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The Pandemic's Effects on the Use of Personal Listening Devices And Prevalence of Hearing Damage in College Students

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by

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Abstract

Personal listening devices (PLDs), such as earbuds and headphones, are prevalent in today's society, and overuse of these devices can cause hearing damage. Since the pandemic caused lockdowns and online classes, college students have presumably had more time to be indoors and to use PLDs, leading to a higher risk or developing hearing damage. Previous studies have explored the PLD use and the prevalence of hearing damage in college students, but this study investigates whether the coronavirus pandemic has affected college students' PLD listening habits and whether these changes are related to the students' disclosure of suspected symptoms of hearing damage. Using a variety of statistical tests and a random forest model trained using cross-validations, I analyzed data from a Qualtrics survey I created for adult college students to determine whether they have used PLDs more and whether their self-disclosure of symptoms of hearing damage, such as muffled sounds, sound sensitivity, persistent ringing in the ears, increased during the pandemic. As hypothesized, the data show a significant increase in the time college students used PLDs (i.e. days per week, hours per day, hours per day for school, and overall), as well as a significant increase in the number of students who reported symptoms of hearing damage during the pandemic. The long-term effects of college students' increased PLD use are not yet known, but if these trends continue due to students' newly-formed habits or increased rates of online classes, college students could be at a higher risk of developing hearing damage due to overuse of PLDs in the future.

Background

As is anyone who regularly uses earbuds or headphones, many college students seem to be at risk for developing hearing loss from prolonged overexposure to loud noises (noise-induced hearing loss, or NIHL) (Berg, et al., 2016). Several studies have investigated the use of personal listening devices (PLDs), such as earbuds and headphones, by college students (Berg, et al., 2016 and Marron et al. 2015), but investigating whether the coronavirus pandemic has had any effects on college students' PLD listening habits is critical. The onset of the coronavirus disease 2019 (COVID-19) pandemic brought not only fear and international lockdowns but also remote, online classes for students of all ages, which encourage PLD use by nature. This could mean that students have had more time to be on their phones and computers using PLDs for both school and pleasure, thus increasing the risk for hearing damage.

The risk of developing hearing damage from excessive PLD use is very possible due to the high volume capacities of many PLDs. According to Naples and Duque (2020), excessive sound can permanently damage the ear's "hair cells," which are responsible for transmitting the sound to the brain, as well as the nerve cells connected to them. Most PLDs deliver a maximum of roughly 105-110 dB of sound to the listener, and exposure to sounds of this magnitude for even five minutes can cause permanent hearing damage (Naples & Duque, 2020). However, specific guidelines for safe daily PLD listening differ. For example, the World Health Organization (WHO, 2015) recommends limiting listening for no more than 60 minutes per day at no higher than 60% volume, yet other research proposes that specifically per day, people can safely listen to PLDs at 70% volume for up to four hours or at 80% for no more than 90 minutes (Portnuff, et al., 2011, and Berg, et al., 2016).

According to an estimate by the World Health Organization (Krug, et al., 2015, p. 1), out of the over 43 million young people aged 12-35 worldwide, almost 50% are exposed to unsafe sound levels from PLD use, and roughly one billion young people could be at risk for developing hearing damage from unsafe listening habits. Furthermore, according to the Pew Research Center (2021), 96% of Americans aged 18-29 own a smartphone, and from the Pearson Student Mobile Device Survey, 87% of American college students use a laptop, Chromebook, or notebook for their studies (Pearson, 2015); both smartphones and laptop computers are compatible with PLDs. These findings are consistent with Berg, et al. (2016) and You, et al. (2020), Berg, et al. (2016) finding that 95% of the college students they surveyed used a PLD. Thus, the majority of college students appear to use PLDs and may be at risk for hearing damage due to overexposure to high sound levels and excessive PLD use.

Due to the prevalence of PLDs, many studies have investigated young people's PLD listening habits and their perceived hearing. You, et al. (2020) found that roughly half of the Korean college students they surveyed used PLDs every day of the week, and 64.5% used them for 0.5-2 hours at a time. They also found that 11.8% reported experiencing hearing difficulties, while 48.1% felt that PLD use could be a cause, and 31.1% felt it might be. Widen, et al. (2017) found that of the Swedish 17-year-olds they studied, most listened every day or several days each week (88.6%), roughly 80% listened 0.5-2 hours each time, and 20% listened 3 hours or more. Furthermore, 21-22% reported experiencing issues with their hearing (e.g. poor hearing or tinnitus). The researchers found that those who listened to PLDs at and above 85 dB listened for longer periods of time and also reported more hearing problems than their peers. Additionally, though Widen, et al. (2017) found no correlation between the estimated and measured sound levels of the 17 year old high school students, Marron et al. (2015) found that college students

were able to accurately judge the intensity of the sound from their PLDs. I am investigating college students' PLD listening habits and self-disclosed symptoms of hearing damage with the assumption that the students' estimates of their PLD volumes are accurate.

The onset of the coronavirus pandemic in 2020 altered the traditional methods of higher education, increasing the amounts of online learning and time spent indoors during the pandemic, and this may affect college students' PLD listening habits in the future. For this study, I hypothesized that overall during the pandemic, college students have been using PLDs more frequently and for longer periods of time than before, and more people would report suspected symptoms of hearing damage. By means of an online, voluntary survey created on Qualtrics and distributed through direct solicitation, SurveyCircle, and Survey Swap, this is what I have investigated.

Few references investigating the pandemic's impact on college students' PLD listening habits have been found, and my work is therefore pioneering. If my research suggests a significant relationship between the pandemic's effects on college students' PLD use and their self-disclosure of hearing damage, it may warrant further research on the broader population and possibly high school students and young adults. If greater numbers of online classes than before the pandemic persist, or if students simply continue using PLDs at higher rates due to new habits formed during the pandemic, students in the future could be using PLDs at consistently higher rates than before the pandemic. This could increase the risk college students face of developing hearing damage from excessive use of PLDs in the future. My research is therefore extremely critical, as no other research on this topic has yet been conducted.

