# Determinants of Depression: Implications for African Americans and other populations during the COVID-19 pandemic

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**Abstract**

**Objective:** To explore the impact of Social Determinants of Health (SDH) on the prevalence of self-reported depression among adults aged ≥18 years in the United States to understand baseline data in advance of an anticipated increase in depression due to the COVID-19 pandemic.

**Methods:** Data were analyzed from the 2017 Behavioral Risk Factor Surveillance System (BRFSS) for adults aged ≥ 18 years. A multivariable logistic regression model was used to estimate the adjusted odds ratios (AORs) and 95% confidence intervals (95% CIs) for factors associated with self-reported depression. All analyses were conducted using SAS version 9.4.

**Results:** The results of the multivariable logistic regression analysis show that females (AOR: 1.80; 95% CI: 1.71-1.87); those with an annual household income of less than $50,000; those who were divorced (AOR= 1.42; 95% CI=1.34-1.51); those who were separated (AOR= 1.41; 95% CI=1.23-1.60); those who were never married (AOR= 1.24; 95% CI=1.16-1.32) and those who perceived their health as poor (AOR= 2.18; 95% CI=2.07-2.30) were significantly more likely to report a history of depression diagnosis. The findings also indicate that feeling unsafe or extremely unsafe in one's neighborhood, not being able to pay bills, and having higher levels of stress were associated with higher odds of reporting a history of depression diagnosis.

**Conclusion:** Three variables of SDH were associated with depression. Since these variables are also impacted due to the COVID-19 pandemic, we can anticipate an increase in depression diagnoses. The results of this study can be used to inform the allocation of resources for depression prevention and treatment.

## Introduction

Depression is one of the most prevalent and debilitating diseases among adults aged 18 or older in the United States (U.S.). It is characterized by a core set of symptoms, including low mood, lack of motivation, loss of pleasure in activities and hobbies, changes in appetite, sleep disturbances, feelings of guilt, and difficulty concentrating [1,2]. These symptoms are likely to increase among the population, given both the realities and the uncertainties due to COVID-19. In 2017, approximately 17.3 million adults in the U.S., or about 7.1% of the U.S. adult population, had at least one major depressive episode in a given year[3]. Research suggests that depression is a risk factor for many chronic conditions such as cardiovascular disease, diabetes, stroke, and Alzheimer's disease, for example [4-6]. Many of these same chronic diseases appear to be associated with more severe illness and death due to the coronavirus infection that causes COVID-19. Depression increases the number of years of life lived with disabilities [7], and it has been associated with excess mortality and substantially lower life expectancy[8]. Individuals diagnosed with depression were twice as likely to die as those without depression [9].

During the past few decades, there has been increased recognition that improving health will require broader approaches that address social, economic, and environmental factors that influence health. Such determinants are socioeconomic and include conditions in which people are born, grow, work, live, and age, and the broader set of forces and systems shaping the needs of daily life [10]. Persons who experience adverse social determinants of health (SDH) often have different health outcomes when infected with the coronavirus that causes COVID-19. In general, persons with low socioeconomic status have poorer mental health and general health status than persons with high socioeconomic status. Differential access to health care is primarily

responsible for health inequities [11] and differences in health outcomes. The differential distribution of adverse health outcomes and death due to COVID-19 has highlighted health and healthcare inequities. Research on SDH is rarely available within the context of depression [12,13]. Just as it has been important to understand the association between SDH and poorer health outcomes due to COVID-19, it will be important to understand the association between SDH and depression, which will indeed be compounded by COVID-19. To provide a baseline understanding, the current study assesses the association between demographics (age, gender, race, and ethnicity), socioeconomic status (household income, education, employment, and marital status), perceived health status, and three SDH (inability to pay mortgage, rent or utility bills, perceived neighborhood safety from crime and frequency of stress) and depression using 2017 Behavioral Risk Factor Surveillance System, a nationally representative survey of states and territories in the U.S. The high prevalence of depression among adults in the U.S. before COVID-19 makes depression and its determinants especially important to consider as we experience this pandemic. This study aims to provide baseline data in understanding the prevalence of self-reported SDH and its associated factors among adults in the U.S. This study's findings could help direct efforts and resources to prevent depression among adults in the U.S., especially as we experience COVID-19.

## Methods

### Data source

Data were analyzed from the 2017 Behavioral Risk Factor Surveillance System (BRFSS). The BRFSS is the nation's leading system of health-related random-digit-dialed telephone survey methods that collect uniform, state-specific data from a random sample of non-institutionalized adult population—aged 18 years or older—who reside in the US [14-17]. The BRFSS collects data on socio-demographics, preventive health practices, and risk behaviors linked to chronic diseases, injuries, and preventable infectious diseases[14-17].

The BRFSS questionnaire is administered continuously by telephone using random-digit-dial sampling methods. The design consists of a probability sample of all households with telephones in the state. A clustering sample design was used to account for differences in the probability of selection and non-response to derive the US and state-based population estimates [14] accurately. Since 2011, the BRFSS has conducted both landline telephone- and cellular telephone-based surveys. The aggregate BRFSS combined landline and cell phone dataset for this study was built from data submitted for 2017 [14].

