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Cortisol awakening response among Latinx and Black students transitioning to college prior to and during the COVID-19 pandemic

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A R T I C L E   I N F O

Keywords:
COVID-19 pandemic
Transition to college
Cortisol awakening response
University belonging
Latinx students
Black students

A B S T R A C T

Globally, the COVID-19 (coronavirus disease 2019) pandemic has resulted in abrupt shifts in ecological and social environments (Brown & Greenfield, 2021; Evers et al., 2021; Greenfield et al., 2021), including school contexts, which became predominately virtual. Almost all college courses were taken in an online format and first-year freshmen transitioning to college reported that this format yielded less interactions with their instructors and peers (Al-Mawee et al., 2021; Clabaugh et al., 2021) as well as higher levels of exhaustion (Gonzalez-Ramirez et al., 2021). These socio-ecological changes, combined with increasing rates of infection, hospitalization, and mortality (Centers for Disease Control and Prevention [CDC], 2021), make the investigation of stress and belonging among this group of students critical. The purpose of the current study is to examine the role of the COVID-19 pandemic (transitioning to college prior to vs. during the COVID-19 pandemic) on cortisol awakening response (CAR) – a biological marker of chronic psychosocial stress – and university belonging among Latinx and Black first-year college students residing in Los Angeles County – one of the United States’ hot spots for COVID-19. We also explore whether university belonging serves as a mediator in the relationship between the COVID-19 pandemic and CAR.

Theoretical perspective

Bronfenbrenner’s (2005) ecological systems theory describes child and youth development as being directly and indirectly influenced by a variety of contexts (microsystem, mesosystem, exosystem, macrosystem and chronosystem). The context most pertinent to our research is the chronosystem – a system that includes the timing of life-altering personal transitions (e.g., birth of a new sibling) as well as major environmental (e.g., hurricanes, natural disasters) and sociohistorical events (e.g., the highly publicized murders of Black individuals and the Black Lives Matter movement; Lightfoot et al., 2018). Bronfenbrenner theorized that these life-altering situations may have pronounced effects on macrosystems (e.g., cultural norms) and microsystems (e.g., social and school contexts) in ways that affect individual development. Within this framework, the COVID-19 pandemic can be defined as a life-altering environmental and sociohistorical event. From an environmental standpoint, the COVID-19 pandemic led to abrupt shifts in ecological and social environments, including school contexts, which became predominately virtual. Almost all college courses were taken in an online format and first-year freshmen transitioning to college reported that this format yielded less interactions with their instructors and peers (Al-Mawee et al., 2021; Clabaugh et al., 2021), indicating higher levels of exhaustion (Gonzalez-Ramirez et al., 2021). These socio-ecological changes, combined with increasing rates of infection, hospitalization, and mortality (Centers for Disease Control and Prevention [CDC], 2021), make the investigation of stress and belonging among this group of students critical.

The purpose of the current study is to examine the role of the COVID-19 pandemic (transitioning to college prior to vs. during the COVID-19 pandemic) on cortisol awakening response (CAR) – a biological marker of chronic psychosocial stress – and university belonging among Latinx and Black first-year college students residing in Los Angeles County – one of the United States’ hot spots for COVID-19. We also explore whether university belonging serves as a mediator in the relationship between the COVID-19 pandemic and CAR.

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https://doi.org/10.1016/j.cresp.2022.100043
Received 31 October 2021; Received in revised form 11 April 2022; Accepted 12 April 2022
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pandemic has posed health risks (infection, hospitalization, mortality) around the globe (CDC, 2021). From a sociohistorical standpoint, the COVID-19 pandemic has altered the long-standing structure of education to be that of a predominately virtual, distanced format. We advance the theory by examining the biological (CAR) and social (university belonging) development of students who transitioned to college prior to (fall 2019) and during the COVID-19 pandemic (fall 2020).

Latinx and Black students transitioning to college in Los Angeles county

Our focus on Latinx and Black students transitioning to college in Los Angeles County is driven by a variety of factors. First, individuals from Latinx and Black communities were among the most impacted by the COVID-19 pandemic. In 2020, at the height of the pandemic — a period in which we assessed our second cohort of students transitioning to college — there were several reports that the Latinx and Black communities in the United States had the highest rates of infection, hospitalization and mortality (Podewils et al., 2020; Substance Abuse and Mental Health Services Administration [SAMHSA], 2020; Tirupathi et al., 2020; Zamarripa & Roque, 2021), especially true for Latinx and Black communities within Los Angeles County (Dador, 2021; Lin & Evans, 2021; Miller, 2021; Service, 2021). According to The Guardian, the average number of Latinx individuals dying from COVID-19 in Los Angeles has increased by more than 1,000% since November of 2020 (Ho, 2021). Several factors contribute to the high COVID-19 rates for these two groups, including underlying health conditions, low access to medical care, employment in service industries (e.g., restaurants, retail), and living in housing situations that make it difficult to social distance (SAMHSA, 2020). Together, these national and regional rates within Los Angeles County reveal a potential source of contextual stress for Latinx and Black students during this period of time.