The Data

Survey

This survey was approved by John Carroll University's Institutional Review Board and classified as Exempt. It consisted of 16 questions for adult college students during the pandemic (any semester from Spring 2020 through Spring 2021) regarding their use of PLDs and whether they experienced symptoms of hearing damage before and during the pandemic, and this survey also included demographic information to better understand the data, such as gender, age, and grade level. Participants were also asked to rate their preferred PLD listening volume on a scale from 1 to 10, with 1 being the softest and 10 being the loudest.

This questionnaire was distributed via direct solicitation and the survey sharing websites SurveyCircle and SurveySwap and accepted responses from May 22, 2021 to October 3, 2021. Of the 212 total participants, forty-seven were recruited through direct solicitation, while 100 came from SurveyCircle and 65 from SurveySwap. After deleting 18 responses consisting of missing values for most or all survey questions, there were 194 participants with usable data left.

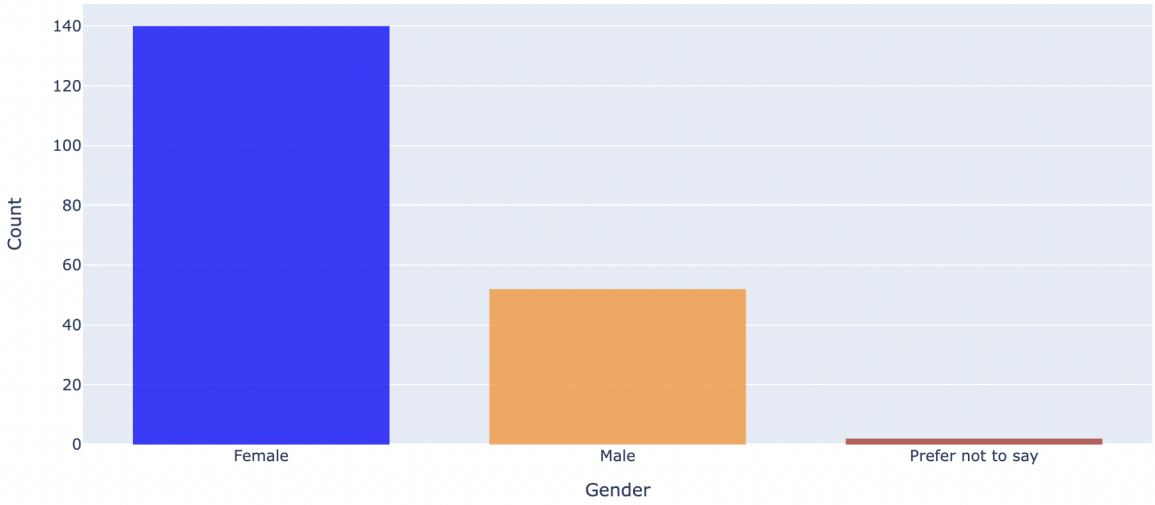
Demographic Information

Gender

Of the 194 survey participants, 140 (72.16%) were female, 52 (26.80%) were male, and 2 (1.03%) preferred not to disclose their gender. The sample for this study therefore consists of unequal gender group sizes (Figure 1).

Figure 1

Distribution of Gender

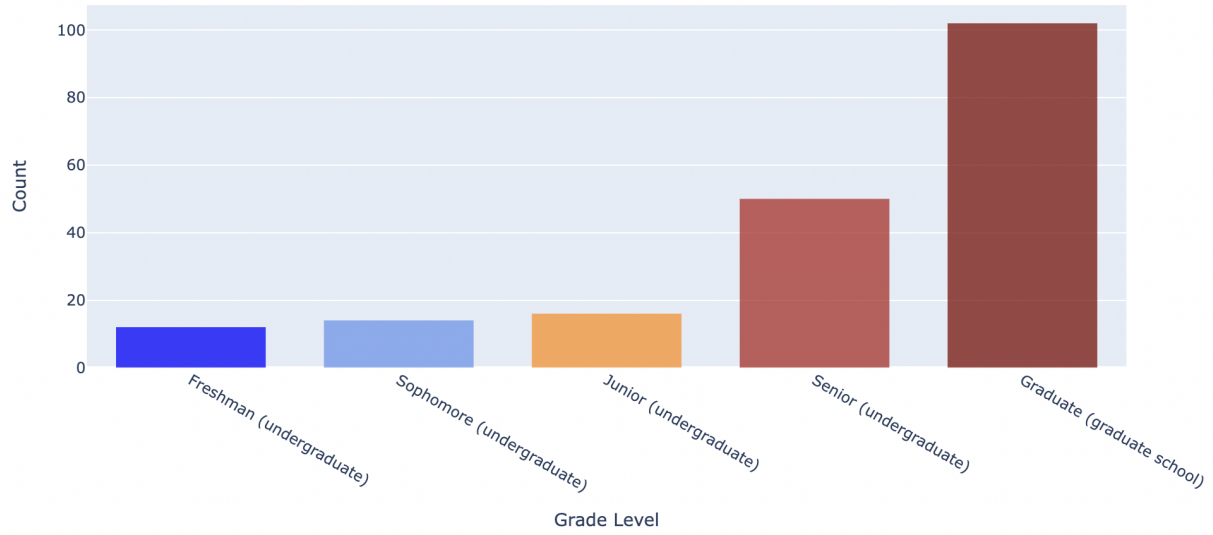


Grade Level

One-hundred two participants (52.58%) were in graduate school during the pandemic (any semester from Spring 2020 through Spring 2021), and 92 (47.42%) were in undergraduate school. Of the undergraduates, 50 (25.78%) were seniors, 16 (8.25%) were juniors, 14 (7.22%) were sophomores, and 12 (6.19%) were freshmen. Therefore, most participants in this study were either graduate students or undergraduate seniors (Figure 2).