In conducting the BRFSS landline telephone survey, interviewers collect data from a randomly selected adult in a household. In conducting the cellular telephone version of the BRFSS questionnaire, interviewers collect data from an adult who participates by using a cellular telephone and resides in a private residence or college housing. With more than 400,000 adults interviewed each year across the United States and participating territories, the BRFSS is the largest continuous telephone health survey system in the US [14]. The BRFSS data are free, publicly available, and used for health policy development and advocacy at national and state levels. Thus data use agreements were not required for this study.

**Measures:** All variables were measured using self-reported data obtained from the 2017 BRFSS.

### Dependent variable

**Self-Reported Depression:** Respondents were classified as having a history of depression diagnosis if they responded "yes" to the question: "Has a doctor, nurse, or other health care professional EVER told you that you have a depressive disorder, including depression, major depression, dysthymia, or minor depression?" Possible responses include "yes", "no", "don't know/not sure", or "refused". Responses to this question were modeled using a dichotomous (i.e., yes/no) format.

### Social determinants of health (Primary Independent Variables)

Not able to pay bills: Respondents' inability to pay their mortgage, rent, or utility bills were determined if they answered "yes" to the question: "During the last 12 months, was there a time when you were not able to pay your mortgage, rent or utility bills?" Possible responses include "yes", "no", "don't know/not sure", or "refused". This variable was modeled using a dichotomous (i.e., yes/no) format.

Perceived neighborhood safety: Perceived neighborhood safety from crime was determined from the question: "How safe from crime do you consider your neighborhood to be? Would you say extremely safe, safe, unsafe, extremely unsafe, don't know/not sure, or refused?"

Perception of Stress: To determine the frequency of stress experienced within the last 12 months, respondents were asked, "Stress means a situation in which a person feels tense, restless, nervous, or anxious, or is unable to sleep at night because their mind is troubled all the time. Within the last 30 days, how often have you felt this kind of stress?" Possible responses include "None of the time," "A little of the time," "Some of the time," "Most of the time," "All of the time," or "don't know/not sure," or "refused."

### Potential confounders

**Sociodemographic characteristics:** To prevent potential confounding by sociodemographic factors, we included gender, race/ethnicity, age, level of education, level of income, marital status, and health status as covariates in our analysis. These confounding variables were selected due to their known associations with depression [18]. Health status was assessed through self-report by asking respondents: "Would you say that in general, your health is excellent, very good, good, fair or poor?" Possible responses include excellent, very good, good, fair, or poor. A dichotomous variable was used in the analysis, comparing those in excellent, very good, or good self-reported health to those in fair or poor self-reported health (hereafter referred to as "poor health")[19].

### Statistical analysis

First, a bivariate analysis was performed to assess factors independently associated with a self-reported history of depression diagnosis among adults aged ≥18 years in the United States. Second, statistically significant variables (p≤0.05) in the bivariate analysis were entered in the final multivariable logistic regression model. Adjusted Odds Ratios (AORs) and 95% Confidence Intervals (95% CIs), obtained from the multivariable logistic regression analysis,

were reported. Participants' records with "don't know/not sure," "refused," or missing values on dependent, independent variables, or covariates measures were excluded from both bivariate and multivariable logistic regression analyses to minimize underestimation. A two-tailed test and a p-value of ≤ 0.05 were considered statistically significant. All descriptive and inferential statistical analyses were performed using SAS version 9.4 [20].

## Results

Descriptive results are presented in Table 1 below. Of the 447,892 participants who responded to the question: "Ever told by a doctor, nurse or another health professional that you have a depressive disorder, including depression, major depression, dysthymia, or minor depression?" 89,209 (20%) reported a history of depression diagnosis, and 358,683 (20%) did not report a history of depression diagnosis. The majority of the respondents who reported a history of depression diagnosis were females (24%), American Indian/Alaska natives (23%), between the ages of 55-64 years (23%), had less than high school level of education (25%), had annual household incomes less than $15,000 (36%), divorced (29%), perceived their health status as poor (38%), perceived their neighborhood as extremely unsafe (43%), were not able to pay their mortgage, rent or utility bills (47%), and were stressed all of the time within the last 30 days (64%) (Table 1).