In addition, Latinx and Black students come from communities that have experienced long-standing social class disparities (Brannon et al., 2017; Solórzano et al., 2005; Vasquez-Salgado et al., 2021a). They are more likely to live in poverty and come from neighborhoods with little to no resources due to racial and economic segregation (Ceballos, 2021; Creamer, 2020). Thus, when the COVID-19 pandemic appeared in the United States and began to rapidly spread, resources became even scarcer, potentially exacerbating the stress experienced by students living in these communities.

Ecological systems theory underscores the importance of these changing contexts and, guided by this framework, we conceptualize the transition to college as a critical and challenging period in development. This may be especially true for Latinx and Black students, whose interdependent culture may mismatch with independent values and practices present in mainstream university contexts (Brannon et al., 2015; Solórzano et al., 2005; Vasquez-Salgado et al., 2015). This mismatch is associated with stress and a lower sense of belonging (Brannon & Lin, 2021; Burgos-Cienfuegos et al., 2015; Jack, 2014; Phillips et al., 2020; Stephens et al., 2012; Vasquez-Salgado et al., 2015, 2018; 2021a). Thus, Latinx and Black students may be at heightened risk for experiencing stress and a lack of university belonging during this period in their educational development. It is possible that this stress and lower sense of belonging might be exacerbated by contextual stressors associated with the COVID-19 pandemic.

Psychosocial and biological stress among college students prior to and during the COVID-19 pandemic

There is substantial evidence documenting the negative costs of the COVID-19 pandemic on students’ mental health in the United States (Clabaugh et al., 2021; Fruehwirth et al., 2021; Lee et al., 2021; Son et al., 2020) and internationally, in Asia and Europe (Husky et al., 2020; Li et al., 2020; Luo et al., 2020; Patsali et al., 2020). A study at a public research university in Kentucky, United States sought to examine undergraduate students’ psychological stress and mental health services usage throughout March, April and May of 2020 and found that 88% of students (n = 2,691) experienced moderate to severe stress (Lee et al., 2021). In a similar study conducted among undergraduate students at a public university in Texas, 71% of students (n = 195) reported that their stress and anxiety had increased due to the COVID-19 pandemic (Son et al., 2020). Interviews with these students revealed stressors ranging from financial difficulties, to difficulty concentrating at home as well as being concerned about one’s health or the health of loved ones. These qualitative findings provide insight into why underrepresented students (e.g., Latinx, Black, low-income) may be more likely to be negatively impacted by the COVID-19 pandemic on an array of different outcomes (e.g., stress, anxiety, feelings of uncertainty) than students from other backgrounds (Clabaugh et al., 2021; Fruehwirth et al., 2021). These studies are important because they provide emerging evidence of the stress college students experienced during the COVID-19 pandemic. The present study extends this literature by examining differences in biological stress response prior to and during the COVID-19 pandemic, controlling for perceptions of general psychosocial stress. This is important since the biological stress response, specifically, the hypothalamic-pituitary-adrenal (HPA) axis function, has been associated with downstream cardiometabolic health in Latinx and Black minority youth (Adam et al., 2018; Toledo-Corral et al., 2013; Weigensberg et al. 2008).

Cortisol awakening response as a measure of biological stress

Cortisol is a glucocorticoid that is released in response to mental and physical stress (Levine, 2006; Katsu, 2021). Cortisol is secreted diurnally through the hypothalamic-pituitary- adrenal (HPA) axis. In psychobiological research, diurnal cortisol patterning is one of the most utilized biological markers of stress biology as it is an index of HPA axis function, an important pathway through which psychosocial stressors may impact physiological mechanisms, namely those associated with cardiometabolic health (Adam et al., 2010; Toledo-Corral et al., 2013; Weigensberg et al. 2008). When external and internal stressors exceed an individual’s adaptive capacities, the measurement of cortisol and other similar stress hormones help determine stressor-specific bodily changes (King & Hegadoren, 2002; Saxbe, 2008), such as changes in blood pressure regulation and glucose and insulin regulation, linked to disease conditions (Adam et al., 2010; Toledo-Corral et al., 2013; Weigensberg et al., 2008).

In healthy individuals, cortisol secretion follows a diurnal pattern or rhythm, where cortisol concentrations are lowest at bedtime, slowly rise through the night, and peak in the morning hours. Throughout the course of the day, cortisol levels gradually decrease, and return to their lowest levels at bedtime as individuals prepare for rest (Clow et al., 2010a; Levin, 2006; Fries et al., 2008). When individuals experience stressors throughout the day, cortisol levels fluctuate, and thereafter, return to homeostasis once they have recovered from the stressor (McEwen & Seeman, 1999). Though there are a number of diurnal elements that can be examined to address possible HPA-axis dysfunction, we focus on the cortisol awakening response (CAR) (Clow et al., 2010a, 2010b) given the conceptualization of CAR as a necessary component of awakening and preparation for daily challenges as well as general preparation for the day ahead (important for students engaging in the transition to college). CAR is a distinctive aspect of the cortisol diurnal cycle as it is characterized by a strong increase in cortisol levels in response to morning awakening (Clow et al., 2010a; Clow et al., 2010b; Fries et al., 2008).