Figure 2

Distribution of Grade Level

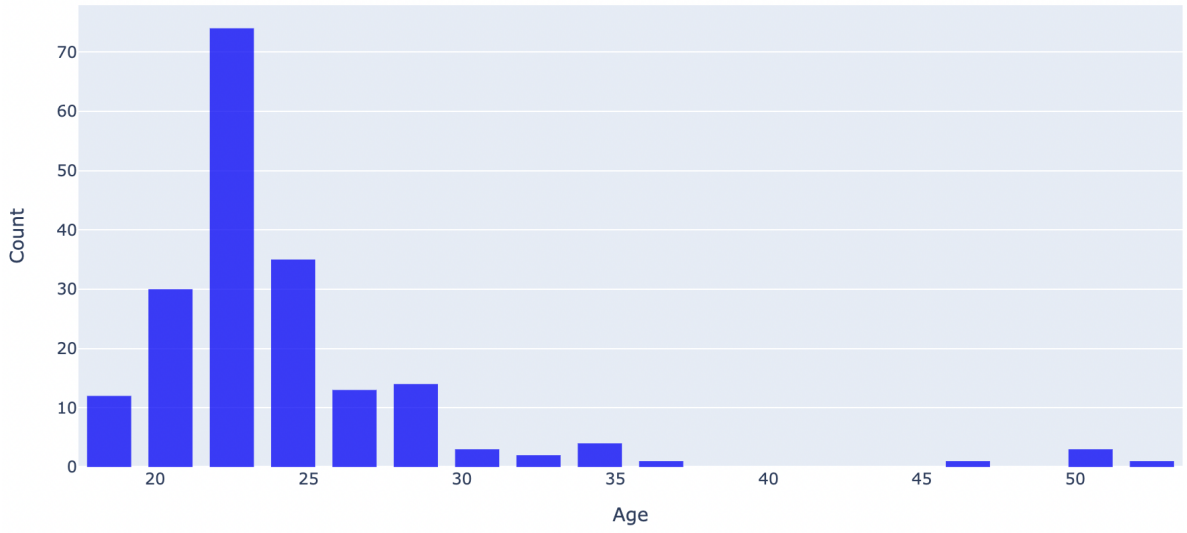


Age

The average age of the participants was 24.29 years old, while the median (and most common) age was 23. The youngest age was 18, while the oldest was 52 (Figure 3). Furthermore, there were 15 outliers above the age of 29.

Figure 3

Distribution of Age



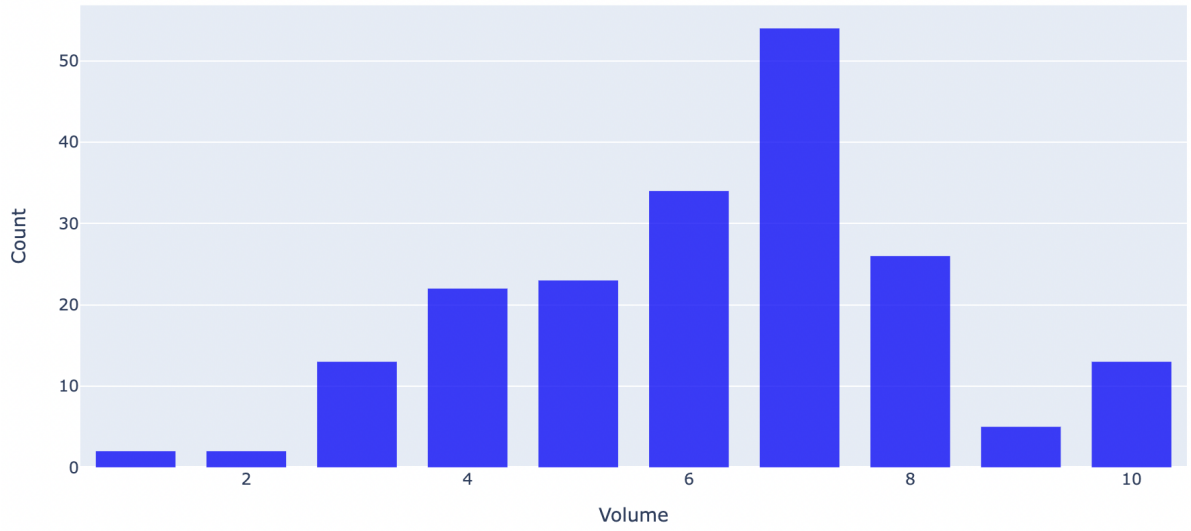
Estimated PLD Volume

According to the WHO (2015), people can safely listen to PLDs at 60% volume for up to 60 minutes. From this survey, on a scale of 1 to 10, with 1 being the softest and 10 being the loudest, 132 (68.04%) participants estimated their typical listening volume to be at least 6 out of 10. Alternatively, according to Portnuff, et al. (2011) and Berg, et al. (2016), people can safely listen to PLDs at 70% volume for four hours or less at a time or at 80% volume for ninety minutes or less. Ninety-eight (50.52%) participants estimated their volume to be at least 7, while 44 (22.68%) estimated theirs to be at least 8. Participants' estimates are assumed to be accurate.

More specifically, the average preferred volume level was 6.25, while the median and most common volume was 7. Furthermore, the minimum preferred volume was 1, while the maximum was 10 (Figure 4).

Figure 4

Distribution of Preferred PLD Volume



Management and Software

After downloading the CSV file of the data set from Qualtrics into a Jupyter Notebook on Google Cloud Platform, the Python programming language was used to clean and prepare the data for analysis. This included renaming the columns appropriately, recoding several columns of ordinal categorical data to label encoding, and deleting extraneous rows.

Another noteworthy change was that in the original survey, when asked whether they felt they used PLDs more during the pandemic, participants could respond with "Yes," "No," "Maybe," and "Not Sure;" the "Not Sure" responses were recoded as "Maybe" due to sameness in meaning. A column for the difference in days per week people listened to PLDs was created by subtracting the days per week before the pandemic from days per week during the pandemic.

