

Association between Increased Perceived Stress and Decreased Self-Rated Health among Adults in Puerto Rico during COVID-19: A Puerto Rico-CEAL Study

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Objective: To examine how perceived changes in stress among adults during the COVID-19 pandemic are associated with changes in self-rated health (SRH) in Puerto Rico.

Methods: This cross-sectional analysis used data from the Puerto Rico Community Engagement Alliance (Puerto Rico-CEAL). Adults aged ≥ 18 years ($n = 654$) completed an online survey from December 2021 through February 2022. One item assessed perceived changes in psychological stress throughout the pandemic. Two separate items assessed SRH (rated from poor to excellent) before and during the pandemic; changes in SRH ratings were calculated. Adjusted Poisson regression models were used to estimate prevalence ratios (PRs) of decreased SRH.

Results: Overall, 72.8% of the sample perceived an increase in psychological stress during the pandemic and 39.6% experienced decreased SRH. In adjusted models, participants reporting perceived increases in stress were more likely to experience decreases in SRH (PR = 2.44; 95% CI, 1.71–3.45) during the pandemic compared with those reporting no change in stress.

Conclusion: Perceived increases in psychological stress during the pandemic were associated with decreased SRH among participants in this Puerto Rico-based sample. Studies are needed to identify stress management strategies during public health emergencies.

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Key words: Perceived change in stress, Self-rated Health, Hispanics, Puerto Rico

The unprecedented social, economic, and health outcomes stemming from the COVID-19 pandemic exacerbated psychological stress levels worldwide. In the United States (US), 67% of adults experienced increased psychological stress during the pandemic, and 78% reported the pandemic as a significant source of stress (1). Challenges in coping with the lockdowns, financial instability, the loss of loved ones, and worries about the future intensified the stress generated by the pandemic (1), to the point that a third of US residents were unable to make basic decisions (e.g., what to wear or what to eat) (2). In Puerto Rico, before the pandemic, 30% of middle-aged adults experienced psychological distress (elevated symptoms of depression, anxiety, or post-traumatic stress disorder) (3), whereas approximately 60% of young adults experienced psychological distress after the pandemic (4). Although the government of Puerto Rico implemented one of the strictest and longest pandemic lockdowns in the US, little is known about changes in psychological stress on the island during this period. This knowledge gap is worrisome given that residents of Puerto Rico were disproportionately exposed to numerous social, environmental, and structural stressors prior to the pandemic. These included political turmoil, natural disasters and their delayed recovery, the highest poverty rate in the US, and a deteriorating healthcare system (5–8). Thus, the COVID-19 pandemic magnified these ongoing stressors.

The aftermath of the acute phase of the COVID-19 pandemic also brought disturbances to the population's health (9,10). United States adults were 51% more likely to report fair or poor

self-rated health (SRH)—a measure of subjective health strongly associated with objective health status (11)—in the later stages of the pandemic (December 2020) than at the start of the pandemic (April 2020) (9). These disparities in SRH during the pandemic were greater among Hispanics, who were 19% more likely than non-Hispanic Whites to report fair or poor SRH. In Puerto Rico, 31% of adults reported fair or poor SRH prior to the pandemic (12), and data from the Puerto Rico Community Engagement Alliance (PR-CEAL) Against COVID-19 Disparities indicate that 39% reported experiencing decreases in SRH during the pandemic (13). Despite this, little is known about factors associated with decreases in SRH during the pandemic in Puerto Rico.

Psychological stress impacts health through negative biological and behavioral adaptations (14,15). Before the pandemic, US adults with moderate and high levels of stress were 36% and 75% more likely, respectively, to have poor SRH compared with those without stress (16). Accordingly, studies worldwide show

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that stress during the pandemic was also associated with lower SRH ratings during this period (17–20). However, no study has evaluated this association among residents of Puerto Rico. Given the detrimental effects of the pandemic on stress levels and SRH, and the disproportionate exposure to social, environmental, and structural stressors prior to the pandemic in Puerto Rico, this study sought to assess the association between perceived changes in psychological stress and SRH among adults during the COVID-19 pandemic.