Although healthy HPA-axis function is marked by increases in CAR, prolonged exposure to psychosocial stressors (such as from the COVID-19 pandemic) may result in lower (or flatter CAR responses). Lower or flatter/blunted CAR may also have effects on “allostatic overload” (i.e., wear and tear on various neuroendocrine and cardiometabolic func-
tions as conceptualized in the allostasic load framework; McEwen & Seeman, 1999), which is also thought to begin with dysregulation of the HPA-axis function. A flat or blunted CAR has been associated with burnout and fatigue (Chida & Steptoe, 2009). It is noteworthy to mention that the only available study connecting the pandemic and cortisol discovered that a lower cortisol response captured before the pandemic predicted higher levels of anxiety, depression and stress under quarantine conditions for undergraduate students (Baliyan et al., 2021). Our research expands prior work by examining HPA-axis function via the CAR among Latinx and Black first-year college students prior to and during the COVID-19 pandemic.

University belonging prior to and during the COVID-19 pandemic

Sense of belonging refers to a feeling of connectedness to others (Booker, 2016). Specifically, university belonging has been defined in the literature as a student’s sense of attachment or connection to the campus as a whole (Hurtado & Carter, 1997). Students with a higher sense of belonging tend to have more self-confidence, an increase in motivation, and greater levels of academic engagement and achievement (Pedler, 2021). Belongingness is influenced by multiple factors including a student’s background, experiences, friends, and external factors such as local and global issues (Mooney, 2021).

Decades of research conducted before the COVID-19 pandemic have revealed that Latinx and Black students are more likely to report lower levels of university belonging than White students (Baker & Robnett, 2012; Gopalan and Brady, 2020; Hurtado et al., 1996; Johnson et al., 2007). This makes sense as underrepresented students are more likely to experience social barriers that may negatively influence their belonging. Compared to White students, underrepresented students face multiple situations that may result in greater distress, such as, micro-aggressions and racism (Primm, 2015). There is also another body of work that has documented Latinx and Black students’ cultural mismatch with the university environment (Brannon & Lin, 2021; Burgos-Cienfuegos et al., 2015; Jack, 2014; Vasquez-Salgado et al., 2015). These situations may serve as one reason underrepresented students report lower levels of belonging (Brannon & Lin, 2021; Hussain and Jones, 2021; Jack, 2014; Nora & Cabrera, 1996). With these social barriers in mind, and universities taking an online approach during the pandemic, there is a decrease in opportunities for building connections.

Several research studies have revealed that university students’ belonging during the COVID-19 pandemic is significantly lower than reports gathered prior to the COVID-19 pandemic (Mooney, 2021; Mulrooney, 2020; Tice et al., 2021; Pedler, 2021). The outbreak of the virus created a disturbance in the typical university environment and this major change has impacted students by decreasing their sense of belonging to their university. In a study done in the United Kingdom, 208 students and 71 academic staff reported reduced feelings of belonging due to the lockdown. The researchers postulated that these reduced feelings of belonging might be due to a lack of physical campus presence as students and staff both rated these as important in their campus experience (Mulrooney, 2020). In fact, due to the changes from in-person to online instruction instigated by the COVID-19 pandemic, the national student survey data in Australia has found a great drop in student engagement and their sense of belonging (Tice et al., 2021). Though these studies are valuable, there is a limited research that has examined underrepresented students’ university belonging prior to and during the COVID-19 pandemic. Our study intends to fill this gap by focusing on a group of Latinx and Black students who transitioned to college for the very first time.

University belonging as a mediator in the relationship between the COVID-19 pandemic and biological stress

The aforementioned literature supports the role of the COVID-19 pandemic (transitioning to college prior to vs. during the COVID-19 pandemic) in affecting Latinx and Black students’ biological manifestations of stress and sense of university belonging. Furthermore, the current research seeks to explore whether university belonging serves as a mediator in the relationship between the COVID-19 pandemic and biological manifestations of stress as indexed by CAR. Our rationale in exploring this mechanism is based on empirical knowledge that university belonging is connected to students’ distress and well-being. Students who report higher levels of university belonging demonstrate better mental health (Civitci, 2015; Gopalan & Brady, 2020; O’Keeffe, 2013). Gopalan and Brady (2020), for example, surveyed 23,750 students from diverse backgrounds during their first-year of study at two and four-year colleges across the United States and found that higher levels of belonging was associated with better academic persistence as well as self-reported mental health two years later. Thus, it quite possible that students who transition to college during the COVID-19 pandemic appear more stressed due to lower feelings of belonging associated with the pandemic. The current research will test this mechanism.

Current study

Based on Bronfenbrenner’s (2005) ecological systems theory, allostatic load framework (McEwen & Seeman, 1999) and the aforementioned literature, the current study has two aims: (1) to examine the role of the COVID-19 pandemic (transitioning to college prior to vs. during the COVID-19 pandemic) on cortisol awakening response (CAR) – a biological marker of chronic psychosocial stress – and university belonging among Latinx and Black first-year students in Los Angeles County – one of the United States’ hot spots for COVID-19; (2) to explore whether university belonging serves as a mediator in the relationship between the COVID-19 pandemic and CAR.

Hypothesis 1: The COVID-19 pandemic will significantly predict CAR. Specifically, Latinx and Black students who began the transition to college during the COVID-19 pandemic will exhibit a lower CAR than students who transitioned to college prior to the COVID-19 pandemic.