For the purposes of statistical analyses on whether participants agreed that they experienced symptoms of hearing damage before and during the pandemic (e.g. muffled sounds, sound sensitivity, persistent ringing in the ears), a derived variable was created in which the answer choices "agree" and "moderately agree" were both classified as "agree," while "disagree" and "moderately disagree" were classified as "disagree;" the "neutral" responses were left as "neutral." This hearing damage variable was also converted into binary form, classifying participants by whether or not they specifically agreed they experienced symptoms of hearing damage before and during the pandemic; thus the two possible values for this variable were "agree" (which included "agree" and "moderately agree") and "not agree" (which included "neutral," "moderately disagree," and "disagree").

Additional variables were derived from both the variable for the number of hours per day people listened to PLDs and the variable for the number of hours per day people listened to PLDs for anything related to school or studying, both for before and during the pandemic. The

answer choices for these two variables ranged from 0-1 hours to 4+ hours. For both hours per day of listening and hours per day of listening for school, a variable was derived which simply classified participants by whether they listened for under or at least 4 hours, since according to Portnuff, et al. (2011) and Berg, et al. (2016), listening to PLDs at 70% volume is safe for up to 4 hours.

Methods and Results

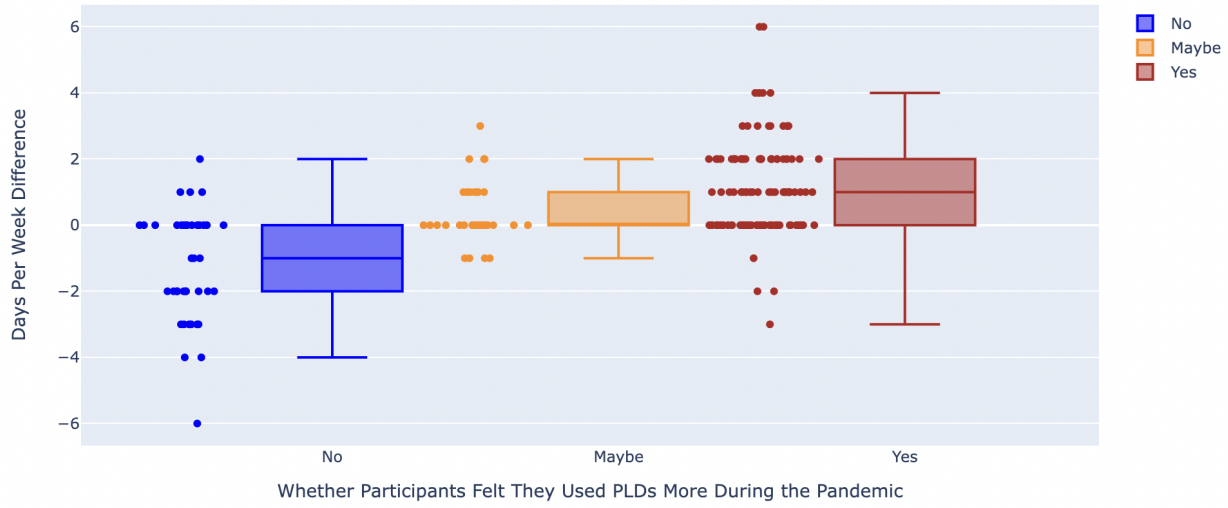
For this study, the significance level 0.05 was used.

Statistical Analyses for Consistency of Responses for PLD Use During the Pandemic

The data concerning participants' changes in PLD use during the pandemic were largely consistent across overall use with days per week, hours per day, and hours per day of use for school. First, those who said, "yes," they felt they used PLDs more during the pandemic, reported a mean increase of 1.07 days in days per week of listening during the pandemic, compared to the mean increase of 0.35 days per week of listening for the "maybe" group and the 1.22 days per week decrease for the "no" group (Figure 5).

Figure 5

Days Per Week Difference in PLD Use, by Perceived Overall Change in PLD Use During the Pandemic



Second, participants' answers for their changes in hours per day of PLD use during the pandemic generally aligned with whether they felt they used PLDs more overall. Whether participants used PLDs for more hours per day during the pandemic was significantly related to whether they specifically said they used PLDs more overall during the pandemic (chi-square statistic = 60.396, p-value = 7.76e-15). Furthermore, the majority of the 119 participants who felt they used PLDs more overall during the pandemic used them for more hours each day (97 (81.51%), compared with the 22 (18.49%) who either did not or were unsure).

Similarly, the change in the hours per day that participants listened to PLDs for school during the pandemic also corresponded with whether they felt they used PLDs more overall. Using PLDs for school for more hours per day during the pandemic was significantly related to using PLDs more overall during the pandemic (chi-square statistic = 55.35, p-value = 1.01e-13). Moreover, 95 (79.83%) of the 119 participants who used PLDs more overall during the pandemic used PLDs for school for more hours per day, while only 24 (20.17%) were unsure or did not.

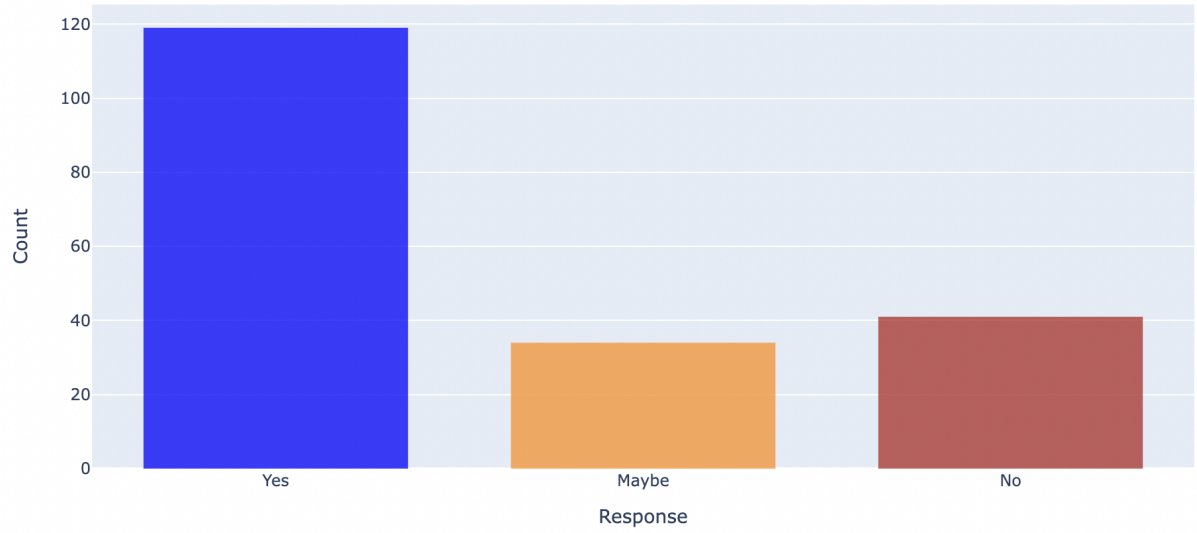
Statistical Analyses of Changes in PLD Use