Methods

Study design and participants

This was a secondary data analysis that used cross-sectional survey data from PR-CEAL (13). The Puerto Rico Community Engagement Alliance (PR-CEAL) conducted an online survey among adults in Puerto Rico using Research Electronic Data Capture (REDCap) to evaluate COVID-19 vaccination and testing, COVID-19–related behaviors and beliefs, and the behavioral and psychosocial impacts of the pandemic. Recruitment occurred from December 30th, 2021, through February 8th, 2022. A flyer with information about the study and a QR code leading to the study eligibility questions and the REDCap online survey was disseminated in-person at randomly selected supermarkets throughout the island. However, with the emergence and spread of the Omicron variant (January 2022), recruitment strategies shifted online, with implementation conducted via social media platforms (Facebook, Instagram, Twitter) and email distribution to academic groups and organizations. Individuals were eligible if they were 18 years or older, resided in Puerto Rico, could answer the questionnaire in Spanish, and had access to an electronic device to complete the questionnaire. Interested participants who accessed the online survey through the QR code first answered eligibility questions to determine whether they resided in Puerto Rico and were 18 years or older. If they answered “no” to either of the two questions, a message indicating that they were not eligible was sent and the survey terminated. Eligible individuals provided electronic consent and completed the survey. Upon survey completion, participants received a \$30 gift card (sent via mail).

Seven hundred and eighty-seven individuals completed the online survey, of whom 4.1% ($n = 32$) were recruited via in-person strategies and 95.9% were recruited via online strategies ($n = 755$). This study was approved by the Institutional Review Board of the University of Puerto Rico, Medical Sciences Campus (#6050220). The present analysis was a complete case analysis. Of the 787 participants, we excluded those with missing data for the following variables of interest: SRH ($n = 16$), change in stress ($n = 1$), age ($n = 2$), education ($n = 13$), health insurance ($n = 1$), COVID-19 diagnosis during the pandemic ($n = 39$), and gender ($n = 4$). In addition, we excluded participants who reported in the survey increasing SRH ($n = 47$), decreasing stress ($n = 8$), and being of sexual-gender minority ($n = 2$) due to sparse data. A total of 654 participants were included in the analysis.

Study measures

Items from the CEAL-initiated Spanish Common Survey 2 (21), as well as items abstracted from the literature and prior

COVID-19–related studies in the US (22) and Puerto Rico (23), were included in the PR-CEAL online survey. Items unavailable in Spanish (the dominant language in Puerto Rico) were translated by the first author and reviewed by the PR-CEAL team. The final instrument was composed of over 80 items.

Perceived change in psychological stress

Perceived change in psychological stress during the pandemic was measured using one item adapted from the Collaborative Cohort of Cohorts for COVID-19 Research (C4R) consortium (22); the item was included in the PR-CEAL online survey. Participants were asked, “Since the start of the COVID-19 pandemic (March 2020), have your stress levels increased, decreased, or stayed the same?” Response options were “increased,” “decreased,” and “stayed the same.” A few participants reported decreased stress ($n = 8$) and were therefore excluded from the analysis. The “no change in stress” group was used as the reference group in all analyses.

Self-rated health

Two items assessed SRH: one before the pandemic and the other at the time of the survey (conceptualized as pandemic SRH). The pre-pandemic SRH item asked, “Prior to the pandemic, how would you have described your overall health?” whereas the pandemic SRH item asked, “How would you currently describe your overall health?” Response options to both items were “poor,” “fair,” “good,” “very good,” and “excellent,” scored from 1 to 5, respectively. Change in SRH during the pandemic was calculated as pandemic SRH minus pre-pandemic SRH. Thus, negative values indicated a decrease in SRH, while positive values indicated an increase. The SRH change score was then categorized as decreased SRH, increased SRH, or no change in SRH. Participants who reported an increased SRH ($n = 47$) were excluded. Thus, the outcome was a binary variable, with the no change in SRH group used as the reference group in all analyses.