Hypothesis 2: The COVID-19 pandemic will significantly predict university belonging. Specifically, Latinx and Black students who began the transition to college during the COVID-19 pandemic will exhibit lower levels of university belonging than students who transitioned to college prior to the COVID-19 pandemic.

Hypothesis 3: University belonging will mediate the relationship between the COVID-19 pandemic and CAR. If this hypothesis is met, it will suggest that Latinx and Black students transitioning to college during the COVID-19 pandemic exhibit a lower CAR due to reduced feelings of university belonging.

Method

Participants

Underrepresented minority students (e.g., Latinx, Black) who were in their first semester at a four-year public university in Los Angeles County were recruited for this study. Across a period of 2 years (fall 2019, fall 2020), participants were recruited through various avenues (e.g., direct emails, flyers, phone calls). All participants lived in Los Angeles County at the time that they took part in our research study and none had preexisting health conditions (e.g., cardiovascular, autoimmune) or learning disabilities at prescreening. Although we had 139 initial participants that completed an online survey and provided salivary samples to assess for cortisol, two participants that lived outside county limits were omitted from analyses as well as one participant that did not provide sufficient levels of saliva. Thus, our final sample consisted of 136 participants.

One-hundred and eleven (81.6%) identified as Latinx, 18 as Black (13.2%) and seven were from multiracial and other backgrounds (e.g., Latinx-White; 5.1%). The sample consisted of 65.4% female and 34.6% male, with an average age of 18.00 (SD = .42). The average level of
We incorporated several safety precautions into our saliva collection protocol during the COVID-19 pandemic to ensure the safety of participants and the research team. These incorporations were informed by guidelines available from the CDC, as well as from consultation with notable salivary bioscience leaders in the field (Salimetrics, UCI IISBR) and the Institutional Review Board and Environmental Health and Safety team at the authors’ institution. For further information regarding the screenings, packet materials and step-by-step procedures of our protocol, please see Vasquez-Salgado et al. (2021b).

Participants who took part in our study prior to the COVID-19 pandemic received $50 for their participation. Those who took part in our study during the COVID-19 pandemic received $60 for their participation as well as an additional $10 if they selected the contact-free drop-off (rather than a pick-up) for the submission of their samples (Vasquez-Salgado et al., 2021b).

**Measures**

**COVID-19 pandemic (transitioned to college prior to vs. during the COVID-19 pandemic)**

The COVID-19 pandemic served as a natural manipulation. Participants were categorized as transitioned to college “prior to the COVID-19 pandemic” (coded as “0”) if they participated in our study in fall 2019 (before the pandemic was introduced in the United States). They were categorized as transitioned to college “during the COVID-19 pandemic” (coded as “1”) if they participated in our study in fall 2020 (after the pandemic was introduced in the United States).

**Cortisol awakening response (CAR)**

CAR was computed as the difference between salivary cortisol concentration at waking (sample 1) and 30 minutes after waking (sample 2; Chida & Steptoe, 2009; MacDonald & Wetherell, 2019). CAR values were averaged across the two days of data collection to provide a more reliable measure of HPA-axis function, which includes diurnal increases in cortisol upon waking (Adam & Kumari, 2009). Both atypically blunted or heightened CAR values have been associated with negative health outcomes (Chida & Steptoe, 2009; Adam & Kumari, 2009). On average, sample 1 (at awakening) was collected at 8:24 a.m. (SD = 1 hr 47 min) and sample 2 (30 minutes after awakening) was collected 8:57 a.m. (SD = 1 hr 47 min).

**University belonging**

A single item indicator from a university belonging scale was used to measure the level of university belonging (Gopalan & Brady, 2020). Participants were asked to rate how much they agreed with the following statement “I feel like I am part of my school.” The response choices were on a 5-point likert scale that ranged from, 1 = strongly disagree to 5 = strongly agree. This measure is similar to conceptualizations of belonging validated in previous research (e.g., Wilson et al., 2015). Higher scores indicated higher levels of university belonging and lower scores indicated lower levels of university belonging.

**Covariates**

All analyses controlled for socioeconomic status (i.e., parental education and income), biological sex (female coded as “0” and male coded as “1”), body mass index (BMI), contraceptive use (“no” coded as “0” and “yes” coded as “1”), regular medication usage (no coded as “0” and yes coded as “1”), caffeine consumption (coded as the average total ounces consumed across saliva collection days), non-compliance (further described below), pink saliva documented by UCI IISBR at salivary processing (pink saliva could indicate contamination; not present coded as “0” and present coded as “1”), as well as perceived wake time.

Design

This quasi-experimental study is part of a larger, ongoing longitudinal project examining cultural mismatch, health and academic development among underrepresented minority students during the transition to college. The focus of the current investigation was on two cohorts of Wave 1 participants in their first semester at a four-year university. Towards the end of their first semester of university, participants completed an online survey and provided saliva samples for cortisol assay. Participants who began the transition to college prior to the pandemic \( (n = 95) \) were recruited in Fall 2019 (October to December) and participants who began the transition to college during the pandemic \( (n = 41) \) were recruited in Fall 2020 (November to January). Our team received permissions across several levels of our institution (e.g., Institutional Review Board, Environmental Health and Safety) to complete this project.