*Table 1. Number and percentage† of respondents who reported having diagnosed with a depressive disorder by select characteristics: 2017 BRFSS, United States*

| Select Characteristics | Self-reported history of depression diagnosis | | Total N (%) | p-value |
|---|---|---|---|---|
| | Yes | No | | |
| | n (%) | n (%) | | |
| Overall | 89209 (20.0) | 358683 (80.0) | 447892 (100) | |
| **Gender** | | | | |
| Male | 29079 (15) | 168645 (85) | 197724 (100) | <0.0001 |
| Female | 60063 (24) | 189834 (76) | 249897 (100) | |
| **Race/Ethnicity** | | | | |
| White, Non-Hispanic | 70965 (21) | 272306 (79) | 343271 (100) | <0.0001 |
| Black, Non-Hispanic | 5860 (16) | 30138 (84) | 35998 (100) | |
| Asian, Non-Hispanic | 834 (8) | 9069 (92) | 9903 (100) | |
| American Indian/Alaskan Native, Non-Hispanic | 1934 (23) | 6522 (77) | 8456 (100) | |
| Hispanic | 6526 (18) | 30511 (82) | 37037 (100) | |
| **Age Group** | | | | |
| 18-24 | 5366 (21) | 20701 (79) | 26067 (100) | <0.0001 |
| 25-34 | 10157 (22) | 36840 (78) | 46997 (100) | |
| 35-44 | 11042 (21) | 40851 (79) | 51893 (100) | |
| 45-54 | 15497 (22) | 54068 (78) | 69565 (100) | |
| 55-64 | 21927 (23) | 74205 (77) | 96132 (100) | |
| 65-69 | 25220 (16) | 132018 (84) | 157238 (100) | |
| **Level of Education** | | | | |
| Did not graduate High School | 8111 (25) | 24290 (75) | 32401 (100) | <0.0001 |
| Graduated High School | 24828 (20) | 97118 (80) | 121946 (100) | |
| Attended College or Technical School | 27792 (22) | 96284 (78) | 124076 (100) | |
| Graduated from College or Technical School | 28252 (17) | 139580 (83) | 167832 (100) | |
| **Level of Income** | | | | |
| Less than $15,000 | 13546 (36) | 23866 (64) | 37412 (100) | <0.0001 |
| $15,000 to <$25,000 | 16202 (26) | 45459 (74) | 61661 (100) | |
| $25,000 to <$35,000 | 8537 (22) | 31056 (78) | 39593 (100) | |
| $35,000 to <$50,000 | 10265 (19) | 42700 (81) | 52965 (100) | |
| $50,000 or more | 27805 (15) | 154197 (85) | 182002 (100) | |

| **Marital Status** | | | | |
| --- | --- | --- | --- | --- |
| Married | 37061 (16) | 195069 (84) | 232130 (100) | |
| Divorced | 17909 (29) | 43214 (71) | 61123 (100) | |
| Widowed | 10322 (19) | 43983 (81) | 54305(100) | <0.0001 |
| Separated | 3161(34) | 6198 (66) | 9359 (100) | |
| Never married | 16652 (23) | 56802 (77) | 73454 (100) | |
| **Perceived General Health** | | | | |
| Good | 56327 (16) | 304640 (84) | 360967 (100) | <0.0001 |
| Poor | 32641 (38) | 53171 (61) | 85812 (100) | |
| **Neighborhood safety from crime** | | | | |
| Extremely safe | 6385 (17) | 31211 (83) | 37596 (100) | |
| Safe | 10077 (22) | 35913 (78) | 45990 (100) | <0.0001 |
| Unsafe | 1119 (38) | 1795 (62) | 2914 (100) | |
| Extremely unsafe | 236 (43) | 314 (57) | 550 (100) | |
| **Bills payment** | | | | |
| Able to pay bills | 14639 (18) | 65822 (82) | 80461 (100) | <0.0001 |
| Not able to pay bills | 3275 (47) | 3768 (53) | 7043 (100) | |
| **Frequency of stress within the last 30 days** | | | | |
| None of the time | 3117 (8) | 35430 (92) | 38547 (100) | |
| A little of the time | 4268 (18) | 19221 (82) | 23489 (100) | |
| Some of the time | 4581 (31) | 10291 (69) | 14872 (100) | <0.0001 |
| Most of the time | 3506 (56) | 2776 (44) | 6282 (100) | |
| All of the time | 2329 (64) | 1283 (36) | 3612 (100) | |

†Frequencies may vary due to missing values.

Table 2 displays the results of multivariable logistic regression for self-reported depression by SDH and confounding variables. Compared to males, females were significantly more likely to report a history of depression diagnosis (AOR= 1.80; 95% CI=1.71, 1.87). Compared to participants with an annual household income of $50,000 or more, participants with an annual household income of $35,000 to $49,999 (AOR= 1.15; 95% CI=1.07, 1.22) had higher odds of reporting history of depression diagnosis as those with an annual household income $25,000 to $34,999 (AOR= 1.18; 95% CI=1.10, 1.27), $15,000 to $24,999 (AOR= 1.22; 95% CI=1.14, 1.31), and less than $15,000 (AOR= 1.46; 95% CI=1.35, 1.60). As compared to married participants, those who were divorced (AOR= 1.42; 95% CI=1.34, 1.51), separated (AOR= 1.41; 95% CI=1.23, 1.61) and never married (AOR= 1.24; 95% CI=1.16, 1.32) had higher odds of reporting a history of depression diagnosis. Compared to respondents who reported their health as good, respondents who reported their health as poor health had higher odds of

