Exercise routine change is associated with prenatal depression scores during the COVID-19 pandemic among pregnant women across the United States

Background
The COVID-19 pandemic has negatively affected physical and mental health worldwide. Pregnant women already exhibit an elevated risk for depression compared to the general public, a pattern expected to be exacerbated by the pandemic. Certain lifestyle factors, including moderate exercise, may help support mental health during pregnancy (e.g., by improving mood and increasing perceptions of control), but it is unclear how the pandemic may be impacting these associations across different locations. Here, we test whether: (i) altered exercise routines during the pandemic are associated with higher depression scores; and, (ii) women living in metro areas are more likely to report exercise changes compared to those in non-metro areas, potentially due to having limited space (both indoors and outdoors) for safe exercise.

Methods
This cross-sectional study uses data from the COVID-19 And Reproductive Effects (CARE) study, an online survey of pregnant women in the United States. Participants were recruited April-June 2020 (n = 1,862). Linear regression analyses assessed whether COVID-19-related exercise change was associated with depression score as measured by the Edinburgh Postnatal Depression Survey. Logistic regression analyses tested whether a participant’s Rural-Urban Continuum Code classification of “metro” was linked with higher odds of reporting exercise changes compared to a “non-metro” classification.

Results
Women who reported exercise changes during the pandemic exhibited significantly higher depression scores compared to those reporting no changes. Moreover, individuals living in metro areas of all sizes were significantly more likely to report exercise changes compared to women living in non-metro areas.

Conclusions
These results suggest moderate exercise may represent a non-pharmaceutical tool for supporting maternal mental health. Providers should explicitly ask patients how the pandemic has impacted their exercise routines and consider this a risk factor for depression. Efforts should be made to recommend exercises that are tailored to individual living conditions and physical health.
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- Human participants
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This study received ethical approval from Dartmouth College (STUDY00032045). Study information (e.g., study summary, purpose, benefits, risks, and privacy protection details) was provided to all participants prior to their completion of the survey. Informed consent was collected by asking potential participants to click a box saying that they had read the study information and consented to participating in the study.
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- If anesthesia, euthanasia, or any kind of animal sacrifice is part of the study, include briefly which substances and/or methods were applied

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The CARE study dataset contains sensitive and potentially identifying participant information. Ethical and legal restrictions therefore prevent us from posting our data to a third-party server. However, data and statistical code will be made available to qualified researchers upon reasonable request. Researchers must agree to privacy and data use expectations that conform to IRB requirements and are central to the welfare of study participants. Requests for data can be easily made using a request form on the study website (https://sites.dartmouth.edu/care2020/request-data-access/).
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Additional data availability information:
Exercise routine change is associated with prenatal depression scores during the COVID-19 pandemic among pregnant women across the United States

Running title: COVID-19-related exercise change and depression by location

Keywords: Perinatal depression; coronavirus; pregnancy; mental health; physical activity

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Abstract

Background: The COVID-19 pandemic has negatively affected physical and mental health worldwide. Pregnant women already exhibit an elevated risk for depression compared to the general public, a pattern expected to be exacerbated by the pandemic. Certain lifestyle factors, including moderate exercise, may help support mental health during pregnancy (e.g., by improving mood and increasing perceptions of control), but it is unclear how the pandemic may be impacting these associations across different locations. Here, we test whether: (i) altered exercise routines during the pandemic are associated with higher depression scores; and, (ii) women living in metro areas are more likely to report exercise changes compared to those in non-metro areas, potentially due to having limited space (both indoors and outdoors) for safe exercise.

Methods: This cross-sectional study uses data from the COVID-19 And Reproductive Effects (CARE) study, an online survey of pregnant women in the United States. Participants were recruited April-June 2020 (n = 1,862). Linear regression analyses assessed whether COVID-19-related exercise change was associated with depression score as measured by the Edinburgh Postnatal Depression Survey. Logistic regression analyses tested whether a participant’s Rural-Urban Continuum Code classification of “metro” was linked with higher odds of reporting exercise changes compared to a “non-metro” classification.