Procedure

Participants interested in our study completed an online prescreening that included several demographic questions as well as a 10-item health questionnaire to screen for health conditions such as inflammatory (e.g., asthma), endocrine disorder (e.g., diabetes), or cardiovascular conditions (e.g., high blood pressure). Students who identified with an underrepresented minority background (e.g., Latinx, Black, Native American, multiracial/other), were in their first year of study at the university, considered a freshman, lived within the Los Angeles County region, were not colorblind and did not have any health conditions or learning disabilities, were invited to join our study via email. Those interested, reviewed and digitally agreed to a consent form that included all details pertaining to the study. Once they provided consent, they completed an online survey. Subsequently, participants completed a secondary health prescreening and received a packet of materials for saliva collection if they met criteria (those that took part in our project during the pandemic were mailed materials). Participants met with a member of our research team via in person (prior to the COVID-19 pandemic) or Zoom (during the COVID-19 pandemic) to receive verbal, visual and written instructions pertaining to the health activity. Subsequent to instructions, participants reviewed and signed a separate consent form for their engagement in the health activity. The at-home health activity involved the placement of a synthetic cotton swab (Salivette®, Sarstedt, Germany) under the tongue for 2 minutes in order to gather saliva; collection occurred across two consecutive weekdays at wake-time (sample 1) and 30 minutes after wake time (sample 2). Participants were instructed to refrain from eating, drinking, brushing their teeth or engaging in activities that may involve placement of items in the mouth (e.g., smoking, chewing gum) until both morning samples have been collected. Participants noted the exact date and time of each saliva collection period on a salivette timesheet log and completed a morning and evening assessment on each day to assess for non-compliance, perceived wake time and caffeine consumption, respectively (details further described in measures section). On the day following their final saliva collection day, participants transported their samples to our laboratory in a mini-cooler pouch with frozen ice packs; our team logged their samples and immediately placed them in a -20°C freezer. Once data collection was finalized, the samples were moved to a -80°C freezer and remained in that freezer until they were transported and processed for salivary cortisol concentrations (μg/dL received; thereafter, transformed to nmol/L) at the University of California, Irvine’s Institute for Interdisciplinary Salivary Bioscience Research (UCI IISBR). Each sample was processed in duplicate using an enzyme-linked immunosorbent assay kit (ELISA). The overall intra-assay coefficient of variation was 5.98% and inter-assay coefficient of variation was 4.84%.
We controlled for these variables because prior research has indicated that these variables can influence salivary cortisol levels (Adam & Kumar, 2009; Granger et al., 2007; Kamodyova et al., 2015; Kudielka & Kirschbaum, 2003; Stavoski et al., 2013). Body mass index (BMI) was calculated by computing a standard equation of weight (in pounds) / height (in meters)^2 × 703. Participants weight (in pounds) and height (in inches) was measured via self-report responses. Non-compliance was determined by the misalignment between saliva collection times reported by the participant and the requested collection times set by the research team (e.g., less than 15-minutes or more than 45-minutes between wake-time sample and the sample to be gathered 30-minutes after wake), as well as sleeping patterns that may affect cortisol levels: awake < 12 hours, awake > 20 hours and woke up after 12:00PM. If participants were non-compliant on at least one aspect, they received a score of “1” as indication of non-compliance. If participants were compliant on all aspects, they received a score of “0”. Overall, 39% of participants were coded as non-compliant and 9.6% had pink saliva in their samples. Lastly, perceived wake time was gathered by asking participants to report the time they woke up on the morning of each saliva collection day. We transformed their wake time into military time and, thereafter, calculated an average of their wake time across both days.

We also accounted for ethnic/racial differences (Black coded as “1” and other groups coded as “0”) in our analyses. This enables us to control for ethnicity-related contextual factors that have been noted in the literature as playing a role in university belonging (e.g., being a minority ethnic group within a school context; Morales-Chicas & Graham, 2017) and CAR (e.g., ethnicity-related stress given the police brutality and highly publicized murders of Black individuals; Adam et al., 2015).

Lastly, given the centrality of stress in our study, we included a general measure of psychosocial stress as a control variable in our analyses (10-item perceived stress scale; Cohen et al., 1983; 1994). Participants were asked to rate (1 = Never to 5 = Very Often) how often they felt or thought a certain way. Sample items included, “Felt nervous or stressed?”, and “Felt difficulties were piling up so high that you could not overcome them?”. Together, the items yielded a Cronbach’s alpha of .85. Inclusion of this measure will enable us to test whether our findings hold over and above participants’ general stress levels.

Results

Preliminary analyses

Our dependent measures (university belonging, CAR) were examined for normality. University belonging and CAR were within acceptable range of skewness and kurtosis (between -2 and 2) for normal distribution (George & Mallery, 2010). Thus, no transformations were conducted. There was one CAR measure that was three standard deviations from the mean; however, inclusion or exclusion of this case did not alter our findings. Therefore, to conserve power, this participant was retained in our analyses.

