frontiers | Frontiers in Education

TYPE Original Research
PUBLISHED 01 February 2023
DOI 10.3389/feduc.2023.1067380

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to
Higher Education,
a section of the journal
Frontiers in Education

RECEIVED 11 October 2022
ACCEPTED 06 January 2023
PUBLISHED 01 February 2023

CITATION
Ardissone AN, Galindo S, Triplett EW and
Drew JC (2023) Online and on-campus
transfer students experienced different impacts
from the pandemic.
Front. Educ. 8:1067380.
doi: 10.3389/feduc.2023.1067380

Online and on-campus transfer students experienced different impacts from the pandemic

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The COVID-19 pandemic caused extensive disruption to higher education, highlighting the negative impacts of emergency shift to online instruction. As a result, advantages of *intentionally* designed, online programs in higher education were overshadowed during the pandemic. Furthermore, socioeconomic disparities were exacerbated during the pandemic which extended to STEM undergraduate transfer students, who are more likely to be low-income, from historically underrepresented groups, older, and first generation in their family to attend college. To better understand the impact of the pandemic on STEM undergraduates, including those in an intentionally designed online program, ordinal regression analysis of 352 student survey respondents enrolled in a life sciences major at a large, R1 institution in the United States spring 2020 through fall 2021 was performed. Three student types are compared: on-campus, first-time in college (FTIC); on-campus transfer (OC-TR); and online transfer (ONL-TR) students. The latter group receives all course delivery online, whereas on-campus student groups received predominately in-person course delivery prior to the pandemic. ONL-TR students were over six times less likely to report negative educational impact compared to on-campus students, FTIC and OC-TR, while controlling for parent education, income, gender, race/ethnicity, and GPA. Additional survey items further explored this result and were validated with academic records and thematic analysis of students' text responses. A pre–/post-pandemic comparison revealed that students maintained a similar course load and GPA, despite increased perceptions of a lower GPA during the pandemic. OC-TR students were over two times more likely to express increased concern related to delayed graduation and higher frequency of feeling stress compared to FTIC and ONL-TR students. Meanwhile, low-income students were more likely to report stressors due to the pandemic's impact on daily life, independent of student type. Taken together, students in this intentionally designed online program were more resilient to the educational and emotional impacts of the pandemic compared to on-campus students. The differences between student groups warn against generalization of student impacts and suggest further research into the positive role of online learning, not just for delivery of educational content and expanding access, but for academic and emotional stability for different student populations.

KEYWORDS

transfer students, stem education, pandemic impacts, online learning, low-income students

1. Introduction

The COVID pandemic caused profound disruption to life and the pursuit of higher education for most undergraduate students (Gupta et al., 2021; Sharaievska et al., 2022). Enrollment drops have been documented and analyzing data from 11.2 million students, the National Student Clearinghouse reported major national declines in undergraduate student enrollment since spring 2020. Transfer student enrollment across all US institutions dropped 13.5% overall during the first 2 years of the pandemic compared to 6.3% enrollment decline for non-transfer students (Causey et al., 2022). Furthermore, as with healthcare disparities, the pandemic only exacerbated existing inequities and stress faced by underrepresented minority, female, and low-income students in STEM (Means and Neisler, 2020a; Perry et al., 2021; Correia et al., 2022; Goldrick-Rab et al., 2022). One study found that low-income students were more likely to experience delayed graduation (Aucejo et al., 2020). Transfer students already face more barriers to achieving successful academic outcomes than their non-transfer peers including more likely to be low-income, caregivers, and working full-time and have lower GPA and retentions (Núñez and Elizondo, 2013; Jenkins and Fink, 2016; Ardissone et al., 2021). These barriers were likely compounded by the pandemic, and transfer student journeys were greatly impacted (Brohawn et al., 2021). One study reported that transfer students may be more negatively affected by the pandemic relative to students who began as freshman (Rodríguez-Planas, 2022).

Regardless of transfer status, an abrupt shift to online learning and the cancelation of research and internship experiences left many students feeling dissatisfied with their education and challenged to maintain motivation and engagement (Means et al., 2020b; Maqableh and Alia, 2021) as well as unprepared to pursue employment or further professional or educational training (Aucejo et al., 2020). Personal health concerns, the disruption and isolation of day-to-day life, and the accompanying shifts in educational instruction all weighed heavily on students' mental health (Fruehwirth et al., 2021; Giusti et al., 2021). Prior to the pandemic, there was growing concern and evidence of depressive symptoms in higher education students (Auerbach et al., 2016) and this has been documented within our own student cohort (Ahrens et al., 2022), which was compounded by the pandemic (Van de Velde et al., 2021).

Unfortunately, the view of online education has been muddled by the emergency shift during the pandemic to remote instruction and that shift furthered the stigma that online learning is of lower quality than face-to-face instruction (Hodges et al., 2020) and increases social disparities (Goudeau et al., 2021). However, studies have shown that online learning is as effective as face-to-face instruction and broadens access and participation in STEM and higher education (Means et al., 2014; Drew et al., 2015, 2016; Ardissone et al., 2020, 2021). Interestingly, one of few studies directly examining the pandemic's impact on students in online programs, Castellanos-Serrano et al. (2022) showed that the gender gap narrowed during lockdown, which was attributed to improved task sharing abilities with both men and women at home but was worse after lockdown compared to pre-pandemic, pointing to unequal social constraints impacting student achievement.

Also, much attention has been focused on the lessons learned from the pandemic on innovative approaches to increasing support, access, and inclusion to and reimagining STEM education through a remote modality (Bhagat and Kim, 2020; Maqableh and Alia, 2021; Mohammed et al., 2021; Selco and Habbak, 2021; Manier et al., 2022). There is much to say about how traditional, face-to-face students fared when obligated to attend courses virtually (Aguilera-Hermida, 2020; Hodges et al., 2020), but it is not known how students who were already enrolled in intentionally designed online programs prior to spring 2020 fared during the pandemic. Furthermore, although there are reports that document the effects of the pandemic on transfer enrollment rates from community colleges to 4-year institutions (Brohawn et al., 2021; Causey et al., 2022), there is a gap in understanding how post-transfer students, who already face more barriers than non-transfer students (Shapiro et al., 2017), were impacted by the pandemic. By studying transfer students in an intentionally designed online program, this study works toward filling these knowledge gaps and distinctions of student experiences during the pandemic.

