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Student Stress in Animal Science

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STUDENT STRESS IN ANIMAL SCIENCE

JAYDEN L. LAWRENCE

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Anecdotally, college students have high levels of stress when compared to the rest of the population. There have been many studies that support this idea in programs outside of animal science, but with the shift in animal science from students that have prior livestock experience to those that do not, it is important to acknowledge how this shift impacts the student population. By evaluating courses in animal science, and how they impact student stress it is possible to determine if the present-day curriculum causes any additional stress on students that have less prior experience.

In the United States, a majority of the agricultural work force comes from Mexico. By taking animal science students to study abroad in places like Mexico, it can help prepare them to enter the workforce with the skills needed to be successful. Short-term study abroad programs are more accessible than traditional long-term study abroad programs with their lower cost and shorter time commitment. However, student stress in short-term programs is not studied as often as traditional programs. Additionally, it is important to recognize the levels of student stress in these programs to ensure that program leaders are giving students the most productive experience.

The aim of the studies included in this thesis were to identify student stress in an animal science course, as well as in animal science short-term study abroad programs. Student stress is quantified through metrics of physiological and psychological stress.

KEYWORDS: animal science, heart rate variability, perceived stress, study abroad, student stress

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CHAPTER I: LITERATURE REVIEW

Stress

When observing and measuring stress, it is important to look at both physiological as well as psychological stress parameters. In general, stress can be defined as "a response in order to maintain the state of stability or homology that the body has maintained against the stimulus to break the mental and physical balance and stability of the body" (Selye, 1956). However, there is a notable difference between how physiological and psychological stressors are defined. Psychological stress has been described as the relationship between a person and their environment that is viewed by the person as exceeding their resources, or harming their well-being (Lazarus & Folkman, 1984). Physiological stress on the other hand is "mediated by a complex interplay of nervous, endocrine, and immune mechanisms that involves the activation of the sympathetic-adreno-medullar (SAM) axis, the hypothalamus-pituitary-adrenal (HPA) axis, and immune system" (Chu et al., 2022, p. 1). Although these two metrics are different, they do have a relationship. When a situation is perceived as stressful and an individual has a heightened level of psychological stress, the nervous system shows the physiological response of "fight or flight" (Chu et al., 2022, p.1).

Physiological stress

Physiological stress can be traced down to a cellular level that is comprised of two components, the slow response that is through the hypothalamic-pituitary-adrenal (HPA) axis, and the quick response of the sympathetic-adreno-medullar (SAM) axis (Chu et al., 2022). The SAM axis secretes epinephrine and norepinephrine, while the HPA axis secretes glucocorticoids including cortisol when responding to a given stressor (Chu et al., 2022). Physiological stress responses can be divided into the autonomic nervous and endocrine systems that are

interconnected (Winters, 2012). The autonomic nervous system is primarily impacted by intracellular action of norepinephrine, which causes increased heart rate, blood pressure, blood glucose levels, pupil dilation, bronchial dilation, and respiratory rate (Winters, 2012). While this is happening, there are also reductions in heart rate variability, gastric mobility, pancreatic activity, and blood flow to the skin, stomach and kidneys (Winters, 2012). Additionally, epinephrine and norepinephrine are released in an endocrine fashion from the SAM axis, contributing to this short-term response (Joëls & Baram, 2009). The endocrine system reflects stress through those reactions of the HPA and SAM axis, where cortisol is the primary long-term stress hormone, whereas epinephrine and norepinephrine are the short-term stress hormones (Perogamvros et al., 2010). In general, for stress studies, cortisol is measured via saliva samples but can be measured through blood samples as well (Winters, 2012).

Autonomic Nervous System and the Stress Response

The autonomic nervous system (ANS) is at the forefront of understanding the physical stress response. This system plays a major role in homeostasis in the body (McCorry, 2007). The ANS is made up of the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS; Waxenbaum et al., 2023). The SNS, which activates during stressful situations triggers the responses of involuntary processes, such as heart rate and respiration (Kemeny, 2023). The SNS is also responsible for the release of norepinephrine which then causes the release of epinephrine, more commonly known as adrenaline (Kemeny, 2023). One way to measure stress is to quantify the result of the SNS being activated with things such as heart rate, or cortisol which is present in the blood, saliva, and urine (Kemeny, 2023). The PNS is dominant during times that are not stressful, sometimes referred to as “rest and digest” (Tindle & Tadi, 2022). The main function of the PNS is to conserve energy that can be used later and regulate

different bodily functions such as digestion or urination (McCorry, 2007). The relationship between these two systems is not zero-sum, if one is heightened it does not mean that the other is lowered (Shaffer & Ginsberg, 2017). Autonomic nervous system activity can be measured through heart rate, passive electrocardiogram (ECG), pulse wave methods (photoplysmography, audiometry, and oscillometry), heart rate variability (HRV), blood pressure, respiratory rate, and electrodermal activity measurement (Winters, 2012).

HRV

Heart Rate Variability is one of the many ways to measure the stress response of the autonomic nervous system. Heart rate variability is defined as the "variation in the time intervals between consecutive heartbeats" (Shaffer & Ginsberg, 2017). Heart rate and HRV are inversely related in that an increase in heart rate results in a reduction in the time between each heartbeat, which in turn means that HRV decreases (McCraty & Shaffer, 2015). Heart rate variability has been used to quantify the exposure of stress, where findings indicate that an increase in stress results in a decrease in HRV (Punita et al., 2016).

There are different methods of measuring HRV including through a chest strap that gathers the data, through smart watches, and fitness devices. Length of HRV readings vary by the goal of the study, but typically there are three different lengths including long term (≥24 hours), short term (~5 minutes) and ultra-short term (<5 minutes) (Shaffer et al., 2020). In short-term readings the primary source of variation is mediated by the PNS, especially with slow, deep breathing, making it a useful measure of stress (Mccraty & Shaffer, 2015). In general, it has been found that long term readings are the standard time for predicting health outcomes such as cardiovascular disease and metabolic diseases (Shaffer et al., 2020). Some studies have also

shown that resting baselines as short as 1 minute (ultra-short term) can be sufficient measurements to examine stress levels (Shaffer et al., 2016).

Heart rate variability can be divided into two separate domains including time domain indices and frequency domain measurements. Time domain indices are used to quantify HRV within a specific time period (Shaffer & Ginsberg, 2017). Frequency domain measurements estimate the distribution of absolute relative power into four frequency bands, two of which (low and high frequency) are commonly utilized in stress studies (Shaffer & Ginsberg, 2017). The power is the energy from the signal that is found within a specified frequency band. The frequency domain measurements are then calculated from these values as either absolute or relative power (Shaffer & Ginsberg, 2017).

The most commonly reported time domain indices are the standard deviation of normal-to-normal intervals (SDNN) and the root mean square of successive differences (RMSSD) (Mccraty & Shaffer, 2015). The SDNN is found by taking the standard deviation of the interbeat intervals (IBI) of normal beats, where normal means that abnormal/ectopic beats have been removed (Shaffer et al., 2014). Generally, SDNN can be connected to stress through the idea that as SDNN increases, there is a higher influence of the PNS (Peabody et al., 2023). The RMSSD is calculated by finding the consecutive time differences between heart beats in milliseconds, then each of the values found is squared (Shaffer & Ginsberg, 2017). After the values are squared, these values are averaged, and the square root is then taken of the calculated average (Shaffer & Ginsberg, 2017). There is a similar connection between RMSSD and stress responses which shows that as RMSSD increases, there is an increase of activity by the PNS (Peabody et al., 2023).

The High Frequency (HF) band includes values from 0.15 Hz to 0.40 Hz and reflects activity from the parasympathetic nervous system, or vagal activity (Mccraty & Shaffer, 2015). There have been studies that link reduced cognitive functions to this which is consistent with the finding that low amounts of HF bands are associated with stress, panic, anxiety or worry (Mccraty & Shaffer, 2015). The Low Frequency (LF) band includes values between 0.04 and 0.15 Hz and primarily reflects the baroreceptor (responsible for relaying information of the volume of blood in vessels and communication with the ANS) mediated influences on heart rate and both PNS and SNS activity (Mccraty & Shaffer, 2015)

The ratio of low frequency to high frequency (LF:HF) domains attempts to estimate the ratio between PNS and SNS activity (Shaffer et al., 2014). The idea was that both PNS and SNS activity are contributors to LF power, whereas PNS is the major contributor to HF power, therefore, a low LF:HF ratio would indicate PNS dominance, and a high ratio indicates SNS dominance and thus stress (Shaffer et al., 2014). However, some authors suggest that the LF:HF ratio does not necessarily reflect SNS and PNS activity due to the complicated nature and non-linearity of HRV (Billman, 2013).

HRV as a measure of stress

Heart Rate Variability has been proven over time to be a good measure of stress and has been studied in a variety of populations. Heart Rate Variability is something scientists have been aware of since the invention of the "Physician Pulse Watch" by John Floyer in the 1700s (Billman, 2011). Eventually, the electrocardiogram was standardized allowing for the evaluation of HRV, which has continued to evolve and expand leading to the connection between HRV and stress (Ernst, 2017; Billman, 2011). Generally, levels of HRV parameters are associated with activity in the parasympathetic nervous system, which is connected to stress levels (Ernst, 2017).

There have been a variety of studies that utilize HRV as a measure of stress (Billman, 2011; Ernst, 2017; Kaegi et al., 1999; Lucini et al., 2002). Kaegi et al. (1999) utilized three different time periods including a baseline, quiet standing, and peak stress state. They found that utilizing the low frequency band of HRV measurements served as a useful tool in assessing stress in training scenarios in students (Kaegi et al., 1999). A similar study by Lucini et al. (2002) took HRV and cortisol measurements in a population of college students before, soon after, and 3 months after an examination. This study evaluated the correlations between cortisol and HRV indices and found that HF, LF, and the LF:HF ratio were correlated to the cortisol measurements and that there were significant differences between the stress and control time periods (Lucini et al., 2002).

Kaegi et al. (1999) evaluated stress with HRV utilizing LF, HF, and the LF:HF ratio in 24-hour time periods to determine stress levels in medical students while in a medical emergency stimulation. This study found that in times of mental stress, there was a significant increase in heart rate and LF power, and an associated decrease in HF power during the stress period in comparison to their resting and standing states (Kaegi et al., 1999). Delaney and Brodie (2000) evaluated HRV as an accurate measure of stress by utilizing the Stroop Word Color Conflict test. The Stroop World Color Conflict test is a test that can be used to induce stress in a participant. In the test, participants are given a list of words printed in colors other than their actual color (the word red would be printed in green ink) and participants are asked to read the ink color, rather than the word (Scarpina & Targini, 2017). During the psychological stress period, they found that their participants had a lower SDNN, which indicated a reduction in the autonomic nervous system response (Delaney & Brodie, 2000). Dishman et al. (2000) had the goal of determining if HRV as a determinant of stress level would be impacted by personality or respiratory fitness. It

was determined that men and women who had higher perceived stress had a lower HRV through the utilization of LF and HF (Dishman et al., 2000). Lucini et al. (2002) continued to support the use of HRV as a measure of stress and continued the research of stress in college students that they refer to as a model of mild, real-life stress. By utilizing a combination of HRV, surveys, and cortisol measurements they were able to conclude that mild, real-life stressors in college aged students can be measured via HRV and these stressors impair cardiovascular homeostasis (Lucini et al., 2002).

Use of and the accuracy of the LF:HF ratio has been debated by researchers. Some studies including Hjortskov et al. (2004), Filaire et al. (2010), Clays et al. (2011), and Endukuru et al. (2016) found a relationship between the LF:HF ratio and stress in their participants. However, Billman (2013) reported that utilizing the LF:HF ratio is not an accurate measure of the balance of the sympathetic and parasympathetic systems and is not necessarily reflective of stress. There are a lot of assumptions that are made when utilizing LF:HF as a stress measure that have proven to be false, such as the assumption that the sympathetic and parasympathetic nervous systems are in a linear relationship (Billman, 2013).

One way to utilize HRV to measure stress is through the use of the Baevsky Stress Index (2008). The Baevsky Stress Index is calculated using the equation as seen in Figure 1.1. In the equation, all values come from HRV metrics where AMo is the mode amplitude, Mo is the mode interbeat interval, and MxDMN is the variation scope that reflects the degree of interval variability (Baevsky, 2008). The equation used is founded on the idea that the variability of the intervals between consecutive heart beats are controlled by the autonomic nervous system. The normal range of the stress index is scores between 80-150, mild stress increases the value by 1.5-2 times, and severe stress increases it by 5-10 times. These values are sensitive to sympathetic

tone rise, which comes from physical or emotional stress (Baevsky, 2017). Dias et al. (2022) supported the idea that the Baevsky Stress Index can be used to identify stress in individuals with their study that showed a negative correlation with Vitamin D levels and the Stress Index values. Vitamin D values have been associated with a variety of disorders including psychological disorders and stress (Dias et al., 2022; Ginde et al., 2009). Similar results were found when Castillo-Aguillar (2023) showed the reliability of HRV parameters in older populations of people, and stated they were able to identify the difference between stressful and non-stressful situations.

Figure 1.1 Stress Index Formula

$$SI = \frac{AMo * 100\%}{2Mo * MxDMn}$$

Psychological Stress

Psychological stress, sometimes referred to as perceived stress, is something that occurs when an individual perceives something in their environment as threatening and determines that it exceeds their ability to adapt (Cohen et al., 1995). There are many definitions that vary slightly from this (Appley & Trumbull, 1967; Mason, 1975). However, they all contain the same theme of environmental demands exceeding an individual's capacity to deal with them, which then results in both psychological and physiological changes (Cohen et al., 1995).

Measuring Psychological Stress and Identifying Demographic Trends

One way to measure psychological stress is the Perceived Stress Survey (PSS; Cohen et al., 1983). The PSS is utilized to measure the degree to which participants feel situations have been stressful (Cohen et al., 1983). This is a 10-question survey that asks respondents about

general thoughts and feelings but does not reference particular situations (Cohen et al., 1983). This survey has given better predictors of stress than other life-event scales (Cohen et al., 1983).