reporting a history of depression diagnosis (AOR= 2.18; 95% CI=2.07, 2.30). Participants who perceived their neighborhood as unsafe (AOR= 1.43; 95% CI=1.28, 1.59) and extremely unsafe (AOR= 1.34; 95% CI=1.07, 1.69) had higher odds of reporting a history of depression diagnosis as those who were not able to pay their mortgage, rent or utility bills (AOR= 1.46; 95% CI=1.36, 1.56). Compared to participants who could pay their mortgage, rent or utility bills, those who could not pay their bills (AOR= 1.46; 95% CI=1.36, 1.56) had significantly higher odds of reporting a history of depression diagnosis. Furthermore, compared to those participants who reported they were not stressed within the last 30 days, participants who reported that they were stressed a little of the time (AOR= 2.25; 95% CI=1.12, 2.38), some of the time (AOR= 4.03; 95% CI=3.80, 4.28), most of the time (AOR= 9.28; 95% CI=8.62, 10.00) and all of the time within the last 30 days (AOR= 11.71; 95% CI=10.65, 12.90) had higher odds of reporting a history of depression diagnosis (Table 2).

**Table 2.** *Adjusted odds ratios and 95% confidence intervals for factors associated with a self-reported history of depressive diagnosis among cancer survivors by select characteristics: 2017 BRFSS, United States*

| Select Characteristics | Self-reported history of depressive disorder | |
| --- | --- | --- |
| | **Adjusted Odds Ratio (AOR)** | **95% Confidence Interval (CI)** |
| **Gender** | | |
| Male | Ref | |
| Female | 1.80 | 1.71 - 1.87 |

| Race/Ethnicity | | |
|---|---|---|
| White, Non-Hispanic | Ref | |
| Black, Non-Hispanic | 0.46 | 0.42 - 0.51 |
| Asian, Non-Hispanic | 0.25 | 0.18 - 0.33 |
| American Indian/Alaskan Native, Non-Hispanic | 1.11 | 0.92 - 1.14 |
| Hispanic | 0.60 | 0.54- 0.66 |
| **Age Group** | | |
| 18-24 | Ref | |
| 25-34 | 1.15 | 1.00 - 1.30 |
| 35-44 | 1.08 | 0.96 - 1.21 |
| 45-54 | 1.12 | 1.00 - 1.26 |
| 55-64 | 1.16 | 1.00 - 1.30 |
| 65-69 | 1.04 | 0.92 - 1.16 |
| **Level of Education** | | |
| Did not graduate High School | 0.80 | 0.73 - 0.88 |
| Graduated High School | 0.83 | 0.78 - 0.87 |
| Attended College or Technical School | 1.03 | 0.98 - 1.09 |
| Graduated from College or Technical School | Ref | |
| **Level of Income** | | |
| Less than $15,000 | 1.46 | 1.35 - 1.60 |
| $15,000 to <$25,000 | 1.22 | 1.14 - 1.31 |
| $25,000 to <$35,000 | 1.18 | 1.10 - 1.27 |
| $35,000 to <$50,000 | 1.15 | 1.07 - 1.22 |
| $50,000 or more | Ref | |
| **Marital Status** | | |
| Married | Ref | |
| Divorced | 1.42 | 1.34 - 1.51 |
| Widowed | 0.96 | 0.90 - 1.04 |
| Separated | 1.41 | 1.23 - 1.61 |
| Never married | 1.24 | 1.16 - 1.32 |
| **Perceived Health Status** | | |
| Good Health | Ref | |
| Poor Health | 2.18 | 2.07 - 2.30 |
| **Neighborhood safety from crime** | | |
| Extremely safe | Ref | |
| Safe | 1.08 | 1.00 - 1.13 |
| Unsafe | 1.43 | 1.28 - 1.59 |
| Extremely unsafe | 1.34 | 1.07 - 1.69 |
| **Bills payment** | | |
| Able to pay bills | Ref | |
| Not able to pay bills | 1.46 | 1.36 - 1.56 |
| **Frequency of stress within the last 30 days** | | |
| None of the time | Ref | |
| A little of the time | 2.25 | 2.12 - 2.38 |
| Some of the time | 4.03 | 3.80 - 4.28 |
| Most of the time | 9.28 | 8.62 - 10.00 |
| All of the time | 11.71 | 10.65 - 12.90 |

## Discussion

Our results demonstrated a relatively higher prevalence of those who were self-reported having a history of depression diagnosis than previously reported (22% vs. 8%)[21]. After adjusting for the effect of all other variables, our study revealed that three variables of SDH, including feeling unsafe or extremely unsafe in one's neighborhood, not being able to pay bills, and having higher levels of stress, were associated with higher odds of self-reported history of depression diagnosis. Feeling unsafe in one's neighborhood is especially problematic during the COVID-19 pandemic, especially when there continues to be guidance to shelter in place. Similarly, the pandemic has led to a loss of livelihood, leading to not paying bills and increased stress.

