

Exercise, grades, stress, and learning experiences during remote learning due to the COVID-19 pandemic

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SUMMARY

During the COVID-19 pandemic, because of social distancing measures, schools had to deliver classes through remote learning. The purpose of this study is to understand the relationships between grades, exercise, stress, and students' learning experience for middle and high school students during this remote learning period. Based on prior literature, we hypothesized that exercise would reduce stress during the remote learning period. We also hypothesized that receiving grades during the remote learning period would increase stress but also enhance students' perceived remote learning experience. To test our hypotheses, we conducted a survey of middle and high school students across different states in the United States. We asked participants to rate what they thought about their levels of stress and remote learning experience during the COVID-19 pandemic. We found that, on average, middle and high school students experienced similar stress levels during the remote learning period due to the COVID-19 pandemic compared to the pre-COVID-19 period. We also found that, on average, middle and high school students' perceived learning experience was lower during the remote learning period due to the pandemic compared to the pre-COVID-19 period. Consistent with our hypotheses, we found that physical exercise helped reduce stress during the remote learning period. We also found that receiving grades for schoolwork increased students' stress and effort during the remote learning period but did not have a significant impact on students' learning experience. Furthermore, we found a significant negative relationship between students' stress and their perceived learning experience.

INTRODUCTION

In this study, we examined the impact of the COVID-19 pandemic on middle and high school students' stress levels and learning experience. During the pandemic, because of social distancing measures, schools have been forced to deliver course materials through remote learning. This is the first time remote learning, defined as the education of students not physically present at a school (1), has been used for K-12 education on a large scale. Therefore, it is unclear whether remote learning is effective or not. Thus, being able

to understand the impact of remote learning on students' learning experience is crucial. Furthermore, remote learning and social distancing may also have significant impacts on the stress of the student population. In this study, we examined the effects of exercise and the presence of grades for schoolwork on the stress level of middle and high school students during the pandemic. We also examined the effect of the presence of grades for schoolwork on students' learning experience.

Prior research suggests that physical exercise reduces stress (2). For example, moderate aerobic exercise has been shown to promote the brain's protective response to stress in rodents (3). During the remote learning period due to the COVID-19 pandemic, most states have implemented "stay-at-home" orders and students must stay at home most of the time. Therefore, the lack of social interaction and outdoor activities may lead to higher stress. We expect exercise to play a critical role in reducing stress in the remote learning period due to the COVID-19 pandemic. This leads to our first hypothesis:

H1: *Exercise will reduce the stress levels of middle and high school students during the remote learning period due to the COVID-19 pandemic.*

Prior research has also shown that the presence of grades for schoolwork increases stress (4). For example, studies have shown grades to be a primary stressor among 6th graders (4). We expect this effect to be exacerbated in the remote learning period due to the COVID-19 pandemic for two reasons. First, most students are not familiar with remote learning, and it may be stressful to adapt to this new mode of learning. If students' schoolwork is going to be graded during this period, students may perceive a lack of fairness, which may lead to higher stress levels. Second, some students do not have adequate access to technology and may worry about the negative impact of the lack of access to technology on their grades, which may add to their stress as well. This leads to our second hypothesis:

H2: *The presence of grades for schoolwork will increase the stress levels of middle and high school students during the remote learning period due to the COVID-19 pandemic.*

Although the presence of grades generally increases students' stress levels, prior research provides some evidence suggesting that the presence of grades can in fact have a generally positive effect on learning. For example, a study conducted using undergraduates in Macau found

a positive correlation between academic pressure, being grades in this case, and the students' learning capability (5). Conversely, during the remote learning period, students have many distractions at home and may lack the discipline and motivation to put effort into their schoolwork. We expect the presence of grades to increase students' motivation and discipline to put in effort into their schoolwork. When students are more engaged with remote learning and devote more effort into schoolwork, we expect them to have a better learning experience. On the other hand, stress has been shown in previous studies to negatively impact focus and other mental faculties, which would damage a student's learning experience (6). It has also been demonstrated that a reduction in stress leads to an increase in academic competence (7). To the extent that the presence of grades increases stress, the presence of grades may have an indirect and negative impact on students' learning experience. Despite arguments on both sides based on prior research, we expect the positive effect of grades on learning experience to dominate the potential negative effect of grades on learning experience. This leads to our third hypothesis:

H3: *The presence of grades for schoolwork will enhance the learning experience of middle school and high school students during the remote learning period due to the COVID-19 pandemic.*

To test our hypotheses, we gathered data using an anonymous survey digitally distributed among a student population. We made the decision to make the survey anonymous so that we would be able to have a larger pool of participants and thus have data that more accurately represented the population. Because we were most interested in the stress level and learning experience of middle and high school students, we sent the survey to middle and high school students from states across the United States to examine our research questions. We measured the main dependent variables on a quantitative basis by asking participants to rate their levels of stress and their learning experience during the COVID-19 pandemic.

