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Environmental Perceptions of College Students during the COVID-19 Pandemic

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In this study, we investigate the environmental perception changes in college students during the COVID-19 pandemic. During the almost worldwide lockdown between March and December 2020, many students experienced dramatic changes in their socioeconomic life that have affected their well-being, ability to learn, and environmental perceptions. Students were sent home from college campuses, many businesses were shut down, and changes were seen in the environment throughout the world. In many places, lockdown policies lead to improved air, water, and land quality, mainly due to fewer vehicle and anthropogenic emissions. An online survey conducted on students enrolled in the University of South Florida and Florida State University demonstrates that most students have become more environmentally conscious after the COVID-19 lockdown, indicating significant perception changes. The students' demographic backgrounds played a major role in affecting their perception changes. Furthermore, mass media was found to have affected the student's perceptions, which demonstrates the important role media plays in directing public opinion, especially among college students and millennials. This study also highlights the environmental issues that underrepresented students face and calls for policies to address them on both educational and socioeconomic levels. **Key Words:** college students, COVID-19, environmental perceptions, socioeconomic impacts, underrepresented students.

Since December 2019, there have been 601.2 million cases of COVID-19 reported worldwide, with over 6.4 million deaths as of September 1, 2022 (World Health Organization (WHO) 2022). It is the fifth pandemic to affect the world since the 1918 flu outbreak, known as the Spanish flu. From February 1918 to April 1920, the pandemic infected ~500 million and killed ~17–50 million, in comparison, the 1957–1958 flu infected in-excess of 100 million and killed ~1.1 million, the 1968 flu killed 1 million, and the 2009 flu killed in-excess of 201,000 (Kilbourne 2006; Simonsen et al. 2013; Barro, Ursúa, and Weng 2020). Therefore, the universities, with no prior experience with such a large-scale pandemic, had to make quick decisions.

Throughout March 2020 almost all colleges and universities in the U.S. moved all students to online classes and sent residential students home (Lederer et al. 2021). With many other non-essential businesses closing down and most people being told to stay home, most students were in the same environment day in and out. These changes, brought about by the pandemic, led many students to have issues with stress, anxiety, and their ability to learn in an environment that was not suitable for school (Kapasia et al. 2020; Day et al. 2021, 2023). However, this lockdown led to improved air (e.g., Elshorbany et al. 2021) and water quality (Bar 2021). The almost global shutdown of many businesses and industries allowed for positive changes to occur in the environment. There were decreases in traffic and vehicle emissions of pollutant criteria (e.g., Elshorbany et al. 2021), and noise pollution that allowed for changes to be seen in air quality,

water quality, and animal behavior (Bar 2021). Decreases in nitrogen dioxide (NO₂) pollutants due to the pandemic occurred near industrial and heavy-traffic regions where lower-income and minority groups live across the United States of America (U.S.) (Kerr, Goldberg, and Anenberg 2021). These vulnerable communities were affected by much higher levels of nitrogen dioxide before the pandemic, and their regions have shown a much higher decline in the pollutant's levels during the lockdown. Decreases in NO₂ and Carbon Monoxide (CO) were also seen in six major cities throughout the state of Florida most likely due to decreased road traffic (El-Sayed, Elshorbany, and Koehler 2021). Decreases in road traffic during the lockdown were also shown to impact air quality across the U.S., with some states seeing higher drops in NO₂, CO, and Ozone (O₃), while other states did not show significant changes because their main sources of air pollution were sources other than traffic (Elshorbany et al. 2021). An earlier study showed that air quality perceptions changed during the COVID-19 lockdowns, increasing in the U.S. from 37% to 75% perceiving good air quality, based on a survey completed in May 2020 (Barbieri et al. 2020). Similar effects were seen worldwide. During lockdowns in Venice, Italy, a reduction in the boat traffic along the canals lead to lower turbidity, and a stop in the discharge of industrial waste into the canals resulted in schools of fish and swans being seen swimming throughout (Braga et al. 2020; Bar 2021). A reduction in particulate matter, nitrogen oxides, sulfur dioxide, and carbon monoxide in India during their lockdown led to an increase in the

visibility in the air and an increase in the air quality throughout the country (Bar 2021). Wildlife started to expand the areas in which they roamed due to a lack of human interference, pumas could be seen walking the streets in Santiago, Chile, herds of deer were walking around in Nara, Japan, and mountain goats were now roaming the streets of Llandudno, Wales, U.K. (Bar 2021).

As pollution criteria started to decrease due to COVID-19, college students' stress and mental health issues started to increase. In the U.S., many students' academic performances dropped, and their overall well-being decreased because they were not in an environment that was conducive to their learning or social wellbeing (Lederer et al. 2021). While in China, researchers noted a significant change in how college students rated their stress and anxiety levels, as more students surveyed said that they were at a moderate stress level or above and that there were more students dealing with anxiety or depression (Zhan et al. 2021). Higher than average stress levels were mostly due to students not being equipped with the experience or knowledge to deal with public health emergencies, as the lack of experience in dealing with their emotions can very easily lead to increases in stress, anxiety, or depression that were seen in the study (Zhan et al. 2021). In India, issues were seen with students living in environments that were not conducive to their learning, with some students studying in more rural areas that had poor internet connections that could have put more stress on them, and other students completely unable to access their online classes because they did not have the technology that was needed (Kapasia et al. 2020). Students in Georgia, U.S. were asked about the use of Google Earth to virtually visit places across North America for their geography class, with students suggesting that they felt more "interconnected" and had a better understanding of how places and locations relate (McDaniel 2022). Students who were doing research and fieldwork also experienced disruptions that put their research on pause (Gibbes and Skop 2022). Previous studies showed that students who were able to be outside for their classes were more engaged and had a better understanding of the material they were learning (Cook 2010). These disruptions to the normal daily lives of college students could have been driven by or have the potential to change their perceptions of life and the external environment. These perception changes could have long-lasting effects on these students and change the way they see the world. College students have been surveyed about how the COVID-19 lockdown impacted their ability to learn online (Kapasia et al. 2020; Day et al. 2021), how their emotional well-being may have changed (Lederer et al. 2021), or even how they felt about doing virtual field trips using Google Earth (McDaniel 2022), but none have been asked solely

about how their environmental perceptions may have also changed during this time. Environmental perceptions refer to the way that the respondents perceive the outdoor environment (changes in air and water quality), along with perceptions of the environment as a whole. Respondents' environmental perceptions can be impacted by several factors, including geographic location, ethnicity, income, and whether they have a past or current experience regarding pollution episodes (Rives, Elshorbany, and Kaylor 2023). There is currently no literature regarding college students' perceptions of outdoor environmental changes as a result of the COVID-19 pandemic.