Perceived Overall Change in PLD Use During the Pandemic

When asked whether they felt they used PLDs more during the pandemic than before, 119 (61.34%) participants said "yes," 41 (21.13%) said "no," and 34 (17.53%) said "maybe" (Figure 6). Thus, significantly over half of the college students in this study felt they used PLDs more overall during the pandemic (z-statistic = 3.24, p-value = 5.90e-4).

Figure 6

Whether Participants Used PLDs More During the Pandemic



Difference in Days Per Week of PLD Use

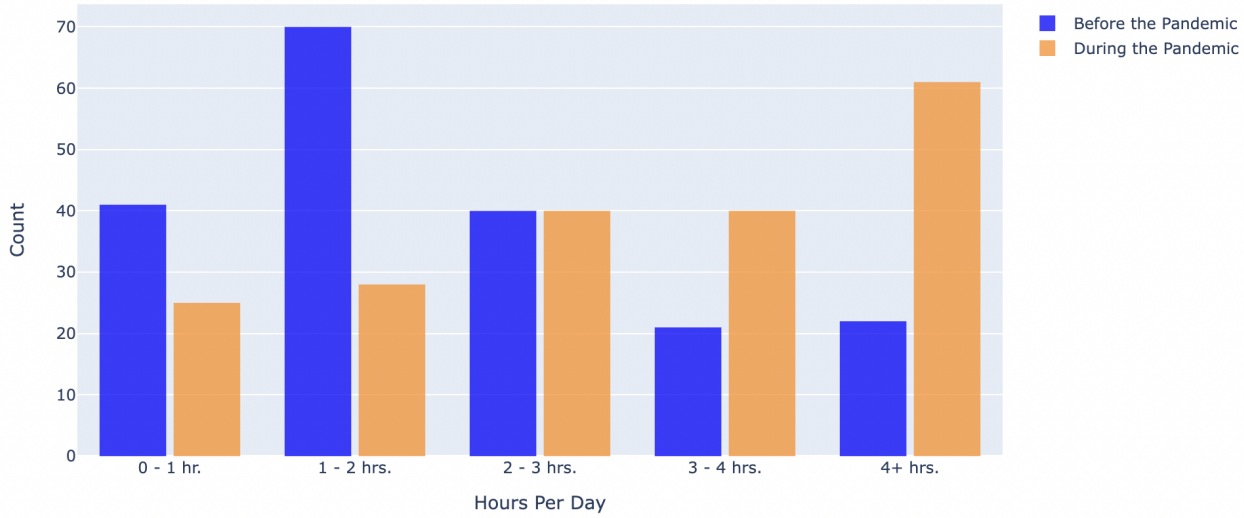
Before the pandemic, participants listened to PLDs for an average of 4.81 days per week, while this number increased to 5.27 during the pandemic. Therefore on average, the college students in this study listened to PLDs for significantly more days per week during the pandemic than they did before (paired t-statistic = -3.81, p-value = 1.85e-4).

Hours of PLD Use Per Day

Before the pandemic, 22 (11.34%) participants listened to PLDs for at least 4 hours per day, the proposed safe listening limit for PLDs at 70% volume (Portnuff, et al., 2011 and Berg, et al., 2016), and this number increased to 61 (31.44%) during the pandemic; this was a significant increase in the proportion of participants who listened for at least 4 hours per day during the pandemic (McNemar statistic = 28.31, p-value = 1.03e-7). Furthermore, fewer participants listened for 0-1 and 1-2 hours per day during the pandemic, while more listened for 3-4 and 4+ hours per day, indicating that overall, the college students in this study listened to PLDs for more hours per day during the pandemic than they did before (Figure 7).

Figure 7

Hours Per Day Participants Used PLDs, Before and During the Pandemic



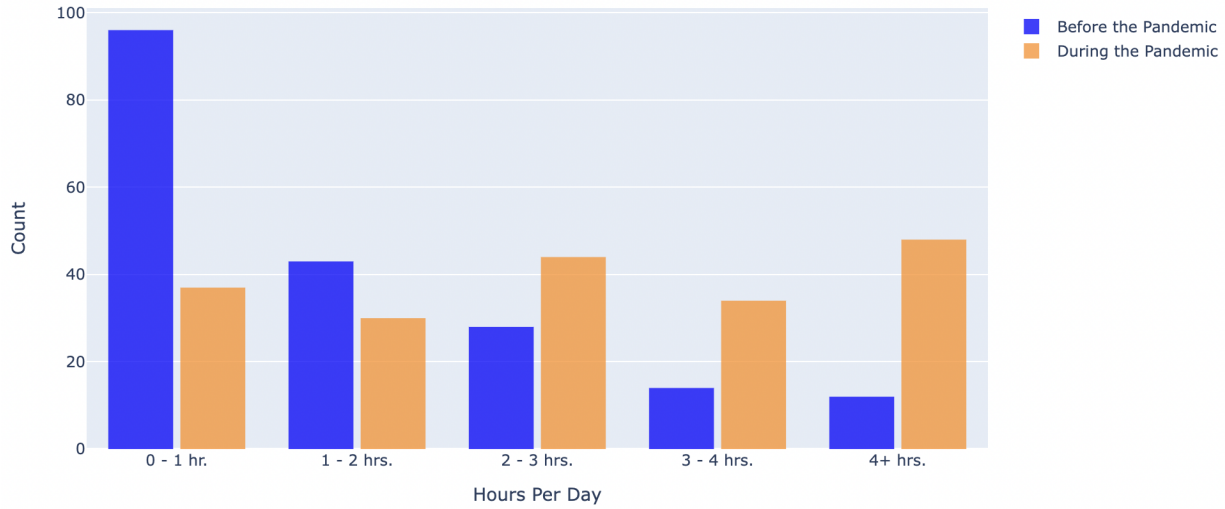
Hours of PLD Use Per Day for Anything Related to School or Studying

