therefore, biomarkers were measured 4 (2009–2013) to 7 (2009–2016) years after the recession.

Measures

Recently, Johnson et al. (2017), reviewing 26 studies using biomarkers to measure allostatic load and the methods used to operationalize allostatic load, found that both the number of biomarkers and the methods used for calculating allostatic load varied significantly across the 26 studies. On the basis of their study, we include a comprehensive set of all the 23 biomarkers available in MIDUS Refresher Biomarker study and use three different operationalizations of allostatic load: (a) mean of standardized values of biomarkers, where each biomarker is winsorized at 1% of each tail (DV1); (b) those in the fourth quartile of DV1 are coded as 1 and those in the remaining three quartiles are coded as 0 (DV2); and (c) mean of count of biomarkers above or below the recommended cutoffs in Karlamangla et al. (2014; listed in Table A1 in the online supplemental materials, [DV3]). All the three outcomes are based on the sum of biomarkers with nonmissing values divided by the count of respective biomarkers with nonmissing values. The three different operationalizations of the allostatic load measure lower concerns that the inferences are an artifact of the operationalization of allostatic load. In the robustness check, we also operationalize the allostatic load measure by including only the cases where biomarker information was available for all 23 biomarkers. The inferences were consistent with the main inferences. To measure the index of recessionary hardships, based on Kirsch and Ryff (2016), we use a count of 17 negative recessionary experiences (Table A2 in the online supplemental materials).

We include a variety of controls. Because allostatic load increases with age (Crimmins, Johnston, Hayward, & Seeman, 2003), we include age in years as a control. We control for sex (1 = male; 2 = female) because allostatic load may also vary systematically between males and females (McEwen, 2002). Those with higher education (1 = no school to some grade school to 12 = terminal degree) may have higher cognitive capacity and resources (e.g., income) to cope with recessionary hardships and thereby realize a lower allostatic load (Juster et al., 2010). Marital status or companionship may also provide necessary social and emotional support to cope with recessionary hardship (Seeman, Singer, Ryff, Dienberg Love, & Levy-Storms, 2002).

Although we do not have access to longitudinal data before the recession, we control for reported prerecessionary conditions in the survey data. We include life satisfaction before the recession, pre- (in $'000) and postrecession (in $'000) household income, and perceived change in income after the recession (1 = more now; 2 = about the same; 3 = less now).

Psychological resources could help cope with recessionary changes (Kirsch & Ryff, 2016); however, these were reported after 2012, and due to the possibility of recessionary experiences also influencing the reported psychological characteristics in 2012, we do not consider these as buffering factors. Specifically, we include sense of control, conscientiousness, purpose in life, emotion-focused coping, and problem-focused coping as controls (Kirsch & Ryff, 2016). The operationalization of each variable in the study is listed in the Table A3 in the online supplemental materials, and the sample descriptives are listed in Table A4 in the online supplemental materials.

Results

In Table 1, we present the results using stepwise regression models with and without controls. In Model 2 (DV1), we include the index of recessionary hardships ($\beta = 0.025$, $p < .001$, $\Delta R^2 = 0.025$). In Model 3, we include controls, and in Model 4, we introduce the index of recessionary hardships ($\beta = 0.026$, $p < .001$, $\Delta R^2 = 0.021$) along with the controls. In Models 5 and 6, we use a similar approach but with the dichotomous measure of allostatic load (DV2). Here, the effects were again positive and significant. Finally, in Models 9–12, again using a similar approach for the continuous measure of the mean of the count of biomarkers above the cutoff (DV3), we find similar effects. Overall, across the three modes of measuring allostatic load, index of recessionary hardships is positively associated with the allostatic load.

Least Absolute Shrinkage and Selection Operator Regression

We draw on a least absolute shrinkage and selection operator (LASSO) regression to assess the relative importance of the variables in the model (Mander, 2014; Tibshirani, 1996). A forward stepwise regression starts with the assumption that all the βs are equal to zero and then finds a predictor most correlated to the outcome (y), thereafter saving the residuals (residual = y minus predicted(y)). This step is repeated until all predictors in the model are included. A LASSO regression minimizes the sum of squared errors, using the sum of the absolute values of the βs as a bound for increasing coefficient of a predictor until that predictor is no longer the one most correlated with the residual. The result is a "rank" of predictors based on their relative association with the outcome.