In 2011, a Microbiology and Cell Science major at a large public land grant research university established an online transfer track (Drew et al., 2015) in which all departmentally delivered courses transitioned to online instruction (for resident, on-campus students as well). Labs continued to be delivered in an in-person format for on-campus students while online distance students took the two required lab courses in a hybrid, online, and accelerated face-to-face format (Drew et al., 2015; Ardissone et al., 2019). This online, distance education program was motivated and designed specifically to meet the needs of transfer students. Because students did not have to relocate to main campus, this distance learning program increased accessibility, and in turn, diversity and broadened participation of women and underrepresented students in STEM (Drew et al., 2016). The different educational tracks within the same major provide a unique opportunity to compare student experiences across transfer status and modality during the pandemic. In this study, three student groups are compared: on-campus, first-time in college (FTIC); on-campus transfer (OC-TR); and online transfer (ONL-TR) students. While there was no change in delivery format of microbiology lecture courses, in spring 2020, all on-campus students had to shift to emergency online instruction for their non-major, in-person courses and many had to relocate from their campus dwellings. Therefore, on-campus students (FTIC and OC-TR) transitioned from receiving some of their course work online to exclusively online, whereas ONL-TR students did not have to contend with such a shift. All departmental lab courses, semester-long and accelerated formats, abruptly shifted to an online format in March 2020 and remained online through summer 2021.

Our previous work demonstrates that different student types—on-campus/online and transfer/non-transfer students—even in the same STEM program, have unique characteristics, needs, and challenges (Drew et al., 2016; Ardissone et al., 2021). Hence, we consider intersectionality (Crenshaw, 1991; Núñez, 2014) as a conceptual framework to capture student experiences during the pandemic. To do this, data were collected in 2020 and 2021 in a longitudinal study design. This study primarily uses ordinal regression methods to quantitatively assess the impact of various factors, and their interaction, on student experiences and success. The applicability of an intersectionality framework is being demonstrated in a range of disciplines, including higher education, and is being used to expose inequalities inherent in institutional policy and promoted change to reduce barriers and achieve equity (Smith, 2009; Ardissone et al., 2021).

The impact of the pandemic on these different types of students is examined through survey data and academic records. We report that the different characteristics of student types translated into starkly disparate responses to the pandemic. The results are organized in three main sections: academic impacts of the pandemic; the pandemic's emotional impact on students looking at specific academic and daily life stressors;

and student voices, a thematic analysis of student text responses. Overall, on-campus transfer students reported more negative impacts of the pandemic while online transfer students were buffered against negative impacts of the pandemic, even when compared to on-campus, first-time in college students.

2. Materials and methods

2.1. Survey instrument and distribution

A 50-item survey instrument was developed for degree-seeking undergraduate majors in the Microbiology and Cell Science (MCS) program at the University of Florida (Available in Supplementary material). Students were asked questions pertaining to the impact of the pandemic on academic performance and milestones, lifestyle changes, and anxiety and worry using multiple choice and Likert scale response questions. Additional questions captured demographic variables not readily available from institutional data sources, such as income level, level of parent education, employment status, and whether the student is a parent. A general open-ended text response item was included and analyzed to get a better understanding of students' situations and used in thematic analysis, as described below. Specifically, students were asked "Please provide any additional comments, questions, and concerns you wish regarding the COVID-19 response and your educational experience."

The survey was administered using Qualtrics (2005), (Qualtrics version 2020, Provo, UT), and respondents were recruited *via* student email listservs. The survey was administered at four different timepoints to capture responses for spring and fall semesters in 2020 and 2021. For each distribution, the survey was available for approximately 2 weeks to students to complete on their own time, and no incentive was offered to students to participate in the study. For all iterations, there was a total of 482 complete responses submitted by 352 unique students out of 1,600 unique undergraduate students enrolled in the MCS program during the semesters of this study, resulting in a 22% response rate. This research was approved by the University of Florida's Institutional Review Board (UF IRB#201601296).

2.2. Study population

Microbiology and Cell Science student respondents were grouped by matriculation status and track into the following student types: on-campus, first-time in college (FTIC); on-campus transfer (OC-TR); and online transfer (ONL-TR) students. Since 2011, all MCS lecture courses have been delivered in an intentionally designed online format regardless of student type (except for labs). The majority of these courses are upper division courses. These courses require the completion of general science courses as prerequisites, which are satisfied in the first 2 years (either at UF or another institution for FTIC or transfer students, respectively). ONL-TR are fully remote and are part of the UF Online program in which all courses are delivered online, regardless of department offering the course. In contrast, on-campus student groups (FTIC and OC-TR) receive a mixture of online and in-person courses. All of the lecture courses for the major are online, but many of their non-major courses are offered in-person. The extent of shift in course delivery for student types was captured in the survey, with over 60% of on-campus respondents (79% of FTIC and 60% of OC-TR students) indicating that they transitioned from exclusively/predominately in-person to exclusively/predominately online course delivery (Supplementary Section 2).

Student identification number was captured by the survey and used to match variables available in enrollment data, including sex, race/ethnicity, GPA, enrollment term, and course load. Additional demographic variables included in analyses obtained from self-reported survey data included: income level (low-income defined as <$50,000 household annual income); parent education level; whether the student is a parent; and employment status. The data were deidentified. There was a total of 352 unique respondents that completed the survey, and they were demographically representative of the total unique student population ($N = 1{,}600$) during the terms the survey was administered, with the exception that there was a higher rate of female respondents (74.7%, $N = 263$) compared to the study population (65.0% female, $N = 1{,}040$). Demographic and socioeconomic characteristics of the survey and student population are provided in Supplementary Table 1.

2.3. Data analysis

Only complete survey responses were included in the analysis of this study. Descriptive statistical analyses comparing student types, survey term, or other demographic variables were performed, and significant differences (value of $p < 0.05$) were determined using Fisher's Exact or Kruskal-Wallis test for categorical or numerical variables, respectively. Likert scale response items were recoded to a nominal, three-point scale, leveled in increasing severity, and analyzed using ordinal logistic regression. Coefficients and CIs were exponentiated to calculate odds ratio and corresponding 95% CIs. Interaction terms with student type were tested to determine within student group effects, but no significant interactions were found and thus not included in ordinal regression models. Survey term was included in all models to control for longitudinal changes in context of the pandemic. All statistical tests and data visualizations were performed in R 3.6.0 (R Core Team, 2019).

Open-ended text responses from qualitative survey items underwent a four-step process to conduct thematic analysis (Harding, 2018) using the Nvivo software (QSR International, 1999). Data were systematically coded during the process following recommendations from Saldaña and Omasta (2022) using a combination of deductive and inductive coding that included both descriptive and *in vivo* codes. One of the authors, an expert in qualitative research, was responsible for coding and conducting the thematic analysis. Audit trail, peer debriefing, triangulation, reflexivity, analytical saturation, and the consideration of alternative explanations are the strategies followed during analysis to ensure the credibility, dependability, confirmability, and transferability of the findings (Lincoln and Guba, 1986). Demographic classifiers, such as student group, were connected as attributes to each participant.

3. Results

3.1. Academic impacts of the pandemic

3.1.1. Online transfer students perceive less of a negative impact of the pandemic on their education

When asked if they agreed or disagreed with the statement, "Adjustments made due to the pandemic have/will negatively affect my

education," the majority, 70%, of respondents indicated that the pandemic would negatively affect their education. On-campus transfer (OC-TR) students reported the worst academic impacts of the pandemic with 81% indicating negative outcomes, but only 39% of online transfer (ONL-TR) student responses indicated a negative impact on their education (Kruskal-Wallis; p-value = 7.54e−06; Figure 1). Meanwhile, 77% of on-campus FTIC students reported negative educational impact due to the pandemic.