The goal of this study is to understand how environmental perceptions regarding air and water quality may have changed during the COVID-19 school closures in college students. As college students were sent home and classes were moved online there were many changes that were also occurring in the global environment during lockdowns. Many of these environmental changes could alter students' perceptions regarding their surrounding environment. Some students live in areas that may have seen more drastic environmental changes than others. As minority students were more likely to live in areas closer to major roadways or industrial areas that have higher levels of air pollution, they may have noticed a sharper decline in pollutants due to the shutdown of many businesses and industrial plants (Fairburn et al. 2019; Johnston et al. 2019). In addition, college students' perceptions could change the way they see the environment before they join the workforce. This study is designed to understand how college students' perceptions have potentially changed while they moved to online classes and there were noticeable changes in the air, water, and land quality. Perception changes of different ethnic groups were also gauged to understand the impact of their local environments, which could in turn impact their perception changes.

Methodology

In the following sections, we discuss the study domain, the survey method, and the applied statistical approach.

Study Domain

Surveyed college students were mainly from the University of South Florida (USF) in addition to some respondents from Florida State University (FSU). To collect a reasonable number of student surveys, a 20% sample of all USF graduate and undergraduate students was requested. All students that were selected were above 18 years old, full-time

degree-seeking students, and surveys were sent to their active university emails. The students who were selected were sent an email that explained what the survey was about and provided the link to respond to it. Electronic mail (email) was the most effective and far-reaching method to receive responses from students. Two reminder emails were sent out within two weeks of the first email to remind them to respond if they could. A second 20% sample of students was requested at USF to ensure that there would be at least 1000 valid respondents to the survey. An unknown percentage of students (ranging between 0.03% and 1%) was requested from FSU as that information was not provided, and an email list using a single email address that was connected to specific student emails was provided to send out the survey. FSU students were requested to be also above 18 years old, full-time, and a mixture of undergraduate and graduate students. At the time of the survey, conducted between February 4th and 22nd, 2022, most of the eligible students were vaccinated and were starting to come back for face-to-face classes (on campus), while some students, especially international students, were still benefiting from the remote option. These students had time to adjust to the changes brought about by COVID-19 while also still being affected by the pandemic, allowing them to look back and reflect on the changes that they had experienced and how that may have affected them. As shown in Figure 1, most survey respondents were located in the Tampa Bay area, and some students were also located in other states or internationally as many students were still studying remotely.

Survey Method

Qualtrics (Qualtrics XM – Experience Management Software 2022) was used to create a survey that could be anonymously sent out to college students. There were no incentives provided to students who took the surveys. Surveys were sent out to Florida State University (FSU) and University of South Florida (USF) students, to see how college students in Florida were affected by the COVID-19 lockdown, and to assess any potential perception changes before and after the COVID-19 lockdown. Surveys were sent to FSU students through their University Survey Request Form and correspondence with their survey review committee to approve the survey and provide an email list to send the survey to students. Surveys were sent out to USF's students through the Registrar's Office, which provided a list of student emails to send the survey to. The survey included a total of 44 questions. To ensure the quality of responses and that all statistical parameters are based on the same number of responses, incomplete surveys (i.e., surveys that had missing answers or were started but never finished) were removed. A

time filter was added so that any survey that took less than 3 min to complete was removed, ensuring there were no responses where students just clicked responses without reading the question. There was no filter used to ensure different IP addresses were connected to each response because computers that are connected to the same Wi-Fi (e.g., in Dorms) can share the same IP address, and there would be overlap with the responding students that lived on campus. Some incomplete surveys made it past the filters and were manually removed. This results in a total of about 1000 valid surveys (see sec. 3.1). The survey questions were related to the impacts of the different factors during the lockdown periods in each state/country where the students were located during the pandemic period (see supplementary for a list of the administered survey questions). These questions allowed for an understanding of what factors (i.e., demographics, local changes, mass media, etc.) may have influenced responses on perception change.

Statistical Analysis

The Qualtrics data were imported into a data analysis software, SPSS version 27.0 (SPSS 2020) for statistical analysis. Survey questions were assigned as categorical variables and were given unique names. The variable names and their corresponding questions are listed in the [supplementary materials](#).

Seven different multinomial logistic regression tests were run for analysis; the tests were run with a 95% confidence interval (Table 1). A list of the variables and their definition is listed in the [supplementary material](#). Each test compared different dependent variables to multiple independent variables to determine the factors that may have impacted the respondents' answers. The tests helped determine how student demographics, mass media, local changes, and respondents' own values contributed to environmental perception changes. The first test measured the mass media reports as a function of demographic factors, i.e., if there were any determining demographic factors in who had or had not seen any news that showed changes in land, air, or water quality during the COVID-19 lockdown. The dependent variable used was See News Reports (if respondents have seen news reports regarding the outdoor environment), while their age, ethnicity, gender, marital status, and if they were graduate or undergraduate students were the independent variables. The second test determined if any perception changes after the lockdown were due to perception changes from seeing news reports. For this test, Percep Change After Lockdown (if they had environmental perception changes after lockdown) was the dependent variable, and their age, News Percep Airq (if news reports on air quality changed their perceptions), News Percep Waterq (if news reports