In an additional study completed by Cohen and Williamson (1988), the authors evaluated the PSS and discussed the scores of different demographic variables. They reported that the mean score for the entire sample was 13.02, that females reported higher levels of perceived stress than males, and that perceived stress decreased with age. Additionally, the average PSS for ages 18-29 was 13.0 (Cohen et al., 1988). In terms of income, Cohen and Williamson (1988) report that PSS declined linearly up to $35,000 a year, and beyond this income, no discernable trend was observed. From an education standpoint, Cohen and Williamson (1988) stated that the more education a participant had, the lower their PSS. In that study, respondents that identified themselves as Caucasian had lower scores than all other reported minorities (Cohen and Williamson, 1988).

Two different studies have supported the idea that women generally report higher perceived stress scores than men through the use of different surveys (Matud, 2004; Mirowsky & Ross, 1995). Matud (2004) examined a sample of 2,816 individuals to determine gender differences in perceived stress and coping styles. They utilized seven different surveys including: the Life Event Stressful Success Questionnaire, Chronic Stress Questionnaire, Minor Daily Stress Questionnaire, Work Role Satisfaction Inventory, Coping Styles Questionnaire, Emotion Control Questionnaire, and General Health Checklist (Matud, 2004). The results showed that women had more daily stress with more chronic problems than men, and women felt their life events were less controllable and more negative (Matud, 2004). These results are similar to those reported by Mirowski and Ross (1995) that examined distress in men and women through

telephone interviews and found that women experience stress about 30% more frequently than men.

Cohen and Williamson (1988) concluded the PSS adequately measures perceived stress. Different studies have also used and investigated the efficacy of the PSS (Lee, 2012; Mirowsky & Ross, 1995; Örücü & Demir, 2009). In systematic review of 19 articles utilizing the PSS completed by Lee (2012), it was determined that the questionnaire has acceptable psychometric properties. Örücü and Demir (2009) found that the PSS is reliable and valid as an assessment of perceived stress in university students.

The PSS has also been utilized in different studies that look at student stress levels. One of these, completed by Denovan et al. (2019), evaluated stress levels among university students in the UK by giving the PSS and two other similar surveys to 524 students whose ages ranged from 18-23. This study found an overall mean score of 19.79 ± 6.37 and cited no differences among gender. An additional study, completed by Anwer et al. (2020), examined PSS scores among university students and reported an average age of 20.54 and an average PSS score of 16.16. The results by Anwer et al. (2020) were lower than those reported by Denovan et al. (2019). Both Anwer et al. (2020) and Denovan et al. (2019) stated that the PSS was psychometrically valid.

College student psychological stress

College students anecdotally have high levels of stress, and this idea has been observed over a variety of studies. Students' confidence in their emotional health has been on a decline since 1985, and there has been a similar increase in students that have cited being overwhelmed (Sax, 1997). Sesay (2019) utilized the PSS in a population of 123 college students and found an average score in their freshmen of 20, which was higher than the average of 17.63 in their

seniors. It was also reported that, in both freshmen and seniors, the two most common causes of stress were their academic workload and financial obligations (Sesay, 2019). Some topics that have been studied in the past on college student stress in the United States include general college student stress levels (Darling et al., 2007; Gonzalez et al., 2010; Morales, 2008), students with learning disabilities (Kaminski et al., 2006), stress in particular majors (Magnussen & Amundson, 2003; Mazerolle, 2011; Merrell et al., 2011) stress in particular ethnicities (Rowland, 2008), generational stress (Shields, 2002), and stress by year in school (Singer et al., 2002). According to the American College Health Association (2023), 49.9% of students surveyed reported that they experienced moderate stress levels, 28.9% experienced high stress levels, 19.8% experienced low stress levels and the remaining 1.3% experienced no stress.

Many studies with different methodologies have worked to quantify the stress levels of this population across different areas of the world (Darling et al., 2007; Goldman & Wong, 1997; Weinstein et al., 2009). One study, completed by Makhubela (2020), utilized the PSS to evaluate student stress levels in 862 South African university students. This study found that their population had a higher mean score (M=21.3) than the general population of the same age group (M=14.2), as well as supported the validity of the use of the PSS in college age students as a tool for stress measurement.

Anticipatory stress

Anticipatory stress is a long-studied idea. One of the early articles that looked into anticipatory stress examined two treatment groups. The treatment groups included temporal uncertainty where participants did not know when an inevitable harm would occur, and event uncertainty where participants knew when the event would occur but not if it would (Monat et al., 1972). They found that in the temporal uncertainty group, their subjects had more of a

disturbance in the anticipation period (Monat et al., 1972). This article also discusses that the emotional efforts that take place in an anticipatory period are processes of preparation occurring prior to the harmful event (Monat et al., 1972). The process of going through a stressful event has been described as starting with the early identification of the stressor, known as cognitive appraisal, a period of anticipation referred to as anticipatory stress, the occurrence of the stressful event, and a period of recovery (Schlatter 2021). Vanderhasselt et al. (2014), used pupillary responses to measure if the anticipation of emotional stimuli influences the processing of the stimuli. Pupillary response can be used to reliably measure stress and has been validated through different studies (Graff et al., 2019; Steinhauer et al., 2004). They found that in anticipation of a task, participants had higher levels of pupillary responses than while completing the task. This supports the idea that when people have high anticipation for a task, the time period of the task may not be as stressful. Nasso et al. (2019) utilized both psychological stress via the Ruminative Responses Scale and physiological stress with heart rate variability (HRV) measures through four phases including baseline, anticipation, interview, and recovery. They found that participants were more stressed in the preparation phases than following the stressor, which in this case was the interview (Nasso et al., 2019).

Student Stress in Study Abroad

Study abroad programs are not a novel area of study, with different specifications. These include anything from assessing cultural awareness to student stress (Butcher et al., 2017; Gibson et al., 2012; Nzaranyimana et al., 2020; Smith & Mitry 2008). Student stress includes investigating mental health of students in long term-study abroad programs (Hunley, 2010; Bathke & Kim, 2016), however, few studies have looked specifically at student stress in short-term study abroad programs (Niehaus et al., 2022; Yamanaka et al., 2021). According to the

Institute of International Education (IIE, 2022), in the 2021/2022 academic year, approximately 65% of study abroad programs were short term (< 8 weeks), taking place in either the summer or the academic year. They also cite that a majority of study abroad programs are considered STEM, with the fields including agriculture (2.9%), engineering (5.6%), health professions (5.6%), math or computer science (3.4%), and physical or life sciences (8.2%), totaling 25.6% of all study abroad programs in comparison to Business and Management (20.8%), Communication and Journalism (5.2%), and all other fields of study (IIE, 2022).

Yamanaka et al. (2021) found that participation in short-term study abroad programs can positively influence the mood state of university students, and that the benefits that are commonly associated with study abroad programs extend beyond those typically reported. This study utilized three surveys, including the Profile of Mood States (POMS), the Satisfaction With Life Scale (SWLS), and the Gratitude Questionnaire (GQ-6), at the time of orientation, day before departure, the day they arrived home, and during a final presentation. They found positive results and stated that by having an understanding of the moods that are associated with study abroad, the authors could help guide the development of programs (Yamanaka et al., 2021).

The role of the faculty member in faculty-led, short-term study abroad programs is crucial to the participants' experience and mental health. Niehaus et al. (2022) examined how and to what extent faculty members were called on to address student mental health needs while abroad in surveys of 473 faculty members from 72 institutions. The demographics of the faculty in the programs that were examined included predominantly white (86.4%) with a slight majority being female (52.6%; Niehaus et al., 2022). This study identified that over half of the faculty had played some role in assisting students with mental health needs in their most recent study abroad

program, and that many of them felt that they were unprepared for those situations (Niehaus et al., 2022).

A study written by Bathke & Kim (2016) examined students' functioning while in a study abroad program with the use of a modified Behavioral Health Measure-20 survey. They found that overall students reported good mental health while abroad but found some patterns when examining the differences between the before-during-after comparison. It was found that 40.78% of their participants reported being rarely or almost never stressed while abroad, 44.05% being stressed sometimes and 14.85% almost always feeling stressed (Bathke & Kim, 2016). This study also examined loneliness, where they reported that 36.7% of their participants sometimes felt lonely and homesick, and that 80.59% of their participants rarely or almost never felt depressed while abroad (Bathke & Kim, 2016). With all of this, the authors concluded that going abroad can lead to improved mental health upon returning home as a result of gaining personal traits such as confidence and problem-solving skills while studying abroad (Bathke & Kim, 2016). A similar study completed by Hunley (2010) examined how participant coping levels and stress prior to going abroad were connected to the levels of stress that the participants felt abroad by utilizing four surveys (Functioning of Students Abroad Questionnaire, the Beck Anxiety Inventory, the Depression Adjective Checklist, and a Revised UCLA Loneliness Scale). This study determined that when participants had higher levels of psychological stress generally, they had poorer academic functioning while abroad (Hunley, 2010).

There is also an area of study abroad research that focuses on the idea of improving student experience with the curriculum. When designing a study abroad program, it is important to consider the time period in which the participants are preparing to go abroad. Jones and Bjelland (2004, p. 963) introduce the idea of preflection which they define as "the process of

being consciously aware of the expectations associated with the learning experience." According to Roberts and Jones (2009, p. 405) students "can be better prepared to interpret the plethora of data and focus on aspects most important for their learning." Some topic suggestions on what should be included in the meetings with students prior to going abroad include safety, culture, travel preparation, and identifying what students already know (Rodriguez & Roberts, 2011). Wingenbach et al. (2006) found that participants were concerned with going abroad due to reasons such as safety, language and financial barriers, and lack of cultural knowledge, when they were questioned about their feelings prior to going abroad. By including sufficient details, educators can decrease anxiety and stress, as well as work to increase participants' excitement prior to leaving (Roberts et al., 2013). The goal of preflections, as well as the preparation period, should be to decrease some of these concerns, and to help students feel comfortable with each other to improve the learning environment (Lutterman-Aguilar & Gingerich, 2002).

Stress in Animal Science

The Animal Science field in undergraduate programs has been seeing a shift from a majority of male students with prior animal experience to a majority of female students with little to no prior animal experience (Boerngen & Rickard, 2020; Bundy et al., 2019). This shift in demographics was previously reported in the 1980's by Taylor and Kaufman (1983). These authors utilized a survey given to both Land Grant and non-Land Grant institutions and found an increase in female students by 46% and an increase in students with little to no animal handling experience between the years of 1970-1980 (Taylor & Kaufman, 1983). One of the concerns cited, that is still present today, is that "non-farm students required more hands-on experience in courses" (Taylor and Kaufman, 1983). However, Pell (1996) stated that although there was an increase in female students in upper-level academia and animal science programs, there was still

a lack of female representation in the academic faculty. The trend of increased numbers of undergraduate students in animal science has continued, as well as the proportion of urban and female students (Buchanan, 2008). In 2011, researchers found that the majority of students in an Introduction to Animal Science course were female, with 59% of them citing a career objective of Veterinary Science (Peffer, 2011) The original idea of "teaching boys to become farmers" has shifted to the new demographic of students, where a majority hope to attend veterinary school instead of farming, and thus it is important to evaluate the animal science curriculum (Coffey, 1917; Buchanan, 2008). Buchanan (2008) noted that the curriculum should be adapted to include students with new interests and different career aspirations.

The addition of new classes helps give students with less discipline-specific knowledge the opportunity to gain skills in these areas. According to Reiling et al. (2003), 4% of students in an Introduction to Animal Science course came from a farming or agricultural background, whereas 86% had minimal or no large animal handling experience. This university implemented a multispecies large animal practicum where students were able to gain experience handling large animals and found that it stimulated student interest and facilitated learning (Reiling et al., 2003). In a different study, after implicating a Beef Management Practicum, research noted that students were able to successfully learn handling, feeding and management skills through experiential learning (Marshall et al., 2011).

Bundy et al. (2019) examined the addition of an introductory animal handling course and its effects on student comfort level with large animals. This study stated that when entering the university, animal science undergraduate students generally have limited experience with handling livestock. Specifically, Bundy et al. (2019) found that 96% of their participants felt the hands-on approach was beneficial for their reinforcement of lecture material, making them more

likely to interact with livestock both inside and outside of the classroom. In a study by Boerngen and Rickard (2020), it was found that, in an introductory to agriculture course, 35.1% of participants reported coming from a farm background. Out of the 35.1% of students that cited a farm background, 52% of those cited having livestock production experience (Boerngen & Rickard, 2020).

Studies on student stress in Animal Science programs are uncommon. However, a recent study was completed on the mental health decline in students studying in pre-veterinary medicine. This study written by Trivedi et al. (2023) utilized two surveys, the Depression, Anxiety and Stress Scale (DASS-21) and the Attitudes Towards Seeking Professional Help short form (ATSPPH-sf) in students in an undergraduate, pre-veterinary program at a Land Grant Institution. Results showed that a decline in mental well-being starts in students' undergraduate program, and over time lead to a decrease in overall mental health including anxiety and depression (Trivedi et al., 2023). Animal science and pre-veterinary students often have similar curricular requirements and plan to attend veterinary school.

Works Cited

American College Health Association. (2023). The American College Health Association National College Health Assessment (ACHA-NCHA), Spring 2023 Reference Group Report.

Anwer, S., Manzar, M. D., Alghadir, A. H., Salahuddin, M., & Abdul Hameed, U. (2020). Psychometric Analysis of the Perceived Stress Scale Among Healthy University Students. *Neuropsychiatric disease and treatment*, *16*, 2389–2396. https://doi.org/10.2147/NDT.S268582

Appley, M. H., & Trumbull, R. (1967). *Century Psychology Series*. Appleton Century Crofts.

Baevsky, R. M., & Berseneva, A. P. (2008). Methodical recommendations use kardivar system for determination of the stress level and estimation of the body adaptability standards of measurements and physiological interpretation. Methodical-recommendations-USE-KARDiVAR-SYSTEM-FOR/74a292bfafca4fdf1149d557348800fcc1b0f33b.