We found that, on average, middle school and high school students experienced similar stress levels during the remote learning period due to the COVID-19 pandemic compared to the pre-COVID-19 period. We also found that, on average, middle and high school students' perceived learning experience was lower during the remote learning period due to the pandemic compared to the pre-COVID-19 period. Consistent with our hypotheses, we found that physical exercise helped reduce stress during the remote learning period. We also found that receiving grades for schoolwork increased students' stress and effort during the remote learning period, but did not have a significant impact on students' learning experience. Furthermore, we found a significant negative relationship between students' stress and their perceived learning experience.

RESULTS

Descriptive Statistics

We measured the change in students' stress levels with the following question: "How have your stress levels changed due to the pandemic?" on a scale of 1 to 7, with 1 indicating "I have

become much less stressed" and 7 indicating "I have become much more stressed." We found that, on average, participants' response to this question was 3.577 with a standard deviation of 1.50. The median of participants' response to this question was 4.00. A mean is not an accurate representation of the data since our data did not follow a normal distribution based on the normal distribution fit test (p -value < 0.01). These results suggested that most students experienced similar stress levels during the pandemic compared to the pre-COVID-19 period.

We measured the change in students' perception of learning experience with the following question: "To what extent has remote learning changed your learning experience?" on a scale of 1 to 5, with 1 indicating "It has a very negative impact on my learning experience" and 5 indicating "It has a very positive impact on my learning experience." We found that, on average, participants' response to this question was 2.679 with a standard deviation of 0.89, suggesting that perceived learning experience was slightly worse for most students during the pandemic compared to the pre-COVID-19 period.

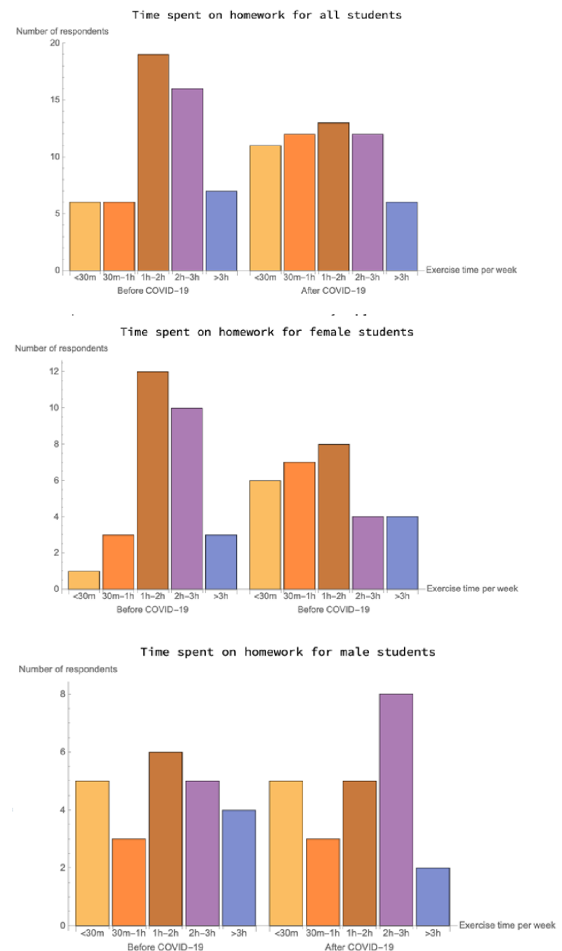


Figure 1: Time spent on homework during COVID-19. Each plot shows the time respondents spent on homework pre-Covid and during the remote learning period as a histogram. (A) Overall, students spent less time on homework during the COVID-19 period. On average, students spent 1.75 hours on homework before COVID-19, while they spent 1.4 hours on homework during the COVID-19 period. Splitting the data by gender reveals that female students (B) generally spent more time on homework than male students (C).