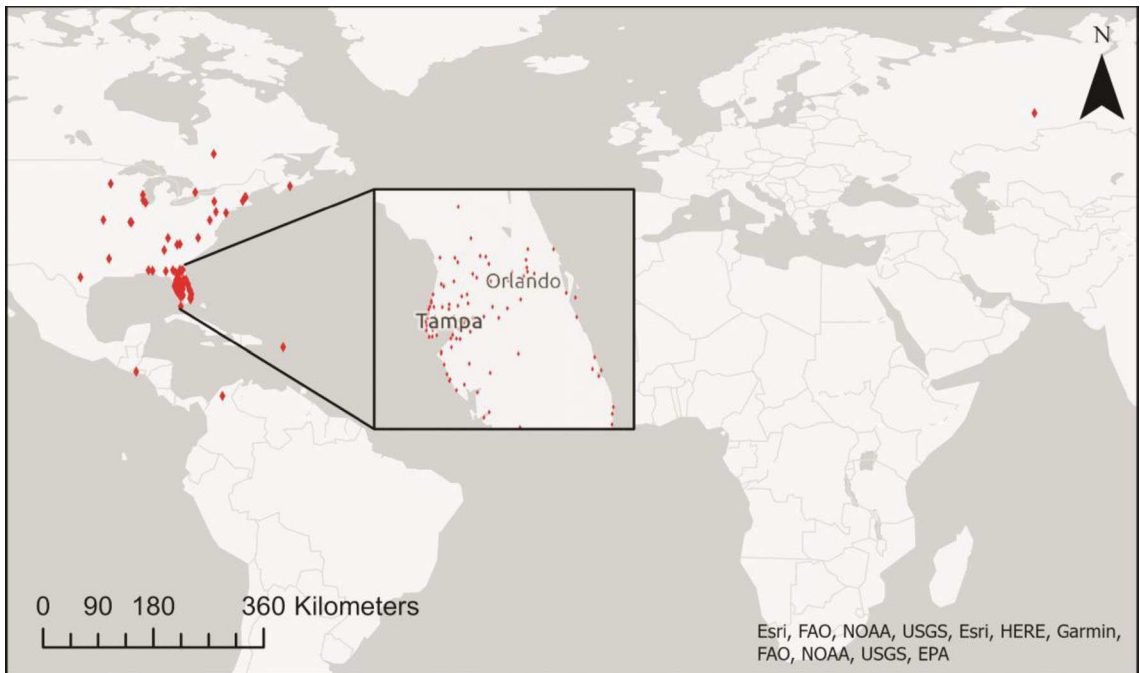


Figure 1 *Geographical distribution of the survey respondents.*

on water quality changed their perceptions), and News Percep Landq (if news reports on land quality (i.e., animals roaming, litter) changed their perceptions) were the independent variables. The third test determined if people, who noticed environmental changes, wish these environmental changes to continue after the pandemic. Here, Change Improve AirWaterq (if they wanted any environmental changes they had seen to continue) was the dependent variable and their age, Changes Locally Air (if they noticed local air pollution changes), Changes Locally Water (if they noticed local water pollution changes), Changes Locally Noise (if they noticed local noise pollution changes), Changes Locally Wildlife (if they noticed local wildlife changes), Changes Locally Pollution (if they noticed local pollution changes in litter), and Changes Locally None (if they noticed no local pollution changes) were the independent variables. The fourth test determined if respondents thought people's environmental concerns changed and whether or not they thought that change would last. For this test, Will Concern Last (if they believed environmental concern would last or not) was the dependent variable, and their age, Concern Change Globally (if they believe environmental concern has changed on a global scale), Concern Change Locally (if they believe environmental concern has changed on a local scale), and During Lockdown Percep Change (if they had environmental perception changes during lockdown) were the independent variables. The fifth test determined how likely respondents would be to make

changes themselves if they wanted to see a change in the world. The dependent variable was Change Your Impact (if they were willing to change their environmental impact), and the independent variables were their age, Positive Enviro Change World (if they wanted to see more positive environmental changes in the world), Help Fight (if they were willing to help fight for environmental changes), Area Live More Change (whether or not they thought the area they lived in needed to be doing more to protect the environment), and Humans Main Cause (whether or not they believed humans to be the main cause of environmental problems). The sixth test analyzed if demographic factors determined if a respondent was more likely to have perception changes. In this test Percep Change After Lockdown (if their environmental perception changed after lockdown) was the dependent variable, while their age, ethnicity, gender, marital status, if they were a graduate or undergraduate student, and their political affiliation were the independent variables. The seventh test determined if ethnicity was a determining factor in whether or not respondents noticed local environmental changes during the lockdown period. For this test ethnicity was the dependent variable, while their age, Changes Locally Air (if they noticed local air pollution changes), Changes Locally Water (if they noticed local water pollution changes), Changes Locally Noise (if they noticed local noise pollution changes), Changes Locally Wildlife (if they noticed local wildlife changes), Changes Locally Pollution (if they

Table 1 A list of the dependent and independent variables of the different regression analyses

Regression test	Dependent variable	Independent variables					
		Age	Ethnicity	Gender	Marital Status	Grad Undergrad	
1	See News Reports						
2	Percep Change After Lockdown	Age	News Percep Airq		News Percep Landq	News Percep Waterq	
3	Change Improve Air/Waterq	Age	Changes Locally Air	Changes Locally Water	Changes Locally Noise	Changes Locally Pollution	Changes Locally None
4	Will Concern Last	Age	Concern Change Globally		Concern Change Locally	During Lockdown Percep Change	
5	Change Your Impact	Age	Positive Enviro Change World		Help Fight	Humans Main Cause	
6	Percep Change After Lockdown	Age	Ethnicity	Gender	Marital Status	Political Affiliation	
7	Ethnicity	Age	Changes Locally Air	Changes Locally Water	Changes Locally Noise	Changes Locally Pollution	Changes Locally None

Note: A list of the variables and their definition is listed in the supplementary material.

noticed local pollution changes in litter), and Changes Locally None (if they noticed no local pollution changes), were the independent variables (Table 1).

The equation used for the multinomial logistic regression is as follows:

$$\Pr[Y_i] = \exp(\beta_1^{(i)}X_1 + \beta_2^{(i)}X_2 + \dots + \beta_m^{(i)}X_m)$$

where Pr[Y] is the probability of the dependent variable, Y as a function of the independent variables, X (see Table 1), and β is their dependency factor.

Regression tests are based on their significance and odds ratio, Exp(B). Since there was a 95% confidence interval, the significance needed to be less than or equal to 0.05. The odds ratio Exp(B) could be any number, and its significance was based on if the number was less or greater than 1, as this determined if the factor was significant to the outcome category or reference category that was chosen from the dependent variable. The reference category refers to the category of the dependent variable chosen that all the tests will be compared to, while the outcome category is all other categories in the dependent variable that are shown in the regression test and are only compared to the reference category. If Exp(B) is greater than 1, then the chance of the outcome category occurring increases that many more times compared to the reference category (Heidel 2022). If Exp(B) is less than 1, the chance of the outcome category occurring decreases that many more times compared to the reference category (Heidel 2022).