Our results show that females were 1.8 times more likely to report a history of depression diagnosis than males. This result is consistent with previous studies that have reported women are diagnosed with depression twice as often as men [22,23]. For example, the prevalence of depression among women was 1.5–3 times higher than that observed in men in previous studies [21,24]. Another study on gender differences in depression reported that depression is more common among females (21%) than males (13%) [25]. While the exact reason why the gender gap exists in the prevalence of depression is unclear, the possible explanation involves biological influences-genes hormones- and psychosocial factors such as more frequent victimization and trauma in childhood, gender role factors (e.g., competing social roles, role restrictions), interpersonal orientation such as increased vulnerability to the emotional pain of others, being more prone to rumination, and greater reactivity to stress in terms of biological responses, self-concept, and coping styles [26-28]. While preliminary results demonstrate that males are more likely to die from COVID-19 infection, females are most impacted economically as many more are considered essential workers. Also, single-parent heads of households may have additional stress and economic burdens due to COVID-19.

Our study shows that respondents with less than high school and high school levels of education were significantly less likely to report a history of depression diagnosis, 20%, and 17% respectively, compared with respondents with a graduate degree. This is contrary to our expectation and against a previous study that reported having a high level of education is universally protective in many health indicators, including depression, across populations [29]. This may, however, be related to a lack of access to health care for persons with high school education or less.

In accord with previous studies that reported a strong inverse relationship between SES and depression [30-33], our findings show that the proportion of self-reported history of depression diagnosis is higher among low-income families and those who could not pay their bills. The economic status of income or financial status variables are significant determinants of depression [34,35]. For example, a study has shown that 15.8% of adults from families living below the federal poverty level (FPL) had depression. In comparison, the prevalence of depression decreased to 3.5% among adults at or above 400% of the FPL[36]. The economic uncertainties related to COVID-19 compound the effect of this determinant on depression.

There are many possible explanations for why high household income was a protective factor for a self-reported history of depression. High household income enables individuals to avoid risk factors and harmful exposures [37], such as those which put persons at greater risk of contracting the virus that causes COVID-19. For example, except for physicians, nurses, and other medical professionals, essential workers are more likely to have lower socioeconomic status. They are more likely at greater risk of exposure to the virus that causes COVID-19. At the same time, high household income minimizes the financial worries of COVID-19 and consequences of other risks when faced [38], enhancing access to healthcare through healthcare insurance coverage that follows employment. Specifically, persons with higher incomes are more likely to enjoy access to healthcare with subsequent better health outcomes prior to the COVID-19 pandemic. There are stark contrasts between how high- and low-income households can weather the pandemic. High household income also increases population access to resources, such as healthy food and a safe living place [39], especially critical during the pandemic. High household income is a proxy of high rewarding low-stress jobs that allow for more earnings, lower exposure to risk factors [40], and increased likelihood of remaining employed through remote work during the pandemic. High household income is also shown to reduce the effects of a wide range of stressors, including but not limited to economic hardship [41], which is caused or exacerbated by the pandemic. However, it is important to note that the association between depression and socioeconomic factors can be bidirectional in the sense that socioeconomic disadvantage can be both a cause and a consequence of depression. That is, depression may lead to reduced education, employment, and income by interfering with one's capacity to function in productive roles, leading to poverty, increasing the development of depression, and exacerbating its outcomes. The pandemic has only highlighted this potentially bidirectional association.

Similar to a previous study that reported married individuals have repeatedly been shown to have a lower prevalence of depression than those who are divorced, widowed, or separated [42], the odds of reporting a history of depression diagnosis was higher for unmarried participants (divorced, separated, or widowed) in our adjusted analysis. Two possible explanations can be provided to explain the association between depression and marital status. On the one hand, depression may increase the risk of marital disruption; alternatively, marital disruption may "cause" depression or increase the risk of depression [43]. The reciprocal relationship between marital status and depression has been examined in previous studies. For example, a longitudinal study has shown an increase in depression after separation and divorce [44]. In research specifically on mothers, data from several mental health surveys showed that previously married mothers were found to have elevated rates of psychiatric disorders compared to those who remained married [45]. The finding that being unmarried is associated with an increased risk of depression indicates that marital status may help identify a group at high risk of depression. Since COVID-19, the number of divorces has increased, likely due to the stress of the pandemic. Additionally, social distancing, which leads to social isolation, is a significant concern, particularly among unmarried people.

We found that, compared with participants who rated their health as good, participants who perceived poor health were more likely to report a history of depression diagnosis, a finding reported in previous studies [46,47]. The possible explanation for this significant finding is related to several stressors and emotional upheavals among participants reporting poor health. Fear of death, interruption of life plans, changes in body image and self-esteem, changes in social role and lifestyle are all important issues to be faced. This, too, is exacerbated during the COVID-19 crisis.

The ability to participate in daily activities is an important measure of the overall health and well-being of the population [48]. A sedentary lifestyle associated with poor health increases the risk of developing depression [49,50]. Because of COVID-19, daily activities have ceased mainly, and social distancing and sheltering in place have led many who can continue to work remotely to adopt a sedentary lifestyle.