Covariates

The covariates in the present analysis were selected based on their potential association with stress and SRH. These included age, gender, education, income, marital status, type of health insurance, pre-pandemic mental health disorders and cardiovascular/cardiometabolic disease diagnoses, positive COVID-19 test, and eating and weight changes during the pandemic. Most of the sociodemographic data were measured using the CEAL Common Survey 2 instrument (21). Participants self-reported gender with response options including “man,” “woman,” “transgender female,” “transgender male,” “non-binary,” “other,” and “prefer not to answer.” Only two individuals self-identified as belonging to a gender minority and four did not disclose their gender; therefore, all were excluded from the analysis, and gender was evaluated as a binary variable (women and men). Individuals reported their highest level of education and total annual household income. A substantial proportion of participants did not disclose income and were thus categorized as “missing.” Participants reported their primary type of health insurance, which was categorized as “private,” “government,” and “other” (including military and unknown coverage). Pre-pandemic diagnoses of

mental health disorders and cardiovascular/cardiometabolic diseases were self-reported and included depression, anxiety, and post-traumatic stress disorder for mental health and obesity, type 2 diabetes, hypertension, hyperlipidemia, stroke, angina, heart attack, heart failure, and atrial fibrillation for cardiovascular/cardiometabolic diseases. To assess COVID-19 status, participants were asked, “Have you ever tested positive for COVID-19?” Lastly, eating frequency/snacking changes and weight were assessed with two items (22). One item asked, “Since the start of the COVID-19 pandemic (March 2020), have you been eating/snacking more, less, or the same?” The second item asked, “Since the start of the COVID-19 pandemic (March 2020), has your weight changed?” Response options were “gained weight,” “lost weight,” and “stayed the same.”

Statistical analysis

Descriptive statistics (mean [SD] for continuous variables and frequencies for categorical variables) were computed for the total sample and contrasted by perceived change in psychological stress status. Chi-square tests were used for all variables except age, which was analyzed using Student's *t* test. The proportion of individuals with decreased SRH versus no change in SRH was also compared by perceived change in psychological stress using a chi-square test. The association between perceived increases in stress and decreases in SRH was evaluated using Poisson models with robust variance errors. These models estimated prevalence ratios (PRs) and 95% CIs for decreased SRH. Model 1 was unadjusted. Model 2 adjusted for age, income, education, gender, marital status, and health insurance. Model 3 included Model 2 and additionally adjusted for pre-pandemic mental health disorders, pre-pandemic cardiometabolic diseases, and positive COVID-19 test. Model 4 included Model 3 and additionally adjusted for pandemic-related changes in weight and in eating frequency. The no change groups for both stress and SRH were used as the reference categories. Stata version 14 (StataCorp LP, College Station, TX, USA) was used. Significance was set at $P < .05$.

Results

Sample characteristics are summarized in Table 1 for the overall sample and by perceived change in psychological stress. The mean

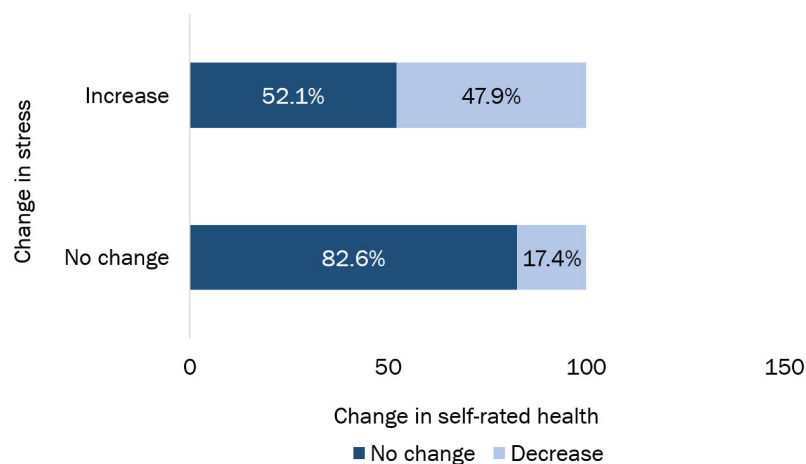
Table 1. Sample characteristics by perceived change in psychological stress status during the COVID-19 pandemic among Puerto Rico-CEAL participants ($n = 654$).