Ordinal regression was used to identify factors that associated with self-reported negative educational impact. When considering student type, survey response term, GPA, household income, gender, race/ethnicity, and parent education, only student type and survey response term significantly associated with how a student perceived the educational impacts of the pandemic. No other characteristics associated with the outcome. Student type had the most predictive power in how individuals responded to the question about negative impact of the pandemic (Table 1), and there were no significant interaction terms. Online students (ONL-TR) were 6.7 times less likely (CI: 3.1–14.9; p-value = 2.10e−06) than FTIC students to indicate a negative impact of the pandemic. Alternatively, OC-TR students were 6.9 times more likely (CI:2.7–18.2; p-value = 9.5e−05) to indicate a negative educational impact of the pandemic compared to ONL-TR students. There was no observed difference in how FTIC and OC-TR students responded to this question. There was some variation across semesters in how students responded, hence the need to control for response term. Students were 2.2 times more likely to indicate a negative effect on their education (CI: 1.2–4.1; p-value = 0.0104) in fall 2020 survey time point.

Students who agreed that the pandemic would negatively affect their education were given a follow-up question to discern the main reasons for the negative perception. Students were given the option to select more than one reason and responded to this item very differently across student types. It should be emphasized that interpretation of these results is restricted only to respondents indicating that the pandemic would have a negative impact on their education, thus only 77, 81, and 39% of FTIC, OC-TR, and ONL-TR respondents, respectively (Table 2). Over 89% of on-campus students (FTIC and OC-TR combined) vs. 53% of ONL-TR students who reported negative educational impacts due to the pandemic indicated reduced quality of education as a primary concern. Further evaluation of this question in the context of the degree of in-person to online transition is provided in Supplementary Section 2. Meanwhile, a higher percentage of OC-TR students (36%) who felt that the pandemic would negatively impact their education selected delayed graduation as the main reason (versus 17% of FTIC students). Although a similar percentage (47%) of ONL-TR students who felt the pandemic would negatively impact their education selected delayed graduation as the main reason, the overall quantity of students was lower (19% of all ONL-TR respondents) because they were less likely to report the pandemic to negatively affect their education.

3.1.2. On-campus transfer students were more likely to report delayed graduation because of the pandemic

To better discern the effect of the pandemic on delaying graduation, all students were asked the term they were planning to graduate pre- and post-pandemic. Changes in expected graduation term were categorized nominally as two or more terms later, one term later, and no delay. Ordinal regression analysis indicated that student type, GPA, URM status, and term were all significantly associated with perceived graduation delays (Supplementary Table 2; Supplementary Figure 1). OC-TR students were 3.1 times more likely (CI:1.5–6.5; p-value = 0.00219) to report graduation delay compared to FTIC students, which was a significant contributor to stress for these students (section 3.2.2). Meanwhile, there was no difference in the probability of ONL-TR students reporting delayed graduation compared to FTIC students. Academic performance, captured by cumulative GPA, was also a strong predictor in whether a student reported delayed graduation. Students with a 1-unit increase in GPA

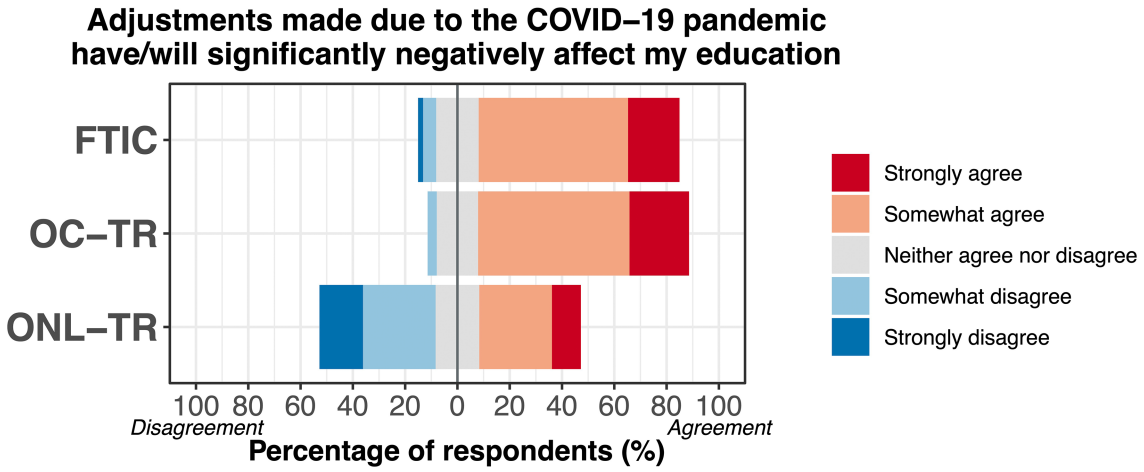

FIGURE 1
Percentage of unique student responses by student type to the negative educational impact question. Students responded on a five-point Likert scale ranging from Strongly Disagree to Strongly Agree, where any level of disagreement with the statement is represented with shades of blue and any level of agreement in shades of red. Each bar represents all (100%) unique student respondents for a given student type, where neutral responses (gray) are centered at 0 (central, vertical line). Multiple responses from the same student were averaged so that percentages represent unique students, not total responses.

TABLE 1 Estimated coefficients with odds ratios (OR) and CIs from the ordinal regression model that estimated the predicted probability of student responses to the negative impact of the pandemic on their education.

Predictors	Estimate	SE	*t* value	*p* value	OR	CI	Interpretation
Student Type							
OC-TR	0.069	0.370	0.186	0.852	1.071	0.510–2.187	No difference to FTIC
ONL-TR	1.903	0.401	4.747	2.10e−06***	6.708	3.071–14.890	6.7x less likely than FTIC
Term							
F20	−0.793	0.309	−2.563	0.0104*	0.453	0.243–0.822	2.2x more likely than S20
S21	0.121	0.332	0.364	0.716	1.128	0.582–2.150	No difference to S20
F21	0.034	0.332	0.101	0.919	1.034	0.535–1.970	No difference to S20
GPA	0.059	0.312	0.188	0.851	1.060	0.583–1.985	No effect on response
Low-income	−0.423	0.279	−1.514	0.130	0.655	0.376–1.126	No effect on response
Gender – female	−0.246	0.275	−0.895	0.371	0.782	0.458–1.351	No effect on response
URM student	0.284	0.250	1.137	0.256	1.328	0.811–2.162	No effect on response
Parent education <4y degree	−0.191	0.288	−0.663	0.507	0.826	0.467–1.447	No effect on response

Responses were consolidated to a three-category scale where Strongly and Somewhat Agree were combined and Strongly and Somewhat Disagree were combined. Response categories were leveled from agree to disagree, so an OR > 1 can be interpreted as decreased probability of reporting an overall negative educational impact resulting from the pandemic. Residual deviance: 558.64, AIC: 582.64.
Statistical significance is indicated by *$p < 0.05$; **$p < 0.01$; and ***$p < 0.001$.
Model formula: Educational impact ~ StudentType + Term + GPA + low-income + Gender + URM + ParentEducation.

were 3.9 times less likely (CI: 2.0–7.8; p-value = 1.16e−04) to report delayed graduation due to the pandemic. Additionally, students were more likely to report delayed graduation in the later distributions of the survey, spring and fall 2021, and if students identified as an URM race/ethnicity. Underrepresented minority students in STEM were 2.5 times more likely (CI:1.4–4.4; p-value = 0.00144) to report delayed graduation.