Results: Women who reported exercise changes during the pandemic exhibited significantly higher depression scores compared to those reporting no changes. Moreover, individuals living in metro areas of all sizes were significantly more likely to report exercise changes compared to women living in non-metro areas.

Conclusions: These results suggest moderate exercise may represent a non-pharmaceutical tool for supporting maternal mental health. Providers should explicitly ask patients how the pandemic has...
impacted their exercise routines and consider this a risk factor for depression. Efforts should be made to recommend exercises that are tailored to individual living conditions and physical health. (300/300 words)

Author summary

The COVID-19 pandemic has negatively impacted the well-being of people across the U.S. and has been linked with elevated depression rates. However, certain groups may be disproportionately impacted, including pregnant women. Given the relatively high rates of depressive symptomology evident among pregnant women prior to the pandemic, supporting the maternal mental health during these challenging times is especially important. However, fetal exposure to psychotropic medications taken by the mother limits their utility, necessitating the use of non-pharmaceutical treatments, such as moderate exercise, to improve mental health outcomes. Yet, regular exercise routines have likely been affected by the pandemic – especially for those living in densely-populated areas where space to exercise safely is limited – but these associations are not well tested among pregnant women. Here, using data from an online survey of 1,862 women living in the U.S., we find that women who reported exercise changes during the pandemic exhibited higher depression scores compared to those able to maintain their exercise routine. Moreover, individuals living in metro areas were more likely to report exercise changes compared to women living in non-metro areas. These findings suggest an association exists between ability to maintain an exercise routine during the pandemic and maternal depression risk. (200/200 words)
Introduction

The COVID-19 pandemic has impacted the health and livelihoods of people around the world. However, certain countries have been hit harder than others, with the United States exhibiting the highest prevalence and mortality estimates globally. As of September 19, 2020, 6,749,092 people living in the U.S. are estimated to have been infected with the novel coronavirus SARS-CoV-2, while 198,940 are thought to have died from the resulting disease COVID-19 (1). Within the U.S., certain populations appear to be at higher risk for negative COVID-19 disease outcomes, including pregnant women. Although the specific effects of COVID-19 on pregnancy are still being tested, some researchers argue pregnant women are generally at higher risk for viral respiratory illness (2). Moreover, other studies indicate that COVID-19 may be associated with an elevated risk for placental injury, pre-eclampsia, preterm birth, and low birth weight (3–5). These recent findings led the CDC to add pregnancy as a risk factor for severe COVID-19 outcomes on June 25, 2020 (6).

In addition to potentially being at an elevated risk for poor COVID-19 health outcomes, the CDC cautions that pregnant women may feel increased stress or anxiety during the pandemic (6). The physical distancing and “stay at home” orders implemented by many local governments to slow the spread of SARS-CoV-2 are thought to increase feelings of anxiety and isolation, especially among already vulnerable populations (7). Pregnancy-associated physiological changes have been clearly linked with increased depression risk, such that 1 in 8 women in the U.S. have been estimated to experience postpartum depression symptoms (8). These depression-related symptoms include fatigue, changes to appetite or sleep, crying more often than usual, withdrawing from loved ones or the baby, feelings of anger, sorrow, hopelessness, worthlessness, or restlessness, and suicidal ideology (8).