	Total ($n = 654$, %)	No change ($n = 178$, 27.2%)	Increase ($n = 476$, 72.8%)	<i>P</i> value
Age; mean (SD)	38.5 (14.1)	41.6 (15.5)	37.3 (13.4)	<.001
Women	479 (73.2)	116 (65.2)	363 (76.3)	.004
Education				.112
≤High school graduate	51 (7.8)	20 (11.2)	31 (6.5)	
Some college	129 (19.7)	40 (22.5)	89 (18.7)	
Undergraduate degree	224 (34.3)	57 (32.0)	167 (35.1)	
Graduate school	250 (38.2)	61 (34.3)	189 (39.7)	
Annual income				.044
≤\$20,000	114 (17.4)	33 (18.5)	81 (17.0)	
\$20,001-40,000	192 (29.4)	53 (29.8)	139 (29.2)	
>40,000	271 (41.4)	62 (34.8)	209 (43.9)	
Missing	77 (11.8)	30 (16.9)	47 (9.9)	
Married/living with partner	303 (46.3)	79 (44.4)	224 (47.1)	.541
Type of health insurance				.149
Private	451 (67.0)	113 (63.5)	338 (71.0)	
Government	146 (22.3)	45 (25.3)	101 (21.2)	
Other/don't know	57 (8.7)	20 (11.4)	37 (7.8)	
Pre-pandemic mental health disorders	126 (19.3)	19 (10.7)	107 (22.5)	.001
Pre-pandemic cardiometabolic diseases	149 (22.8)	46 (25.8)	103 (21.6)	.254
Positive COVID-19 test	157 (24.0)	42 (23.6)	115 (24.2)	.880
Pandemic changes in eating frequency				<.001
Increased	261 (39.9)	37 (20.8)	224 (47.1)	
Decreased	88 (13.5)	17 (9.6)	71 (14.9)	
No change	305 (46.6)	124 (69.7)	181 (38.0)	
Pandemic changes in weight				<.001
Decreased	103 (15.8)	23 (12.9)	80 (16.8)	
Increased	351 (53.7)	61 (34.3)	290 (60.9)	
No change	200 (30.6)	94 (52.8)	106 (22.3)	
Pre-pandemic SRH				.006
Excellent	178 (27.3)	61 (34.3)	117 (24.6)	
Very good	273 (41.7)	78 (43.8)	195 (41.0)	
Good	157 (24.0)	33 (18.5)	124 (26.0)	
Fair	46 (7.0)	6 (3.4)	40 (8.4)	
Poor	0 (0.0)	0 (0.0)	0 (0.0)	
Pandemic SRH				<.001
Excellent	100 (15.3)	47 (26.4)	53 (11.1)	
Very good	214 (32.7)	76 (42.7)	138 (29.0)	
Good	180 (27.5)	39 (21.9)	141 (29.6)	
Fair	136 (20.8)	14 (7.9)	122 (25.6)	
Poor	24 (3.7)	2 (1.1)	22 (4.6)	

Abbreviations: SRH, self-rated health; Puerto Rico-CEAL, Puerto Rico Community Engagement Alliance.

age was 38.5 ± 14.1 years; most participants were women and had undergraduate or graduate degrees. Over 40% were married or living with a partner, 67% had private health insurance, about 20% had a pre-pandemic mental health or cardiometabolic disorder diagnosis, and a quarter tested positive for COVID-19. Around 40% reported increased eating frequency during the pandemic, and 54% reported weight gain. Nearly three-fourths perceived increased psychological stress, and about 40% reported decreased

Figure 1. Proportion of decrease in SRH by perceived change in psychological stress during the COVID-19 pandemic among Puerto Rico-CEAL participants (n = 654)



Chi-square test P value < .001.

SRH. Those who perceived increased stress (vs. no change) were more likely to be younger and female, and to have higher incomes, pre-pandemic mental health disorders, and lower SRH before and during the pandemic (all $P < .05$). Additionally, a higher proportion of those reporting increased stress (vs. no change) also reported increased eating/snacking frequency and weight during the pandemic (all $P < .05$).

Figure 1 shows the proportion of individuals who experienced a decrease in SRH during the pandemic by perceived changes in psychological stress. A significantly higher proportion of participants who reported increases in psychological stress during the pandemic also experienced a decrease in SRH (47.9%) compared with those who reported no change in stress (17.4%; $P < .001$). Poisson models show similar results (Table 2). In the unadjusted model (Model 1), individuals reporting increases in psychological stress were more likely to experience a decrease in SRH (PR = 2.75; 95% CI, 1.97–3.84) compared with those with no

change in stress. This estimate remained nearly unchanged after adjusting for sociodemographic characteristics (Model 2: PR = 2.74; 95% CI, 1.94–3.85) and slightly decreased after additional adjustment for clinical characteristics (Model 3: PR = 2.66; 95% CI, 1.89–3.75). With further adjustment for changes in weight and eating/snacking frequency, the PR for decreased SRH decreased to 2.43 (95% CI, 1.71–3.45), although the association remained statistically significant.