3.1.3. Majority of students maintained a similar course load during the pandemic

For fall 2020, spring 2021, and fall 2021 survey distributions, students were asked how the pandemic affected their course load. Overall, 83% of respondents said there was no change in their course load while 14% said that they were taking fewer credits than they would have prior to the pandemic. Ordinal regression results showed there was no difference in how student types responded to the question. GPA was the only main effect with a 1-unit increase in GPA indicating that students were 2.7 times more likely to enroll in a similar number of credits rather than fewer (CI:1.2–6.0; p-value = 0.0188; Supplementary Table 3; Supplementary Figure 2). Of the students that reported taking fewer courses ($N = 37$), over two-thirds cited limited time as being the primary reason for a reduced course load with additional concerns regarding online instruction or mental health. Furthermore, at the onset of the pandemic in spring 2020, 12% of all respondents (18 of 154) reported having to withdraw from one or more courses, and there were no significant differences between student types, nor any other variables tested.

Academic records were used to validate the self-reported impact on course load by comparing within student change in course load for those enrolled fall 2019 and fall 2020 ($N = 257$). For all students enrolled in both terms, 21% decreased their course load in fall 2020, which aligned well with student-matched perceptions; 17% reported enrolling in fewer credits on the survey. There was no significant difference in the change of credits taken across student types (Kruskal-Wallis test, p-value = 0.0771; Supplementary Figure 3). Of the students that took a reduced course load fall 2020 compared to fall 2019, the median decrease was four credits and resulted in 12% of all students in the comparison transitioning from full- to part-time enrollment ($N = 30$ of 257).

3.1.4. Students maintained a similar GPA during the pandemic despite perceptions

Over half of all student responses (53% of 482) reported that their GPA was less than it would have been in the absence of a pandemic. However, this was highly indicative of the survey term in which the response was given (Figure 2A) and the students' actual GPA. Students were 2.7 and 2.3 times more likely to perceive a decrease in their GPA in fall 2020 and spring 2021 (Supplementary Table 4). Higher performing students (per 1-unit increase in GPA) were 2.9 times less likely to perceive a decrease in GPA due to the pandemic. Also, students whose parents had not earned a 4-year degree or higher were 2.0 times more likely to perceive a lower GPA.

Student type was not a significant indicator of how students perceived the pandemic impacted their GPA. Although a higher percentage of OC-TR students indicated a lower perceived GPA, 66.3%, compared to other student groups: 50.6% FTIC and 47.8% ONL-TR; this trend was not robust to statistical testing when controlling for GPA, which is lower for transfer students (Supplementary Table 1), survey term, and other variables included in the ordinal regression analysis.

Using academic records, there was no overall change in cumulative GPA within student groups across terms (Figure 2B; ANOVA, p-value = 0.48). Therefore, although students perceived a lower GPA at the beginning of the pandemic, this could not be validated by academic records. Furthermore, of those respondents who perceived a lower GPA and whose GPA had decreased since the start of the pandemic ($N = 65$), the average decrease was minimal (a decrease of 0.12 ± 0.17 GPA points), suggesting that students were likely to overestimate the impact of the pandemic on their cumulative GPA.

TABLE 2 Percentage of respondents by student type indicating reasons for perceived negative educational impact of the pandemic.

Student type	FTIC	OC-TR	ONL-TR
N reporting negative educational impact (percent of respondents within student group)	193 (77%)	44 (81%)	15 (39%)
I feel the quality of the education I receive during the pandemic will be less.	90.7%	79.6%	53.3%
My education will be delayed, putting me behind track to graduate.	17.1%	36.4%	46.7%
Other	17.1%	22.7%	53.3%

N represents the number of students that *Strongly* or *Somewhat agreed* that the pandemic would have a negative impact on their education.

3.2. Emotional impacts of the pandemic

The survey included several items pertaining emotional impacts due to the pandemic, including items addressing aspects of mental health, such as frequency of feeling: nervous, anxious or on edge; uncontrollable worry; and isolated from others. Also, respondents were asked to what extent the pandemic impacted their stress regarding several aspects of academic and daily life. Significant results of regression analyses of these items are summarized in Table 3 and presented in more detail in the following subsections.

3.2.1. On-campus transfer students expressed more anxiety and worry

When respondents were asked to reflect on the previous 2 weeks: 49.2% frequently (*Always* or *Most of the time*) felt nervous/anxious/on edge; 39.6% frequently experienced uncontrollable worrying; and 42.8% frequently felt isolated from others. When considering multiple variables including student type, survey term, GPA, income, URM status, and parent education level, ordinal regression analysis showed that OC-TR students were 2.2 (CI = 1.1–4.4; p-value = 0.023) and 2.1 (CI:1.1–4.1; p-value = 0.0212) times more likely to report frequent anxiety and uncontrollable worry, respectively (Table 3). Furthermore, when restricting analyses to transfer students, OC-TR students were 3.1 (CI:1.2–7.9; p-value = 0.0165) and 3.7 (CI:1.5–9.4; p-value = 0.00522) times more likely to report increased anxiety and uncontrollable worry, respectively, compared to ONL-TR students. This difference in student types was reflected in that for OC-TR students 66% (compared to 46 and 40% for FTIC and ONL-TR, respectively) and 56% (compared to 38 and 26% for FTIC ONL-TR, respectively) reported frequent anxiety and uncontrollable worry, respectively. There was no difference in student types in frequency of feeling isolated from others.

The term in which students responded to the survey was not a significant predictor for the frequency of feeling nervous/anxious/on edge nor uncontrollable worry (Supplementary Tables 5, 6). Therefore, students' levels of anxiousness and worry were not abated nearly 2 years into the pandemic (from spring 2020 to fall 2021). However, there was a change over time in how students responded to the frequency of feeling isolated from others, in which students were 1.8 times less (CI:1.0–3.3, p-value = 0.0466; Supplementary Table 7) to report feeling isolated in fall 2021, the latest survey collection time point of this study.

Student type was the primary indicator for the anxiety and uncontrollable worry emotional impact questions, but gender and income status were also significant predictors. Female students were more likely to report increase frequency of feeling anxious/nervous/on edge, worried, and isolated (Supplementary Figure 4; Supplementary Tables 5–7), hence the need to control for gender in these analyses. Also, low-income students were 1.8 times more likely (CI:1.1–2.8; p-value = 0.0192) to report frequent uncontrollable worry (Supplementary Table 6), which is expanded on in the daily life stressors section (3.2.3).