Preliminary analyses (t-tests, \( \chi^2 \)tests) revealed that there were no significant differences among among students who participated in our study prior to versus during the COVID-19 pandemic in regards to parental education level, income, biological sex, ethnicity, BMI, medications, caffeine consumption, non-compliance, pink saliva and perceived stress \((p = .278 \text{ to } p = .958)\). However, there were significant differences in contraceptive use, such that those who transitioned to college prior to the COVID-19 pandemic reported higher contraceptive use than those who transitioned during the COVID-19 pandemic, \( \chi^2(1, 136) = 3.92, p = .048 \). In addition, there was a mean difference in perceived wake time among the groups, \( t(134) = -6.14, p = .001 \), such that those who transitioning to college prior to the COVID-19 pandemic woke at later times \((M = 9:34 \text{ a.m.}, SD = 1 \text{ hr } 32 \text{ min})\) than participants who transitioned to college prior to COVID-19 pandemic \((M = 7:48 \text{ a.m.}; SD = 1 \text{ hr } 31 \text{ min})\). In addition, preliminary analyses revealed that BMI, caffeine consumption, pink saliva, and biological sex were marginally related to CAR. Having a higher BMI, \( r(136) = -.15, p = .075 \), caffeine consumption, \( r(136) = -.17, p = .051 \), pink saliva in sample, \( r(136) = .15, p = .086 \), and being male, \( r(136) = -.16, p = .062 \), was associated with lower CAR. There were no relationships between other covariates (parental education, income, ethnicity, contraceptive use, medications, non-compliance, perceived wake time, perceived stress) and CAR, \( ps = .135 -.899 \). There were no relationships between the covariates (parent education level, income, biological sex, ethnicity, BMI, contraceptive use, medications, caffeine consumption, non-compliance, pink saliva, perceived wake time) and university belonging, \( ps = .189 -.933 \), except for perceived stress. Higher levels of perceived stress was associated with lower levels of belonging, \( r(136) = -.26, p = .002 \). Nonetheless, we controlled for all variables in our analyses as these variables are standard controls in research pertaining to salivary cortisol.

Table 1

| Step 1 | B     | SE    | t     | p     | 95% CI     |
|--------|-------|-------|-------|-------|------------|
| Parent Education | .56 | .78 | .73 | .470 | -.97 - 2.10 |
| Parent Income | .30 | .75 | .40 | .691 | -1.18 - 1.178 |
| Biological Sex (Male) | -2.60 | 1.51 | -1.73 | .087 | -5.58 - .38 |
| Ethnicity (Black) | .14 | 2.07 | .07 | .946 | -3.96 - 4.42 |
| BMI | -1.14 | .69 | -1.65 | .102 | -2.51 - .23 |
| Contraceptive use | -3.20 | 2.35 | -1.36 | .176 | -7.84 - 1.45 |
| Medications | 4.73 | 3.40 | 1.39 | .166 | -2.00 - 1.146 |
| Caffeine consumption | -1.09 | .69 | -1.58 | .117 | -2.46 - .28 |
| Non-Compliance | -.86 | 1.48 | - .58 | .586 | -3.79 - 2.08 |
| Pink Saliva | -1.68 | 2.34 | -.72 | .473 | -6.30 - 2.94 |
| Perceived Wake Time | -1.20 | .73 | -1.65 | .102 | -2.64 - .24 |
| Perceived Stress | -.87 | .70 | -1.23 | .221 | -2.26 - .53 |
| R² | .13 | | | | |

Note: N = 136. Biological Sex (Female, Male), Ethnicity (Latinx/Other, Black), Contraceptive Use (No/Yes), Medications (No/Yes), Non-Compliance (No/Yes), and Pink Saliva (No/Yes) covariates were dummy coded as 0, 1, respectively. Transitioned to College Prior to the COVID-19 Pandemic group was labeled 0 and Transitioned to College During the COVID-19 pandemic group was labeled 1. \( p < .10 \), \( \ast p < .05 \).

Hypotheses 1 and 2

Hierarchical linear regressions were utilized to test Hypotheses 1 and 2. The hierarchical linear regressions were modeled with covariates in Step 1 (parental education and income, biological sex, ethnicity, BMI, contraceptive use, medications, caffeine consumption, non-compliance, pink saliva, perceived wake time, and perceived stress) and COVID-19 pandemic (transitioned to college prior to vs. during the COVID-19 pandemic) in Step 2. We used similar covariates across models to maintain consistency.

Hypothesis 1. In line with our expectations (as shown in Table 1), the COVID-19 pandemic significantly predicted CAR, \( b = -3.90, SE = 1.64, p = .019, 95\% CI [-7.14, -.65] \). Latinx and Black students who began their transition to college during the COVID-19 pandemic \((M = 1.48 \text{ nmol/L}, SD = 7.95)\) exhibited a lower CAR than participants who transitioned to college prior to the COVID-19 pandemic \((M = 5.17 \text{ nmol/L}, SD = 7.61)\).