Discussion

To our knowledge, the present study is the first to examine the association between perceived changes in psychological stress and changes in SRH in Puerto Rico. These results indicate that a perceived increase in psychological stress during the pandemic was associated with a decline in SRH during the pandemic among adults on the island. This association was independent of sociodemographic and clinical factors, as well as changes in eating habits and weight.

Our study found that 73% of the participants experienced increased psychological stress during the pandemic. This proportion is comparable but slightly higher than that reported by the American Psychological Association for US adults (67%) (1). Our estimate may represent a long-term stress burden given that the US estimate stems from data collected in 2020, when the pandemic was at its peak, whereas ours extended through 2022. Nonetheless, it should be interpreted with caution given that it was assessed retrospectively. Additionally, we observed that 40% of our sample experienced a decrease in SRH during the pandemic. This is higher than what has been previously reported in a longitudinal study in the Netherlands, where 67% reported having the same SRH as they did before the pandemic and only 11% reported a decrease (24). These differences may be due to the timing of data collection and differences in study populations. Their study assessed SRH in 2014 (baseline) and during the pandemic in April–May 2020, excluding individuals who had

COVID-19 and including only participants of the Netherlands Twin Study. As with changes in stress, baseline SRH was assessed retrospectively and thus may be biased. Even with this limitation, our study makes an important contribution by focusing on an underserved and underrepresented but high-risk population with a high burden of stressors.

Our findings are consistent with those of previous studies that highlighted similar associations between stress and SRH (17,18,25). For example, among people in China during the early stages of the pandemic (February 2020), it was found that greater stress was significantly

Table 2. Association between perceived change in psychological stress and change in self-rated health during the COVID-19 pandemic among Puerto Rico-CEAL participants (n = 654)

Change in stress	Model 1 PR (95% CI)	Model 2 PR (95% CI)	Model 3 PR (95% CI)	Model 4 PR (95% CI)
No change	1.00	1.00	1.00	1.00
Increase	2.75 (1.97–3.84)	2.74 (1.94–3.85)	2.66 (1.89–3.75)	2.43 (1.71–3.45)

Abbreviation: PR, prevalence ratio

Model 1, unadjusted;

Model 2, adjusted for age, income, education, gender, marital status, and health insurance;

Model 3, Model 2 + pre-pandemic mental health disorders + pre-pandemic cardiometabolic diseases + positive COVID-19 test;

Model 4, Model 3 + pandemic changes in weight + pandemic changes in eating frequency.

correlated with lower SRH ($r = 0.646$, $P < .01$) (18). A similar result was observed among students in Australia during the early-to-mid stages of the pandemic (August–September 2020), in which each one-unit increase in SRH was associated with a 0.4-point reduction in psychological stress (25). Lastly, in Poland (April 2020), it was found that those with the worst current SRH, compared with prior to the pandemic, had higher levels of psychological stress (17). These findings underscore the global relevance of our study and its unique contribution by assessing a longer time frame.

The mechanisms by which increases in psychological stress may negatively affect SRH are complex and multifactorial. There is a vast body of research documenting how stress can negatively influence health behaviors. For example, stress may lead to altered eating behaviors, such as snacking more frequently, overeating, and consuming foods high in fat and sugar (26–29). While our analysis adjusted for changes in general eating and snacking behavior and still found a significant association between stress and SRH, we lacked data on specific dietary choices made during periods of stress. This information should be integrated into future investigations for a more comprehensive understanding of stress-related health outcomes. Sleep and physical activity may also help explain the association between stress and SRH. Research has documented that sedentariness and suboptimal sleep mediate the association between stress and overall SRH (30). Although these variables were not collected in the Puerto Rico-CEAL survey, future studies in Puerto Rico should include them, especially given that only 28% of the population meets the physical activity recommendation and 59% have suboptimal sleep duration (12).