In the present study, we also found that respondents who perceived their neighborhoods as unsafe or extremely unsafe from crime were significantly more likely to report a history of depression diagnosis, 43%, and 34%, respectively, than respondents who perceived their neighborhoods as extremely safe. This finding is consistent with previous studies that report neighborhood safety perceptions are associated with psychosocial distress [51-53]. The possible explanation for this significant finding is that individuals who live in unsafe neighborhoods might be those with low SES and have already been vulnerable to poorer health. Increasing perception of safety, perhaps through community-building interventions or increased surveillance, are critical points of interventions at the neighborhood level to reduce the prevalence of depression associated with neighborhood safety perceptions and to facilitate shelter in place and social distancing orders during the pandemic.

Our results support previous findings that showed higher stress levels were associated with depressive symptoms [54-56]. Specifically, our study shows that the odds of a self-reported history of depression diagnosis was 2.3 times, four times, 9.3 times, and 23 times higher among participants who reported they were stressed "a little of the time," "some of the time," "most of the time" and "all of the time" in the last 30 days, respectively. It is expected that the pandemic will only worsen these outcomes. The connection between stress and depression is complex. The possible explanation for the significant association observed between stress and depression is that stress, particularly chronic stress, can lead to elevated cortisol levels or the "stress hormone" and reduced serotonin and other neurotransmitters in the brain, including dopamine, which in turn may result in increased risk for depression [57]. Research suggests that depression does not occur because of too much or too little of certain brain chemicals. Instead, there are many possible causes of depression, including genetically determined predisposing factors, lower education, poor economic status, early life experiences, and stressful life events [58,59]. For example, several genes may influence the stress response, leaving people more or less likely to become depressed in response to stressful life events. Prior to COVID-19, stress was an often-neglected part of everyday life that could adversely affect mental health. The COVID-19 pandemic has caused medical and economic crises and food insecurity, which has added acute stress for many. The prevalence of depression among US adults and the strong association with stress underscores the need for proactive public health efforts to prevent severe consequences among populations at most risk for depression, especially those who already experienced SDH, which are now exacerbated by the pandemic.

**Study Limitations:** Several limitations of our study should be considered when interpreting the findings. First, the BRFSS is a telephone-based survey and is administered to civilian, non-institutionalized adults. Therefore, the BRFSS excludes individuals without telephone service, military bases, and individuals in institutions. For this reason, generalizability to the entire US population is limited. Second, since the BRFSS is a phone survey answered by each participant, some of the questions may be subject to recall or reporting bias. Despite these limitations, the present study builds on the previous research by demonstrating the association between SDH and self-reported depression.

## Conclusion

We conclude that the socio-demographic factors (age, gender, race, and ethnicity, education and income, and marital status), perceived health status, and three SDH (inability to pay mortgage, rent or utility bills, perceived neighborhood safety from crime and frequency of stress) are important factors in explaining the variability in the prevalence of self-reported depression in our study population. The COVID-19 pandemic has highlighted the disproportionate impact of COVID-19 on African Americans and other populations who experience more adverse health outcomes due to SDH. It is anticipated that these three SDH will be most impacted during the COVID-19 pandemic. Therefore, there is an urgent need to consider these areas to plan prevention strategies for individuals at greater risk for depression. In our findings and previous studies, the reported variability in the prevalence of depression suggests that longitudinal data are required to provide more accurate estimates of the prevalence of depressive disorders among adults in the US. However, it can be reasonably anticipated that depressive disorders will increase, especially in populations already experiencing SDH, because of the pandemic. The results of this study can be used to align resources better to address a likely increase in depression post-COVID-19.

**Conflict of interest statement**: The authors declare that they have no conflict of interest.

**Ethical approval statement:** This study utilized de-identified data from the 2017 BRFSS, downloaded to a password-protected computer. BRFSS data are in the public domain, and data use agreements are not required [60].

## References

1. Goodwin FK, Jamiso KR. Manic-depressive illness: bipolar disorders and recurrent depression. 2nd edn.. New York: Oxford

University Press; 2007.

2. National Institute of Mental Health. Chronic Illness & Mental Health. Available from: https://www.nimh.nih.gov/health/publications/chronic-illness-mental-health/index.shtml#pub3. Accessed Date: February 24, 2020.

3. National Institute of Mental Health "Major Depression", National Institute of Mental Health. Prevalence of Major Depressive Episode Among Adults (2017). Available from https://www.nimh.nih.gov/health/statistics/major-depression.shtml#part_155029. Accesed date: February 19, 2020.

4. Krishnan KR, Delong M, Kraemer H, et al. Comorbidity of depression with other medical diseases in the elderly. Biol Psychiatry. 2002;52(6):559-588.

5. Kupfer DJ, Frank E. Comorbidity in depression. Acta Psychiatr Scand Suppl. 2003;(418):57-60.

6. Dickey B, Normand SL, Weiss RD, Drake RE, Azeni H. Medical morbidity, mental illness, and substance use disorders. Psychiatr Serv. 2002;53(7):861-867.

7. Vos T, Flaxman AD, Naghavi M, et al. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010 [published correction appears in Lancet. 2013;381(9867):628.