Using *lars* routine in Stata 15.1 on DV1, in Figure A1 (in the online supplemental materials), the importance of each variable in predicting allostatic is presented. The earlier the starting point of a curve on the x-axis, the higher its importance in predicting allostatic load. The results show that, as expected, respondent's age is the primary and the most important predictor of allostatic load. Indeed, the allostatic load increases with age (Gruenewald, Seeman, Karlamangla, & Sarkisian, 2009; McEwen, 2002). However, the second most important predictor is the experience of recessionary hardships (the dashed line), followed by conscientiousness. LASSO regression further shows the relevance of our predictor relative to other predictors in the model. The results were similar for DV3.

Dose–Response Model

In the main analysis, we assume a linear effect of recessionary hardships on allostatic load; however, given the cumulative and cascading effects of the recessionary hardships (Burgard & Kalousova, 2015), the intensity of its effect could be nonlinear. We draw on the dose–response modeling (Cerulli, 2017) on the continuous measure of allostatic load (DV1) and scale the index of recessionary hardships (treatment) from 0 to 100.[3] Using *ctreatreg* routine in Stata 15.1 (Cerulli, 2017), in Figure A2(a) in the online supplemental materials, those with recessionary hardships (dashed line) on average were more likely to have higher allostatic load than those reporting zero experiences of negative recession events (long-dash dot line). In Figure A2(b) in the online supplemental materials, although at low levels of negative experiences (between

[3] The routine *ctreatreg* requires such scaling for the treatment variable. Those reporting zero negative events are coded as zero and for those reporting one or more events the values are scaled from 1 to 100.

Table 1
Regression Estimates

	DV = allostatic load (continuous)			
	OLS			
	(1)	(2)	(3)	(4)
Variables	Null	Direct effect	Controls	Direct effect + Controls
Index—recessionary hardships		.0246*** (.00677)		.0264*** (.00707)
Respondent's sex			−.0403 (.0347)	−.0505 (.0344)
Respondent's calculated age			.0137*** (.00162)	.0145*** (.00161)
Satisfied with life before the recession			.00604 (.0249)	−.00580 (.0248)
Prerecession income (in $'000)			−.000887* (.000417)	−.000807+ (.000413)
Postrecession income (in $'000)			−.000592 (.000391)	−.000477 (.000387)
Total household income compared with before recession (about the same)			.0534 (.0451)	.0398 (.0447)
Total household income compared with before recession (less now)			.0641 (.0448)	.0161 (.0460)
The highest level of education completed			−.0110 (.00796)	−.0103 (.00786)
Marital status—Separated			−.0184 (.128)	−.0802 (.127)
Marital status—Divorced			−.0488 (.0537)	−.0548 (.0531)
Marital status—Widowed			−.271* (.110)	−.272* (.109)
Marital status—Married			−.0513 (.0502)	−.0490 (.0496)
Sense of control			−.0230 (.0244)	−.00858 (.0244)
Conscientiousness personality trait			.0205 (.0399)	.0239 (.0394)
Purpose in life			−.00435 (.00335)	−.00497 (.00331)
Emotion-focused coping			−.00463 (.00337)	−.00453 (.00333)
Problem-focused coping			−.00395 (.00340)	−.00435 (.00336)
Constant	−.0529** (.0179)	−.123*** (.0262)	.0371 (.224)	−.0993 (.224)
Observations	526	526	526	526
R^2	.000	.025	.215	.236
χ^2				
p value				

Notes. DV = dependent variable; OLS = ordinary least squares. Standard errors are in parentheses.
+ $p < .1$. * $p < .05$. ** $p < .01$. *** $p < .001$.

one and 60 units) the increase in allostatic load is negligible, the increase is significant at treatment levels above the mean. Finally, in Figure A2(c) in the online supplemental materials, the dose–response function and its derivative confirm that the influence on allostatic load at low to medium levels is negligible but increases significantly at higher levels of recessionary hardships.