COVID-19 and time spent on homework

First, we wanted to find out how the COVID-19 pandemic affected the average time students spent on homework. We discovered that students spent less time on homework during the COVID-19 period (**Figure 1**). On average, students spent 1.75 hours on homework before COVID-19, while they spent 1.4 hours on homework during the COVID-19 period.

When an intergroup analysis was made between the males and females who participated in the study, there was a noticeable decrease in the time female students spent on homework assignments before compared to during the COVID-19 period, but this was not the case for male students. We calculated that the amount of time male students spent on homework assignments was 1.73 hours before the COVID-19 period, and 1.58 hours during the COVID-19 period. The Paired Student's t-test suggested that this difference is not statistically significant ($p = 0.47$). We calculated that the amount of time female students spent on homework assignments was 1.93 hours before COVID-19, and 1.47 hours during the COVID-19 period. The Paired Student's t-test suggested that this difference was statistically significant (p -value = 0.01). Such results indicated that female students spent significantly less time on homework assignments during the COVID-19 period than before the COVID-19 period.

Test of Hypothesis 1: Exercise and stress

Our first hypothesis was that exercise would reduce students' stress levels during the COVID-19 pandemic. To test this hypothesis, we examined the relationship between hours exercised and stress levels. On average, students spent about 40 minutes exercising each day during the COVID-19 pandemic. We categorized respondents with exercise time of less than one hour as "low exercise group" and those with exercise time of more than one hour as "high exercise group" (**Figure 2**). We performed a t-test to compare the difference of stress level in the low exercise time group and high exercise time group. The p -value was 0.016, suggesting that exercise and stress had a significantly negative relationship during the COVID-19 pandemic. This result supports our first hypothesis. In addition, we ran the t-test on the data again, picking a different cutoff for the "low" and "high" exercise time group (less than 30 minutes as low and more than 30 minutes as high). The p -value for this t-test was 0.047. In both t-tests, the p value was below 0.05, supporting our hypothesis that exercise helps reduce stress.

Test of Hypothesis 2: Grades and stress

Next, we tested our second hypothesis, which posited that the presence of grades for schoolwork during the remote learning period due to COVID-19 pandemic would increase students' stress levels. 63.4% of the students in our sample received grades for schoolwork during the COVID-19 pandemic. Students who received grades during the remote learning period of the pandemic had significantly higher self-reported stress levels than students who did not receive grades (**Figure 3**, $p = 0.05$). This result is consistent with our second hypothesis.

Test of Hypothesis 3: Grades and learning experience

Next, we tested our third hypothesis, which predicted that the presence of grades for schoolwork would enhance students' learning experience during the remote learning

period due to COVID-19 pandemic. As mentioned above, we measured learning experience as our participants' answer to the question "To what extent has remote learning changed your learning experience?" on a scale of 1 to 5, with 1 indicating "It has a very negative impact on my learning experience" and 5 indicating "It has a very positive impact on my learning experience". We found that, on average,

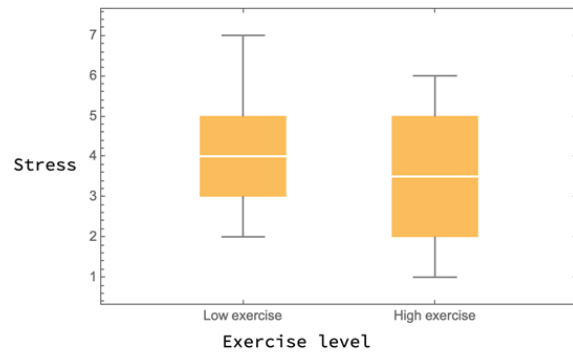


Figure 2: Relationship between exercise and stress. This figure shows the boxplot of the stress levels for low exercise time and high exercise time group. Results show that students who exercise more have a significantly lower level of stress during the COVID-19 pandemic (t-test, $p = 0.05$).