Baevsky, R., & Chernikova, A. G. (2017). Heart rate variability analysis: Physiological foundations and Main Methods. *Cardiometry*, (10), 66–76. https://doi.org/10.12710/cardiometry.2017.10.6676

Bathke, A., & Kim, Y.-H. (Ryoka). (2016). Keep calm and study abroad: The effect of learning abroad on Student Mental Health. *Frontiers: The Interdisciplinary Journal of Study Abroad*, *27*(1), 1–16. https://doi.org/10.36366/frontiers.v27i1.371

Billman, G. E. (2011). Heart rate variability? A historical perspective. *Frontiers in Physiology*, *2*. https://doi.org/10.3389/fphys.2011.00086

Billman, G. E. (2013). The LF/HF ratio does not accurately measure cardiac sympatho-vagal balance. *Frontiers in Physiology*, *4*. https://doi.org/10.3389/fphys.2013.00026

Boerngen, M. A., & Rickard, J. W. (2020). Assessment and perception of student farm background in an introductory agriculture course. *Natural Sciences Education*, *49*(1). https://doi.org/10.1002/nse2.20013

Buchanan D. S. (2008). ASAS Centennial Paper: animal science teaching: a century of excellence. Journal of animal science, 86(12), 3640–3646. https://doi.org/10.2527/jas.2008-1366

Bundy, J. M., Sterle, J. A., Johnson, A. K., & Krahn, G. T. (2019). The impact of an introductory animal handling course on undergraduate students who lack previous livestock handling experience. *Journal of Animal Science*. https://doi.org/10.1093/jas/skz095

Butcher, R., Wiedenhoeft, M. H., & Loynachan, T. E. (2017). Long-term student benefit of International Agricultural Study Abroad Courses. *Natural Sciences Education*, *46*(1), 170012. https://doi.org/10.4195/nse2017.06.0012

Castillo-Aguilar, M., Mabe Castro, M., Mabe Castro, D., Valdés-Badilla, P., Herrera-Valenzuela, T., Guzmán-Muñoz, E., Lang, M., Niño Méndez, O., & Núñez-Espinosa, C. (2023). Validity and Reliability of Short-Term Heart Rate Variability Parameters in Older People in Response to Physical Exercise. International journal of environmental research and public health, 20(5), 4456. https://doi.org/10.3390/ijerph20054456

Chu, B., Marwaha, K., Sanvictores, T., & Ayers, D. (2022). Physiology, Stress Reaction. In *StatPearls*. StatPearls Publishing.

Clays, E., De Bacquer, D., Crasset, V., Kittel, F., de Smet, P., Kornitzer, M., Karasek, R., & De Backer, G. (2011). The perception of work stressors is related to reduced parasympathetic activity. International archives of occupational and environmental health, 84(2), 185–191. https://doi.org/10.1007/s00420-010-0537-z

Coffey, W. C. (1917). The Curriculum. Journal of Animal Science, 1917(1), 82–93. https://doi.org/10.2527/jas1917.1917182x

Cohen, S., Kessler, R. C., & Gordon, L. U. (1995). Strategies for measuring stress in studies of psychiatric and physical disorders. In S. Cohen, R. C. Kessler, & L. U. Gordon (Eds.), Measuring *stress: A guide for health and social scientists* (pp. 3–26). Oxford University Press.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*(4), 385. https://doi.org/10.2307/2136404

Cohen, S., & Williamson, G. (1988). Perceived stress in a probability sample of the United States. In S. Spacapan, & S. Oskamp (Eds.), The social psychology of health: Claremont symposium on applied social psychology. Newbury Park, CA: Sage.

Darling, C. A., McWey, L. M., Howard, S. N., & Olmstead, S. B. (2007) College student stress: The influence of interpersonal relationships on sense of coherence. Stress and Health, 23, 215–229. DOI: 10.1002/smi.1139

Delaney, J. P., & Brodie, D. (2000). Effects of short-term psychological stress on the time and frequency domains of heart-rate variability. *Perceptual and Motor Skills*, *91*(6), 515. https://doi.org/10.2466/pms.91.6.515-524

Denovan, A., Dagnall, N., Dhingra, K., & Grogan, S. (2019). Evaluating the Perceived Stress Scale among UK university students: implications for stress measurement and management. Studies in Higher Education, 44(1), 120-133 10.1080/03075079.2017.1340445

Dias, C. J., Barroso, R., Dias-Filho, C. A. A., Ferreira, A. C., Cabido, C. E. T., Crestani, C. C., Silva, M. S., Pinheiro, A. N., Rodrigues, B., & Mostarda, C. T. (2022). Possible influences of vitamin D levels on sleep quality, depression, anxiety and physiological stress in patients with chronic obstructive pulmonary disease: a case control study. Sleep science (Sao Paulo, Brazil), 15(Spec 2), 369–374. https://doi.org/10.5935/1984-0063.20210019

Dishman, R. K., Nakamura, Y., Garcia, M. E., Thompson, R. W., Dunn, A. L., & Blair, S. N. (2000). Heart rate variability, trait anxiety, and perceived stress among physically fit men and women. International journal of psychophysiology: official journal of the International Organization of Psychophysiology, 37(2), 121–133. https://doi.org/10.1016/s0167-8760(00)00085-4

Endukuru, C. K., Tutor, E., Bhopal, A., & Tripathi, S. (2016). Medical Science Evaluation of Cardiac Responses to Stress in Healthy Individuals -A Non Invasive Evaluation by Heart Rate Variability and Stroop Test. *International Journal of Scientific Research*.

Ernst G. (2017). Hidden Signals-The History and Methods of Heart Rate Variability. Frontiers in public health, 5, 265. https://doi.org/10.3389/fpubh.2017.00265

Filaire, E., Portier, H., Massart, A., Ramat, L., & Teixeira, A. (2010). Effect of lecturing to 200 students on heart rate variability and alpha-amylase activity. European journal of applied physiology, 108(5), 1035–1043. https://doi.org/10.1007/s00421-009-1310-4

Gibson, K. D., Benjamin, T. J., Oseto, C. Y., & Adams, M. M. (2012). A Short-Term Study Abroad Course in Costa Rica. NACTA Journal, 56(1), 23–27.

Ginde, A. A., Mansbach, J. M., & Camargo, C. A., Jr (2009). Association between serum 25-hydroxyvitamin D level and upper respiratory tract infection in the Third National Health and Nutrition Examination Survey. Archives of internal medicine, 169(4), 384–390. https://doi.org/10.1001/archinternmed.2008.560

Graff, T. C., Luke, S. G., & Birmingham, W. C. (2019). Supportive hand-holding attenuates pupillary responses to stress in adult couples. PloS one, 14(2), e0212703. https://doi.org/10.1371/journal.pone.0212703

Goldman, C. S., & Wong, E. H. (1997). Stress and the college student. Education, 117(4), 604-611.

Gonzalez, T., Hooper, Jr., H. H. (Buddy), Lee, A. S., & Lin, J. (2010). A study of correlations among yoga enhancement design and cognition of college student learning and practitioner success. International Journal of Organizational Innovation, 2, 271–286.

Hjortskov, N., Rissén, D., Blangsted, A. K., Fallentin, N., Lundberg, U., & Søgaard, K. (2004). The effect of mental stress on heart rate variability and blood pressure during computer work. European journal of applied physiology, 92(1-2), 84–89. https://doi.org/10.1007/s00421-004-1055-z

Hunley, H. A. (2010). Students' functioning while studying abroad: The impact of psychological distress and loneliness. *International Journal of Intercultural Relations*, *34*(4), 386–392. https://doi.org/10.1016/j.ijintrel.2009.08.005

Institute of International Education. (2023). "Profile of U.S. Study Abroad Students, 2000/01-2021/22." Open Doors Report on International Education Exchange.

Joëls, M., & Baram, T. Z. (2009). The neuro-symphony of stress. Nature reviews. Neuroscience, 10(6), 459–466. https://doi.org/10.1038/nrn2632

Jones, B.L. and D. Bjelland. 2004. International experiential learning in agriculture. AIAEE 2004: Proc. of the 20th Annual Conference, 20, 963-964.

Kaegi, D. M., Halamek, L. P., Van Hare, G. F., Howard, S. K., & Dubin, A. M. (1999). Effect of mental stress on heart rate variability: Validation of simulated operating and delivery room training modules. *Pediatric Research*, *45*(4, Part 2 of 2). https://doi.org/10.1203/00006450-199904020-00463

Kaminski, P. L., Turnock, P. M., Rosen, L. A., & Laster, S. A. (2006). Predictors of academic success among college students with attention disorders. Journal of College Counseling, 9(1), 60. DOI: 10.1002/j.2161- 1882.2006.tb00093.x

Kemeny, M. E. (2003). The Psychobiology of Stress. Current Directions in Psychological Science, 12(4), 124-129. https://doi.org/10.1111/1467-8721.01246

Lazarus, R. S., & Folkman, S. (1984). Stress, appraisal, and coping. Springer publishing company.

Lee, E.-H. (2012). Review of the psychometric evidence of the perceived stress scale. Asian Nursing Research, 6(4), 121–127. https://doi.org/10.1016/j.anr.2012.08.004

Lehman, H. K., & Ballow, M. (2020). Chapter 47—Nutritional and stress effects on immunologic function. In K. E. Sullivan & E. R. Stiehm (Eds.), Stiehm's Immune Deficiencies (Second Edition) (pp. 1007–1020). Academic Press. https://doi.org/10.1016/B978-0-12-816768-7.00047-8

Lucini, D., Norbiato, G., Clerici, M., & Pagani, M. (2002). Hemodynamic and autonomic adjustments to real life stress conditions in humans. *Hypertension*, *39*(1), 184–188. https://doi.org/10.1161/hy0102.100784

Lutterman-Aguilar, A., & Gingerich, O. (2002). Experiential pedagogy for study abroad: Educating for global citizenship. *Frontiers: The Interdisciplinary Journal of Study Abroad*, *8*(1), 41–82. https://doi.org/10.36366/frontiers.v8i1.94

Magnussen, L., & Amundson, M. J. (2003). Undergraduate nursing student experience. Nursing and Health Sciences, 5, 261–267. DOI: 10.1046/j.1442- 2018.2003.00158.x

Mason, J. W. (1975). A historical view of the stress field. Part 2. *Journal of Human stress. 1.* 22-36.

Makhubela, M. (2020). Assessing psychological stress in South African university students: Measurement validity of the perceived stress scale (PSS-10) in diverse populations. *Current Psychology, 41* (5), 2802-2809. https://doi.org/10.1007/s12144-020-00784-3

Marshall, T. T., Hoover, T. S., Reiling, B. A., & Downs, K. M. (1998). Experiential learning in the Animal Sciences: Effect of 13 years of a beef cattle management practicum. *Journal of Animal Science*, *76*(11), 2947. https://doi.org/10.2527/1998.76112947x

Matud, M. P. (2004). Gender differences in stress and coping styles. Personality and Individual Differences, 37(7), 1401–1415. https://doi.org/10.1016/j.paid.2004.01.010

Mazerolle, S. M. (2011). Perceptions of burnout from the students' perspective. Athletic Training Education Journal, 6, 60–68. http://www.nataej.org/

Mccraty, R., & Shaffer, F. (2015). Heart rate variability: New perspectives on physiological mechanisms, assessment of self-regulatory capacity, and Health Risk. Global Advances in Health and Medicine, 4(1), 46–61. https://doi.org/10.7453/gahmj.2014.073

McCorry, L. K. (2007). Physiology of the autonomic nervous system. *American Journal of Pharmaceutical Education*, *71*(4), 78. https://doi.org/10.5688/aj710478

Merrell, R. S., Hannah, D. J., Van Arsdale, A. C., Burman, M. P., & Rice, K. G. (2011). Emergent themes in the writing of perfectionists: A qualitative study. Psychotherapy Research, 21, 510–524. DOI: 10.1080/10503307.2011.587468

Mirowsky, J., & Ross, C. E. (1995). Sex differences in distress: Real or artifact? *American Sociological Review*, *60*(3), 449. https://doi.org/10.2307/2096424

Monat, A., Averill, J. R., & Lazarus, R. S. (1972). Anticipatory stress and coping reactions under various conditions of uncertainty. *Journal of Personality and Social Psychology*, *24*(2), 237–253. https://doi.org/10.1037/h0033297

Morales, E. E. (2008). The resilient mind: The psychology of academic resilience. Educational Forum, 72, 152–167. doi: 10.1080/00131720701805017

Nasso, S., Vanderhasselt, M. A., Demeyer, I., &De Raedt, R. (2019). Autonomic Regulation in Response to Stress: The Influence of Anticipatory Emotion Regulation Strategies and Trait Rumination. *American Psychological Association 19*(3), 443-454. http://dx.doi.org/10.1037/emo0000448

Niehaus, E., & Nyunt, G. (2022). Uncovering the potential learning in short-term study abroad. *Journal of Student Affairs Research and Practice*, *60*(3), 417–432. https://doi.org/10.1080/19496591.2021.1997758

Nzaranyimana, T., Orvis, K. S., & Russell, M. A. (2020). Assessing Cultural Awareness & International Engagement Skills Through Experiential Learning: The Spring 2018 Study Abroad Experiences in Rural Areas of Peru For Twelve Undergraduate Students From Purdue University in The College Of Agriculture. NACTA Journal, 64(2), 414-420.

Örücü, M. Ç., & Demir, A. (2009). Psychometric evaluation of Perceived Stress Scale for Turkish University students. *Stress and Health*, *25*(1), 103–109. https://doi.org/10.1002/smi.1218

Peabody, J. E., Ryznar, R., Ziesmann, M. T., & Gillman, L. (2023). A Systematic Review of Heart Rate Variability as a Measure of Stress in Medical Professionals. Cureus, 15(1), e34345. https://doi.org/10.7759/cureus.34345

Peffer, P. A. L. (2011). Demographics of an Undergraduate Animal Sciences Course and the Influence of Gender and Major on Course Performance . *NACTA Journal*, *59*(1), 26–31.

Pell, A. N. (1996). Fixing the leaky pipeline: Women scientists in academia. Journal of Animal Science, 74(11), 2843–2848. https://doi.org/10.2527/1996.74112843x

Perogamvros, I., Keevil, B. G., Ray, D. W., & Trainer, P. J. (2010). Salivary cortisone is a potential biomarker for serum free cortisol. The Journal of Clinical Endocrinology & Metabolism, 95(11), 4951-4958.