Recent evidence suggests that maternal depression symptomatology has become even more common during the COVID-19 pandemic. Specifically, one study comparing mental health among
pregnant women/new mothers before and after the onset of the pandemic found that rates of clinical
depression and moderate to high anxiety significantly increased with the onset of the pandemic (7).
These changes appear to be directly linked with the disruptions to daily routines, social isolation, and
fears of developing COVID-19, highlighting the need for increased maternal health screening and
treatment (7). Other factors, including increased COVID-19-related financial stress or changes to working
plans in pregnancy have also been associated with increased depression (9,10). Given the probable
exposure of offspring to any psychotropic medications taken by the mother during pregnancy or
breastfeeding (11), the identification of non-pharmaceutical treatments to reduce maternal depression
is of great interest.
One such alternative treatment may be maintaining a regular exercise routine throughout
pregnancy and the postpartum period, which has been shown to both prevent and help treat depression
symptoms among women able to safely engage in moderate to vigorous physical activity (11–15).
Regular exercise has been linked with several beneficial effects, including improved body satisfaction
(16), reduced physical discomfort (17), feelings of physical control despite somatic changes linked with
pregnancy (18,19), and improved mood through the release of endorphins and neurotransmitters
(18,20). It has therefore been recommended by the American College of Obstetricians and Gynecologists
that pregnant women without medical contraindications engage in at least 150 minutes of moderate-
intensity aerobic activity every week, divided into 30 minutes intervals most days of the week (21). Yet,
many pregnant women do not exercise at the recommended levels, due in large part to fatigue, time
constraints (e.g., work and childcare), and pregnancy-related physical limitations (e.g., back pain,
swelling, and joint pain) (22,23). Differences are also apparent by location, with pregnant women living
in urban areas exhibiting significantly higher levels of moderate physical activity compared to those
living in rural areas, likely because of increased access to fitness centers (24,25).
Regardless of location, the benefits of exercise during pregnancy appears to be especially relevant during the COVID-19 pandemic, with women who reported at least 150 min of moderate intensity exercise exhibiting significantly lower scores for both anxiety and depression than those who did not (7). Yet the direct effects of the pandemic on exercise regimens among pregnant women remains poorly tested. Given the effects of shelter in place orders, it seems likely that many women’s exercise routines will be disrupted by the pandemic, especially in metro areas (e.g., due to fitness centers and parks closing or a fear of viral exposure while exercising outside in a densely populated area). Conversely, women in less densely populated areas may feel safer going outside to engage in physical activities. However, the relationship between pandemic-related changes in exercise routines and depression risk has yet to be directly tested, and it is unclear how geographic location may impact this association.

We therefore use data drawn from the COVID-19 and Reproductive Effects (CARE) study to test the following two hypotheses among pregnant women living in the U.S.:

1) Participants who report changes in their exercise routines during the COVID-19 pandemic will demonstrate significantly higher depression scores compared to women who are able to maintain their exercise routine during the pandemic.

2) Compared to individuals who live in non-metro areas, participants living in metro areas (of all sizes) will be significantly more likely to report COVID-19-related changes in their exercise routines.

Materials and methods

Study design
The COVID-19 And Reproductive Effects (CARE) study was posted on social media platforms (Facebook, Twitter) and distributed via email to contacts working in maternity care and public health. Pregnant women over the age of 18 and living in the U.S. were invited to participate in a short survey assessing how the COVID-19 pandemic was impacting their medical care and birth plans. The data presented here were collected between April 16 – June 16, 2020. This study received ethical approval from Dartmouth College (STUDY00032045).

The survey was administered in REDCap which automatically captures survey responses. Only women who met the inclusion criteria (i.e., living in the U.S., over 18 years of age, and currently pregnant) were eligible to participate in the survey. The survey completion rate (i.e., the percentage of those who consented to take the survey and actually went through to the end of the questionnaire) was 80%. During the study period, there were 1,862 surveys collected that included responses for all study variables. Data on depression symptomatology, exercise routines, and geographic location were collected, along with various covariates known to influence exercise patterns and depression risk.

Depression scores: Depression symptoms were screened using the Edinburgh Postnatal Depression Survey (EPDS), resulting in a participant score ranging from 0 (minimum) to 30 (maximum) (26). Depression scores were analyzed continuously.

Exercise routine changes: Participants were asked “has your exercise routine changed at all since the COVID-19 pandemic began?” Participants responded yes or no. Additionally, participants were asked the number of days per week (on average) they engaged in moderate exercise for at least 30 minutes.