3.2.2. Online transfer students were less likely to report academic stressors

Regarding the pandemic's impact on stressors related to academic circumstances, student type was the most significant predictor with ONL-TR students less likely to express stress compared to their on-campus peers (Figure 3). Expectedly, ONL-TR students were 23 times less likely to report stress adapting to online courses in response to the pandemic. Over 50% of on-campus students (FTIC and transfer) said they were extremely or very stressed due to adapting to online courses compared to less than 10% of ONL-TR students.

Furthermore, ONL-TR students were 5.4 times less likely to feel stress regarding future university closures and disruptions and 3.0 times less likely to report stress maintaining scholarship and/or program eligibility requirements (Table 3). Inverse to their ONL-TR peers (26.1%), a higher percentage OC-TR students (50.6%) reported stress maintaining scholarship and/or program eligibility and was trending but not significant when accounting for the variables included in the regression analysis (p-value = 0.0543; Supplementary Table 11). FTIC and ONL-TR students expressed similar levels of stress attributed to graduating on schedule, 57.3 and 71.7% expressed some concern, respectively. Conversely, graduating on time was a significant stressor for OC-TR students who were five times more likely to report stress due to delayed graduated than non-transfer peers. Over 95% of OC-TR students expressed some stress concerning delayed graduation.

Student performance (captured by GPA) was also an indicator of how students responded to academic stressor items. Higher performing students (a 1-unit increase in GPA) were 2.3 and 2.7 times less likely to report stress related to graduating on schedule and maintaining scholarship and/or program eligibility, respectively (Table 3) regardless of student type. Furthermore, student responses to academic stressors did not change across terms except for delayed graduation in which students became significantly more concerned in later semesters, spring and fall 2021. Students were 2.5 times more likely to report stress due to graduating on schedule in fall 2021 compared to the beginning of the pandemic (spring 2020). Other characteristics, such as race/ethnicity, parent education, and income status were not associated with outcomes related to academic stressors suggesting that modality (captured by student type) and student performance were the primary indicators contributing to academic stressors.

3.2.3. Low-income students were disproportionately affected by the pandemic's effect on daily life

The pandemic greatly impacted students' lives and presented numerous daily stressors. Unlike academic stressors, student type was not the key predictor in student response to pandemic's effect on daily stressors. Ordinal regression analyses revealed that low-income (annual

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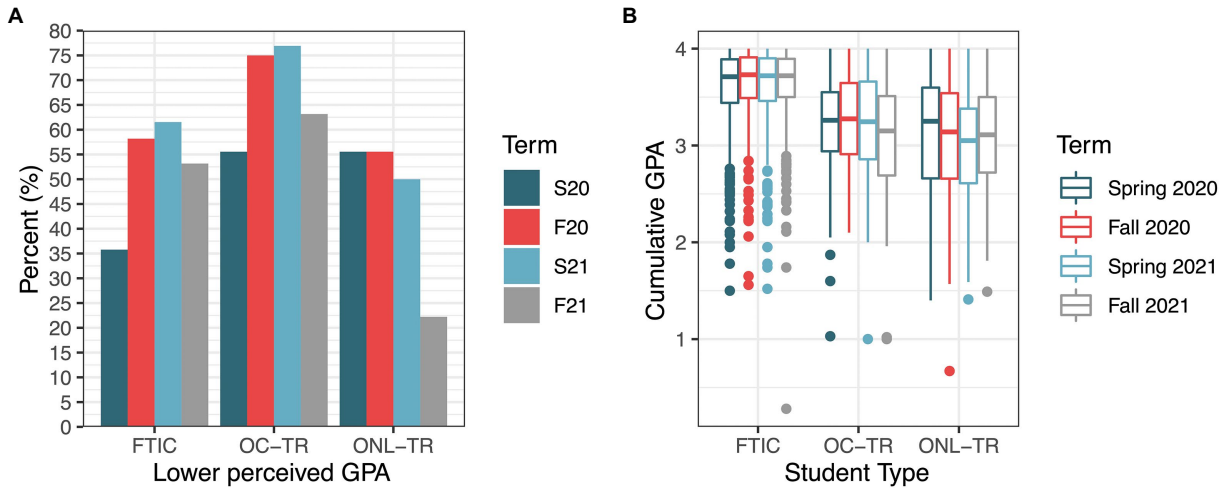

FIGURE 2
Perceptions of lower GPA were greatest at the height of the pandemic (fall 2020 and spring 2021) but could not be validated by academic records. **(A)** The percentage of respondents that perceived a lower GPA (53% of 482 responses) during the pandemic by student type and term. However, **(B)** no differences were observed in entering cumulative GPA for all enrollments across spring 2020, fall 2020, spring 2021, and fall 2021 terms separated by student type.