Punita, P., Saranya, K., & Kumar, S. (2016). Gender difference in heart rate variability in medical students and association with the level of stress. National Journal of Physiology, Pharmacy and Pharmacology, 6(5), 431. https://doi.org/10.5455/njppp.2016.6.0102325042016

Reiling, B. A., Marshall, T. T., Brendemuhl, J. H., McQuagge, J. A., & Umphrey, J. E. (2003). Experiential learning in the animal sciences: Development of a multispecies large-animal management and production practicum1. Journal of Animal Science, 81(12), 3202–3210. https://doi.org/10.2527/2003.81123202x

Roberts, T. G., & Jones, B. L. (2009). A brain–based, experiential learning framework to guide international experiences. AIAEE: Proceedings of the 25th Annual Conference, 404–411.

Roberts, T. G., Conner, N. W., & Jones, B. L. (2013). An Experiential Learning Framework for Engaging Learners During Study Abroad Experiences. *NACTA Journal*, *57*(3a), 28–35. http://www.jstor.org/stable/nactajournal.57.3a.28

Rodriguez, M., & Roberts, T. G. (2011). Identifying best practices for a successful study abroad program. *Journal of International Agricultural and Extension Education*, *18*(1), 19–33. https://doi.org/10.5191/jiaee.2011.18102

Rowland, A. L. (2008). The health challenges of urban Latino college students as revealed through student journaling. Journal of Hispanic Higher Education, 7, 131–143. DOI: 10.1177/1538192707313937

Sax, L. J. (1997). Health Trends Among College freshmen. *Journal of American College Health*, *45*(6), 252–264. https://doi.org/10.1080/07448481.1997.9936895

Scarpina, F., & Tagini, S. (2017). The Stroop color and word test. *Frontiers in Psychology*, *8*. https://doi.org/10.3389/fpsyg.2017.00557

Selye, H. (1956). *The stress of Life / Hans Selye*. McGraw-Hill.

Sesay, M. G. (2019). *Perceived Stress in College Students: Prevalence, Sources, and Stress Reduction Activities* (thesis).

Shaffer, F., & Ginsberg, J. P. (2017). An overview of heart rate variability metrics and norms. *Frontiers in Public Health*, *5*. https://doi.org/10.3389/fpubh.2017.00258

Shaffer, McCraty, R., & Zerr, C. L. (2014). A healthy heart is not a metronome: an integrative review of the heart's anatomy and heart rate variability. Frontiers in Psychology, 5. https://doi.org/10.3389/fpsyg.2014.01040

Shaffer, F., Meehan, Z. M., & Zerr, C. L. (2020). A critical review of ultra-short-term heart rate variability norms research. *Frontiers in Neuroscience, 14*. https://doi.org/10.3389/fnins.2020.594880

Shaffer, F., Shearman, S., & Meehan, Z. M. (2016). The promise of Ultra-Short-Term (UST) heart rate variability measurements. *Biofeedback, 44*(4), 229–233. https://doi.org/10.5298/1081-5937-44.3.09

Shields, N. (2002). Anticipatory socialization, adjustment to university life, and perceived stress: Generational and sibling effects. Social Psychology of Education, 5, 365–392. DOI: 10.1023/A:1020929822361

Schlatter, S., Schmidt, L., Lilot, M., Guillot, A., & Debarnot, U. (2021). Implementing biofeedback as a proactive coping strategy: Psychological and physiological effects on anticipatory stress. Behaviour Research and Therapy, 140, 103834. https://doi.org/10.1016/j.brat.2021.103834

Singer, J. A., King, L. A., Green, M. C., & Barr, S. C. (2002). Personal identity and civic responsibility: 'Rising to the occasion' narratives and generativity in community action student interns. Journal of Social Issues, 58, 535–556. DOI: 10.1111/1540-4560.00275

Steinhauer, S. R., Siegle, G. J., Condray, R., & Pless, M. (2004). Sympathetic and parasympathetic innervation of pupillary dilation during sustained processing. *International Journal of Psychophysiology*, *52*(1), 77–86. https://doi.org/10.1016/j.ijpsycho.2003.12.005

Smith, D.E., & Mitry, D. J (2008) Benefits of Study Abroad and Creating Opportunities: The Case for Short-Term Programs . *Journal of Research in Innovative Teaching 1(*1), 236-245

Taylor, R. E., & Kauffman, R. G. (1983). Teaching Animal Science: Changes and Challenges. Journal of Animal Science, 57(suppl_2), 171–196. https://doi.org/10.2527/animalsci1983.57Supplement_2171x

Tindle, J. & Tadi, P. (2022). Neuroanatomy, Parasympathetic Nervous System. *StatPearls Publishing.*

Trivedi, S., Clark, J. C., Long, L., Daniel, G. A., Anderson, S. M., & Zheng, Y. (2023). Assessing the mental wellbeing and help-seeking behaviors of pre-veterinary undergraduates at a land-grant institution. *Journal of Veterinary Medical Education*. https://doi.org/10.3138/jvme-2022-0096

Vanderhasselt, M. A., Remue, J., Ng, K., & De Raedt, R. (2014) The interplay between the anticipation and subsequent online processing of emotional stimuli as measured by pupillary dilatation: The role of cognitive reappraisal. *Frontiers in Psychology 5* https://doi.org/10.3389/fpsyg.2014.00207

Waxenbaum, J. A., Reddy, V., & Varacallo, M. (2023). Anatomy, Autonomic Nervous System. *StatPearls*.

Weinstein, L., & Laverghetta, A. (2009). College student stress and satisfaction with life. College Student Journal, 43(4).

Wingenbach, G., Chmielewski, N., Smith, J., Pina Jr., M., & Hamilton, W. (2006). Barriers to international experiential participation. *Journal of International Agricultural and Extension Education, 13*(3). https://doi.org/10.5191/jiaee.2006.13306

Winters, J. (2012). Physiological measurement (s) of the stress response. In *Handbook of stress, coping, and health: Implications for nursing research, theory, and practice* (2nd ed.). essay, Sage Publications.

Yamanaka, T., Yamagishi, N., Nawa, N. E., & Anderson, S. J. (2021). Assessing changes in mood state in university students following short-term study abroad. *PLOS ONE*, *16*(12). https://doi.org/10.1371/journal.pone.0261762

CHAPTER II: STUDENT STRESS IN ANIMAL SCIENCE STUDY ABROAD

Abstract

Study abroad programs increase a student's exposure to different cultures, traditions, and ways of life. While the benefits of participating in a study abroad program have been well documented, barriers, such as language, culture, and environment, may present themselves to program participants. Participants are introduced to a variety of new experiences both prior to and while abroad, which have the potential to introduce additional stress on students, in conjunction with the stress more typically experienced during a 'traditional' college experience. This study aims to quantify student stress prior to and while studying abroad in relation to their demographics and life experiences. Over a 12-day period in December 2022 in Mexico City, Mexico, students participated in an Animal Science focused study abroad program. Psychological and physiological stress data were collected in conjunction with student demographic and background characteristics. Data analysis showed that participant's perceived stress scores were higher prior to going abroad, than while abroad, and that a participant's ethnicity was a predictor of perceived stress ($P < 0.05$). However, physiological stress was not impacted by study abroad or demographic information ($P > 0.05$).

Keywords: animal science, heart rate variability, student stress, study abroad

Study Abroad Programs and Student Stress: An Animal Science Curriculum Case Study

Study abroad programs have been shown to provide a variety of academic and personal benefits to students. These benefits include exposure to a foreign language, development of cross-cultural skills and understanding, and enhancing the student's formal education (Smith & Mitry, 2008). However, challenges while participating in these programs can and do arise that students must confront. For example, students may experience an increase in stress and anxiety

associated with encountering differences in cultures, values, assumptions, and expectations when visiting their host country (Berry, 2005). Increases in stress and anxiety have been shown to lead to a decline in overall mental health (American Psychiatric Association). Previous studies have examined the relationship between student mental health and participation in study abroad programs (Hunley, 2010; Bathke & Kim, 2016). Hunley (2010) determined students that have "high functioning" mental health tend to continue having a high functioning mental health while abroad, resulting in a positive abroad experience. Conversely, students with lower mental health functioning prior to leaving tended to have a harder time abroad. Bathke and Kim (2016) found their participants had reported overall good mental health while studying abroad.

Students participating in study abroad programs have traditionally done so on a yearly or per-semester basis; typically beginning their program in either the Fall or Spring semester of the academic year. In recent years however, short-term study abroad (STSA) programs have seen an increase in popularity (Institute of International Education, 2022). Short-term study abroad is defined as having a duration of less than 8 weeks (Sanger & Mason, 2019). The present study utilized a STSA program.

Defining and Measuring Stress

Selye (1956) defined stress as "a response in order to maintain the state of stability or homology that the body has maintained against the stimulus to break the mental and physical balance and stability of the body." Two forms of stress that are commonly investigated are psychological and physiological stress (Kogler et al., 2016). Psychological stress has been defined as a "particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and endangering his or her well-being" (Lazarus & Folkman, 1984). Physiological stress, however, is the response of bodily systems to

stress, and commonly includes a combination of increased heart rate, respiration rate, and production of steroid hormones, which includes cortisol that initiates a cascade of more systemic responses to stress (Chu et al. 2022). It is important to note the relationship between the two forms of stress. When a situation is perceived as stressful, individuals have a heightened level of physiological stress (Chu et al., 2022). Studies have shown that psychological stressors like speaking publicly, or some form of conflict, have been shown to increase blood pressure and heart rate, which are physiological stress symptoms (Kamarck & Lovallo, 2003). With defining different types of stress comes the challenge of determining how to best measure them (Kim et al., 2018).

One method of physiological stress measurement is heart rate variability (HRV). Heart rate variability measures the time intervals between consecutive heart beats over a specified period (Shaffer & Ginsberg, 2017). Classifications of HRV readings include 24-hour, short term (5 minutes) and ultra-short term (<5 minutes; Shaffer & Ginsberg, 2017). In relation to stress, a lower HRV level has been shown to reflect a higher measure of stress (de Vries et al., 2021; Kim et al., 2018; Punita et al., 2016). When stress occurs, a physiological response is for one's heart rate to increase. As heart rate increases, the time between heart beats becomes shorter and less variable, thus leading to decreases in HRV (McCraty & Shaffer, 2015).

A method for measuring psychological stress levels is the Perceived Stress Survey (PSS) developed by Cohen et al. (1983). The PSS is a "brief and easy-to administer measure of the degree to which circumstances in an individual's life have been appraised as stressful" and has been shown to be both a reliable and valid measure of stress (Cohen et al., 1983). This survey has been used in a variety of studies as a measure of perceived stress, including student stress,

stress levels in health care workers, and other populations as it continues to serve as a reliable test (Agius 1996; Örücü & Demir, 2009; Roberti et al., 2006; White et al., 2021).

The goal of this study was to examine both physiological and psychological stress levels of students participating in a STSA program. To the authors' knowledge, few studies have researched STSA programs and their effects on student mental health and stress (Nguyen, 2017; Yamanaka et al., 2021). A potential benefit of this study is to identify stress levels in our student population and identify future research areas.

Methods

This study was conducted in December 2022 during a 12-day, undergraduate Animal Science study abroad program in Mexico City, Mexico hosted by the Illinois State University Department of Agriculture. The program included course lectures on many facets of the agriculture industry in Mexico, Spanish lessons, as well as agricultural and cultural excursions across Mexico City and surrounding areas. During a pre-departure meeting, students were informed of the study and provided a consent form that detailed the purpose and design of the study. Student participation was strictly voluntary with neither penalty nor reward provided for participation. All study procedures were approved by the Illinois State University Institutional Review Board, protocol #2022-172.

Study Participants

Summary statistics of study participants are shown in Table 1. All student participants were female and majoring in either Animal Science or Pre-Veterinary Medicine programs. While having all female participants is not reflective of the general population, it is common in study abroad programs to have a majority female participant population (Institute of International Education, 2023). Three participants were seniors, three were juniors, and one was a sophomore.

The majority of participants had little to no experience with international travel, with one citing moderate experience. Of the seven participants, five identified as Caucasian and two identified as non-Caucasian/minority ethnicities.

Study Design and Implementation

This study was divided into two phases: prior to departure (PRE), and while abroad (ABRD). Data collected included psychological and physiological stress parameters. Psychological stress data were collected via a modified version of the PSS. This modification included changing the question text from "*In the past month*…" to "*In the past 24 hours*…" (see Figure 1). The survey consists of 10 Likert scale questions, with six "negative" questions and four "positive" questions. Questions were scored ranging from 0-4 and assigned based on the participants' responses. An aggregate score was calculated by summing the 10 individual question scores, where the participant responses for the six "negative" questions remained the same, and the responses from the four "positive" questions were reversed. For example, a response in a "negative" question of 3, remained a 3 when the aggregate score was calculated; however, a response of 3 for a "positive" question was reversed, and replaced with 1 when calculating the aggregate score. Aggregated scores from the survey can thus range from a low of 0, which is reflective of little to no perceived stress, to a high of 40, which is reflective of high perceived stress. Physiological stress data included heart rate and HRV parameters utilizing heart rate monitors (Polar H9, Polar Electro, Kempele, Finland). For this, participants were asked to sit and complete the PSS, while acclimating to a resting heart rate state. Heart rate monitors were then applied to student participants, where HRV data was collected over a 2.5 minute period utilizing the Elite HRV smart phone app (Elite HRV Inc., Asheville, NC, USA). The app provided breathing cues to participants during the collection period to ensure a steady heart rate.

Collection of stress data took place 30 days, 9 days, and 2 days prior to departure and during all 12 days of the study abroad program. Data during ABRD were collected soon after participants awoke for the day and prior to departure.

Statistical Analysis

Data were analyzed utilizing the mixed procedure of SAS (version 9.4; Cary, NC 27513), where statistical significance was determined when $P \leq 0.05$. Two separate models were run; one with HRV as the dependent variable and one with PSS as the dependent variable. In both models the independent variables were ethnicity, international travel experience, phase of study, and two-way interactions of ethnicity by phase, and international experience by phase. Ethnicity included Caucasian and non-Caucasian levels, international experience included none and minor levels, and phase included PRE and ABRD levels. A repeated measures statement was included by day with participant as the subject. Tukey adjustments were utilized to look at the pairwise comparisons for significant interaction effects. Residual panels were analyzed for homogeneity of variance and normality of residuals.