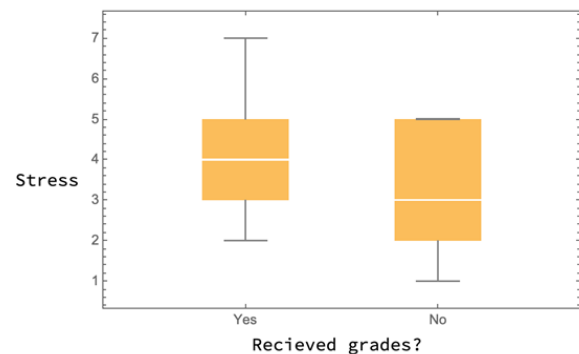


Figure 3: Relationship between grades and stress. Boxplot of the stress levels for students who receive grades and for students who do not receive grades. Results show that students receiving grades have significantly higher levels of stress during the COVID-19 pandemic.

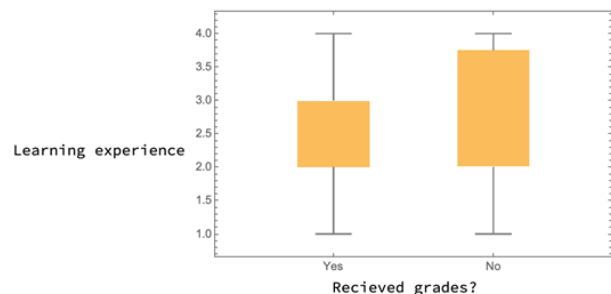


Figure 4: Relationship between grades and learning experience. Boxplot of the learning experiences for students who receive grades and for students who do not receive grades. Results show that there is not a significant difference in learning experience between the group receiving grades and the group not receiving grades, during the COVID-19 pandemic.

participants' response to this question was 2.679, with a standard deviation of 1.431.

Figure 4 shows the boxplot for learning experiences of the group of students who did not receive grades and the group of students who received grades. We performed a t-test to compare the difference in learning experiences between these two groups. The p -value was 0.720, showing that the presence of grades for schoolwork did not have a significant positive impact on the students' perceived learning experience during the remote learning period (**Figure 4**). These results suggest that even though grades increased stress, they did not have significant impact on the students' perceived learning experience. The results do not support our third hypothesis.

To shed further light on the relationship between grades and learning experience, we also assessed the extent to which a lack of grades influenced students' efforts. We asked the following question in the survey: "To what extent has a lack of grades in the remote learning period affected your effort?" on a scale of 1 to 7, with 1 indicating that a lack of grades led to much less effort than before the remote learning period and 7 indicating that a lack of grades led to much greater effort than before the remote learning period. The average response was 3.250, with 66% of students indicating that a lack of grades led to less effort and only 14.6% of students indicating that a lack of grades led to more effort. This provides evidence that the lack of grades led to a decrease in students' efforts.

In summary, we found that, on average, middle and high school students experienced similar stress levels during the pandemic compared to the pre-COVID-19 period. We also found that, on average, middle- and high-school students perceived learning quality to be lower during the pandemic compared to the pre-COVID-19 period. Furthermore, we found that consistent with our hypotheses, physical exercise helped reduce stress during the pandemic. Finally, we found that the presence of grades for schoolwork increased stress during the pandemic but does not have a significantly impact on students' perceived quality of learning. We found that the presence of grades for schoolwork did enhance the students' effort during the remote learning period.

Additional Analyses

We conducted additional analyses to shed further light on the relationships between exercise, grades, stress, and

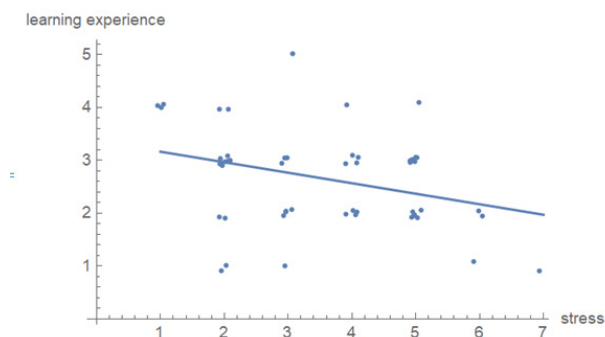


Figure 5: Relationship between stress and learning experience. Regression results with learning experience as the dependent variable, and stress level as the independent variable. Results show that students with higher stress levels have significantly lower levels of learning experience during the COVID-19 pandemic.

learning experience for middle and high school students during the remote learning period due to the COVID-19 pandemic. In this section, we discuss the results from these additional analyses.