Hypothesis 2. As expected (as shown in Table 2), the COVID-19 pandemic significantly predicted university belonging, \( b = -.80, SE = .19, p = .001, 95\% CI [-1.18, -.42] \). Latinx and Black students who transitioned to college during the COVID-19 pandemic \((M = 2.63, SD = .97)\) had significantly lower levels of university belonging than students who transitioned to college prior to the COVID-19 pandemic \((M = 3.33, SD = .89)\).
Table 2
Hierarchical Linear Regression Model for Role of COVID-19 Pandemic (Transitioned to College Prior to vs. During COVID-19 Pandemic) on University Belonging.

|                     | B  | SE  | t    | p   | 95% CI |
|---------------------|----|-----|------|-----|--------|
| Step 1              |    |     |      |     |        |
| Parent Education    | .02| .10 | .17  | .864| -.17-.21|
| Parent Income       | .07| .09 | .77  | .445| -.11-.25|
| Biological Sex (Male) | -.22| .19 | .119 | .236| -.59-.15 |
| Ethnicity (Black)   | -.08| .26 | .31  | .755| -.58-.42 |
| BMI                 | .00| .00 | .00  | 1.00| -.17-.17 |
| Contraceptive use   | -.15| .29 | .52  | .607| -.72-.42 |
| Medications         | .52| .42 | .125 | .212| -.30-.135|
| Caffeine consumption| -.11| .09 | .126 | .211| -.28-.08 |
| Non-Compliance      | -.08| .18 | .45  | .654|-.44-.28 |
| Pink Saliva         | .52| .29 | 1.82 | .071| -.05-1.09|
| Perceived Wake Time | -.14| .09 | 1.54 | .127| -.32-.04 |
| Perceived Stress    | -.28| .09 | 3.28 | .001| .45-.11 |
| R²                  | .14|    |      |     |        |

| Step 2              |    |     |      |     |        |
| COVID-19 Pandemic   | -.80| .19 | 4.15 | .001| -.11-.42 |
| R²                  | .24|    |      |     |        |

Note. N = 136. Biological Sex (Female, Male), Ethnicity (Latinx, Other, Black), Contraceptive Use (No/Yes), Medications (No/Yes), Non-Compliance (No/Yes), and Pink Saliva (No/Yes) covariates were dummy coded as 0, 1, respectively. Transitioned to College Prior to the COVID-19 Pandemic group was labeled 0 and Transitioned to College During the COVID-19 pandemic group was labeled 1. †p < .10, **p < .01, ***p < .001.

Hypothesis 3

Our final hypothesis predicted that university belonging would mediate the relationship between the COVID-19 pandemic and CAR. If this hypothesis is met, it will suggest that Latinx and Black students transitioning to college during the COVID-19 pandemic exhibit a flatter CAR due to lower feelings of university belonging. Mediation using 5,000 bootstrap resamples (Preacher & Hayes, 2008) was conducted to test this hypothesis. SPSS Version 25 with a PROCESS macro developed by Andrew F. Hayes was utilized. The mediation method yields information about the mediator’s indirect effect size and a 95% confidence interval based on the 5,000 bootstrap resamples. If there is no zero within the confidence interval, the mediator is significant (Preacher & Hayes, 2008; Stephens et al., 2014). Contrary to expectations, we found that university belonging was not a significant mediator (95% CI [-.217, .79]).

Fig. 1.

Discussion

The purpose of our study was to examine the role of the COVID-19 pandemic (prior to vs. during the COVID-19 pandemic) on cortisol awakening response (CAR) – a biological marker of chronic psychosocial stress – and university belonging among Latinx and Black first-year college students residing in Los Angeles County – one of the United States’ hot-spots for COVID-19. We also explored whether university belonging served as a mediator in the relationship between the COVID-19 pandemic and CAR. Our major findings revealed that students who transitioned to college during the COVID-19 pandemic exhibited a flatter CAR and lower levels of belonging than students who transitioned to college prior to the COVID-19 pandemic. These findings have several implications that we discuss in the sections below.

In line with our expectations, Latinx and Black students who transitioned to college during the COVID-19 pandemic had a flatter CAR than students who transitioned to college prior to the COVID-19 pandemic. An allostatic load framework and research suggests a flatter CAR is a reflection of prolonged or chronic exposure to stress (or wear and tear of HPA-axis function; Chida & Steptoe, 2009; McEwen & Seeman, 1999). Thus, this finding suggests that students in their first semester of university were physiologically more stressed if they began their college trajectory during a period recognized as life-altering (Bronfenbrenner, 2005); students who did not begin their college trajectory during such a period appeared to be less stressed as indexed by the hormone cortisol. Our findings provide further instantiation to Bronfenbrenner’s (2005) ecological systems theory that recognizes the chronosystem (inclusive of life-altering environment and sociohistorical events) as having effects on human development. Recent studies have focused solely on self-reported measures of stress in examining students’ response to the pandemic (Clabaugh et al., 2021; Fruehwirth et al., 2021; Lee et al., 2021; Son et al., 2020). Therefore, our study extends the literature in providing evidence that transition to college during the COVID-19 pandemic can play a negative role on an objective marker of stress biology via the CAR. This is important as unhealthy cortisol patterns have been linked to an array of negative health outcomes (e.g., future cardiovascular conditions; McEwen & Seeman, 1999).