Twelve (6.19%) participants listened to PLDs for at least 4 hours per day for school before the pandemic, compared with 48 (24.74%) during the pandemic; the pandemic therefore saw a significant increase in the proportion of participants who listened for at least 4 hours per

day (McNemar statistic = 27.84, p-value = 1.32e-7). Moreover, the amount of time the college students in this study used PLDs for school each day generally increased, since during the pandemic, fewer participants listened for 0-1 and 1-2 hours per day, while more listened for 2-3, 3-4, and 4+ hours per day (Figure 8).

Figure 8

Hours Per Day Participants Used PLDs for School, Before and During the Pandemic



Statistical Analyses on Reporting of Hearing Damage

Disclosure of Suspected Symptoms of Hearing Damage, Before and During the Pandemic

Before the pandemic, 32 (16.49%) participants agreed they experienced one or more potential symptoms of hearing damage (i.e. muffled sounds, sound sensitivity, persistent ringing in the ears), while this number increased to 54 (27.84%) during the pandemic. The proportion of participants who disclosed symptoms of hearing damage therefore significantly increased during the pandemic (McNemar statistic = 12.03, p-value = 5.23e-4).

Whether Participants Felt They Used PLDs More During the Pandemic and Whether They Reported Symptoms of Hearing Damage During the Pandemic

Whether or not participants specifically said, "yes," they felt they used PLDs more overall during the pandemic, was not significantly related to whether they agreed that they experienced symptoms of hearing damage during the pandemic, but the p-value was very close to the significance level 0.05 (chi-square statistic = 3.54, p-value = 0.0599). However, of the 54 participants who agreed that they experienced symptoms of hearing damage during the pandemic, 39 (72.22%) felt they used PLDs more overall, compared to the 15 (27.78%) who felt they did not or were unsure.

Furthermore, whether participants specifically said, "yes," they felt they used PLDs more overall during the pandemic, was significantly related to whether they agreed more (or disagreed less) that they experienced hearing damage during the pandemic than they did before (chi-square statistic = 4.23, p-value = 0.0397). Of the 44 participants who agreed more (or disagreed less) that they experienced hearing damage during the pandemic, 33 (75.00%) felt they used PLDs more, while only 11 (25.00%) felt they did not or were unsure.

Difference in Days Per Week of PLD Use and Whether Participants Reported Symptoms of Hearing Damage During the Pandemic

The average difference in days of PLD use per week for participants who agreed that they experienced symptoms of hearing damage during the pandemic was an increase of 0.98 days, and those who responded neutrally used PLDs 0.21 more days per week, on average, during the pandemic; those who disagreed saw an average increase of 0.44 days. This degree to which participants agreed they experienced symptoms of hearing damage during the pandemic was

significantly related to the average difference in days per week they listened to PLDs (F-statistic = 3.87, p-value = 0.023). Specifically, those who agreed they experienced hearing damage during the pandemic reported a significantly larger increase in the number of days per week that they listened to PLDs than those who disagreed, this difference being 0.7665 days (from Tukey HSD: lower = 0.1148, upper = 1.4182, adjusted p-value = 0.0165). Therefore, a larger increase in days per week of listening to PLDs was significantly related to whether the college students in this study reported symptoms of hearing damage during the pandemic.

Hours of PLD Use Per Day and Whether Participants Reported Symptoms of Hearing Damage During the Pandemic

Of the 54 participants who agreed that they experienced symptoms of hearing damage during the pandemic, 35 (64.81%) used PLDs for more hours per day during the pandemic, compared to the 19 (35.19%) who did not. Moreover, using PLDs for a greater number of hours per day during the pandemic was significantly related to stronger agreement (or weaker disagreement) of experiencing symptoms of hearing damage during the pandemic (chi-square statistic = 4.04, p-value = 0.0444). Of the 44 participants who agreed more (or disagreed less) that they experienced hearing damage during the pandemic than they did before, 32 (72.73%) used PLDs for more hours per day, while 12 (27.27%) did not.

Hours of PLD Use Per Day for Anything Related to School or Studying and Whether Participants Reported Symptoms of Hearing Damage During the Pandemic

During the pandemic, 34 (62.96%) of the 54 participants who reported symptoms of hearing damage during the pandemic used PLDs for more hours per day for school, while 20

(37.04%) did not. Furthermore, whether participants used PLDs for more hours per day for school during the pandemic was not significantly related to whether they agreed more (or disagreed less) that they experienced hearing damage during the pandemic than they did before (chi-square statistic = 2.76, p-value = 0.097). However, 31 (70.45%) of the 44 participants who agreed more (or disagreed less) that they experienced hearing damage during the pandemic used PLDs for more hours per day for school during the pandemic, while only 13 (29.55%) did not.

Random Forest Model to Predict Disclosure of Hearing Damage During the Pandemic

Following the statistical analyses done above, a random forest (RF) model was built to identify the most important variables in predicting whether participants agreed that they experienced symptoms of hearing damage during the pandemic. Because RF models do not accept missing values, a copy of the original dataset was made with missing values filled in.

The following variables used in the RF model contained some missing values, which were filled in: age, whether participants used PLDs for school for more hours per day during the pandemic, and whether participants specifically agreed that they experienced symptoms of hearing damage before the pandemic. Missing values and outliers for age (age over 29) were filled in with the mean age for that participant's grade level.