Geographic location: Participants self-reported their zip codes. This information was used to generate a Rural-Urban Continuum Code (RUCC) for each respondent (27). The RUCC is based on the county located at the zip code center point, with each participant receiving a code on a 1-9 scale. For this analysis, the codes were collapsed as follows: 1) metro county of 1 million people or more, 2) metro county of 250,000 to 1 million people, 3) metro county of less than 250,000 people, and 4) all non-metro
counties. In addition, participants reported whether or not they lived in an area where they were currently required to shelter in place (i.e., not leave home, except for essential activities).

Age: Participants self-reported their age in years.

Current gestational week: Participants indicated their current gestational week.

Race/ethnicity: Race/ethnicity were self-reported and measured according to the Office of Management and Budget Standards (28). Native Hawaiian/Pacific Islander participants were re-classified as “Other” due to a small sample size (n = 3).

Household income: Participants indicated their household income from the following options: Less than $10,000 (1); $10,000 – $19,999 (2); $20,000 – $34,999 (3); $35,000 – $49,999 (4); $50,000 – $74,999 (5); $75,000 – $99,999 (6); $100,000+ (7). A composite household income variable was created for analysis: < $49,999, $50,000 – $99,999, and $100,000+.

Education: Participants selected their highest completed education from the following options: Some high school, no diploma (1); High school graduate, diploma or the equivalent (for example: GED) (2); Some college credit, no degree (3); Trade/technical/vocational training (4); Associate degree (5); Bachelor’s degree (6); Master’s degree (7); Professional degree (8); Doctorate degree (9). A composite education variable was created for analysis: less than a bachelor’s degree, a bachelor’s degree, or a degree beyond a bachelor’s degree.

Financial stress: Participants were asked to rate whether they agreed or disagreed (Likert question; 5 options ranging from strongly disagree to strongly agree) with the statement “I am worried about my financial situation due to the COVID-19 crisis.” Participants who stated that they agreed or strongly agreed with the statement were classified as having experienced COVID-19-related financial stress.

Risk status: Women were asked whether their pregnancy was classified as “high-risk.” In addition, participants aged 35 or older were classified as “high-risk”.
Statistical analysis

Data analyses were conducted using Stata 14. All continuous variables exhibited normal distributions, with skewness values within approximately ±0.5 and kurtosis values within approximately ±3. Multicollinearity was not detected between any variables; all VIF values were in an acceptable range of 1.01-1.65. Study descriptive statistics were calculated, and regression analyses were conducted to test the study hypotheses. Results were considered statistically significant at a p-value of less than 0.05.

Hypothesis 1: Linear regression analyses assessed whether exercise routine change during the COVID-19 pandemic was significantly associated with participant depression score.

Hypothesis 2: Logistic regression analyses tested whether a participant RUCC classification of “metro” was linked with significantly higher odds of reporting an altered exercise routine during the pandemic compared to a classification of “non-metro”.

All regression models adjusted for maternal age, education, income, financial stress, week of pregnancy at time of survey, race/ethnicity, and “high-risk” pregnancy.

Results

Sample characteristics and descriptive statistics

The study sample was spread out across all 50 states, including one participant in the U.S. territory of Puerto Rico (Figure 1). A clear majority of the sample (92.3%) indicated they lived in a location that required individuals to shelter in place (i.e., stay home, except for essential activities) at the time they completed the survey. Most women in the sample were physically active, with 56.4% of respondents reporting they engaged in moderate exercise for at least 30 minutes three or more days per week (versus the 17.9% of women who reported they were inactive).
Sample descriptive statistics are presented in Table 1. Mean participant age was 31 years old and the mean number of weeks pregnant was 26. Most respondents were white (87% of the sample), educated (77% had at least a bachelor’s degree), lived in a metro area of 1 million or more people (61% of the sample), and were relatively high-income (55% reported an annual household income of $100,000 or more). Still, approximately 43% of participants reported that they worried about their financial situation due to the COVID-19 pandemic. Most participants (65%) did not indicate a high-risk pregnancy. Additionally, the majority of participants (60%) reported that their exercise routine had changed during the COVID-19 pandemic. Finally, participants varied in depression scores as measured by the EPDS scale, ranging from the minimum score of 0 all the way to the maximum score of 30; the mean EPDS score was 10.6.