Results

Participant PSS summary statistics are summarized in Table 2. The mean HRV was 45.86 ± 10.36 (standard deviation) with a minimum score of 19.00 and a maximum score of 89.00. The mean PSS score was 15.90 ± 6.88 (standard deviation) with a minimum score of 4.00 and a maximum score of 36.00.

Perceived stress model results are shown in Table 3. An effect was shown regarding phase on PSS, where participants' scores were higher in the PRE phase (17.0 ± 1.9; LS mean ± SE) than in the ABRD phase (13.2 ± 1.5; $P = 0.051$). Ethnicity was also found to have a significant effect, with Caucasian participants having higher PSS scores (20.6 ± 1.4) than non-

Caucasian participants (9.5 ± 2.6; $P = 0.018$). Prior international experience had no effect on PSS scores ($P = 0.185$).

The interaction between phase and ethnicity was found to be significant ($P = 0.019$; Figure 2), with Caucasian participants having higher PSS scores in the PRE phase compared to the ABRD phase. No discernable differences were detected between Caucasian participants in ABRD, non-Caucasian participants in PRE, or non-Caucasian participants in ABRD ($P \geq 0.268$). An interaction effect between international experience and phase was identified ($P = 0.020$; Figure 3), where participants with no prior abroad experience had higher PSS scores in the PRE (21.7 ± 1.72) than in the ABRD phase (13.0± 1.39; $P = 0.009$). No significant differences were shown between phases for participants who had prior abroad experience ($P = 0.147$).

Model findings concerning participant HRV is shown in Table 4. Overall**,** no effects of phase, ethnicity, or international experience on HRV were identified ($P \geq 0.228$). Interaction between international experience and phase was also not significant ($P = 0.103$; Figure 4). There was an interaction effect of ethnicity by phase ($P = 0.021$; Figure 5), however, no discernable trends were observed ($P \geq 0.108$).

Discussion

Prior to leaving for the STSA program, participants were faced with a variety of stressors. This program overlapped with the university's final exam week, so the participants in this STSA were required to take their final exams early (prior to departure) or to take their finals while abroad. Taking their final exams early or abroad and working with their professor for coordination were potential stressors for our participants. Along with their schoolwork, participants were preparing to travel abroad, for some this being their first international experience. It is intuitive that these additional stressors would result in higher student stress

levels in the PRE phase. This could be explained by the idea of anticipatory stress. Once the students were abroad, new stressors were introduced, associated with a different culture and experiences.

Prior studies have evaluated the idea of anticipatory stress. Vanderhasselt et al. (2014) reported that participants showed higher levels of pupillary responses in preparation for a difficult task than while they were completing the task. This aligns with the idea that when individuals have high anticipation for an event or task, their emotional load during the task itself is not as high. This is similar to what this study found, as participants showed higher psychological stress in the PRE stage compared to the ABRD stage. Similar results were found in Nasso et al. (2019), where participants perceived stress was higher prior to the stressor than during the stressful event. That study measured both psychological stress with self-reported surveys and physiological stress via HRV in four stages (baseline, anticipatory, interview preparation, and recovery). Their perceived stress results were similar to this study in that participants showed higher perceived stress leading to the event in question. However, physiologically, they found significantly lower HRV during their anticipatory and preparation stages than they did in the recovery stage, which is contrary to the results of this study.

A study completed by Dewey et al. (2018) looked at the relationship between general anxiety, classroom anxiety, and language proficiency during a semester long study abroad. This study measured cortisol levels in students three months prior to going abroad and 2 weeks prior to returning to the United States. They reported participants that had higher stress levels prior to leaving tended to have higher cortisol levels while abroad. They stated the anxiety or stress of studying abroad was comparable to those of moderate consistent stressors, not those of extreme

stressors. This study by Dewey et al. (2018) reported physiological indications of stress, contradicting the results of this study.

An additional study completed by Denovan et al. (2019) looked at perceived stress scores among university students in the United Kingdom. The average age of their participants ranged from 18-23 and consisted of 300 women and 224 men. They found overall PSS scores averaged 19.8 ± 6.4, which was higher than the average scores reported by Cohen et al. (1994) that found an average score of 14.2 ± 6.2 for ages 18-29. Denovan et al. (2019) concluded that their population had high stress levels. In relation to this study, the reported results of the PRE phase had an average score of 17.0 ± 1.9, which was closer to those reported by Denovan, and the ABRD average score of 13.2 ± 1.5 which was closer to those reported by Cohen et al. (1994). With this in mind, participants from this study had scores considered high in both the PRE and ABRD stage. When split by ethnicity, the scores for Caucasian participants averaged 20.6 ± 1.4, which was closer to those found by Denovan (2019), while non-Caucasian participant's average scores of 9.5 ± 1.6 were closer to those found by Cohen et al. (1994). In this case the results of the Caucasian participants fell within the high stress range and the non-Caucasian participants did not.

However, the NH Department of Administrative Services (2020), which has been cited by others (Torales et al., 2020; Vives et al., 2022), states that scores ranging from 0-13 are considered low stress, 14-26 are considered moderate stress, and 27-40 are considered high stress. With this scale in mind, the PRE scores (17.0 ± 1.86), ABRD scores (13.2 ± 1.5), and the Caucasian participant scores (20.6 ± 1.4) would fall within the moderate stress category, and the non-Caucasian scores (9.5 ± 2.6) would fall within the low stress category. Non-Caucasian participants in this study were from higher populated areas based on the demographic surveys.

This may serve as an explanation for the lower stress felt by the participants with the program being held in Mexico City, a very large metropolitan area.

Heart Rate Variability, a measure of the autonomic nervous system, has been studied previously. Most studies have seen a response in HRV when introduced to different stressors (Kim et al., 2018). A study by Michels et al. (2013) found that low HRV might serve as an indicator for stress in children. Another study by Lucini et al. (2002) looked at HRV prior to an examination in college students, and found that mild, real-life stressors can have effects on cardiovascular homeostasis. Taelman et al. (2011) found that HRV can be sensitive to any change in mental or physical state.

This study's results were different from all of these in that there were no significant differences between the events in question. The differences between this study and others could be for a variety of reasons. Participants in this study may have not been physiologically stressed prior to and while abroad or may have had the same stress levels prior to and while abroad. Heart rate variability can be difficult to categorize due to differences between individuals. The authors of this study believe that future research on physiological stress while studying abroad is warranted. With additions to the current methods, other methods could be used to determine physiological stress levels and take individuality, as well as baseline stress, more into account.

Summary

In summary, participants felt they were more stressed prior to departure than they were abroad, with ethnicity and international experience playing a significant role in the level of stress that was felt. No significant differences in physiological stress were identified. Limitations of this study included a small sample size and unbalanced participant demographics. Future

research is needed on student stress and study abroad in different program lengths and locations, as well as in more diverse student populations.

References

Agius, R. M., Blenkin, H., Deary, I. J., Zealley, H. E., & Wood, R. A. (1996). Survey of perceived stress and work demands of consultant doctors. *Occupational and Environmental Medicine*, *53*(4), 217–224. https://doi.org/10.1136/oem.53.4.217

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (*5th ed.) https://doi.org/10.1176/appi.books.9780890425596

Bathke, A., & Kim, Y.-H. (2016). Keep calm and study abroad: The effect of learning abroad on Student Mental Health. *Frontiers: The Interdisciplinary Journal of Study Abroad*, *27*(1), 1–16. https://doi.org/10.36366/frontiers.v27i1.371

Berry, J. W. (2005). Acculturation: Living successfully in two cultures. *International Journal of Intercultural Relations*, *29*(6), 697–712. https://doi.org/10.1016/j.ijintrel.2005.07.013

Chu, B., Marwaha, K., Sanvictores, T., & Ayers, D. (2022). Physiology, Stress Reaction. *StatPearls*. StatPearls Publishing.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*(4), 385-396. https://doi.org/10.2307/2136404

Cohen, S., Kamarck, T., & Mermelstein, R. (1994). Perceived stress scale. *Measuring stress: A guide for health and social scientists*, *10*(2), 1-2.

de Vries, H., Kamphuis, W., Oldenhuis, H., van der Schans, C., & Sanderman, R. (2021). Moderation of the stressor-strain process in interns by heart rate variability measured with a wearable and smartphone app: Within-subject design using continuous monitoring. *JMIR Cardio*, *5*(2),e28731-e28731. https://doi.org/10.2196/28731

Denovan, A., Dagnall, N., Dhingra, K., & Grogan, S. (2019). Evaluating the Perceived Stress Scale among UK university students: implications for stress measurement and management. *Studies in Higher Education, 44*(1), 120-133 10.1080/03075079.2017.1340445

Dewey, D. P., Belnap, R. K., & Steffen, P. (2018). Anxiety: Stress, Foreign Language Classroom Anxiety, and Enjoyment During Study Abroad Program in Amman, Jordan. *Annual Review of Applied Linguistics 38.* 140-161 doi: 10.1017/S0267190518000107

Hunley, H. A. (2010). Students' functioning while studying abroad: The impact of psychological distress and loneliness. *International Journal of Intercultural Relations*, *34*(4), 386–392. https://doi.org/10.1016/j.ijintrel.2009.08.005

Institute of International Education. (2022) Detailed Duration of U.S. Study Abroad, 2005/06-2020/21. *Open Doors Report on International Education Exchange.*

Institute of International Education. (2023). "Profile of U.S. Study Abroad Students, 2000/01-2021/22." *Open Doors Report on International Education Exchange.*

Kamarck TW, & Lovallo WR. (2003) Cardiovascular reactivity to psychological challenge: conceptual and measurement considerations. *Psychosom Med.* 65(1):9–21. https://doi.org/10.1097/01.psy.0000030390.34416.3e

Kim, H. G., Cheon, E. J., Bai, D. S., Lee, Y. H., & Koo, B. H. (2018). Stress and heart rate variability: A meta-analysis and review of the literature. *Psychiatry Investigation*, *15*(3), 235–245. https://doi.org/10.30773/pi.2017.08.17

Kogler, L., Mueller,V. I., Chang, A., Eickhoff, S. B., Fox, P. B., Gur, R. C., & Derntl, B. (2016). Psychosocial versus physiological stress- meta-analyses on deactivations and activations of the neural correlates of stress reactions. *Neuroimage, 119,* 235-251. https://doi.org/10.1016/j.neuroimage.2015.06.059

Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping*. Springer Publishing Company.

Lucini, D., Norbiato, G., Clerici, M., & Pagani, M. (2002). Hemodynamic and autonomic adjustments to real life stress conditions in humans. *Hypertension*, *39*(1), 184–188. https://doi.org/10.1161/hy0102.100784

McCraty, R., & Shaffer, F. (2015). Heart rate variability: New perspectives on physiological mechanisms, assessment of self-regulatory capacity, and Health Risk. *Global Advances in Health and Medicine*, *4*(1), 46–61. https://doi.org/10.7453/gahmj.2014.073

Michels, N., Sioen, I., Clays, E., De Buyzere, M., Ahrens, W., Huybrechts, I., Vanaelst, B., & De Henauw, S. (2013). Children's heart rate variability as stress indicator: Association with reported stress and Cortisol. *Biological Psychology*, *94*(2), 433–440. https://doi.org/10.1016/j.biopsycho.2013.08.005

Nasso, S., Vanderhasselt, M. A., Demeyer, I., &De Raedt, R. (2019). Autonomic Regulation in Response to Stress: The Influence of Anticipatory Emotion Regulation Strategies and Trait Rumination. *American Psychological Association 19*(3), 443-454. http://dx.doi.org/10.1037/emo0000448

Nguyen, A. (2017). Intercultural competence in short-term study abroad. *Frontiers: The Interdisciplinary Journal of Study Abroad*, *29*(2), 109–127. https://doi.org/10.36366/frontiers.v29i2.396

NH Department of Administrative Services. (2020). Perceived Stress Scale. *NH Department of Administrative Services*. https://das.nh.gov/wellness/docs/percievedstressscale.pdf

Örücü, M. Ç., & Demir, A. (2009). Psychometric evaluation of Perceived Stress Scale for Turkish University students. *Stress and Health*, *25*(1), 103–109. https://doi.org/10.1002/smi.1218

Punita, P., Saranya, K. & Kumar, S.S. (2016) Gender Difference in Heart Rate Variability in Medical Students and Association with the Level of Stress. *National Journal of Physiology, Pharmacy and Pharmacology, 6*(5), 431-437. DOI:10.5455/njppp.2016.6.0102325042016

Roberti J. W., Harrington L. N., & Storch E. A. (2006) Further Psychometric Support of the 10-Item Version of the Perceived Stress Scale. *Journal of College Counseling, 9*(2), 135-147. https://doi.org/10.1002/j.2161-1882.2006.tb00100.x

Sanger, J., & Mason, L. (2019). Who's counting? Understanding the landscape of graduate learning overseas. New York: Institute of International Education.

Selye, H. (1956). *The stress of Life / Hans Selye*. McGraw-Hill.