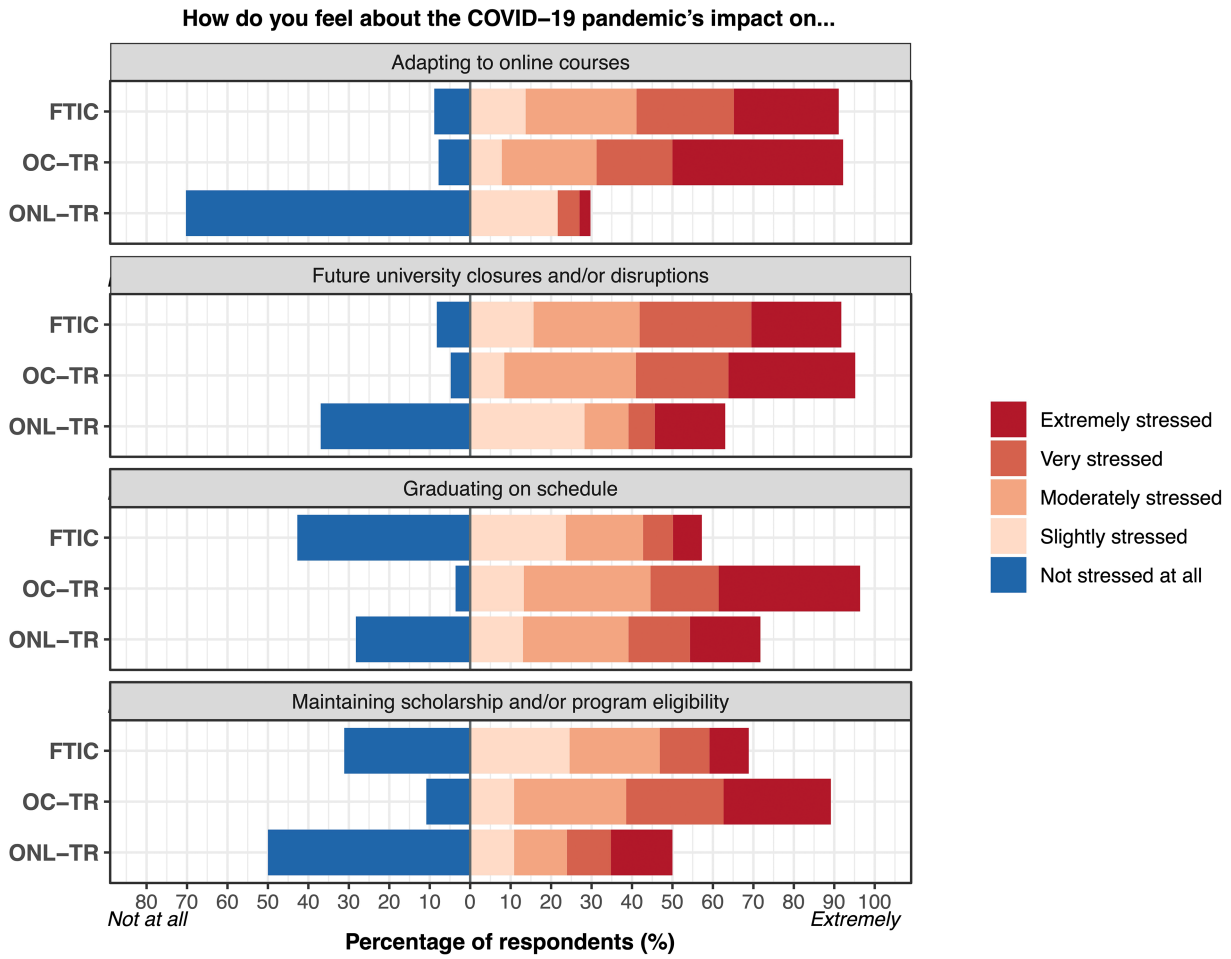

FIGURE 3
Online transfer students reported less stress related to academic disruptions during the pandemic. Percentage of responses based on a five-point Likert scale of level of stress to the pandemic's impact on four academic stressors during the pandemic: adapting to online courses; future university closures/disruptions; graduating on schedule; and maintaining scholarship and/or program eligibility.

TABLE 3 Summary of significant predictors of responses to academic and daily stressors and emotional impact-related survey items.

Emotional impact items	Significant ordinal regression results (OR≤0.5 and≥2)		Odds ratio (95% CI)	*p* value	Interpretation
	Predictor	Specific factor			
Frequency of feeling nervous, anxious, or on edge	Student type	OC-TR	2.199 (1.127–4.406)	0.023*	2.2x more likely than FTIC
Frequency of uncontrollable worry	Student type	OC-TR	2.121 (1.127–4.062)	0.0212*	2.1x more likely than FTIC
Frequency of feeling isolated from others	Gender	Female	2.135 (1.307–3.504)	0.00254**	2.1x more likely than males
Academic Life Stressors					
Adapting to all online courses	Student type	ONL-TR	0.043 (0.016–0.117)	6.82e−10***	23x less likely than FTIC
	Gender	Female	2.255 (1.324–3.843)	2.78e−03**	2.3x more likely than males
Future university closures/disruptions	Student type	ONL-TR	0.184 (0.082–0.404)	2.92e−05***	5.4x less likely than FTIC
	Term	Spring 2021	0.430 (0.231–0.797)	7.48e−03**	2.3x less likely than Spring 2020
Graduating on schedule	Student type	OC-TR	4.974 (2.644–9.520)	9.00e−07***	5.0x more likely than FTIC
	GPA	Unit increase	0.426 (0.239–0.740)	3.04e−03**	2.3x less likely
	Term	Fall 2021	2.526 (1.398–4.606)	2.29e−03**	2.5x more likely than S20
Maintaining scholarship and/or program eligibility	Student type	ONL-TR	0.338 (0.152–0.726)	6.250e−03**	3.0x less likely than FTIC
	GPA	Unit increase	0.370 (0.206–0.650)	6.63e−04***	2.7x less likely
Daily Life Stressors					
Meeting financial obligations if unable to work	Student type	OC-TR	2.470 (1.272–4.915)	8.50e−03**	2.5x more likely than FTIC
	Income	Low-income	3.207 (1.993–5.208)	1.90e−06***	3.2x more likely than not low-income
Providing enough food for myself or family	Income	Low-income	4.655 (2.842–7.717)	1.50e−09***	4.7x more likely than not low-income
Providing childcare if schools remain closed	Student type	OC-TR	4.624 (1.466–14.426)	8.02e−03**	4.6x more likely and
	Student type	ONL-TR	20.953 (7.507–61.148)	1.03e−08***	21x more likely than FTIC
Receiving medical care for myself or my family	Income	Low-income	2.713 (1.694–4.375)	3.67e−05***	2.7x more likely than not low-income
Receiving medication for myself or family	Income	Low-income	2.120 (1.312–3.439)	2.21e−03**	2.1x more likely than not low-income

Significant student characteristics with an odds ratio ≥ 2 or ≤ 0.5 are presented. Complete results of regression analyses for each item are included in the Supplementary Tables 5–16. The model formula tested each item as a response variable and included student type, term, income, gender, URM, and parent education as independent variables. Responses were consolidated to a three-category scale. Response variables were leveled in increasing severity, so from no frequency or stress to the most. Therefore, odds ratios greater than one should be interpreted as more likely to report emotional impact or stress. Reference groups for student type is FTIC and for term is Spring 2020.
Statistical significance is indicated by *$p < 0.05$; **$p < 0.01$; and ***$p < 0.001$.

household earnings <$50,000) was the primary factor that correlated with increased stress on a student's ability to meet financial obligations, provide enough food, medical care, and medications to themselves and/or their family (Figure 4; Table 3).

Low-income students obviously face financial hardships and were 3.2 times more likely to report stress in meeting financial obligations regardless of whether they are FTIC or transfer students and extended to students' reported stress in providing food, medical care, and medication. Stress in meeting financial obligations disproportionately affected OC-TR students as nearly two-thirds of the OC-TR students surveyed self-reported as low-income (Supplementary Table 1) and hence were 2.5 times more likely to report stress in meeting financial obligations. However, this effect of student type did not extend to stress related to food, medical care, and medication security.

Nearly half of all respondents (44.2%) reported some level of stress about the pandemic's effect on their being able to provide enough food for themselves or their families. However, low-income students were 4.7 times more likely (CI:2.8–7.7, p-value = 1.50e−09) to report stress regarding food security with 67% of low-income students reporting stress compared to 32% of non-low-income students.

Providing childcare was a significant stressor for student parents, who were primarily ONL-TR student respondents, 31.1% expressed some level of stress in providing childcare (Supplementary Figure 5). When controlling for all factors, ONL-TR students were 21 times more likely (CI:7.5–61; p-value = 1.03e−8) to report stress in providing childcare than their FTIC counterparts, 5.4% of whom expressed some level of stress in providing childcare. Also, OC-TR students expressed a higher level of stress in providing childcare (11% expressed some level of stress and were 4.6 times more likely) compared to FTIC students. While none of the OC-TR students surveyed reported being parents, they did indicate that they had younger siblings living at home.