Figure 1. Study participant locations across the United States. The number of participants in each zip code is summarized across United States counties and displayed as percentage of county population (29), with darker colors representing areas where participants make up a higher percentage of the county population (see legend). Data are presented for the sample used in the present analyses (n = 1,862). State and county spatial data courtesy Census.gov.

Table 1. Descriptive statistics of model variables. Sample means (with standard deviation and range) or frequency (percent) of model variables, for 1,862 participants included in the analyses.

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<th>Variable</th>
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<td>Age (years)</td>
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<tr>
<td>Weeks pregnant at time of survey</td>
<td>26.0 (8.73; 0-41)</td>
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<tr>
<td>Edinburgh Postnatal Depression Survey (EPDS) score</td>
<td>10.6 (5.34; 0-30)</td>
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<tr>
<td>Frequency (%)</td>
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<td>Race/ethnicity:</td>
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<td>White</td>
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<td>24 (1.29%)</td>
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<tr>
<td>Asian</td>
<td>60 (3.22%)</td>
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<tr>
<td>American Indian or Alaskan Native</td>
<td>12 (0.64%)</td>
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Hypothesis 1

Linear regression analyses were carried out to assess whether exercise routine change during the pandemic was significantly associated with depression score, measured using the EPDS (Table 2).
Participants who were older (B = -0.071, 95%CI: -0.140-(-0.001), p = 0.046), reported a higher household income (compared to < $49,999) of $50,000 - $99,999 (B = -0.944, 95%CI: -1.77-(-0.112), p = 0.026) or $100,000+ (B = -1.34, 95%CI: -2.22-(-0.470), p = 0.003), and were more highly educated (compared to less than a bachelor’s degree) with either a bachelor’s degree (B = -0.873, 95%CI: -1.56-(-0.189), p = 0.012) or a degree beyond a bachelor’s degree (B = -1.13, 95%CI: -1.83-(-0.426), p = 0.002) exhibited significantly lower depression scores.

Conversely, participants who were Hispanic, Latino, or Spanish in origin (B = 1.29, 95%CI: 0.306-2.27, p = 0.010) or who reported experiencing COVID-19-related financial stress (B = 2.26, 95%CI: 1.78-2.75, p < 0.001) displayed significantly higher depression scores. Finally, as hypothesized, women who reported their exercise routine had changed during the pandemic demonstrated significantly higher depression scores (B = 0.917, 95%CI: 0.434-1.40, p < 0.001).

Table 2. Linear regression model assessing associations between reported exercise changes during the COVID-19 pandemic and depression, as measured by a continuous Edinburgh Postnatal Depression Survey (EPDS) score. Beta coefficients are provided with standard errors, 95% confidence intervals, and p-values for each variable included in the model.

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<th>p-value</th>
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<td>Age (years)</td>
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<td>0.046</td>
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<td>Weeks pregnant at time of survey</td>
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<td>White</td>
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<td>Hispanic, Latino, or Spanish origin</td>
<td>1.29 (0.501, 0.306-2.27)</td>
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<td>Black or African American</td>
<td>0.039 (1.05, -2.02-2.10)</td>
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<td>Asian</td>
<td>-1.01 (0.673, -2.33-0.311)</td>
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<td>American Indian or Alaskan Native</td>
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<tr>
<td>Other</td>
<td>-0.456 (0.859, -2.14-1.23)</td>
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Hypothesis 2