Stress and learning experience

We examined the effect of stress on students' perceived learning experience during the COVID-19 pandemic. We ran a regression model on both variables to find a line of best fit (**Figure 5**). Our line of best fit was represented by an equation $y = 3.36 - 0.20x$, with an R-squared value of 0.11. Results show that stress was negatively associated with students' perceived learning experience during the COVID-19 pandemic.

Gender differences in time spent on homework and exercise time

Although gender effect is not the focus of our study, we found some interesting gender differences. For example, we found that female students spent significantly less time on homework during COVID-19 than before the COVID-19 period. More interestingly, the graph of the amount of time female students spent on homework pre-COVID-19 showed a normal distribution, with 75% of female students spending 1-2 hours on their homework before COVID-19. The time female students spent on homework during the COVID-19 period was less clustered, with only 20% of female students reporting they spent 1-2 hours on their homework. Our conjecture is that before COVID-19, female students were more likely to talk in person about how much time they spent on homework, and they may have adjusted the time they spent on homework based on social norms (8). However, during the COVID-19 period, female students had fewer opportunities to talk in-person, making them less likely to adjust their studying time based on their perceived social norms.

Another gender difference we documented is that, on average, male students exercised more during the COVID-19 period than female students within our sample. Interestingly, we also found that, on average, male students reported less stress due to COVID-19 than female students. We hypothesize that these two results may be related to each other because we found that physical exercise can reduce stress (**Figure 2**).

Stress by grade level and by gender

One interesting finding is that there was no difference in stress levels between the middle and high schoolers, but there was a significant difference in stress between male and female students, with female students having a higher level of stress than male students. We ran two t-tests between the middle schoolers and the high schoolers and between male and female students, and made two box plots comparing the four groups. We found that there was no significant difference between the stress levels of middle and high schoolers, but there was a significant difference, with a p -value of 0.0424, between female and male students (**Figure 6**).

Parental involvement and stress

In our survey, we asked students to state how much they agreed with various statements about how much parents monitored their learning, for example, whether their parents participate in, help with, check grades, or talk about schoolwork. We ran a regression to examine the relation between parental

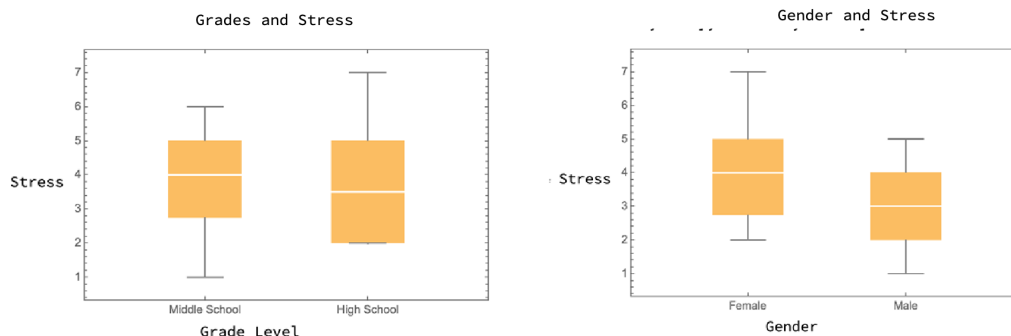


Figure 6: Relationship between stress, and both gender and grades. Boxplots of stress level by grade level and by gender. (A) Results show that there is no difference in stress between the middle and high schoolers. (B) Results show that female students have a significantly higher level of stress than male students.

involvement in student learning and students' stress level. We found that there was no statistically significant relationship between parental participation (p -value = 0.66), parental help (p -value = 0.51), or parents checking grades (p -value = 0.65) in schoolwork and students' stress level. Interestingly, there was a statistically significant and positive relationship between parental talking about schoolwork and students' stress level (coefficient = 0.65, p -value < 0.01).

DISCUSSION

Interpretations of results and directions for future research

In this section, we discuss interpretations of some of our results and provide some directions for future research based on these interpretations.

First, we found that receiving grades for schoolwork increased students' stress and effort during the remote learning period, but did not have a significant impact on students' learning experience. Furthermore, we found a significant negative relationship between students' stress and their perceived learning experience. It is possible that increase in academic pressure will lead to better performance up to some level (eustress) but is detrimental to performance (distress) after a certain point. While we recognize that there is a difference between eustress and distress, our survey does not contain the data necessary to test the difference. Future research can dig deeper into the nuances in the relationship between stress and performance and identify the threshold beyond which stress becomes detrimental to performance.