To avoid statistical errors due to the low number of respondents in some categories, some categories were combined into a larger category. A Hessian Matrix Error occurred in some of the regression tests, while some other tests had an error where there were “cells (i.e., dependent variable levels by subpopulations) with zero frequencies”. The Hessian matrix error was due to a low percentage of responses within certain ethnicity, gender, and marital status variables. Ethnicity was separated into six different categories, “Hispanic or Latino,” “Black or African American,” “Native American or American Indian,” “Asian/Pacific Islander,” “White,” and “Other.” To solve the Hessian Matrix Error the categories with the smallest number of responses were combined, this meant that “Native American or American Indian” and “Other” were combined and a new dummy variable was created under the name “Other.” The categories within Marital Status are “Single, never married,” “Married or domestic partnership,” “Widowed,” “Divorced,” and “Separated.” “Widowed,” “Divorced,” and “Separated” were combined because they had the lowest number of responses and a new dummy variable labeled “Other” was created. The categories within Gender are “Male,” “Female,” “Non-binary/third gender,” and “Prefer not to say.” “Non-

binary/third gender” and “Prefer not to say” were combined into an “Other” category due to their low number of responses, and a new dummy variable was created. These combined variables solved the Hessian Matrix Error. The “cells (^{i.e.} dependent variable levels by subpopulations) with zero frequencies” error was due to having a continuous covariate, in this case, that variable was Age (Chan 2005). Age was then combined into three different categories, “18–22” equaled 1, “23–29” equaled 2, and “30+” equaled 3, this was done to reduce the number of cells with zero frequencies since age was not a continuous covariate anymore. The number of cells with zero frequencies error was still present, however, the number was small enough to be negligible.

Results and Discussion

Survey Composition

The total number of eligible USF students was 43,680 students (see sec. 2.2). 20% of USF students (8,736 students) were requested two times, yielding a total of 17,472 students requested out of the total number of USF students. There were only 918 reliable responses, see sec. 2.2, so there was only a 5% response rate of usable responses. Of all students at USF and FSU, there were 1170 responses before the filters were applied. After the filters were applied, there was 953 total with 918 responses from USF, and 34 responses from FSU.

The majority of respondents were White (60%), followed by Hispanic respondents (17%), Asian/Pacific Islander (11%), Black or African American (8%), and others (4%). Most respondents were undergraduate students (66%), compared to graduate students (34%). Female respondents represented 65%, males 31%, and others 4%. As expected from a traditional student population in the U.S., the majority of respondents were single, never married (80%), followed by married students or domestic partnership (17%), and others (3%) (Figure 2). Political ideologies included independents making up 41% of respondents, democrats 28%, strong democrats 15%, republicans 13%, and strong republicans 3%, see Figure 2.

Regression Analysis

As shown in Figure 3, the No Local Changes (variable is “changes locally non”) has the highest odds ratio value, while Local Pollution Changes (variable is “Changes locally pollution”) has the lowest. A higher odds ratio indicated a more certain correlation between the dependent and independent variables used in each test. The values below one, however, do not indicate that they are negative

results, only that those variables support the reference category that they were tested against. The degrees of freedom vary with each regression test as there were different numbers of factors being tested in each one, regression test one had 5, regression test two had 8, regression test three had 14, regression test four had 4, regression test five had 5, and regression test six had 12.

In the following sections, the factors affecting changes in students’ perceptions as a result of the COVID-19-related lockdowns are investigated.

Impact of Mass Communication on Students’ Perceptions

Here regression tests related to mass media perceptions were conducted. In the first regression test, demographic factors (including education level, see sec. 2.2) that could influence if respondents had seen the news reports of ongoing environmental changes throughout the world due to the COVID-19 lockdown were investigated. The only significant factor in this test was if the student was a graduate or undergraduate, with a significance $p = 0.028$, and an odds ratio of 1.614 (Table 2). Since the odds ratio is greater than 1, as the response number (graduate students being a 1 and undergraduate students being a 2) increases, the more likely respondents were to watch the news. The relative proportion of responses shows that 83% of graduate students watched the news regarding environmental changes more compared to 75% of undergraduates.

The seventh regression test looked at if the media as a whole had any impact on environmental perception changes during the COVID-19 lockdown. The test showed that watching news reports on the environment did impact respondents’ perception changes. The dependent variable “Did you see news reports” is a significant factor for both responses, if they became more environmentally conscious and slightly more environmentally conscious, with a significance of $p = <0.001$ and 0.009 respectively. The Exp(B) values were both less than 1, being 0.364 and 0.566 respectively (Table 2, Figure 3). This indicates mass media had a significant impact on the students’ environmental perceptions, ^{i.e.} students who watched the news reports were more likely to have perception changes, and those who did not see news reports were less likely to have perception changes. These results are consistent with previous reports showing that mass media played a large part in how people across the globe felt about COVID-19 and how they decided to respond (Barua et al. 2020) (Figure 4).

Demographic Factors

Previous reports showed that demographics are key to understanding why respondents answer in certain