The variables for the hours per day participants listened to PLDs before and during the pandemic had been label encoded from 0 to 4 for 0-1 hours to 4+ hours, respectively; participants whose hours per day label increased during the pandemic had used PLDs for more hours per day for school during the pandemic. Missing values for hours per day for school were filled in with the mean hours per day for school label (rounded to a whole number) for participants with the same difference in days per week of PLD use. Therefore, in this machine

learning copy of the dataset, the binary variable recording whether participants used PLDs for more hours per day for school during the pandemic contained no missing values since the missing values were filled in for the two variables from which this variable was derived.

Lastly, missing values for the extent to which participants agreed they experienced symptoms of hearing damage before the pandemic were filled in with neutral values; for the version of this variable used in the RF model, these participants' responses were therefore classified as "not agree" for whether they experienced symptoms of hearing damage before the pandemic.

The RF model predicting whether participants agreed that they experienced symptoms of hearing damage during the pandemic was built in Python using a pipeline (which standardized the data by removing the mean and scaling it to the unit variance and set the number of trees to 1000) and GridSearchCV. The data was split into a training dataset containing 135 (70%) of the 194 total observations and a test dataset containing the remaining 59 (30%). The model was trained using 15 k-fold cross validation since 15 was the factor of the number of observations in the training dataset which gave optimal performance. The model was refitted on the recall score, and lastly, the GridSearchCV ran using the maximum depth for each tree from 1 to 10 levels to select the optimal depth.

Model Results and Feature Importances

The RF model accurately predicted 53 (89.83%) of the 59 participants in the test dataset by whether they specifically agreed that they experienced symptoms of hearing damage during the pandemic. This model correctly classified 10 of the 14 participants who agreed they had hearing damage during the pandemic (71.43% precision score), and 10 of the 12 participants

predicted as having reported hearing damage during the pandemic were correctly classified (83.33% recall score).

The optimal tree depth determined by the GridSearchCV for this model was 8, and whether participants agreed that they experienced symptoms of hearing damage during the pandemic was the most important feature in this model (Table 1).

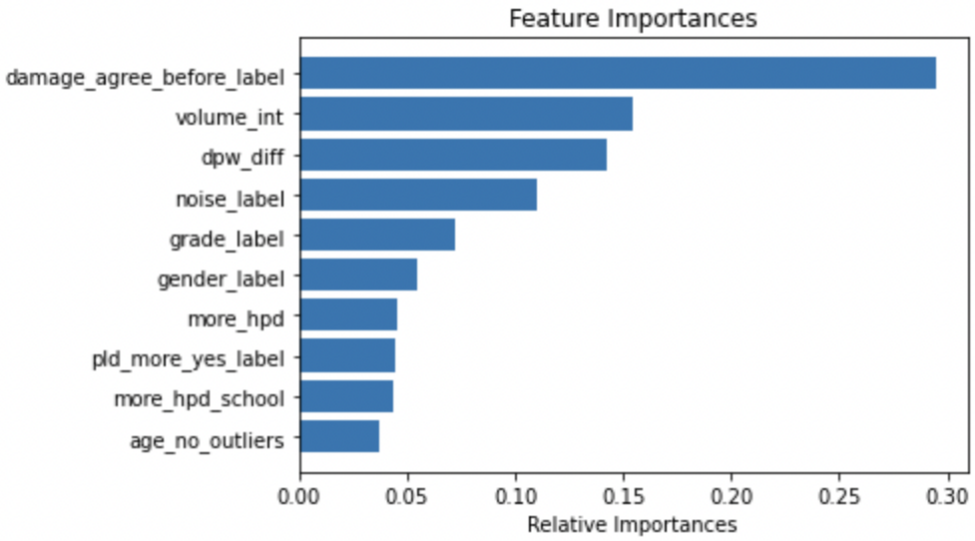
Table 1

Feature Importances in Random Forest Model

Feature	*Importance*
Whether participants agreed they experienced symptoms of hearing damage before pandemic *(damage_agree_before_label)*	0.29455161
Preferred PLD volume *(volume_int)*	0.15465989
Difference in days per week of PLD listening, before and during pandemic *(dpw_diff)*	0.14246137
Extent to which participants agreed that they turned up PLD volume in presence of environmental noise; values of "agree," "moderately agree," "neutral," "moderately disagree," and "disagree" *(noise_label)*	0.10995546
Grade level *(grade_label)*	0.0723676
Gender *(gender_label)*	0.05496702
Whether participants used PLDs for more hours per day during pandemic *(more_hpd)*	0.04565847
Whether participants felt they used PLDs more overall during pandemic *(pld_more_yes_label)*	0.0442809
Whether participants used PLDs for school for more hours per day during pandemic *(more_hpd_school)*	0.04362517
Age *(age_no_outliers)*	0.03747251

Figure 9

Feature Importances Chart



Whether participants reported symptoms of hearing damage before the pandemic was the most important predictor of whether they reported it during the pandemic (Figure 9), but participants' preferred volume, difference in days per week of listening, the extent to which they agreed they turned up their PLDs in the presence of environmental noise, and their grade level were also notably important. The remaining features used in this model, such as participants' gender, age, whether they used PLDs for more hours per day for anything or specifically for school during the pandemic, and whether they used PLDs more overall during the pandemic, were less important but still contributed predictive power. Therefore, even though past experiences with hearing damage were important, demographic factors and changes in PLD listening habits during the pandemic also affected whether the college students in this study reported hearing damage during the pandemic.

Conclusions

Studies have investigated the use of PLDs in college students, but the lockdowns caused by the coronavirus pandemic appeared to have increased the time for college students to be indoors and using PLDs. Notably, this study found that, as hypothesized, significantly more individuals reported symptoms of hearing damage during the pandemic than before. Moveover, not only have most college students in this study used PLDs more overall during the pandemic than they did before, but they used PLDs significantly more frequently and for longer periods of time, as was also hypothesized. Almost all of these changes in PLD use were significantly related to whether the students reported symptoms of hearing damage during the pandemic, which also significantly increased during the pandemic. This research therefore concludes that the increase in the number of college students who experienced hearing damage during the pandemic was significantly related to the students' changes in PLD use during the pandemic.