8. Fortes C, Mastroeni S, Alessandra S, et al. The combination of depressive symptoms and smoking shorten life expectancy among the aged. Int Psychogeriatr. 2012;24(4):624-630.

9. Sullivan MD, O'Connor P, Feeney P, et al. Depression predicts all-cause mortality: epidemiological evaluation from the ACCORD HRQL substudy. Diabetes Care. 2012;35(8):1708-1715.

10. World Health Organization, Social determinants of health. http://www.who.int/social_determinants/en/. Accessed: June 28, 2019.

11. Braveman P, Egerter S, Williams DR. The social determinants of health: coming of age. Annu Rev Public Health. 2011;32:381-398.

12. Hiatt RA, Breen N. The social determinants of cancer: a challenge for transdisciplinary science. Am J Prev Med. 2008;35(2 Suppl):S141-S150.

13. Lauder W, Kroll T, Jones M. Social determinants of mental health: the missing dimensions of mental health nursing?. J Psychiatr Ment Health Nurs. 2007;14(7):661-669.

14. Centers for Disease Control and Prevention, Behavioral Risk Factor Surveillance System . Available from: https://www.cdc.gov/brfss/about/index.htm.

15. Frazier EL, Franks AL, Sanderson LM. Using behavioral risk factor surveillance data. In: Using chronic disease data: a handbook for public health practitioners. Atlanta: Centers for Disease Control, 1992.

16. Mokdad AH, Stroup DF, Giles WH. Behavioral Risk Factor Surveillance Team. Public health surveillance for behavioral risk factors in a changing environment. Recommendations from the Behavioral Risk Factor Surveillance Team. MMWR Recomm Rep. 2003;52(RR-9):1-12.

17. Xu F, Town M, Balluz LS, et al. Surveillance for certain health behaviors among States and selected local areas - United States, 2010. MMWR Surveill Summ. 2013;62(1):1-247.

18. Osborn DP, Fletcher AE, Smeeth L, et al. Factors associated with depression in a representative sample of 14 217 people aged 75 and over in the United Kingdom: results from the MRC trial of assessment and management of older people in the community. Int J Geriatr Psychiatry. 2003;18(7):623-630.

19. Zahran HS, Kobau R, Moriarty DG, et al. Health-related quality of life surveillance--United States, 1993-2002. MMWR Surveill Summ. 2005;54(4):1-35.

20. SAS Institute Cary NC USA.

21. Brody DJ, Pratt LA, Hughes JP. Prevalence of Depression Among Adults Aged 20 and Over: United States, 2013-2016. NCHS Data Brief. 2018;(303):1-8.

22. Blanco C, Okuda M, Markowitz JC, Liu SM, Grant BF, Hasin DS. The epidemiology of chronic major depressive disorder and dysthymic disorder: results from the National Epidemiologic Survey on Alcohol and Related Conditions. J Clin Psychiatry. 2010;71(12):1645-1656.

23. Pratt LA, Brody DJ. Depression in the U.S. household population, 2009-2012. NCHS Data Brief. 2014;(172):1-8.

24. Kessler RC. Epidemiology of women and depression. J Affect Disord. 2003;74(1):5-13.

25. Kessler RC, Berglund P, Demler O, et al. The epidemiology of major depressive disorder: results from the National Comorbidity Survey Replication (NCS-R). JAMA. 2003;289(23):3095-3105.

26. Cyranowski JM, Frank E, Young E, Shear MK. Adolescent onset of the gender difference in lifetime rates of major depression: a theoretical model. Arch Gen Psychiatry. 2000;57(1):21-27.

27. Freeman EW, Sammel MD, Liu L, Gracia CR, Nelson DB, Hollander L. Hormones and menopausal status as predictors of depression in women in transition to menopause. Arch Gen Psychiatry. 2004;61(1):62-70.

28. Piccinelli M, Wilkinson G. Gender differences in depression. Critical review. Br J Psychiatry. 2000;177:486-492.

29. Steiner M, Dunn E, Born L. Hormones and mood: from menarche to menopause and beyond. J Affect Disord. 2003;74(1):67-83.

30. van Beljouw IM, Verhaak PF, Cuijpers P, van Marwijk HW, Penninx BW. The course of untreated anxiety and depression, and determinants of poor one-year outcome: a one-year cohort study. BMC Psychiatry. 2010;10:86.

31. Johnson-Lawrence V, Griffith DM, Watkins DC. The effects of race, ethnicity, and mood/anxiety disorders on the chronic physical health conditions of men from a national sample. Am J Mens Health. 2013;7(4 Suppl):58S-67S.

32. Bowen ME, González HM. Childhood socioeconomic position and disability in later life: results of the health and retirement study. Am J Public Health. 2010;100 Suppl 1(Suppl 1):S197-S203.

33. Herd P, Goesling B, House JS. Socioeconomic position and health: the differential effects of education versus income on the onset versus progression of health problems. J Health Soc Behav. 2007;48(3):223-238.