Additionally, we found that Latinx and Black students who transitioned to college during the COVID-19 pandemic reported significantly lower levels of belonging than students who transitioned to college prior to the pandemic. This finding is aligned with previous research conducted with larger samples that did not focus on underrepresented groups (Mooney, 2021; Mulrooney, 2020; Tice et al., 2021). Contrary to expectations, university belonging did not mediate the relationship between the COVID-19 pandemic (transitioned to college prior to vs. during the COVID-19 pandemic) and CAR. This suggests that there are other experiences not captured in our model that might explain differences in CAR among our participants. For example, perhaps fear of COVID-19 or other chronic psychosocial stressors (e.g., such as burnout or fatigue; Chida & Steptoe, 2009) might be a more appropriate mediator of this relationship. It may also be that the COVID-19 pandemic was simply an overall strong predictor of CAR, and thus, a preliminary link established in our data between low levels of university belonging and a flatter CAR could not hold within the mediation model.

Our findings have several implications. We provide evidence that students who transitioned to college during the COVID-19 pandemic appeared to have an altered HPA-axis function compared to students who transitioned to college before the pandemic. This information suggests a need for stress reduction interventions, programs and policies for Latinx and Black first-year students and all students transitioning to col-
lege. This corroborates decades of research that have confirmed the need for support of minoritized students transitioning to college (Brannon & Lin, 2021; Jack, 2014; C. Suárez-Orozco & M. Suárez-Orozco, 1995; Vasquez-Salgado et al., 2015) and we argue that, at this particular moment in our society, the need is critical. This can be conducted via culturally-based wellness initiatives that aid students in reducing stress levels. For example, this may include designated wellness centers and spaces, alongside wellness coaching zoom-in sessions offered by members of the campus community with cross-cultural training and awareness. More funding can also be given to clubs and organizations for wellness-centered activities, with an emphasis on those that provide education and space for culturally-based methods of stress reduction and relaxation.

Furthermore, because university belonging was much lower among Latinx and Black students who transitioned to college during the COVID-19 pandemic, it is encouraged that universities create more opportunities for students to feel connected to their campus community. This can be done by creating hybrid communities or hubs (with in-person and online formats) that foster connection among students on a range of first-year experience topics that have cross-cultural relevance in the literature (e.g., communicating with faculty, discussions pertaining to cross-cultural identities and experiences as first-year students, attending extracurricular events or activities as a community). These cross-cultural connections can make way for further peer connections and should be designed in a format that promotes continuation of connection.

Lastly, our findings suggest a need for future inquiries. Scientists must delve deeper into these patterns by identifying cultural strengths or factors that protect students against the negative role the COVID-19 pandemic plays in stress and perceptions of belonging. This is important as there are several strengths that youth from communities of color bring with them in their transition to college (Covarrubias et al., 2019; Yosso, 2005) and there are multiple pathways in development (García Coll et al., 1996; Greenfield, 2009; Rogoff, 2003; Vasquez-Salgado & Greenfield, 2021). This can aid higher education institutions in incorporating empirically-informed interventions, programs and policies into their curriculum and campus community.

There were notable limitations in our study. First, our sample sizes were unequal in our comparisons of students who transitioned to college prior to and during the COVID-19 pandemic. This may have contributed to the lack of significance in our mediation model. Future studies examining biological mechanisms, like CAR, throughout the COVID-19 pandemic, should strive to incorporate larger samples. Our team has a protocol that is published to aid scientists in safe biospecimen collection during this and future pandemics (Vasquez-Salgado et al., 2021b). Second, there could have been other factors that explained differences in CAR among the two cohorts of students (e.g., sleep, physical activity; Giuntella et al., 2021; Puccinelli et al., 2021; Stalder et al., 2016). Additionally, our measurement of the CAR only included two samples and the inclusion of three samples (wake, 30-min and 40-min post-wake) would have provided a more thorough investigation given that peak concentrations of cortisol may vary between males and females (e.g., Stalder et al., 2016). This might explain why there was a marginal association between our control variable, biological sex, and CAR. Nevertheless, we controlled for biological sex in our analyses and our findings held over and above this variable. Also, the current research utilized a one-item measure of university belonging. Though similar conceptualizations have been used in other research (Gopalan & Brady, 2020; Wilson et al., 2015), university belonging is a multidimensional construct. Lastly, a final limitation was that our study was confined to students attending a public university in one geographical location: Los Angeles County. It is possible that because this particular county was a COVID-19 hot-spot in the United States, our results might not hold in other geographical areas where the rates of infection, hospitalizations and mortality were significantly lower. Future studies should examine whether the patterns noted in our study vary as a function of geographical location or COVID-19 pandemic tier status.

Overall, we have documented the negative role the COVID-19 pandemic (transitioned to college prior to vs. during the COVID-19 pandemic) has on CAR—a biological marker of chronic psychosocial stress and university belonging. Our findings illuminate the need for interventions, programs and policies aimed at fostering positive transitions to college during this critical developmental, historical period, and beyond. They also demonstrate the need for the continued study of biological stress responses in order to delve deeper into understanding the impact of the COVID-19 pandemic on student health.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

The development of this manuscript was supported by the National Institute of General Medical Sciences of the National Institutes of Health under Award Numbers R25GM118975, TL4GM118977 and UL1GM118976. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

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