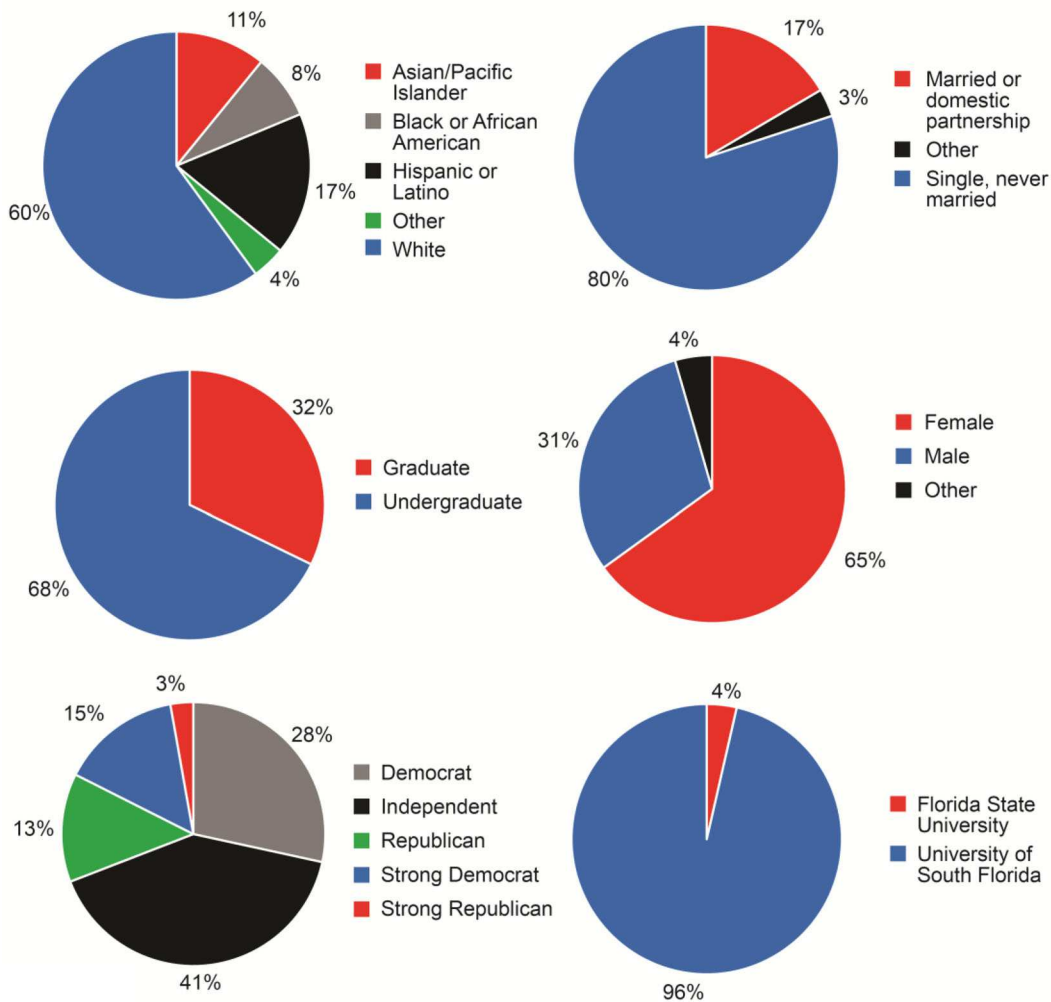


Figure 2 Survey composition related to student demographics.

ways, showing that different responses to climate change depend on the respondents' demographics (Poortinga et al. 2019). The second and sixth regression tests both look at demographic factors affecting perception changes after lockdown (Table 2). In the second regression test, the significant factors in determining if the respondent had no change in environmental perceptions, were their age and whether or not they had seen news reports on water quality, with a significance of $p = 0.002$ and <0.001 respectively. The odds ratios for respondents' age and if they had seen water quality news reports were 1.365 and 1.981, respectively. In the sixth regression test, respondents' age had a significance of $p = 0.003$ and an odds ratio of 1.531 for responding they had no change in environmental perceptions. Respondents' ethnicity, gender, and marital status in the sixth regression test in regard to responding no change in environmental perception, were all significant, with a significance of $p = 0.006$,

<0.001 , and 0.012 respectively. Ethnicity had an odds ratio of 1.139, gender had an odds ratio of 0.517, and marital status had an odds ratio of 0.615. For both regression tests, age had an odds ratio above 1, indicating that the older they were, the less likely the respondent would have changed their perceptions of the environment (Figure 5). The odds ratio for the factor regarding whether or not they had seen news reports on water quality was greater than 1, indicating that a respondent was more likely to have no environmental perception change if they did not have a perception change on water quality because of news reports they had seen. Ethnicity had an odds ratio that was greater than 1 and indicated that a respondent was more likely to not change their perception if they were white. Gender and marital status both had an odds ratio that was less than one, which indicated that being single or not male, their perception was more likely to change. These results are consistent with the body of

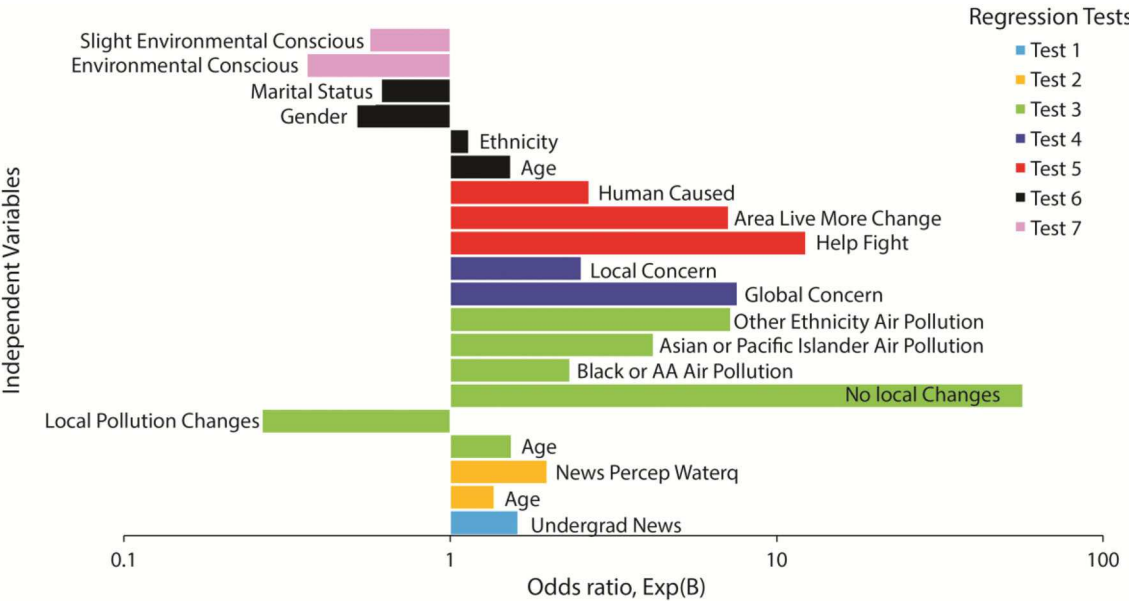


Figure 3 Odds ratio of the significant variables, with values above 1 indicating the variable supports the outcome category and values below 1 indicating the variable supports the reference category.