Allostatic Load Based on Cases With All 23 Nonmissing Biomarkers

In operationalizing DV1, DV2, and DV3, we take the total of nonmissing biomarkers and divide it by the count of biomarkers with nonmissing data. However, this may bias our estimates. Using only the cases with no missing information on all the 23 biomarkers ($N = 415$), in Table A5 in the online supplemental materials, we present the results using the continuous measure (DV4, similar to DV1) and a dichotomous measure (DV5, similar to DV2) based on participants with no missing information on any of the biomarkers. We find that the inferences are consistent with the main inferences.

Contingency Based on Sex and Age

In Table A6 in the online supplemental materials, we test whether the proposed association is contingent on sex and age. Using a continuous measure of allostatic load (based on missing [DV1] and nonmissing [DV4] operationalizations), we find that the effects are not significant for age; however, females experiencing similar recessionary hardships as males were more likely to have higher levels of allostatic load (Figure A3 in the online supplemental materials).

Discussion

In this work, we aimed to build on Kirsch and Ryff (2016) who found support for the association between recessionary hardships and reported chronic conditions, the frequency of acute somatic symptoms, self-rated physical health, and waist circumference. Extending Kirsch and Ryff (2016), we proposed that recessionary hardships could be associated with the allostatic load. We found that those reporting recessionary hardships during the Great Recession had a stronger association with the allostatic load. The findings are robust to alternate measures of allostatic load. The findings in the LASSO regression show that negative recession events, after respondent's age, are salient in predicting allostatic load. Further delving into the proposed association, the dose–response analysis showed that the relationship is nonlinear and increasing at higher levels of the index of recessionary hardships.

Kirsch and Ryff (2016) found that education could be a buffer to mitigating the negative effects of recessionary hardships on reported chronic conditions and waist circumference. Because the survey and biomarker data were collected after the recession, we do not explore the buffering role of prerecessionary characteristics because reported hardships in 2012–2015 period may be influenced by during recession experiences (i.e., unobservable in the error term of the regression could influence both the extent of recessionary hardships and allostatic load) and malleare perception of recessionary experiences (i.e., recessionary hardships could

DV = allostatic load (1 = in top quartile; 0 = not in top quartile)				DV = mean of count of allostatic loads above cutoffs			
Logit				OLS			
(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Null	Direct effect	Controls	Direct effect + Controls	Null	Direct effect	Controls	Direct effect + Controls
	.109** (.0383)		.0983* (.0466)		.00870** (.00264)		.00794** (.00283)
		−.189 (.239)	−.226 (.240)			−.00675 (.0138)	−.00982 (.0138)
		.0496*** (.0118)	.0541*** (.0121)			.00474*** (.000644)	.00498*** (.000646)
		−.00703 (.171)	−.0508 (.173)			.00709 (.00990)	.00353 (.00992)
		−.00263 (.00310)	−.00241 (.00310)			−.000296+ (.000166)	−.000272 (.000165)
		−.00369 (.00294)	−.00301 (.00297)			−.000180 (.000156)	−.000146 (.000155)
		−.0329 (.319)	−.0704 (.319)			.0206 (.0180)	.0165 (.0179)
		.145 (.306)	−.0250 (.320)			.0175 (.0178)	.00305 (.0184)
		−.0472 (.0540)	−.0476 (.0544)			−.00672* (.00317)	−.00653* (.00315)
		.423 (.798)	.173 (.825)			.0136 (.0509)	−.00503 (.0510)
		.0319 (.353)	.0124 (.355)			−.00947 (.0214)	−.0113 (.0212)
		−1.195 (.839)	−1.196 (.839)			−.0648 (.0438)	−.0650 (.0435)
		−.181 (.361)	−.146 (.363)			−.00541 (.0200)	−.00472 (.0198)
		−.241 (.163)	−.193 (.166)			−.00706 (.00970)	−.00272 (.00976)
		.109 (.272)	.120 (.275)			−.00477 (.0159)	−.00375 (.0158)
		−.0282 (.0222)	−.0315 (.0223)			−.00185 (.00133)	−.00204 (.00133)
		−.00172 (.0233)	−.00227 (.0236)			−.00152 (.00134)	−.00149 (.00133)
		−.00801 (.0232)	−.00826 (.0232)			−.000626 (.00135)	−.000745 (.00135)
−1.296*** (.106)	−1.630*** (.164)	−.168 (1.539)	−.719 (1.586)	.324*** (.00695)	.299*** (.0102)	.374*** (.0892)	.333*** (.0898)
526	526	526	526	526	526	526	526
				.000	.020	.177	.190
	7.849	52.99	57.37				
	.0051	<.001	<.001				