Logistic regression analyses were carried out to assess whether participant geographic location (i.e., non-metro vs. metro), as assessed by RUCC, was associated with significantly higher odds of reporting an altered exercise routine during the COVID-19 pandemic (Table 3). Participants who were farther along in their pregnancy had significantly lower odds of reporting changes to their exercise (OR = 0.986, 95%CI: 0.975-0.997, p = 0.010). Meanwhile, participants with a higher household income (compared to < $49,999) of $50,000 - $99,999 (OR = 1.56, 95%CI: 1.11-2.18, p = 0.010) or $100,000+ (OR = 1.58, 95%CI: 1.11-2.26, p = 0.012) and were more highly educated (compared to less than a bachelor’s degree) with either a bachelor’s degree (OR = 1.54, 95%CI: 1.17-2.03, p = 0.002) or a degree beyond a bachelor’s degree (OR = 2.04, 95%CI: 1.53-2.71, p < 0.001) exhibited significantly higher odds of reporting exercise routine changes. Participants who reported experiencing pandemic-related financial stress (OR = 1.26, 95%CI: 1.03-1.54, p = 0.024) also displayed significantly higher odds of reporting exercise routine changes.
Finally, compared to participants living in a non-metro area, those living in a metro area of 1 million or more people (1.96, 95%CI: 1.42-2.71, p < 0.001), a metro area of 250,000 – 999,999 people (OR = 1.72, 95%CI: 1.21-2.46, p = 0.003), or a metro area of < 250,000 people (OR = 2.03, 95%CI: 1.29-3.20, p = 0.002) demonstrated significantly higher odds of reporting exercise routine changes, as hypothesized (Figure 2).

Table 3. Logistic regression model assessing associations between participant Rural-Urban Continuum Code (RUCC) and reported exercise change. Odds ratios are provided with standard errors, 95% confidence intervals, and p-values for each variable included in the model.

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR (SE, 95% CI)</th>
<th>p-value</th>
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<td>Intercept</td>
<td>0.429 (0.196, 0.176-1.05)</td>
<td>0.063</td>
</tr>
<tr>
<td>Age (years)</td>
<td>1.00 (0.015, 0.974-1.03)</td>
<td>0.874</td>
</tr>
<tr>
<td>Weeks pregnant at time of survey</td>
<td><strong>0.986 (0.006, 0.975-0.997)</strong></td>
<td>0.010</td>
</tr>
<tr>
<td>Race/ethnicity:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>reference</td>
<td></td>
</tr>
<tr>
<td>Hispanic, Latino, or Spanish origin</td>
<td>1.39 (0.295, 0.913-2.10)</td>
<td>0.125</td>
</tr>
<tr>
<td>Black or African American</td>
<td>1.04 (0.462, 0.433-2.48)</td>
<td>0.936</td>
</tr>
<tr>
<td>Asian</td>
<td>1.52 (0.467, 0.833-2.78)</td>
<td>0.173</td>
</tr>
<tr>
<td>American Indian or Alaskan Native</td>
<td>1.27 (0.772, 0.388-4.18)</td>
<td>0.691</td>
</tr>
<tr>
<td>Other</td>
<td>0.935 (0.329, 0.469-1.86)</td>
<td>0.848</td>
</tr>
<tr>
<td>Household income:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; $49,999</td>
<td>reference</td>
<td></td>
</tr>
<tr>
<td>$50,000 - $99,999</td>
<td><strong>1.56 (0.267, 1.11-2.18)</strong></td>
<td>0.010</td>
</tr>
<tr>
<td>$100,000+</td>
<td><strong>1.58 (0.289, 1.11-2.26)</strong></td>
<td>0.012</td>
</tr>
<tr>
<td>Education level:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than a bachelor’s degree</td>
<td>reference</td>
<td></td>
</tr>
<tr>
<td>Bachelor’s degree</td>
<td><strong>1.54 (0.216, 1.17-2.03)</strong></td>
<td>0.002</td>
</tr>
<tr>
<td>Degree beyond a bachelor’s degree</td>
<td><strong>2.04 (0.297, 1.53-2.71)</strong></td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Financial stress (no vs. yes) | 1.26 (0.129, 1.03-1.54) | 0.024
--- | --- | ---
High-risk pregnancy (no vs. yes) | 1.10 (0.133, 0.870-1.40) | 0.420
RUCC:
| Non-metro | reference | 
| Metro, 1 million+ | 1.96 (0.323, 1.42-2.71) | <0.001 |
| Metro, 250,000 – 999,999 | 1.72 (0.313, 1.21-2.46) | 0.003 |
| Metro, < 250,000 | 2.03 (0.470, 1.29-3.20) | 0.002 |