Table 2 The significant factors used in the analysis showing the significance of the dependent variable and Exp(B) value determining if significance was for the outcome or reference category, for all regression tests

Dependent variable	Category	Sig. (p)	Exp(B)
Regression test 1			
No (did not become environmentally conscious)	Undergrad or graduate?	0.028	1.614
Regression test 2			
No perception changes after lockdown	Age	0.002	1.365
	Change perspective on water quality?	<0.001	1.981
Regression test 3			
Indifferent to have environmental changes continue	Age	0.001	1.541
	Changes Locally Pollution	0.007	0.265
No to having environmental changes continue	Changes Locally None	0.027	56.768
Black or African American	Changes Locally Air Pollution	0.035	2.328
Asian or Pacific Islander	Changes Locally Air Pollution	<0.001	4.189
Other Ethnicity	Changes Locally Air Pollution	0.002	7.224
Regression test 4			
No, environmental concern will not last	Concern changed globally?	<0.001	7.569
	Concern changed locally?	<0.001	2.516
Regression test 5			
No, I will not change my environmental impact	Willingness to help fight	<0.001	12.258
	Area live more change	<0.001	7.107
	Humans main cause	0.002	2.660
Regression test 6			
No perception changes after lockdown	Age	0.003	1.531
	Ethnicity	0.006	1.139
	Gender	<0.001	0.517
	Marital Status	0.012	0.615
Regression test 7			
Became more environmentally conscious	See news reports	<0.001	0.364
Became slightly more environmentally conscious	See news reports	0.009	0.566

Note: At a 95% confidence interval, variables should have a significant value of less than or equal to 0.05. Odds ratios (Exp(B)) with values above 1 indicate the variable supports the outcome or reference category.

literature that shows demographics (e.g. gender, age, ethnicity) can influence people’s perceptions of climate change (Gaither et al. 2019; Johnston et al. 2019). This is because racial and ethnic minorities are more likely to live in urban and industrial areas where pollution is more apparent (Fairburn et al. 2019).

Local Factors

The third regression test looked at how changes seen locally might impact if people want any positive environmental changes to continue. The variables Age, Changes Locally None, and Changes Locally Pollution were all significant factors in determining

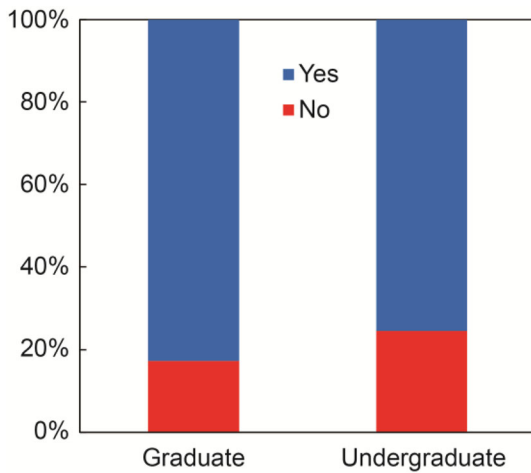


Figure 4 Students' responses on whether they watched the news regarding environmental changes during the pandemic.

how students responded (Table 2). Changes Locally None meant that the respondent did not see any changes locally, and Changes Locally Pollution meant that the respondent saw changes in the litter that was in their area. Age was significant in determining if the respondent was indifferent or thought the changes should not continue, the significance was 0.001 and 0.018, respectively, and the odds ratios were 1.514 and 2.048 respectively, indicating that the older the respondent the more likely they were to be indifferent or think that the environmental changes should not continue. The odd ratio reflects the correlation between the dependent and independent variable, *i.e.*, does not indicate the relative fraction of students agreeing with that variable. If the respondent did not see any local changes was a significant determining factor for the respondent to say no changes should be made to continue improving the environment, the significance was 0.027, but with a very high odds ratio of 56.768, indicating that respondents who said they did not notice any local environment changes would almost certainly say that no changes needed to be made to the environment. Respondents seeing local changes in pollution was a significant determining factor for the indifference with a significance of 0.007, however, the odds ratio was 0.265. An odds ratio of less than 1 indicated that if the respondent said they saw changes locally they were more likely to say that these positive environmental changes should continue.

Respondents' age as a factor continued to show that if respondents were older, they were more likely to be indifferent or say no to having any environmental changes continue. If a respondent did not recognize that they had seen any local environmental changes during the lockdown period, they were also more likely to say that no changes should be

made to continue improving the environment because no changes had occurred in the first place. The majority of respondents did say that they noticed changes in the pollution (e.g., litter) that they could see locally, and while there were many who saw pollution but did not think that any real changes needed to continue, the majority who saw pollution locally did want these changes to continue (Figure 6). Ethnicity was also a determining factor in noticing local changes. If the respondent was black or African American, Asian or Pacific Islander, or in the other category, they were more likely to have noticed changes in air pollution, with their significance and odds ratios seen in Table 2.

Cook, (2010) showed that people are in general concerned about changes in the land they see locally, with many understanding the importance of keeping their surrounding environment unpolluted. This correlates with the data collected showing that respondents who noticed decreased pollution in their local outdoor environment wanted those changes to continue.

Global and Local Concern

The fourth regression test looked at if respondents thought any environmental concern would last after the lockdown ended (by the time this survey was sent, the majority of lockdowns had ended). How respondents felt about environmental concern on a global and local were both significant factors, both having a significance of <0.001 , and an odds ratio equaling 7.569 and 2.516, respectively (Table 2). Since the odds ratio is greater than 1 for both factors, students' responses that they did not think concern had changed on a global or local scale, indicated that they did not think any environmental concern would last (Figure 7). Both responses also show that a respondent was much more likely to say concern for the environment would last if they believed perceptions had changed on a local or global scale (Figure 7). This shows that students who have become more environmentally conscious will continue to be concerned about the environment after the COVID-19 era. Prior research also agrees with the result that concern for the local environment increased during the COVID-19 pandemic (Rousseau and Deschacht 2020), with this data going a step further and suggesting that respondents' believe concern for the environment has also changed on a global scale.