34. Assari S. Unequal Gain of Equal Resources across Racial Groups. Int J Health Policy Manag. 2018;7(1):1-9.

35. Demakakos P, Nazroo J, Breeze E, Marmot M. Socioeconomic status and health: the role of subjective social status. Soc Sci Med. 2008;67(2):330-340.

36. Subramanyam MA, Diez-Roux AV, Hickson DA, et al. Subjective social status and psychosocial and metabolic risk factors for cardiovascular disease among African Americans in the Jackson Heart Study. Soc Sci Med. 2012;74(8):1146-1154.

37. Brody DJ, Pratt LA, Hughes JP. Prevalence of Depression Among

Adults Aged 20 and Over: United States, 2013-2016. NCHS Data Brief. 2018;(303):1-8.

38. Freese J, Lutfey K. Fundamental causality: Challenges of an animating concept for medical sociology. In Handbook of the Sociology of Health, Illness, and Healing: A Blueprint for the 21st Century; Springer Science & Business Media: New York, NY, USA, 2010; pp. 67–81.

39. Link BG, Phelan J. Social conditions as fundamental causes of health inequalities. In Handbook of Medical Sociology; Bird CE, Conrad P, Fremont AM, Timmermans S. Eds.; Vanderbilt University Press: Nashville, TN, USA, 2010; pp. 3–17.

40. Fuller-Rowell TE, Doan SN. The social costs of academic success across ethnic groups. Child Dev. 2010; 81(6): p. 1696-713.

41. Zajacova A, Everett BG. The Nonequivalent Health of High School Equivalents. Soc Sci Q. 2014;95(1): 221-238.

42. Montez JK, Hummer RA, Hayward MD. Educational attainment and adult mortality in the United States: a systematic analysis of functional form. Demography. 2012;49(1):315-336.

43. Wade TJ, Cairney J. The effect of sociodemographics, social stressors, health status and psychosocial resources on the age-depression relationship. Can J Public Health. 2000;91(4):307-312.

44. Wade TJ, Pevalin DJ. Marital transitions and mental health. J Health Soc Behav. 2004;45(2):155-170.

45. Roterman M. Marital breakdown and subsequent depression. Health Rep 2007;18:33–44. .

46. Cairney J, Pevalin DJ, Wade TJ, Veldhuizen S, Arboleda-Florez J. Twelve-month psychiatric disorder among single and married mothers: the role of marital history. Can J Psychiatry. 2006;51(10):671-676.

47. Thielke SM, Diehr P, Unutzer J. Prevalence, incidence, and persistence of major depressive symptoms in the Cardiovascular Health Study. Aging Ment Health. 2010;14(2):168-176.

48. Colman I, Ataullahjan A. Life course perspectives on the epidemiology of depression. Can J Psychiatry. 2010;55(10):622-632.

49. HealthyPeople 2020, Available from: https://www.healthypeople.gov/2020/about/foundation-health-measures/General-Health-Status. .

50. Bize R, Johnson JA, Plotnikoff RC. Physical activity level and health-related quality of life in the general adult population: a systematic review. Prev Med. 2007;45(6):401-415.

51. U.S. Department of Health and Human Services, Physical Activity and Health: A Report of the Surgeon General. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Atlanta, USA. 1996.

52. Clark CR, Kawachi I, Ryan L, Ertel K, Fay ME, Berkman LF. Perceived neighborhood safety and incident mobility disability among elders: the hazards of poverty. BMC Public Health. 2009; 9: 162.

53. Hale L, Hill TD, Friedman E, et al. Perceived neighborhood quality, sleep quality, and health status: evidence from the Survey of the Health of Wisconsin. Soc Sci Med. 2013;79:16-22.

54. Meyer OL, Castro-Schilo L, Aguilar-Gaxiola S. Determinants of mental health and self-rated health: a model of socioeconomic status, neighborhood safety, and physical activity. Am J Public Health. 2014;104(9):1734-1741.

55. Keller A, Litzelman K, Wisk LE, et al. Does the perception that stress affects health matter? The association with health and mortality. Health Psychol. 2012;31(5):677-684.

56. Gillespie NA, Whitfield JB, Williams B, Heath AC, Martin NG. The relationship between stressful life events, the serotonin transporter (5-HTTLPR) genotype and major depression. Psychol Med. 2005;35(1):101-111.

57. Dixon WA, Reid JK. Positive life events as a moderator of stress-related depressive symptoms. J Couns Dev. 2000;78:343-347.

58. Dienes KA, Hazel NA, Hammen CL. Cortisol secretion in depressed, and at-risk adults. Psychoneuroendocrinology. 2013;38(6):927-940.

59. Andrews B, Wilding JM. The relation of depression and anxiety to life-stress and achievement in students. Br J Psychol. 2004;95(Pt 4):509-521.

60. Kessler RC. The effects of stressful life events on depression. Annu Rev Psychol. 1997;48:191-214.

61. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention: Behavioral Risk factor Surveillance 2010 System survey user's guide, survey and codebook. Available at https://www.cdc.gov/brfss/annual_data/annual_2017.html; Accessed February 19, 2020.