Figure 2. Percentage of study participants reporting change in exercise routine by United States county for (A) metro counties, and (B) non-metro counties. Map colors represent the proportion of participants in the sample reporting exercise routine changes during the pandemic within a given county (see legend), ranging from blue (a low percentage of sample participants reported exercise changes) to red (a high percentage of sample participants reported exercise routine changes). Metro counties are displayed in gray-scale according to the USDA Rural-Urban Continuum Codes (RUCC), while non-metro counties are displayed in white (27). State and county spatial data courtesy Census.gov.

Discussion

The study findings support both hypotheses. Women who reported exercise changes during the COVID-19 pandemic exhibited significantly higher depression scores compared to those who reported no changes. Moreover, individuals living in metro areas of all sizes were significantly more likely to report exercise changes compared to women living in non-metro areas, potentially because women living in more rural areas felt safer venturing outside for walks or other forms of physical activity given the lower population density and less perceived risk of viral exposure. Although cross-sectional and preliminary in nature, these results align with existing studies demonstrating the beneficial effects of exercise during pregnancy (11–15), suggesting moderate exercise may serve as a tool for supporting mental health during pregnancy.
Further, the association documented here suggests one possible mechanism by which the ongoing COVID-19 pandemic may impair maternal mental health. Business closures and stay at home orders resulting from the pandemic may directly inhibit one’s ability to engage in physical activity. The majority of study participants (92.3%) indicated they were currently experiencing shelter in place orders, likely leading to disruptions in daily routines, including ability to engage in normal exercise activities. This idea is generally supported by preliminary analyses from the sample suggesting that a high percentage of participants (47.4%) explicitly reported exercising less following the onset of the pandemic, while many fewer respondents reported they were exercising more (9.12%). This difference suggests that exercise changes during the pandemic have generally resulted in less physical activity. This may be linked with gym, recreation center, and park closures that disrupt normal exercise routines, especially in urban areas where there is limited green space available for outdoor physical activity.

The disruption of exercise routines may have several negative effects contributing to elevated depression symptomatology, including decreased body satisfaction, increased physical discomfort, perceptions of not being in control (of both physical changes associated with pregnancy and everyday activities), as well as poor mood (16–20). Thus, maternal depression risk—already a concern among pregnant women prior to the COVID-19 pandemic—may be exacerbated during the pandemic partly because of disruptions to daily routines, including typical exercise regimens. The effects of altered exercise routines on maternal health may be especially relevant in the CARE study sample. These data were collected from women living in the U.S., the country hardest hit by the COVID-19 pandemic thus far (1). The prolonged nature of the lockdowns and current uptick of infections in many parts of the country will likely continue to disrupt normal routines, including ability to exercise, for the foreseeable future. Consequently, the association between depression score and changes in exercise routine documented here suggest that maternal depression screenings should account for the impact of COVID-19 on physical activity levels, in addition to other effects of the pandemic on maternal well-being.
Additionally, providers should consider how ability to engage in physical activity during the pandemic may influence maternal mental health, particularly among women living in urban areas. Providers and/or fitness specialists could work with pregnant women and new mothers to find simple routines (e.g., exercises that can be completed safely from home without specialized equipment and which do not require much open space) to encourage physical activity during the pandemic across all demographics and living conditions. Indeed, it has been suggested that household chores, walks, gardening, and online fitness classes may be possible alternatives to support maternal physical and mental health (7).