Factors Indicating Personal Change

The fifth regression tested if certain responses indicated that people were more likely to want to change their environmental impact. Their willingness to help fight for environmental changes, if they thought the region that they lived in needed

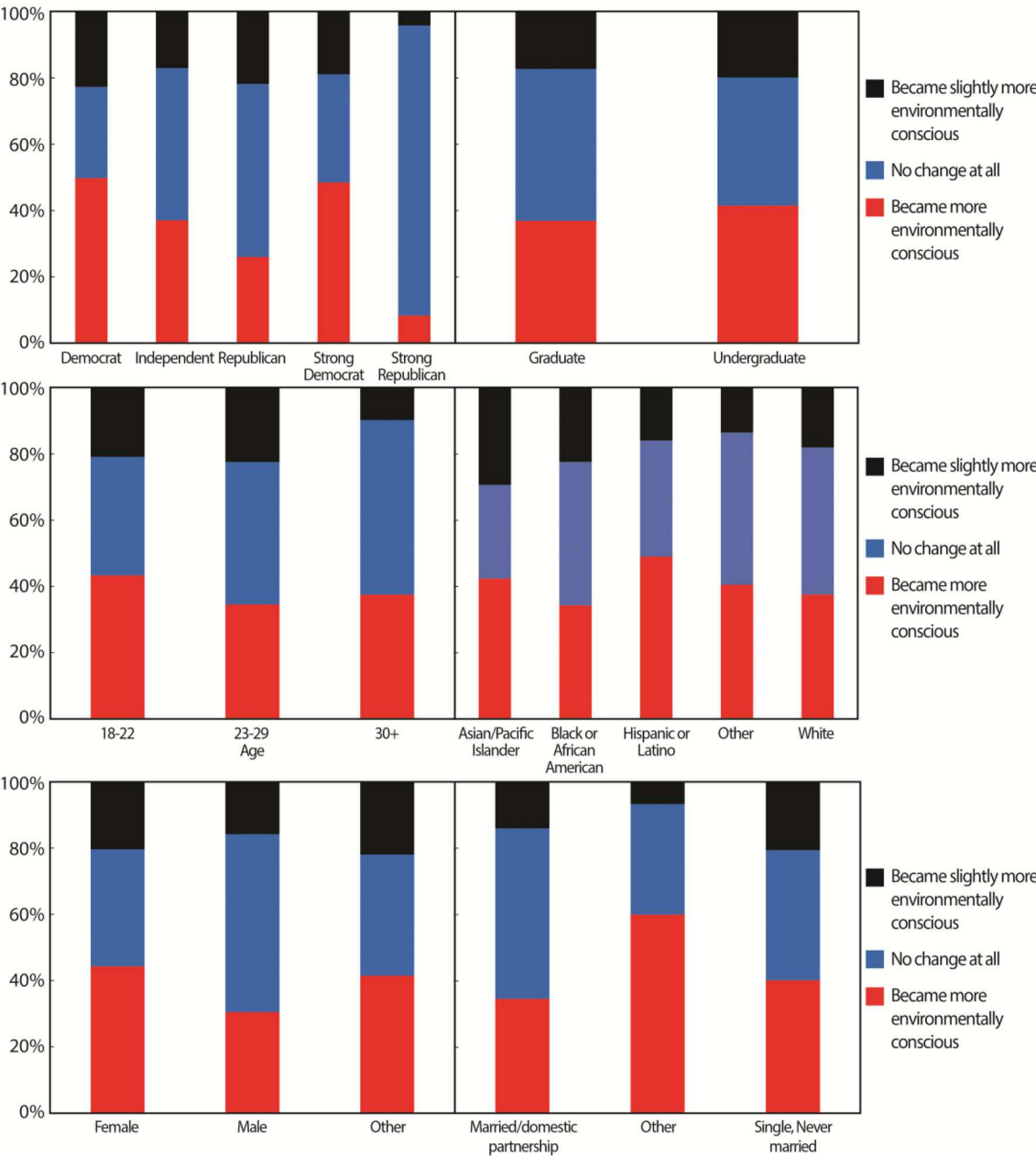


Figure 5 *Relative percent of student responses regarding their perception changes by demographic.*

to make more environmental changes or not, and whether or not they believed humans to be the main cause, were all significant determining factors (Table 2). Their willingness to help fight and wanting the area they live in to make more changes both had a significance of <0.001 , while if they thought humans were the main cause had a significance of 0.002. Their willingness to help fight, whether the area they lived in needed to make more changes or not, and whether they believed humans to be the main cause had an odds ratio of

12.258, 7.107, and 2.660, respectively. These results indicate that if the respondents are wanting to help fight for change, if they believe humans to be the main cause of environmental problems, or if they want their local area to make more environmental changes then they are more likely to want to change their environmental impact (Figure 8). These results are also in agreement with previous perception studies showing increased public interest and concern about climate change issues (Schmitz et al. 2018).

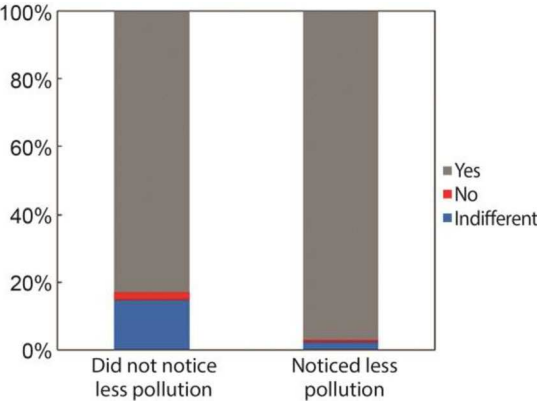


Figure 6 Students' responses on if they noticed changes in pollution (ex. litter) in their local area, and if they wanted any positive changes in the environment to continue.

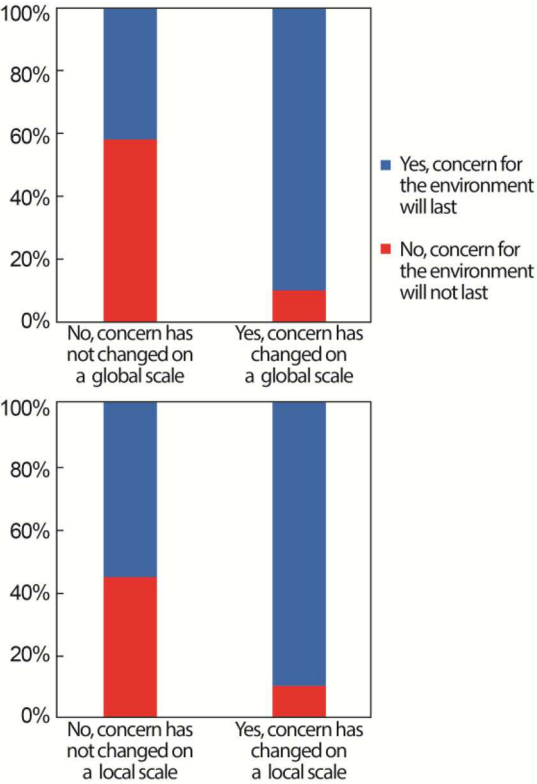


Figure 7 The figures show a comparison of whether the respondent thought environmental concern had changed and if they thought that concern would last.