3.3. Student voices

At the end of the survey, students were invited to provide any comments or concerns they had regarding the pandemic and their educational experience. A total of 69 responses were submitted. Students mostly elaborated on the key issues that students had mentioned previously. However, three additional themes emerged.

3.3.1. Online education

Multiple on-campus students expressed concerns that the switch to online education equates to lower quality than in-person instruction; this concern was particularly true for labs. It is possible that some of these feelings were exacerbated by general frustration and dissatisfaction. One student remarked, "Online labs are not the same experience…I would be extremely disappointed if my labs, both as courses and outside research, were moved online in the fall because I feel that would leave a huge gap in my science education." (Spring 2020). However, some students shared that they have never felt comfortable learning in online settings. There were some students that considered the quality of education to be the same.

3.3.2. Mental health

There are multiple instances through the students' responses not only to the general comments but also to other questions that show the significant effects that the pandemic had on the mental health of students. Words like *isolation*, *stress*, *anxiety*, *extreme mental*, and *emotional distress* were common in the responses. The lives and plans changed from 1 day to the next without giving them the time and space they needed to think and adapt to the changes. These students were not immune to the prevailing uncertainty, the extent of the pandemic and its impacts, and the lack of precedents or preparation that the whole world was experiencing. One student described the toll, "I may be taking some time away from school to fix my mental, physical, and financial health. I am exhausted and mentally in the worst place I have been in a long time" (Spring 2021). Another student shared, "I have never felt so set up to fail. At this point, I am contemplating postponing the continuation of my degree because of the horrible states of my mental, physical, and financial health after this last year…The overall experience of the past year has broken me" (Spring 2021).

3.3.3. Institutional response

There were mixed and strong feelings reported by students in relation to the ways in which the institution responded during the COVID-19 pandemic. Some students expressed their gratitude to the institution, faculty members, and staff for everything that was done to maintain, as much as possible, the ongoing educational activities (e.g., moving classes to online delivery). However, multiple students considered it unfair to pay regular fees for services that they were not utilizing because they were not on campus. While some students complained about the disruptions resulting from modifying course delivery and stopping research and other extracurricular activities, others felt that the institution should do even more in terms of mandating the use of facemasks and vaccinations. Many students expressed high levels of concerns regarding their health. As one student commented, "I just feel as though I'm not receiving as quality of an educational experience. However, I understand the circumstances are very serious and I do not want my health and others put in danger. I do feel as though I should not be paying as much in tuition either, since I am not accessing as many resources on campus nor am I getting the hands on, learning experiences of a normal semester," (Spring 2020).

4. Discussion

There is a gap in understanding how the pandemic affected students academically and emotionally through the lens of student type—whether a student was already in an online program and/or if the student was a transfer or non-transfer student. This study describes the impact of the pandemic in the context of different enrollment types and characteristics of students in the same STEM major who were taking the same classes with the same expectations.

Perhaps expectedly, transfer students in the online track were buffered from negative academic impacts and stresses compared to on-campus students. That online transfer students were less likely to feel that the pandemic would have a negative impact on their education implies that they are able to be more adaptable and resilient to perturbations in their academic experience. All courses ONL-TR students were planning to take prior to the pandemic were designed for online modality, so ONL-TR students were accustomed to nearly all their courses (except for accelerated labs) to be online. However, of the ONL-TR students that felt the pandemic would have a negative impact on their education (38.9% of ONL-TR respondents), half cited disruptions to the accelerated lab and other in-person research and volunteer experiences. One of the main concerns voiced by ONL-TR students was the shift of the accelerated, in-person lab course transitioning completely online. This is one of the only in-person experiences expected by ONL-TR students and the learning gains students earn from this are significant (Ardissone et al., 2019). Yet, ONL-TR students expressed similar levels of feeling anxiety and uncontrollable worry to on-campus FTIC students and faced different daily life challenges, like providing daycare. Therefore, impacts of the pandemic were more likely to affect other aspects of their daily life but not necessarily affect the perceived quality of their education. Online transfer students are more likely to be independent, older, employed full-time, parents or have dependents. These "adult learners" do not perceive their principal identity to be a student and likely have very different expectations for their academic experience (Kasworm, 2010). This contrasts with on-campus students who are likely seeking on-campus college experiences and culture.

Approximately 90% of on-campus students (FTIC and transfer) cited the rushed transition of courses to an online modality as well as feeling that virtual learning is not conducive to their learning style as the reasons of the negative educational impacts of the pandemic. This was warranted considering this subset of students did not intend to pursue online learning nor were many of their non-major courses designed for it. Unfortunately, this only furthered the stigma that online education is lower quality. By working toward changing student perceptions of online modalities with evidence-based studies, that they can be successful and achieve similar outcomes to traditional, in-person modalities, would promote students' attitudes and performance in online education, as shown by Giusti et al. (2021).

On-campus transfer students reported the worse academic impacts and stressors of the pandemic compared to on-campus, first-time in college and online transfer students. OC-TR students were more likely to report delayed graduation and this negative impact greatly contributed to their increased level of stress and emotional well-being, as they were more likely to report heightened anxiety and uncontrollable