However, efforts must be made to recommend exercises tailored to each individual’s living conditions and physical health, as the negative effects of changed exercise routines are not likely to be experienced equally across all sociodemographic groups. Specifically, higher-income women with access to more resources may find it easier to adopt alternative forms of exercise as the pandemic continues (e.g., purchase home gym equipment or exercise videos), allowing them stay physically active even if they live in urban areas where they cannot easily access a gym or exercise outside. Conversely, lower-income communities located in densely populated areas without infrastructure (e.g., green space and sidewalks) to support safe outdoor activities during COVID-19 may be more substantially impacted by pandemic-related public facility closures and shelter in place orders. However, this remains to be directly tested using a more diverse sample.

**Limitations**

It should be noted that despite the strengths of these analyses (e.g., large sample size and participants from across the country), several important study limitations exist. First, this study is cross-sectional, making it difficult to establish causality. For instance, it is not possible to definitively establish
whether the significant relationship observed between exercise routine change during the pandemic and depression score is due to disrupted exercise routines leading to later depression or to maternal depression leading to decreased motivation to exercise. The relationship between physical activity and depression appears to be bidirectional in nature, with exercise protecting against depression but baseline depression also subsequently decreasing physical activity levels (30). Longitudinal data collection is needed to establish these causal relationships.

In addition, due to the use of convenience sampling, these data are not representative of the U.S. population as a whole; white, educated, wealthy women are overrepresented in the present sample (31). Additional work is needed to determine whether the associations observed here are also evident across a more representative, diverse sample of the U.S. population. Finally, quantitative data on prepandemic exercise patterns were not collected, making it difficult to establish whether the patterns documented here partly reflect pre-existing physical activity differences. For example, previous work indicates that pregnant women living in urban areas exhibit higher levels of moderate exercise compared to those living in rural areas (24,25); these women may therefore be less likely to report exercise changes as they were not regularly exercising prior to the pandemic. Still, this pattern does not detract from the finding that urban women appear to be exercising less during the pandemic, which may negatively impact their physical and mental well-being.

Conclusions

The COVID-19 pandemic has far-ranging effects on both mental and physical health. Certain segments of the population may be especially impacted by the pandemic; including pregnant women, who already suffer from an elevated depression risk compared to the general public (8). The findings presented here support previous work and suggest an association exists between ability to maintain an
exercise routine during pregnancy and depression risk. Providers should explicitly ask patients how the pandemic has impacted their exercise routines and consider this a risk factor for depression. Moreover, efforts should be made to recommend exercises that are tailored to individual living conditions (e.g., whether they can safely exercise outdoors) and physical health. Specifically, the findings presented here indicate that women living in metro areas were significantly more likely to report exercise routine changes during the pandemic than women living in non-metro areas. This may signify an opportunity for interventions—especially in urban areas—which rely on simple exercises that can safely be performed at home without specialized equipment (e.g., squats, lunges, side-lying leg lifts, etc.). Importantly, exercise recommendations may be most effective if communicated by providers who understand the personal health and space limitations of each individual patient. Exercise represents a potential non-pharmaceutical tool to support both mental and physical health among pregnant women, both during and after the pandemic.

Acknowledgements

We would like to thank Nadia Clement for her assistance building the online survey and designing the recruitment flyers. We would also like to thank Margaret Sherin, Gloriuese Uwizeye, and Chlöe Sweetman for their valuable feedback on the questionnaire during development. Further, we express our gratitude to Grace Alston, Cecily Craighead, Amanda Lu, and Rebecca Milner for their assistance in data coding. Finally, we thank Matthew Nagy for his assistance in data cleaning.
References


Supporting information

S1 Checklist. STROBE Checklist.
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Gildner
STROBE_checklist_v4_combined_PlosMedicine.docx