Shaffer, F., & Ginsberg, J. P. (2017). An overview of heart rate variability metrics and norms. *Frontiers in Public Health*, *5*. https://doi.org/10.3389/fpubh.2017.00258

Smith, D.E., & Mitry, D. J (2008) Benefits of Study Abroad and Creating Opportunities: The Case for Short-Term Programs . *Journal of Research in Innovative Teaching 1(*1), 236-245

Taelman, J., Vandeput, S., Gligorijević, I., Spaepen, A., & Van Huffel, S. (2011). Time-frequency heart rate variability characteristics of young adults during physical, mental and combined stress in laboratory environment. *Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE Engineering in Medicine and Biology Society. Annual International Conference, 2011*, 1973–1976. https://doi.org/10.1109/IEMBS.2011.6090556

Torales, J., Ríos-González, C., Barrios, I., O'Higgins, M., González, I., García, O., Castaldelli-Maia, J. M., & Ventriglio, A. (2020). Self-perceived stress during the quarantine of COVID-19 pandemic in Paraguay: An exploratory survey. *Frontiers in Psychiatry, 11*. https://doi.org/10.3389/fpsyt.2020.558691

Vanderhasselt, M. A., Remue, J., Ng, K., & De Raedt, R. (2014) The interplay between the anticipation and subsequent online processing of emotional stimuli as measured by pupillary dilatation: The role of cognitive reappraisal. *Frontiers in Psychology 5* https://doi.org/10.3389/fpsyg.2014.00207

Vives, N., Binefa, G., Vidal, C., Mila, N., Munoz, R., Guardiola, V. Rial, O., & Garcia, M. (2022) Short-Term Impact of the COVID-19 Pandemic on a Population-Based Screening Program for Colorectal Cancer in Catalonia (Spain). *Preventive Medicine*, 155 https://doi.org/10.21203/rs.3.rs-562834/v1

Yamanaka, T., Yamagishi, N., Nawa, N. E., & Anderson, S. J. (2021). Assessing changes in mood state in university students following short-term study abroad. *PLOS ONE*, *16*(12). https://doi.org/10.1371/journal.pone.0261762

Tables

Table 2.1 Animal Science Study Abroad in Mexico Program Student Demographics

Characteristic	# of Participants
Sex	
Female	7
Male	0
Ethnicity	
Caucasian	5
Non-Caucasian	2
Academic Classification	
Sophomore	1
Junior	3
Senior	3
Academic Program	
Animal Science	3
Pre-Veterinary Science	4
Level of International Experience	
None	5
Minor	2

Table 2.2 Summary Statistics for Participant Heart Rate Variability (HRV) and Perceived Stress Survey (PSS)

Variable	N	Mean	Standard Deviation	Minimum	Maximum
HRV	99	45.87	10.35	19.00	89.00
PSS	99	15.90	6.87	4.00	36.00

Table 2.3 Ethnicity, Prior International Experience, and Phase Effects on Participant Perceived Stress During Study Abroad

Variable	Coefficient	Standard Error	P-Value
Ethnicity			
Caucasian	20.6	2.6	0.020
Non-Caucasian	9.5		
International Experience			
None	17.3	2.6	0.185
Minor	12.8		
Phase			
Pre-Departure (PRE)	17.0	1.9	0.018
While Abroad (ABRD)	13.2		

Note. [1]Phase consisted of measurements prior to departure (PRE; 30, 9 and 2 days prior) and while abroad (ABRD; days 1-12).

Table 2.4 Ethnicity, Prior International Experience, and Phase Effects on Participant Heart Rate Variability During Study Abroad

Variable	Coefficient	Standard Error	P-Value
Ethnicity			
Caucasian	48.0	18.0	0.250
Non-Caucasian	40.9		
International Experience			
None	48.3	18.3	0.228
Minor	40.7		
Phase			
Pre-Departure (PRE)	43.9	3.7	0.743
While Abroad (ABRD)	45.0		

Note. [1]Phase consisted of measurements prior to departure (PRE; 30, 9 and 2 days prior) and while abroad (ABRD; days 1-12).

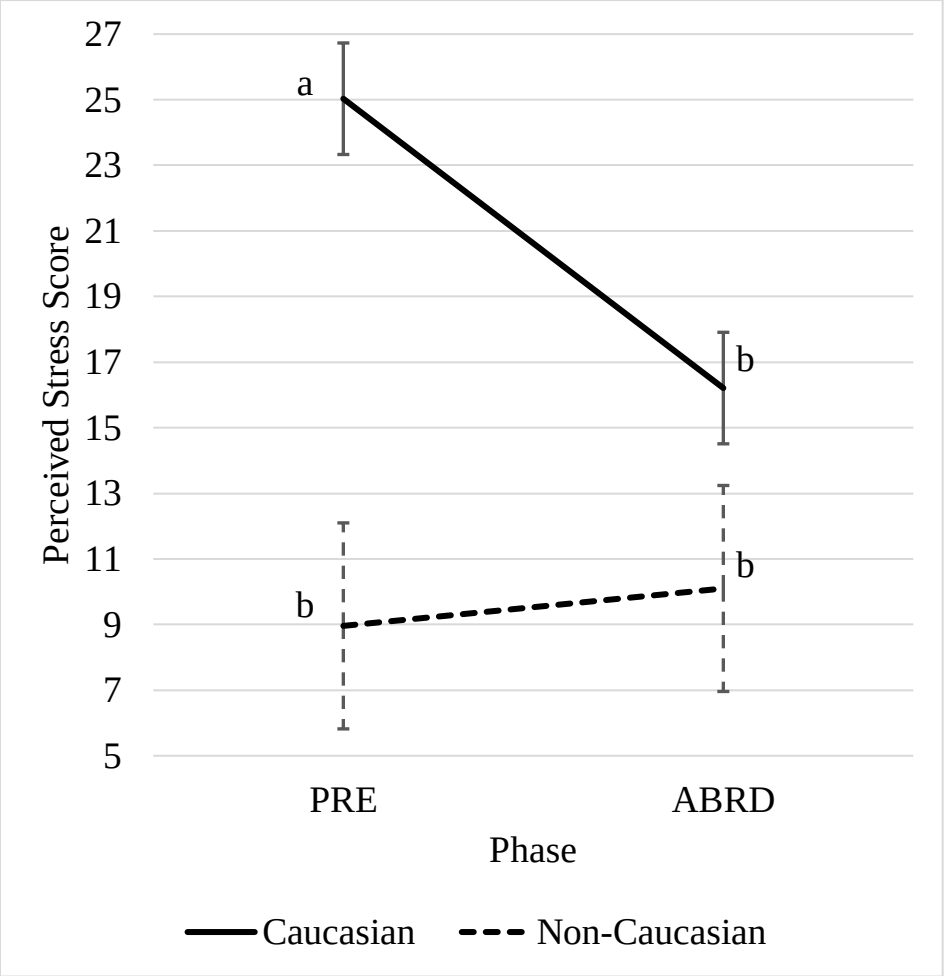
Figures

Figure 2.1 Modified Perceived Stress Scale

In the past 24 hours, how often have you been upset because of something that happened unexpectedly?
In the past 24 hours, how often have you felt that you were unable to control the important things in your life?
In the past 24 hours, how often have you felt nervous and stressed?
In the past 24 hours, how often have you felt confident about your ability to handle your personal problems?
In the past 24 hours, how often have you felt that things were going your way?
In the past 24 hours, how often have you found that you could not cope with all the things that you had to do?
In the past 24 hours, how often have you been able to control irritations in your life?
In the past 24 hours, how often have you felt that you were on top of things?
In the past 24 hours, how often have you been angered because of things that happened that were outside of your control?
In the past 24 hours, how often have you felt difficulties were piling up so high that you could not overcome them?

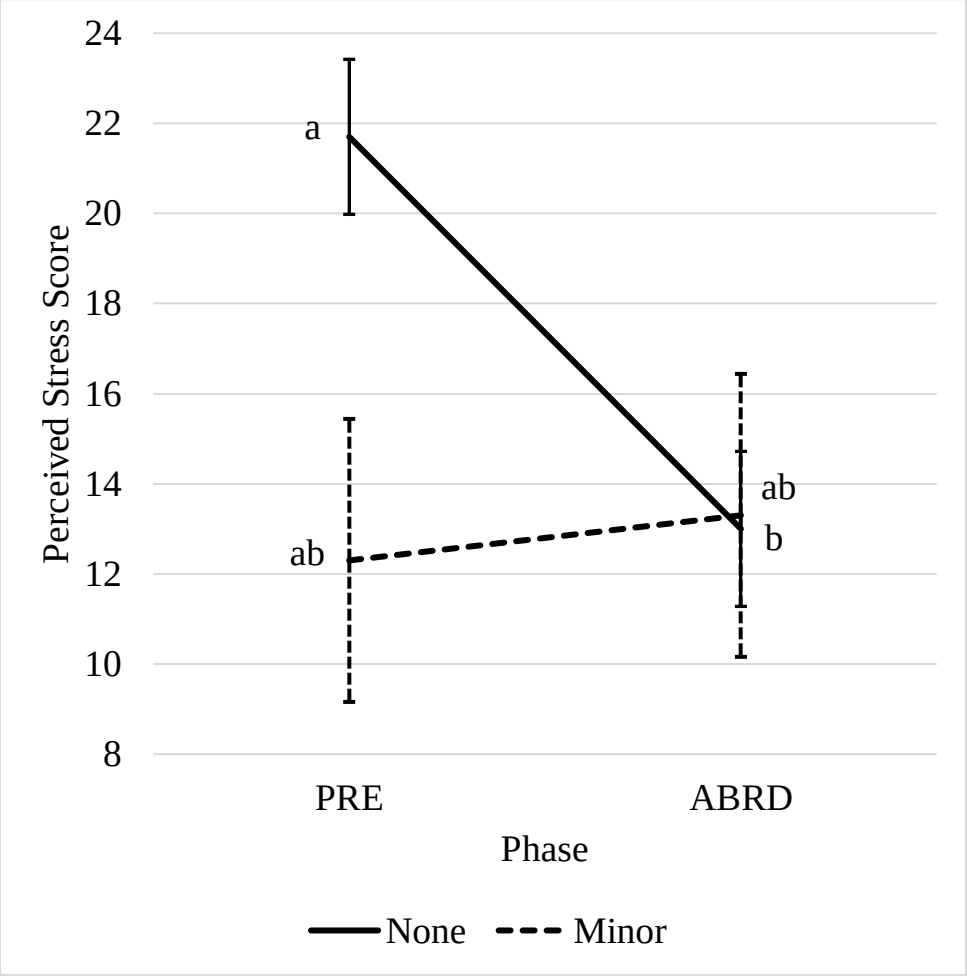
Note. Participants were given this 10 question, 5 point Likert scale survey (modified from Cohen et al., 1983) throughout the study prior to departure for the study abroad program and every day while abroad on the program. For each of these questions, they were asked to choose one of the following to describe which best described how they felt: 0 - never 1 - almost never 2 - sometimes 3 - fairly often 4 - very often. The survey was graded with the following criteria: To begin, the scores were reversed for questions 4, 5, 7, and 8. The scores were adjusted like this:0 = 4, 1 = 3, 2 = 2, 3 = 1, 4 = 0. All scores were then summed together (reverse scores for 4, 5, 7, 8 and normal scores for 1, 2, 3, 6, 9, 10).

Figure 2.2 Interaction of Ethnicity by Phase on Perceived Stress of Study Abroad Participants



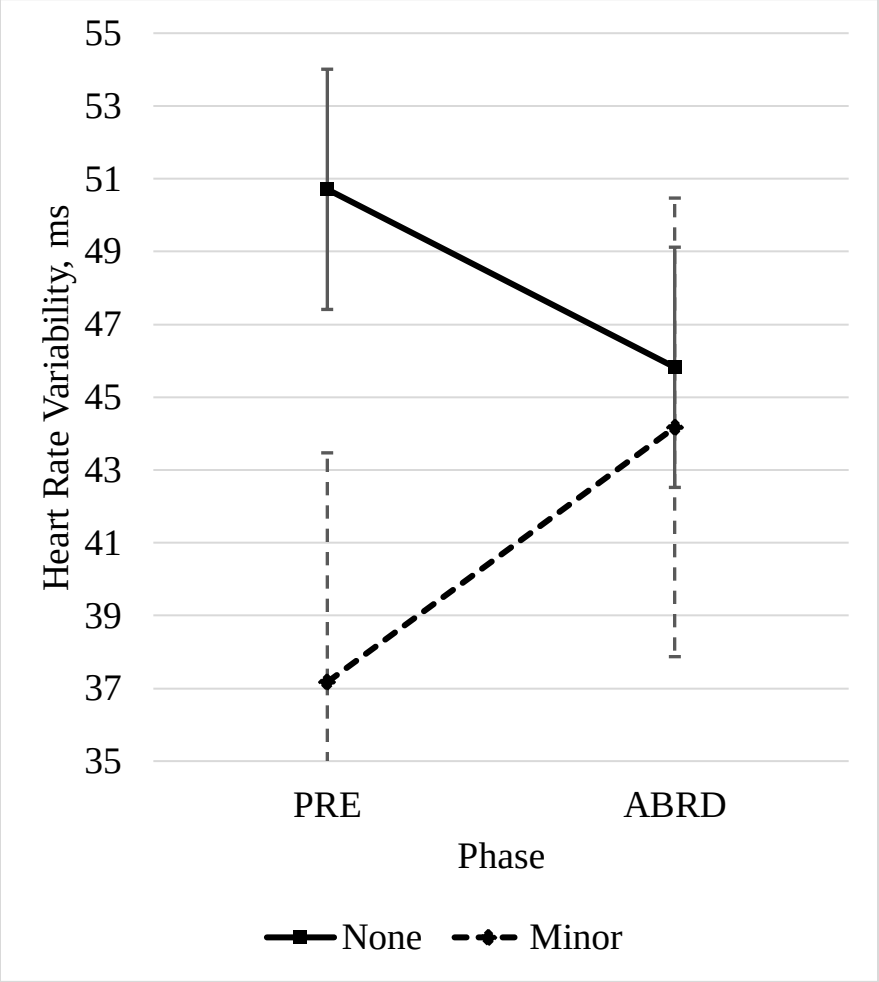
Note. This figure illustrates the interaction effect of ethnicity by phase on participant perceived stress. The PRE phase consisted of 30, 9 and 2 days prior to departure for the study abroad program, whereas the ABRD program consisted of days 1-12 while abroad. [ab] Letters that differ are statistically different from one another ($P < 0.05$).