Environmental Perception Changes

As can be deduced from survey question 34 (Table S9), 59% of respondents became more environmentally conscious (Figure 9), indicating that more

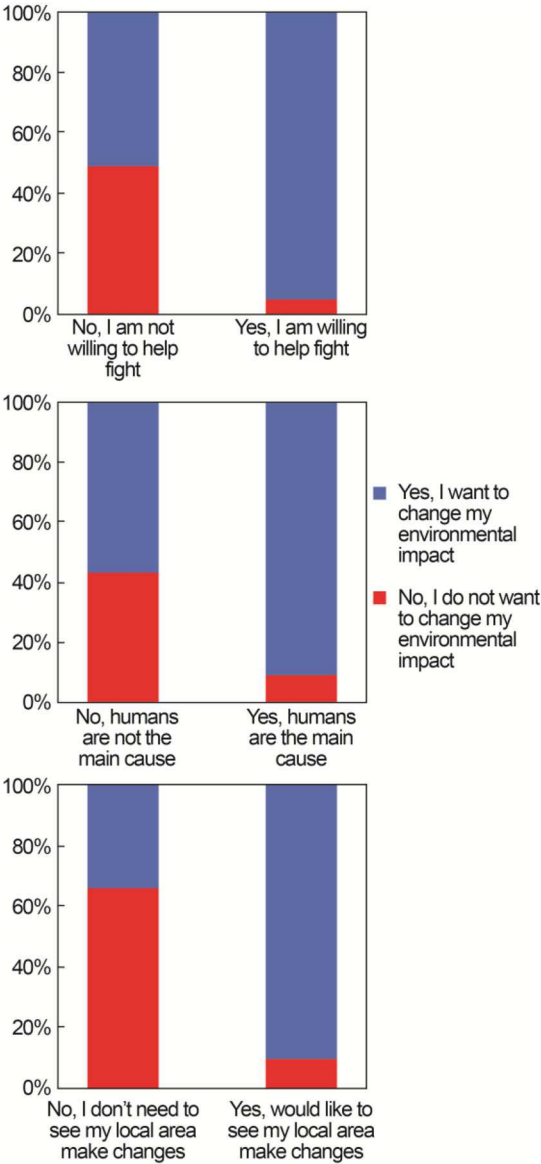


Figure 8 Relative responses determining if students were more likely to change their impact if they were to help fight for environmental changes, if they believed humans were the main cause, or if they wanted to see changes in their local area.

respondents had a positive change in how environmentally conscious they were, regardless of how they responded to the rest of the survey. Surveys conducted during the COVID-19 lockdowns (e.g., Garrido-Cumbrera et al. 2021) were in agreement with these data, showing that there were positive improvements to people's perceptions of the environment, specifically due to the changes related to the lockdown.

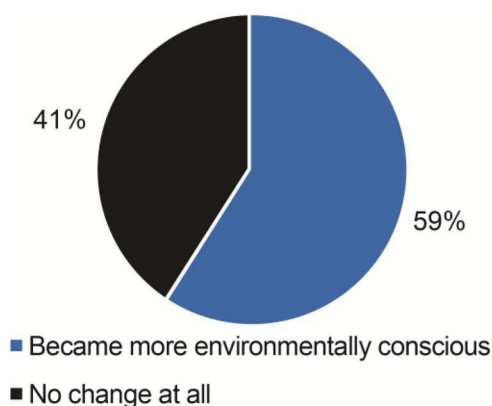


Figure 9 Student responses showing if their environmental perceptions changed after the COVID-19 lockdown.

Conclusion

In this study, we investigated students' perceptions regarding their environment during the COVID-19 lockdowns and their future perspectives. There were noticeable environmental perception changes due specifically to the COVID-19 lockdowns. Our results indicate that the majority of respondents did have more positive environmental perception changes, and are becoming more environmentally conscious. The majority of respondents said that there was a definite change in their environmental perceptions after the lockdown, with 59% of respondents having perception changes, and 41% having no change at all. Media was found to have an impact on students' environmental perceptions. When looking at whether respondents saw the news, it was shown that respondents were more likely to have perception changes if they had seen the news compared to those who had not. However, when looking at specific news reports that showed changes in air quality or land quality, there was no impact on how a respondent's environmental perceptions may have changed. Previous reports showed also that mass media has an impact on viewers' perceptions and can influence the way they think, especially in consideration of information dealing with COVID-19 (Barua et al. 2020).

Demographics were a key factor in determining if environmental perceptions did change during the COVID-19 lockdown. Respondents who were not white, were younger, single, and female, or were more independent or democratic-leaning, became more environmentally conscious, and their perceptions did change, which is consistent with previous literature regarding the impact demographics have on people's perceptions (Garrido-Cumbrera et al. 2021). There was a majority of nonwhite and

non-Hispanic surveyors who responded that they noticed changes in air pollution during the pandemic. The data correlates with previous studies showing that changes in air pollution were disproportionately attributed to minority respondents, with more minority areas generally having higher levels of pollution (Kerr, Goldberg, and Anenberg 2021).

The study provides also an insight into what students thought of the varying environmental changes, based on their residence location (e.g., nearby industrial locations) or different environmental factors (e.g., air quality, water quality), going on throughout the world during the COVID-19 lockdown and how it may have affected them. This data represents most of the student population. However, the result of this study is limited by its subjects, i.e., full-time students, a majority of undergraduates, and the exclusion of part-time students. The changes in environmental perceptions, especially those of minorities indicate that more needs to be done to improve air quality for these communities, as a majority of those respondents noted changes in air quality during the lockdown and wanted the better air quality to continue. Furthermore, the study asked participants to consider their perceptions of issues that happened before the pandemic. Therefore, the potential for "memory decay" is a limitation of this study when asked to recall past perceptions and actions that influenced decisions (Stallings 2002). For instance, since memories change with the passage of time, the responses may not have been identical should they have been interviewed before COVID for instance with the same question. However, this was not possible to capture as the world had no idea it was about to enter a global pandemic. Future research may include gathering a larger number of responses from universities across the country to determine if different geographic locations across the country are a factor in how students respond. ■

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Supplemental Material

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