influence the reporting of coping strategies, life purpose, or other psychological buffers). Nevertheless, the buffering effects are critical and with the availability of instrumental variables or pre- and postdesigns, more robust inferences could be drawn. Building from Kirsch and Ryff (2016) and our results, the value of buffers in mitigating the effects of recessionary hardships could be further understood through pre- and postdesigns.

The findings have practical implications. First, previous studies have supported worsening well-being, greater psychological depression, and uptake of unhealthy behaviors during the recession. Our findings paint a bleaker picture. The recessionary hardships seem to have a much deeper effect at the biomarker level. After a recession, for individuals and government bodies the expected burden from medical costs from recessionary hardships may be higher in medium- to long-term. Although fatalities and suicides along with psychological distress could manifest in the short-term after a recession, recessionary hardships could have long-term damaging effects on an individual's physiological systems. Second, the findings also call for greater budgetary allocations for lowering medium- to long-term health costs after a recession. Government awareness programs and workshops could be salient to buffer against the negative effects of the recession. Third, for the individuals, buffering against the long-term negative effects of recessionary hardships is important; that is, physical activity, diet, and active coping approaches may provide the necessary buffers.

The findings must also be interpreted in the light of the following limitations. First, the key limitation of the analysis is that we cannot unpack the association between negative recessionary experiences and allostatic load. A variety of individual, group, and regional factors could interact unidirectionally and/or recursively in driving allostatic load. Therefore, we do not infer nor imply causality. We include a wide range of controls, including prerecessionary vulnerabilities (Kirsch & Ryff, 2016); however, unobservables explaining both recessionary hardships and allostatic load cannot be fully ruled out and lack of archival prerecession information limit our ability to draw more reliable inferences.

Second, we cannot examine longitudinal patterns of evolution of allostatic load before and after the onset of the recession. The temporal and directional patterns of change in allostatic load may be particularly helpful in further understanding the proposed association. Although much of allostatic load research has also drawn on cross-sectional data, understanding longitudinal patterns could further shed light on the gradients between the experience of adversity in recession and allostatic load. Third, the reporting on recessionary hardships could be subject to recall and retrospective bias. However, studies have found that recalling major events that have significant impact one's life are less subject to recall bias (Kirsch & Ryff, 2016). Related to retrospective bias the respondents were asked to report the occurrence of the event on a "yes/no" basis, as the measurement error resulting from social desirability in such reporting is lower than it would be on a continuous scale measuring the magnitude of the effect. Finally, after casewise deletion, the prevalence of non-White participants was very small in our sample. As such we could not meaningfully control for the racial differences. Given past studies have identified differences in Black–White disparities in allostatic load, this is an important direction for future replication (Howard & Sparks, 2016).

In conclusion, this study is the first to examine the influence of negative recession events on allostatic load. Extending previous research that has examined postrecession uptick in negative health behaviors, emergency room visits, and higher mortality, using a comprehensive set of 23 biomarkers, this study examined the implications of recession for the overall physiological system. The study underscores the relevance of worsening physiological outcomes in face of recessionary hardships.

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