Discussion

The findings from this study, that more college students reported hearing damage during the pandemic and that these symptoms were related to the changes in PLD use the pandemic brought on, are concerning. Because this study is the first of its kind, further research is needed to more thoroughly investigate this phenomenon not only in college students but also in other populations. The pandemic lockdowns affected many outside the college population, for example younger students taking online classes and employees working virtually from home, and people from all walks of life may have experienced similar changes in PLD use and therefore an increase in the prevalence of hearing damage.

Furthermore, even as the pandemic eventually subsides, the world's increased reliance on remote, virtual solutions may persist for the foreseeable future, at least to some degree. Future research is needed to investigate whether the pandemic will have lasting effects on people's lifestyles, PLD use, and therefore the prevalence of hearing damage. As such, educational programs should be implemented for college students and the broader public on safe listening, including more clearly defined standards and recommendations for safe PLD use. If harmful new PLD listening habits formed during the pandemic are lasting, college students and society in general could face a higher risk of developing hearing damage in the future.

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Appendix A: Survey Transcript

Have College Students Been Using Earbuds/Headphones More During the COVID-19 Pandemic?

Start of Block: Default Question Block

Q3 Have College Students Been Using Earbuds or Headphones More During the Coronavirus Pandemic?
My name is Morgan Fink, and I am a student at John Carroll University doing research for my senior honors capstone project. In this study, I am trying to find out if college students like you have been using earbuds or headphones more during the coronavirus pandemic, with more online classes and time at home or in dorms etc. This survey is 16 questions long and should only take about 7 minutes to complete. If at any time you no longer wish to participate, you may close your browser and leave the survey.

Your name or any other identifier will not be collected in this survey, and your personal data will not be identified in the results; all responses will be kept completely confidential. Your de-identified data could be used for future research studies or distributed to another investigator for future research studies without your additional informed consent.

If you have any questions or concerns about this study or any of these procedures, please contact Morgan Fink at mfink22@jcu.edu. If you have any questions or concerns about the rights and welfare of research participants, please contact the John Carroll University Institutional Review Board Administrator at irb@jcu.edu or (216) 397-1527.

Your participation is completely voluntary and greatly appreciated. You may quit this survey without penalty.

By continuing with this survey you confirm that you are at least 18 years of age, have attended a college/university during any semester(s) during the pandemic (March 2020 to May 2021), and that you consent to participate. If you do not consent to participate, please exit this survey or close your browser.

End of Block: Default Question Block

Start of Block: Profile & Explanation

Q5
These questions will help me better understand your survey responses and will enable me to look for any general patterns in the data, e.g. whether younger respondents tend to use PLDs at higher levels than older respondents.

But what's a "PLD?" A PLD is a personal listening device - this is the shorthand I will use throughout this survey instead of saying "earbuds, headphones, etc."

Q4 Gender:

▼ Male (1) ... Prefer not to say (3)

Q2 Age:

_____

Q6 What was your grade level during the 2020-21 academic year?
If you graduated in Spring 2020, just choose "Senior (undergraduate)."

▼ Freshman (undergraduate) (1) ... Graduate (graduate school) (5)

Q7 With 1 being softest and 10 being full volume, how would you rate the loudness (%) of your preferred PLD listening levels?

▼ 1 (softest) (1) ... 10 (loudest) (17)

Q8 Indicate your level of agreement with this statement: "The amount of noise around me causes me to increase my PLD volume."

▼ Agree (14) ... Disagree (18)

End of Block: Profile & Explanation

Start of Block: Before COVID

Q9
Before the Pandemic

These questions ask you about your experiences pre-pandemic. On the next (and last!) page, I will ask you these same questions, as well as one more, for during the pandemic.

Q3 Before the pandemic, about how many hours per day did you use a PLD?

▼ 0 - 1 hr. (1) ... 4+ hrs. (5)

Q10 Before the pandemic, about how many days per week did you use a PLD?

▼ 1 day (1) ... 7 days (7)

Q11 Before the pandemic, about how many hours per day did you spend listening to a PLD for anything related to school or studying?

▼ 0 - 1 hr. (1) ... 4+ hrs. (5)

Q12 Before the pandemic, during which situations (excluding listening to online classes) did you frequently use a PLD? Choose all that apply to you:

- ☐ Relaxing/leisure (1)
- ☐ Physical activity (2)
- ☐ Chores (of any sort) (3)
- ☐ Transportation (4)
- ☐ Sleeping (5)
- ☐ Other (6)

Q13
Indicate your level of agreement with this statement: "Before COVID, I experienced one or more symptoms of potential hearing damage (e.g. muffled sounds, sound sensitivity, persistent ringing in your ears)."

▼ Agree (1) ... Disagree (5)

End of Block: Before COVID

Start of Block: During COVID

Q16
During the Pandemic

These are the same questions you just answered (plus one more), this time for during the pandemic.

Q17 During the pandemic, about how many hours per day did you use a PLD?

▼ 0 - 1 hr. (1) ... 4+ hrs. (5)

Q18 During the pandemic, about how many days per week did you use a PLD?

▼ 1 day (1) ... 7 days (7)

Q19 During the pandemic, about how many hours per day did you spend listening to a PLD for anything related to school or studying?

▼ 0 - 1 hr. (1) ... 4+ hrs. (5)

Q20 During the pandemic, during which situations (excluding listening to online classes) did you frequently use a PLD? Choose all that apply to you:

- ☐ Relaxing/leisure (1)
- ☐ Physical activity (2)
- ☐ Chores (of any sort) (3)
- ☐ Transportation (4)
- ☐ Sleeping (5)
- ☐ Other (6)

Q21
Indicate your level of agreement with this statement: "During COVID, I experienced one or more symptoms of potential hearing damage (e.g. muffled sounds, sound sensitivity, persistent ringing in your ears)."

▼ Agree (1) ... Disagree (5)

Q20 In general, do you feel you have used PLDs more often during the pandemic?

▼ Yes (1) ... Not Sure (4)

End of Block: During COVID