Figure 2.3 Interaction of Prior International Experience by Phase on Perceived Stress of Study Abroad Participants



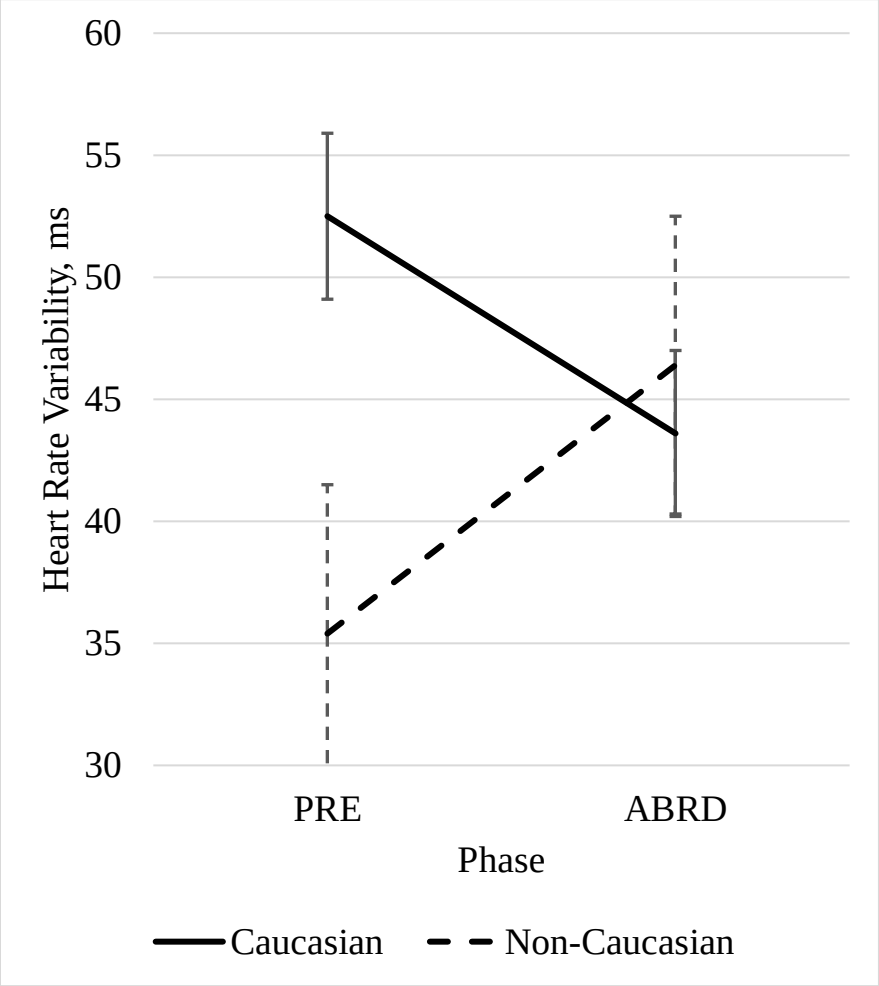
Note. This figure illustrates the interaction effect of International Experience by phase on participant perceived stress The PRE phase consisted of 30, 9 and 2 days prior to departure for the study abroad program, whereas the ABRD program consisted of days 1-12 while abroad. [ab] Letters that differ are statistically different from one another ($P < 0.05$).

Figure 2.4 Interaction of Prior International Experience by Phase on Heart Rate Variability of Study Abroad Participants



Note. This figure illustrates the interaction effect of International Experience by phase on participant Heart Rate Variability. The PRE phase consisted of 30, 9 and 2 days prior to departure for the study abroad program, whereas the ABRD program consisted of days 1-12 while abroad.

Figure 2.5 Interaction of Ethnicity by Phase on Heart Rate Variability of Study Abroad Participants



Note. This figure illustrates the interaction effect of Ethnicity by phase on participant Heart Rate Variability. The PRE phase consisted of 30, 9 and 2 days prior to departure for the study abroad program, whereas the ABRD program consisted of days 1-12 while abroad

CHAPTER III: EVALUATING STUDENT STRESS IN RELATION TO A SHORT-TERM STUDY ABROAD PROGRAM IN ANIMAL SCIENCE

Abstract

While study abroad programs provide many benefits for participants, they can be very intimidating and stress-inducing for individuals that choose to participate. This study aimed to quantify student physiological and psychological stress surrounding a short-term study abroad program. By utilizing a modified Perceived Stress Survey (PSS) and a Stress Index that is derived from heart rate variability measurements, results have shown how student demographics and program adjustments can impact student stress levels. The results show that Caucasian participants had higher PSS scores than non-Caucasian participants ($P < 0.01$). Participants also had higher PSS scores prior to leaving than while abroad ($P < 0.01$). However, participants were more physiologically stressed while they were abroad than prior to leaving ($P = 0.01$). Following a change in the program's curriculum, there was also a decrease in psychological stress between participants in this study and a preliminary study conducted the year prior.

Keywords: HRV, stress, animal science, study abroad

EVALUATING STUDENT STRESS IN RELATION TO A SHORT-TERM, STUDY ABROAD PROGRAM IN ANIMAL SCIENCE

In the United States, a large percentage of agricultural workers come from Mexico and other countries located in Central America (Zahniser et al., 2018). The National Center for Farmworker Health (2022) estimates that 63% of all agricultural workers in the United States have Mexican heritage. With the present demographic of the agricultural workforce, it is important that US students have the skills and characteristics to make them successful in these environments. When students study abroad, they can gain experiences that are applicable to their

future careers. Study abroad programs can increase leadership and communication skills, relationship building, and adaptability and flexibility in participants which are all skills applicable to future careers (Harder et al., 2015). Past studies have found that when students go abroad, they are able to gain a better understanding of diversity, which helps to bridge cultural gaps (Bruening & Frick, 2004). Short-term study abroad programs give students the opportunity to study abroad in a way that is less expensive and time consuming than traditional programs, increasing the accessibility to students. There has been an increase of interest in short-term programs, according to a survey given to 527 US higher education institutions by the Institute of International Education (2023), where about 60% of students studying abroad chose programs less than 8 weeks in length.

One consideration in designing a study abroad program is the period of time preparing the students to go abroad. Jones and Bjelland (2004, p. 963) discussed the idea of preflection, which they define as "the process of being consciously aware of the expectations associated with the learning experience". This preflection period increases participants' capacity to learn from the experiences abroad and allows them to become better prepared for the variety of knowledge that comes with going abroad (Jones & Bjelland, 2004; Roberts et al., 2013). Preflection also allows students to become familiar with the other trip participants prior to being abroad (Koernig, 2007). According to Roberts et al. (2013), educators should ensure that students understand the details of the upcoming experience, as well as the applicability of the trip to help reduce anxiety and stress, while also increasing excitement and focus. Some suggestions for the period prior to leaving include pre-sessions geared towards topics of concern and safety, giving students an overview of cultural practices, and topics geared towards emotional and physical needs of the learners (Roberts et al., 2013).

A variety of topics related to study abroad have been studied in the past. However, student mental health, specifically student stress while abroad, has not been commonly investigated. Bathke and Kim (2016) examined student mental health while abroad over different programs. The participant demographics in their trips were a majority female, and a majority of the trips were approximately a semester long, but also included programs that were over the summer, short-term, and a yearlong. Bathke and Kim (2016) found that 40.78% of study abroad participants almost never felt stressed, 44.05% reported being stressed sometimes, and 14.85% reported often or always being stressed while abroad. Hunley (2009) evaluated psychological stress and loneliness while studying abroad in a semester-long program. That study found that participants had higher psychological stress levels while they were abroad than while they were at home (Hunley, 2009).

Psychological stress in both college students and people of all ages can be measured via the Perceived Stress Scale (PSS; Cohen et al., 1983). The PSS is a Likert-Scale survey that consists of 10 questions and has long been utilized in different environments to determine psychological stress (Andreou et al., 2011; Anwer et al., 2020; Roberti et al., 2006). The scores of the PSS have been divided into three different categories of severity. These categories include scores between 0-13 which is considered mild stress, 14-26 which is considered moderate stress, and 27-40 which is considered severe stress (Graves et al., 2021). Örücü & Demir (2009) reported an average score of 18.9 in college-aged students, with a standard deviation of 6.8, which supports the idea that college aged students score within the moderate stress category (Graves et al., 2021).

Additionally, stress can be quantified with physiological measures such as heart rate variability (HRV), which is the change of the time intervals between adjacent heartbeats (Shaffer

& Ginsberg, 2017). Heart rate variability has been shown to serve as a measure of physiological stress in a variety of studies in different populations (Dishman et al., 2000; Orsila, 2008; Taelman, 2009), and is inversely proportional with stress, where a lower HRV is reflective of increased stress (Kim et al., 2018). One method of utilizing HRV as an indicator of stress is through the Baevsky Stress Index (SI), a directly proportion indicator of stress. The SI is calculated using the equation shown in figure 1 (Baevsky, 2019). Generally, the SI is reported as the square root of the calculated value to ensure normal distribution for statistical analysis (Dias et al., 2022). The scores of the SI can be divided into different zones of stress severity, where SI scores less than 7.1 are considered low, 7.1-12.2 considered normal, 12.2-22.4 considered elevated, 22.4-30 considered high and greater than 30 considered very high (Tarvainen et al., 2018). The SI attempts to "describe the degree of centrally managed sympathetic regulation of mental or physical stress" (Walker, 2019, p. 42). The nervous system is split into two different categories, the sympathetic, and the parasympathetic nervous systems (Chu et al., 2022). The sympathetic nervous system, which is active when the body is under stressful conditions, is linked highly to the SI, which in turn links the SI to physiological stress (Walker, 2019).

The goal of this study was to continue the examination of physiological and psychological stress in students in Animal Science study abroad programs from a preliminary study initially completed by Lawrence et al. (2024). This program focuses on animal agriculture in Mexico due to the demographics of the US agricultural workforce in order to prepare students for future careers in animal agriculture. Curricular adjustments were made by the program coordinator in an attempt to reduce stress and to further identify stress levels in the participants.

Methods

This study is an adapted version of a preliminary study completed by Lawrence et al. (2024). The present study was conducted in January 2024 during a 10-day Animal Science study abroad program located in the Yucatan state of Mexico. This program was hosted by the Department of Agriculture at Illinois State University. The program included cultural excursions around the state and trips to local producers' livestock operations. Students were invited to participate in the study in the first meeting prior to going abroad, and consent and demographic surveys were collected. The program coordinator had no access to the names of students that were participating in the study or their data until all data was de-identified after completion of the program. All study procedures were approved by the Illinois State University Institutional Review Board, (Protocol #2022-172).

Study Participants

A summary of participant demographics is included in Table 1. There were 12 total participants majoring in Animal Science or Pre-Veterinary Medicine, 10 of whom were female. The ages of participants ranged from 19 to 26 years, with an average of 21.5 years. Seven of the participants identified as Caucasian, and five identified as non-Caucasian ethnicities. The academic years ranged from sophomore to seniors. Participant prior experience abroad varied and were divided into two groups: those that had been abroad less than two times (n = 8), and those that had been abroad two or more times prior to this program (n = 4). Spanish language comprehension was based on participant self-ranking, with 8 individuals who identified that they knew some Spanish and ranked themselves in the minor category, and 4 individuals who identified that they had a complete comprehension of Spanish and ranked themselves in the major category.

Study Design and Implementation

Data for this study were collected in two phases: prior to going abroad (PRE) and while abroad (ABRD). The data collected in the PRE phase took place once every three weeks between September 28th and December 8th, 2023. All study measurements were collected in the mornings between the hours of 0800 and 1000, in an on-campus office. Measurements that took place in the ABRD phase took place in the participant's hotel room shortly after waking up each morning while abroad. The metrics that were measured in both time periods included physiological and psychological stress. Psychological stress was measured with a modified version of the PSS, a Likert type survey consisting of 10 questions with scores for each question ranging from 0-4 (Cohen et al. 1983). The scale was changed from the original PSS in that "*in the past month*" was changed to "*in the past 24 hours*" (figure 2), which is the same adjustment that was utilized by Lawrence et al. (2024). To score these surveys, there were 6 positive questions (questions 1, 2, 3, 6, 9, and 10) that were added directly, and there were 4 negative questions (4, 5, 7, and 8) that were "reversed." After this, the number was added to the overall score. For example, in the negative questions, if the participant scored it as a 0, it would be added to the overall score as a 4. The overall scores of this survey can vary from a high of 40, to a low of 0.

Physiological stress was measured through HRV with the smart phone application Kubios HRV version 2.2 software (Kubios, Finland) that connected to chest straps (Polar H9, Polar Electro, Kempele, Finland). The chest straps were moistened with water and placed on the lower sternum. Participants were then asked to sit and complete the PSS to allow their heart rate to fall to a resting rate. After this, their chest straps were connected their phones via Bluetooth and they completed a three-minute HRV test. From the HRV data, the Baevsky Stress Index (SI)

was used to indicate physiological stress. Data were then given to the research team and were de-identified and entered it into an excel spreadsheet.

Statistical Analysis

The data were analyzed using the mixed procedure of SAS (version 9.4; Cary, NC 27513), and statistical significance was determined when $P \leq 0.05$. Two separate models were utilized: one with PSS score as the dependent variable, and the other with the SI. The independent variables included ethnicity, time period, abroad experience, and level of Spanish language comprehension. A repeated measures statement was included by day with the participant as the subject. The assumptions were tested with residual panels for homogeneity of variance and normality of residuals.

Additional analyses were completed using the preliminary results from Lawrence et al. (2024) in combination with the results of the present study. This model utilized PSS as the dependent variable with trial (preliminary and present study), period (PRE and ABRD), and their interaction as the independent variables. A repeated measurement was included by measurement with participant as the subject. All assumptions were tested with the residual panels for homogeneity of variance and normality of residuals.

Results

Summary statistics of the data are included in Table 2. The average SI score was 12.9 ± 6.3 (average ± standard deviation). The minimum SI was 1.43 with a maximum of 43.9. The average PSS score was 10.9 ± 6.1 with a minimum score of 0 and a maximum score of 28.

The PSS results are summarized in Table 3. The main effect of ethnicity showed that Caucasian participants (15.3 ± 1.1; LS mean ± SE) had higher PSS scores than non-Caucasian participants (8.3 ± 1.1; $P < 0.01$). Participant study abroad experience and Spanish language

comprehension level did not have an impact on PSS scores ($P \geq 0.13$). Results from the time period of measurements showed participants had higher PSS prior to leaving (14.4 ± 1.0) than while they were abroad (9.2 ± 0.8; $P < 0.01$).

The SI results are summarized in Table 4. There were no differences in ethnicities, or participant Spanish language comprehension level on SI values ($P \geq 0.12$). Participant prior experience abroad for SI was greater when participants had been abroad two or more times (15.3 ± 1.2) than those that had less prior experience (11.5 ± 0.9; $P = 0.03$). The time period of when measurements were taken showed that participants had higher SI values while abroad (14.9 ± 0.8) than prior to leaving (11.9 ± 1.0; $P = 0.02$).