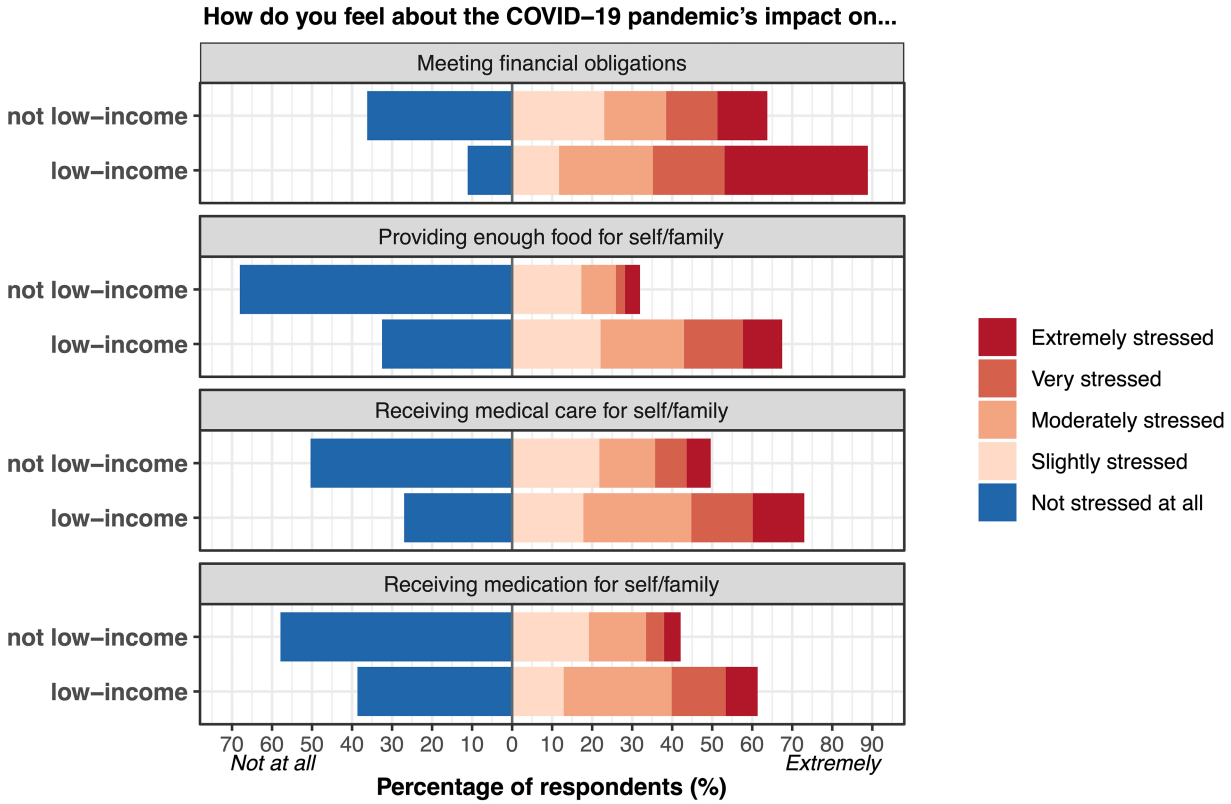

FIGURE 4
Low-income students were disproportionately affected by the pandemic's impact on daily life stressors. Percentage of responses based on a five-point Likert scale of level of stress to the pandemic's impact on four daily stressors: meeting financial obligations; providing enough food for self/family; receiving medical care for self/family; and receiving medication for self/family. Low-income is defined as annual household income <$50,000, which was self-reported and included as a survey item.

worry due to the pandemic. OC-TR are more likely to be first-generation in college, from low-income households, from underrepresented minorities and women (Drew et al., 2016; Ardissone et al., 2020; Supplementary Table 1). Hence OC-TR students face more barriers to attending, higher risks if they fail, and may struggle to feel a sense of belonging (Townley et al., 2013), factors that could contribute to anxiety and worry even in the absence of a pandemic.

While conditions of the pandemic were expected to contribute to an increase in students' frequency of feeling anxious, worried, and isolated (section 3.2.1), it is difficult to gage the extent to which the pandemic contributed to these feelings as students were not surveyed prior to the pandemic. However, no significant change was observed across the four survey terms even though conditions of the pandemic changed (e.g., vaccines became available, campuses reopened, etc.), suggesting that students feel a high rate of anxiety/nervousness and worry generally. There has been an increased awareness of mental health issues in undergraduate student populations prior to and even more so during the pandemic (Auerbach et al., 2016; Van de Velde et al., 2021). Student text responses in this study clearly attributed the pandemic to mental health challenges (section 3.3). In this work, we did not attempt to quantify the pandemic's impact on students' mental health. Others have done this (reviewed in Li et al., 2021). However, it is clear that empathy in acknowledging and helping students manage mental health issues is important.

There was a large discrepancy in students' perceptions of how the pandemic affected their GPAs. Overall, when looking at academic records of the whole student population, there were minimal changes in student GPA and course load. Yet, a majority of students (53%) perceived a lower GPA due to changes resulting from the pandemic. Students' perception of their GPA was influenced by their actual GPA and the education level of their parents. GPA is a heavily weighted outcome as its value influences post-baccalaureate admissions to various degree programs and professional schools, and it is also a student's gage to their academic success and self-confidence (Townley et al., 2013). This disconnect between perceived and actual GPA during the pandemic suggests that students underestimated or did not fully realize their academic performance as it was overshadowed by the concerns of pandemic disruptions. Furthermore, it shows that first-time in college students exhibit less confidence in their academic ability.

Disparities of low-income populations during the pandemic have been highlighted in educational as well as other social and professional contexts (Aucejo et al., 2020; Kanter et al., 2021). Although income level was not a significant indicator of academic impacts of the pandemic, it was the primary predictor of daily life stressors including ability to meet financial obligations, food security, and medical care and medications. While transfer students are more likely to be from low-income households (Radwin et al., 2013; Supplementary Table 1), student type was not a significant predictor of how students responded to survey questions related to daily life stressors. This highlights the need to provide additional resources to low-income students, particularly during the pandemic or other extensively disruptive events.

While transfer students face many barriers, which were exacerbated by the pandemic, not all transfer students are the same and the context

of their learning modality needs to be considered. Transfer students in the online track were significantly buffered from the negative academic and emotional impacts as compared to the on-campus transfer students and in some cases, on-campus, first-time in college students. The differences between the two transfer groups warns against the generalization of transfer students and suggests further research into the positive role of online learning, not just for delivery of educational content and for expanding access, but for academic and emotional stability for different student populations. Online pathways present a viable, affordable, and advantageous option for students, particularly ones who face more challenges to their success.

We are not promoting online modality as a one-size fits all solution to circumnavigating the inequities baked-in to higher education structures and policies. Indeed, one of the main criticisms of online education that it exacerbates the "digital divide" because underrepresented groups are less likely to have access to reliable digital resources (Hamburg and Lütgen, 2019), which was largely exacerbated by the unpreparedness of institutions for an immediate shift to online instruction during the pandemic (Means and Neisler, 2020a). However, others have demonstrated that this "digital divide" in online learning, caused by socioeconomic disparities, were mitigated during the pandemic when policy was focused and efficiently responsive to this specific issue (Liu, 2021).

Therefore, as exemplified with this study, within the correct context, support, and infrastructure, online programs can be extremely successful in reducing student barriers to success for underrepresented students. Given the commitment numerous universities have declared to promoting online education (Allen and Seaman, 2016), a continued understanding of the efficacy of online programs is needed, especially as technology and social contexts change and online program design, structures, and supports adapt. Although this study focuses on a seemingly niche subpopulation, post-transfer undergraduate in an online, distance STEM program, the underlying approach of thoughtful design to meet students where they are and the inherent adaptability of such a program to contend with academic disruptions (e.g., the pandemic) is generalizable. This achievement serves as a pillar in the advancement of online STEM education.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by University of Florida's Institutional Review Board (UF IRB#201601296). Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

AA contributed to survey design, performed data analysis and visualization, and was the primary author of the manuscript. SG was primary survey author and performed qualitative analysis and editing of the manuscript. ET contributed to study design and writing of the manuscript. JD contributed to study design and analysis and writing of the manuscript. All authors contributed to the article and approved the submitted version.

Funding

This research is funded by a grant from the National Science Foundation S-STEM (Award #1643780), titled *Florida Pathways to Success: A Research University/Minority-Serving Community College Partnership to Enhance Retention and Diversity of Transfer Students*.

Acknowledgments

We are very grateful to all the Microbiology and Cell Science (MCS) students for taking the time to complete the survey used in this study and advancing the program's research efforts, particularly during the stressful times of the pandemic. Also, we would like to thank the faculty and staff of the MCS Department at the University of Florida for their support in aiding students during the pandemic and facilitating research efforts. Finally, we thank the NSF S-STEM program for funding.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2023.1067380/full#supplementary-material

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