The Mental Health of Teens During the COVID-19 Pandemic
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Abstract
Motivation: The American Psychological Association (APA) reports 81% of Gen Z teens (ages 13–17) experience more intense stress due to COVID-19 related changes to schooling [5]. However, the APA’s report does not highlight specific stressors, which need to be identified and mitigated to improve mental wellbeing.

Objective: The objective of this study is to scientifically identify stressors, exacerbated due to COVID-19 responses, that impact the mental health of high school students and elicit approaches to reduce their impacts.

Methods: This study uses well-established, survey-based scientific methods along with statistical analyses to identify key stressors and potential solutions. The survey includes a broad range of stressors specific to high schoolers, controls, and mental health estimators to identify changes in mental health. The study applied robust statistical approaches to validate survey data, establish internal consistency, and elicit statistically significant results.

Findings: The survey (n = 107) shows statistically significant (p < 0.001) degradation in the mental health of online learners vs in-person. Extensive correlation analysis showed that transitioning to online learning has the most influence on degrading mental health, school time (p = 0.034). Many other factors such as gender, race, homework time, school time, physical activity time, pre-existing mental health issues, and therapy did not have a significant influence on mental health degradation (see Figure 2). Survey respondents had two major consistent suggestions to improve students’ mental health: reduce homework load and increase mental health awareness. Both of these suggestions are feasible as steps can be taken in schools to work towards these goals.

Summary: This study supplies statistically significant evidence that transitioning to an online learning modality has the most influence on degrading mental health of high school students.

Number of Respondents in Each Learning Type

<table>
<thead>
<tr>
<th>In Person</th>
<th>Online</th>
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<tbody>
<tr>
<td>27 (25.2%)</td>
<td>80 (74.8%)</td>
</tr>
</tbody>
</table>

Number of Responses: 107

Methods
This study uses a well-established scientific method for conducting descriptive and exploratory research using a survey-based approach [1].

• Target population: High school students.

• Data collection: The self-administered survey included structured and unstructured questions. The survey was constructed based on the target population: high school students. The survey was validated to ensure it was clear and included necessary control variables and stressors [5] (independent variables) to assess their impact on mental health estimators (dependent variables).

• The survey was approved by William Mason High School Administration. The fully anonymized web-based survey was administered to biomedical science students for 30 days (Dec 1 to Dec 30 2020). Participation was voluntary and no incentives were provided to the respondents.

• The survey included 3 variable types: 6 stressors, 5 controls, and 7 mental health estimators.

• Data Analysis: The survey data was analyzed using statistical methods to draw inferences and conclusions. The validity and reliability of survey data was extensively verified using Cronbach’s alpha [6]. Principal Component Analysis (PCA) [3], a two-sample T-Test, Correlograms, and multivariate regression analysis [2].

• After establishing that the survey data is valid, reliable, consistent, and devoid of hidden relationships, correlation analysis was pursued to estimate the influence of the stressors and controls on the mental health related dependent and intermediate variables. The analysis was conducted using Microsoft Excel and R statistical software [4].

• Data sharing: Data was fully anonymized and only summary statistics and charts were used to share results. Pie charts and bar graphs were utilized.

• Biases: Only biomedical science students were allowed to participate by school administration. The majority of the students in the school are white (56% in school vs 36% participants) but the majority of survey responders are Asian (28% in school vs 66% participants). However, this variable is at the edge of statistical significance (p = 0.049) but this cannot be confirmed due to this bias.

Research Question
How have the changes caused by COVID-19 affected the mental health of high school students?

Acknowledgements
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The Significance of the Impact of Variables on Change in Mental Health

<table>
<thead>
<tr>
<th>Variable</th>
<th>p-value</th>
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<tbody>
<tr>
<td>Learning Type</td>
<td>0.034</td>
</tr>
<tr>
<td>Gender</td>
<td>0.049</td>
</tr>
<tr>
<td>Race</td>
<td>0.315</td>
</tr>
<tr>
<td>School Time</td>
<td>0.983</td>
</tr>
<tr>
<td>Homework Time</td>
<td>0.631</td>
</tr>
<tr>
<td>Physical Activity Time</td>
<td>0.938</td>
</tr>
<tr>
<td>Therapy</td>
<td>0.585</td>
</tr>
<tr>
<td>Current Therapy</td>
<td>0.795</td>
</tr>
</tbody>
</table>

The T-test showed that the change in mental health is significant (p = 0.034) correlation. That is, students transitioning to online learning showed a significant (p = 0.034) change in mental health. Race had a very weak significance (p = 0.049). Due to the bias in this data no conclusions can be drawn without further study (see Figure 2).

References
4. This study pursued a data-driven, scientific, and ethical approach to assess the impact of the COVID-19 pandemic on the mental health of high schoolers (see Figure 4).

Results
• The survey data were verified using Cronbach’s alpha, which is a test to establish reliability and internal consistency in survey data. This is a crucial validation step to prove that the survey data is meaningful. For the estimators, the Cronbach’s alpha was > 0.78, which in social sciences is considered a “fairly high value”, thereby establishing consistency, validity, and reliability of the responses [6]. The key outcome of this analysis is that the conclusions drawn from the survey data are statistically significant and reproducible.

• Principal Component Analysis (PCA) [3], a technique used to make large data sets easier to understand by summarizing the data, was used to check if some of the controls and stressors are redundant and can be discounted in further analyses. Results from PCA showed that nearly all of the controls and stressors are relatively uncorrelated and provide useful, independent information. Systematic set of stressors and controls are not inherently predictive: multivariate statistical analysis [2] was pursued. The regression analysis established that there is no inherent model or hidden linear relationship between independent and dependent variables.

• A two-sample T-Test was then conducted to verify that the change in mental health is significant using the Mental Health Change intermediate variable. Note that, Mental Health Change December 2020 - Before March 2020 Mental Health. The T-Test showed that the change in mental health was significant, with mental health degradation of 0.636 (p = 0.001). Figure 4 displays a visual shift in the overall mental health curve. Figure 3 compares the change in mental health between online and in-person students.

Conclusions
This study pursued a data-driven, scientific, and ethical approach to assess the impact of the COVID-19 pandemic on the mental health of high school students (see Figure 4).

• This study reports statistically significant evidence that transitioning to an online learning modality has the most influence on degrading mental health (see Figure 3). The two-sample T-Test conclusively showed the degradation in the mental health of online students. Moreover, the results also showed that other factors such as gender, homework time, school time, physical activity time, pre-existing mental health issues, and therapy did not influence mental health changes (see Figure 3). The study also provides actionable approaches to alleviate some of the stressors experienced by high schoolers, specifically reducing workload and raising mental health awareness. Despite race being slightly statistically significant (p = 0.049), due to known population skewes, no conclusions can be safely drawn without additional data (see Figure 2).

• The change in mental health of respondents from before March 2020 to after March 2020 is relatively small (see Figure 4). The focus of the research is to help visualize the degradation in overall mental health of students.

Figure 1: The percentage of survey respondents in each learning type.

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Figure 2: The analyses which represent the statistical significance of the variable's effect on a student's change in mental health.

Figure 3: Change in mental health of respondents based on learning type. Mental health was rated on a scale of 1-5 with 1 being Poor, 3 being Neutral, and 5 being Excellent.

Figure 4: Overall mental health of respondents from before March 2020 to after March 2020 is relatively small (see Figure 4). The focus of the research is to help visualize the degradation in overall mental health of students.