Research supporting allostatic load theory (the wear and tear of the body's regulatory systems due to chronic stress) indicates that negative physiological adaptations occurring during prolonged exposure to stress may affect health (31,32). These adaptations include biological parameters such as primary markers (e.g., cortisol) and secondary markers of allostatic load (e.g., obesity and cardiometabolic indicators). Although we adjusted for pre-pandemic self-reported cardiometabolic disease diagnoses and self-reported weight changes, we lacked data on objective measures of allostatic load, which need to be considered in future studies.

Our results have significant public health implications, highlighting the need for policies, educational campaigns, and interventions that promote effective coping strategies during global and public health emergencies. Further research should identify specific stressors that affected adults in Puerto Rico during the pandemic and that may also be relevant during other crises (such as natural disasters). For example, studies outside Puerto Rico suggest that stressors such as work stress, social isolation, and financial strain impact overall health (33–36). This information can help guide public health strategies aimed at addressing key stressors and empowering communities during emergencies.

This study has strengths and limitations to consider when interpreting the results. Although we assessed changes in SRH and psychological stress, the pre-pandemic period was evaluated retrospectively, an approach that could lead to recall bias and misclassification. Because these variables rely entirely on self-reported data, they are subject to social desirability bias, which can

cause participants to underreport negative changes. Nonetheless, self-reported measures remain valuable for capturing perceptions and experiences, which are crucial for understanding the subjective impact of the pandemic. In addition, we assessed perceived changes in stress with only a single item, consistent with prior pandemic research (22), but future longitudinal studies should include existing valid scales to assess this. Self-rated health was also measured with a single-item scale, which, though widely used and correlated with health outcomes (37–40), did not permit the identification of the specific health dimensions most affected. Furthermore, the use of an online survey, necessitated by pandemic restrictions, may have introduced selection bias, particularly with the overrepresentation of women and individuals with higher educations. This limits the generalizability of our findings to the broader adult population in Puerto Rico. A noteworthy strength of this study lies in its focus on the adult population in Puerto Rico, a population that had been disproportionately exposed to multiple social and environmental stressors prior to the pandemic. Lastly, our survey evaluated stress and SRH from the onset of the pandemic up until the study assessment (December 2021–February 2022), potentially capturing a broader portion of the pandemic experience than other studies, which have focused on specific stages of the pandemic (early vs. Omicron periods).

In conclusion, this study documented that perceived increases in psychological stress during the pandemic were associated with decreased SRH among adults in Puerto Rico. Further studies are needed to continue evaluating how prolonged stress affected overall health during the pandemic to inform public health interventions and support systems that promote well-being during future public health emergencies.

Resumen

Objetivo: Examinar cómo el cambio percibido en estrés psicológico durante la pandemia de COVID-19 está asociado con cambios en la salud autopercebida (SRH, por sus siglas en inglés) en Puerto Rico. **Métodos:** Este análisis transversal utilizó datos del Puerto Rico Community Engagement Alliance (Puerto Rico-CEAL). Adultos (≥ 18 años; $n = 654$) completaron una encuesta en línea entre diciembre de 2021 y febrero de 2022. Una pregunta evaluó el cambio percibido en el estrés psicológico a lo largo de la pandemia. Dos ítems por separados evaluaron la SRH (calificada de pobre a excelente) antes y durante la pandemia; se calculó el cambio en las calificaciones de SRH. Se usaron modelos de regresión de Poisson para estimar las razones de prevalencia (RP) de la disminución de SRH. **Resultados:** En general, el 72.8% de la muestra percibió un aumento en el estrés psicológico durante la pandemia y el 39.6% experimentó una disminución en SRH. En modelos ajustados, aquellos que reportaron aumentos en estrés fueron más propensos a experimentar una disminución en SRH (RP = 2.44; IC 95% = 1.71-3.45) durante la pandemia en comparación con aquellos que no reportaron cambios en niveles de estrés. **Conclusión:** El aumento percibido en estrés psicológico durante la pandemia se asoció con una disminución en SRH entre los participantes de esta muestra en Puerto Rico. Se necesitan estudios para identificar estrategias de manejo del estrés durante emergencias de salud pública.

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