Second, we found that students who exercised more felt less stressed, and students who received grades during remote learning felt more stressed. These results could help school districts design curricula to reduce stress levels and improve students' learning experience. However, there might also be some alternative explanations for this. For example, one alternative explanation is that students who have more practice with self-care are more likely to exercise more and more likely to use stress relief techniques. Finally, we did not find statistically significant relationships between parental involvement and learning experience in our study, future studies may shed light on the types of parental involvement that are truly beneficial to students' learning experience.

Limitations and practical implications

One limitation of our survey is that most of the survey

questions were about what was happening during the COVID-19 pandemic, so we cannot speak to whether the relationships among exercise, grades, stress, and learning also hold in the pre-COVID-19 period. Future studies could examine whether the presence of grades for schoolwork during remote learning causes more stress than during face-to-face learning. Results of our study and future research could help school districts decide on whether grades should be given during remote learning, considering that the COVID-19 pandemic may go on for quite a while. This would require schools to take a holistic view on how much importance they put onto reducing stress and how much importance they place on students' learning experience.

The results documented in this study could provide valuable and timely information for students, parents, teachers, and school administrators. Since the pandemic is unlikely to disappear anytime soon and many school districts in the U.S. will continue to deliver instruction through remote learning in the 2020-2021 academic year, insights from this study could inform school administrators and teachers' decisions as they help the students and parents navigate remote learning during the pandemic. More broadly speaking, studies on stress and its relationship to technology use, exercise, grades, and the recent pandemic will prove to be invaluable, since reducing stress for students has recently been pushed into the limelight.

MATERIALS AND METHODS

Participants

Participants were recruited from the 6th, 7th, and 8th grades of a private school and from the 8th, 9th, 10th, 11th, and 12th grades of a public high school in a Midwest state, as well as various public and private schools from other states in the nation. A total of 54 responses were recorded, 27 from the two schools in the Midwest, and 27 from the latter pool. Out of the 54 participants, 29 were male, and 25 were female. Out of the 54 participants, 5.6% of the participants were in 6th grade, 13% were in 7th grade, 13% were in 8th grade, 9.3% were in 9th grade, 24.1% were in 10th grade, 22.2% were in 11th grade, and 13% were in 12th grade. The survey was sent with parental permission.

In the survey, we asked participants about their experience with remote learning, defined as the education of students who may or may not be physically present at a school, including both synchronous and asynchronous learning, for all subjects

taught at school. The way we define remote learning follows Kaplan and Haenlein (1). Although not every respondent answered every question, most respondents answered all questions of interest in this survey, and only two of the survey questions that were used in our study had missing values. Since these two questions were only used in the descriptive statistics and the mediation analysis, we have complete data for the variables we used in our main analyses.

Materials

The survey was designed with the assistance of Professor Clara Xiaoling Chen of the University of Illinois Urbana-Champaign. When the preliminary draft of the survey was completed, copies were sent to various anonymous middle school and high school teachers and students, who responded with suggested additions and changes to the survey. The final survey incorporated several rounds of feedback from middle and high school teachers and students. We used Google Forms for the survey. The final survey included three parts. The first part contained the consent form. The second part asked demographic questions and general questions on schoolwork and homework before and during the COVID-19 pandemic. The third and final part asked more specific questions regarding students' experiences with remote learning.

Procedure

Participants were chosen by sending an email to the parents of all the students in the two schools in the Midwest, and to various other parents across the country with whom the authors have personal contact. If the parents of the students consented to their children taking the survey, the electronic form was sent to their children. The data was later analyzed using Excel and Wolfram Mathematica (9). We first saved the raw data from Google Survey in Excel format, and then exported the Excel spreadsheet into Wolfram Mathematica for all statistical analyses. For descriptive statistics, we checked the distribution of these variables, and provided mean and standard deviations. For hypotheses tests, we used boxplots to visualize the results when the independent variable is categorical, and the dependent variable is continuous. We used regression plots to visualize our results when both the independent variable and the dependent variable is continuous.

We sent out our survey on May 6, 2020, when participants had been practicing distance learning for approximately two months. The survey responses arrived between May 26, 2020 and June 24, 2020.

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