The combined PSS results from the present study and preliminary study are included in Table 5. There was a difference between trials where the preliminary trial had an overall higher PSS (18.9 ± 1.2) than the present study (12.2 ± 0.9; $P < 0.01$). There was also an overall difference between periods where the PRE period had a higher PSS (19.8 ± 0.9) than the ABRD period (11.2 ± 0.7; $P < 0.001$). The interaction of period and trial tended to differ ($P = 0.06$; figure 3) where the PSS score while ABRD in the preliminary trial (13.7 ± 1.1) was higher than the ABRD score in the present trial (8.8 ± 1.0; $P = 0.02$). The PRE period of the preliminary trial (24.1 ± 1.5) was greater than the PRE period of the present trial (15.5 ± 1.1; $P < 0.001$). The PRE period of both trials were greater than the ABRD period in their respective trials ($P < 0.001$).

Discussion

Perceived Stress Surveys are long utilized in the quantification of psychological stress. It is important to note that for this study, the time period was changed from “in the last month” to “in the last 24 hours”. While the questions being asked are the same, the time period is different from the original publication written by Cohen et al. (1983), however this modification has been

previously utilized (Lawrence et al., 2024). Generally, PSS scores are categorized into three divisions: mild which is a score from 0-13, moderate which is a score from 14-26, and severe which is a score from 27-40 (Graves et al., 2021). The overall average of the present study, average score while abroad, both categories of abroad experience, both major and minor levels of Spanish comprehension, and non-Caucasian participant average scores all fall into the mild category. All of these are also less than the average of 14.2 reported for individuals aged 18-29 throughout the United States, and the "student" average of 15.3, reported by Cohen and Williams (1988). In the preliminary study, the overall average would be classified within the moderate stress category (Lawrence et al., 2024). With the additions of the preflections prior to going abroad in the present study, the overall average PSS score of the current study may show that these meetings and assignments were effective in their goal of reducing psychological stress related to study abroad.

In the present study, non-Caucasian participants had lower PSS scores than Caucasian participants. It has been previously reported that individuals that identify as African American have lower lifetime rates of major depression in comparison to Caucasian counterparts, however, there is not a current sense of the level of mental health status within major ethic groups in the United States (Williams, 2018). Cohen and Williamson (1988) reported contradictory results to the present study, showing Caucasian participants had the lowest average score, followed by Hispanic, African American, and other minority ethnicities. In the present study, Caucasian participants had PSS scores in the moderate stress category, whereas non-Caucasian participants' scores were in the mild category. In the present study, Caucasian participants' average score was higher than what was reported by Cohen and Williamson (1988).

The Baevsky Stress Index, as a reflection of the sympathetic nervous system, increases as an individual becomes more stressed. According to Tarvainen et al. (2018), the Stress Index is divided into different stress zones. For the present study, the values fell within the normal, and elevated stress zones. The participant demographic categories that fell within the normal stress zone included Caucasian participants, those that have been abroad greater than twice prior to the study abroad trip, and participants' scores within the PRE phase (Table 4). All other variable categories fell within the elevated stress category, including non-Caucasian participants, participants that had been abroad less than two times, and measurements taken within the abroad phase (Table 4). While abroad, some activities that were completed were potentially physically taxing for some students including walking for long periods of time, riding bicycles, and standing for long durations in elevated temperatures. This may partially explain why some participants saw a difference in their physiological stress levels, especially if participants did not exercise regularly prior to leaving.

Overall, there is little literature on student stress while studying abroad. The goal of the present study, as well as the preliminary study, was to evaluate student stress while abroad in short term study abroad programs. One study, written by Hunley (2009), evaluated psychological stress in students studying abroad in Rome. They found that students experienced more psychological distress and loneliness while they were abroad than they did prior to departure. An additional study written by Bathke and Kim (2016) found similar results, where students had an increase of loneliness while they were abroad in comparison to while they were home. These studies are contradictory to the present study. This could be due to the difference in the methodologies, both of the studies mentioned took fewer measurements prior to going abroad than the present study. It could also be due to the differing lengths in the programs studied which

included semester, year, summer, and short term for Bathke and Kim (2016), a 14-week trip in the study completed by Hunley (2009), and 10 days in the present study. However, Maultsby and Stutts (2019) found similar results to the present study where students were less stressed and reported less depression abroad.

The PSS results of the present study could be partially explained by the idea of anticipatory stress. Anticipatory stress is the concept that in the time period preparing for a difficult task an individual shows higher stress than they do while completing the task itself (Nasso et al., 2019). Anticipatory stress is crucial because it causes individuals to develop coping strategies so that there are appropriate behavioral adjustments in response to the actual stressor (Schlatter et al., 2021). In terms of study abroad, the participants are likely anticipating the events and stressors of the trip. While they are abroad, they are able to cope with the stressors of the program due to their stress prior to leaving, thereby resulting in reduced psychological stress while abroad.

For the present study, the results of the physiological and psychological stress measures showed contradictory results. Anecdotally individuals would expect that physiological and psychological stress would follow a similar trend. Epel et al. (2018), stated that the association between self-reported stress scores, especially in Likert-type scaling, generally have a weaker connection to biological, or physical stress. With the use of the PSS, this explanation could serve as a possible reason for the contradiction found in the present study between physiological and psychological stress.

In designing a study abroad program, one of the most significant time periods to plan is the period leading up to students leaving to go abroad. Past research has concluded that preflection provides the bridge between “thinking about an experience and actually learning from

the experience" (Jones and Bjellan, 2004, p. 963). After the first program was completed (Lawrence et al., 2024), the program director implemented preflection journals into the course and integrated them into the pre-departure meetings that took place prior to leaving. These prompts encouraged students to think more about the material they were learning, how they were going to apply it, and how they felt in terms of being prepared for going abroad. Preflection journals are a long-utilized method in study abroad programs (Klein, 2012; Roberts et al., 2013; Wingenbach et al., 2006). With the preflections, the program coordinator also included additional meetings prior to leaving that included more information on the itinerary and expectations of the trip, as well as team building activities to help promote a more positive learning community while abroad (Lutterman-Aguilar & Gingerich, 2015). The preflection meetings may have been partially responsible for the decrease in the PSS scores that were seen between the preliminary and present trials. In the first program, there were fewer meetings with no preflections and limited team building, and the PSS scores were significantly higher. The preflections also allowed the program coordinator to gain awareness of concerns that participants had, and to modify the program to best fit their needs.

Summary

In summary, participants had an overall higher perceived, or psychological stress prior to leaving than while they were abroad. Ethnicity also had an impact on psychological stress scores, where Caucasian participants had a higher stress level than non-Caucasian participants. These results were the same as what was found in a preliminary study. There was also a significant decrease in perceived stress between the preliminary and the present study, likely due to the addition of preflections in the curriculum. For participant physiological stress, participants that had more abroad experience were more stressed than those who did not. Participants were also

more physiologically stressed abroad, than they were in the period prior to leaving. Limitations for this study include a small sample size, as well as unbalanced demographics. Future research is needed on student stress in study abroad programs with additional measures of physiological stress.

References

Andreou, E., Alexopoulos, E. C., Lionis, C., Varvogli, L., Gnardellis, C., Chrousos, G. P., & Darviri, C. (2011). Perceived Stress Scale: Reliability and Validity Study in Greece. *International Journal of Environmental Research and Public Health*, *8*(8), Article 8. https://doi.org/10.3390/ijerph8083287

Anwer, S., Manzar, M. D., Alghadir, A. H., Salahuddin, M., & Abdul Hameed, U. (2020). Psychometric Analysis of the Perceived Stress Scale Among Healthy University Students. *Neuropsychiatric disease and treatment*, *16*, 2389–2396. https://doi.org/10.2147/NDT.S268582

Baevsky, R. M., & Berseneva, A. P. (2008). Methodical recommendations use kardivar system for determination of the stress level and estimation of the body adaptability standards of measurements and physiological interpretation. Methodical-recommendations-USE-KARDiVAR-SYSTEM-FOR/74a292bfafca4fdf1149d557348800fcc1b0f33b.

Bathke, A., & Kim, Y.-H. (2016). Keep calm and study abroad: The effect of learning abroad on Student Mental Health. *Frontiers: The Interdisciplinary Journal of Study Abroad*, *27*(1), 1–16. https://doi.org/10.36366/frontiers.v27i1.371

Bruening, T. H., & Frick, M. (2004b). Globalizing the U.S. undergraduate experience: A case study of the benefits of an international agriculture field-based course. Journal of International Agricultural and Extension Education, 11(1), 89- 96.

Chu, B., Marwaha, K., Sanvictores, T., & Ayers, D. (2022). Physiology, Stress Reaction. *StatPearls*. StatPearls Publishing.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*(4), 385-396. https://doi.org/10.2307/2136404

Cohen, S., & Williamson, G. (1988). Perceived stress in a probability sample of the United States. In S. Spacapan, & S. Oskamp (Eds.), The social psychology of health: Claremont symposium on applied social psychology. Newbury Park, CA: Sage.

Dias, C. J., Barroso, R., Dias-Filho, C. A. A., Ferreira, A. C., Cabido, C. E. T., Crestani, C. C., Silva, M. S., Pinheiro, A. N., Rodrigues, B., & Mostarda, C. T. (2022). Possible influences of vitamin D levels on sleep quality, depression, anxiety, and physiological stress in patients with chronic obstructive pulmonary disease: a case control study. Sleep science (Sao Paulo, Brazil), 15(Spec 2), 369–374. https://doi.org/10.5935/1984-0063.20210019

Dishman, R. K., Nakamura, Y., Garcia, M. E., Thompson, R. W., Dunn, A. L., & Blair, S. N. (2000). Heart rate variability, trait anxiety, and perceived stress among physically fit men and women. International journal of psychophysiology: official journal of the International Organization of Psychophysiology, 37(2), 121–133. https://doi.org/10.1016/s0167-8760(00)00085-4

Epel, E. S., Crosswell, A. D., Mayer, S. E., Prather, A. A., Slavich, G. M., Puterman, E., & Mendes, W. B. (2018). More than a feeling: A unified view of stress measurement for population science. Frontiers in neuroendocrinology, 49, 146–169. https://doi.org/10.1016/j.yfrne.2018.03.001

Facts about agricultural workers fact sheet. NATIONAL CENTER FOR FARMWORKER HEALTH. (2022). https://www.ncfh.org/facts-about-agricultural-workers-fact-sheet.html

Graves, B. S., Hall, M. E., Dias-Karch, C., Haischer, M. H., & Apter, C. (2021). Gender differences in perceived stress and coping among college students. PLOS ONE, 16(8). https://doi.org/10.1371/journal.pone.0255634

Harder, A., Andenoro, A., Roberts, T. G., Stedman, N., Newberry, M., Parker, S. J., & Parker, M. T. (n.d.). Does Study Abroad Increase Employability? *NACTA Journal*, *59*(1), 41–48.

Hunley, H. A. (2010). Students' functioning while studying abroad: The impact of psychological distress and loneliness. *International Journal of Intercultural Relations*, *34*(4), 386–392. https://doi.org/10.1016/j.ijintrel.2009.08.005

Institute of International Education. (2023). "Profile of U.S. Study Abroad Students, 2000/01-2021/22." Open Doors Report on International Education Exchange.

Jones, B.L. and D. Bjelland. 2004. International experiential learning in agriculture. AIAEE 2004: Proc. of the 20th Annual Conference, 20, 963-964.

Kim, H. G., Cheon, E. J., Bai, D. S., Lee, Y. H., & Koo, B. H. (2018). Stress and Heart Rate Variability: A Meta-Analysis and Review of the Literature. Psychiatry investigation, 15(3), 235–245. https://doi.org/10.30773/pi.2017.08.17

Klein, C. (2012). The Phenomenon of Combining Service Learning and Study Abroad: A Qualitative Inquiry (Dissertation, Texas Tech University).

Koernig, S. K. (2007). Planning, organizing, and conducting a 2-week study abroad trip for undergraduate students: Guidelines for first-time faculty. *Journal of Marketing Education*, *29*(3), 210–217. https://doi.org/10.1177/0273475307306886

Kubios_HRV_Users_Guide.pdf. (2018). Retrieved from https://www.kubios.com/downloads/Kubios_HRV_Users_Guide.pdf

Lavoie, J., & Douglas, K. (2012). The Perceived Stress Scale: Evaluating Configural, Metric and Scalar Invariance across Mental Health Status and Gender: Journal of Psychopathology & Behavioral Assessment. Journal of Psychopathology & Behavioral Assessment, 34(1), 48–57. https://doi.org/10.1007/s10862-011-9266-1

Lawrence, J., Barrowclough, M., & Lugar, D. (2024). Study Abroad Programs and Student Stress: An Animal Science Curriculum Case Study. *NACTA Journal*, *68*(1). https://doi.org/10.56103/nactaj.v68i1.169

Lutterman-Aguilar, A., & Gingerich, O. (2015). Experiential pedagogy for study abroad: Educating for global citizenship. Frontiers: The Interdisciplinary Journal of Study Abroad, 8, 41-82.

Maultsby, K. D., & Stutts, L. A. (2019). A longitudinal examination of study abroad: Student characteristics and psychological health associations. *College Student Affairs Journal*, *37*(2), 184–199. https://doi.org/10.1353/csj.2019.0014

Nasso, S., Vanderhasselt, M. A., Demeyer, I., &De Raedt, R. (2019). Autonomic Regulation in Response to Stress: The Influence of Anticipatory Emotion Regulation Strategies and Trait Rumination. *American Psychological Association 19*(3), 443-454. http://dx.doi.org/10.1037/emo0000448

Orsila, R., Virtanen, M., Luukkaala, T., Tarvainen, M., Karjalainen, P., Viik, J., Savinainen, M., & Nygård, C. H. (2008). Perceived mental stress and reactions in heart rate variability--a pilot study among employees of an electronics company. International journal of occupational safety and ergonomics: JOSE, 14(3), 275–283. https://doi.org/10.1080/10803548.2008.11076767

Örücü, M. Ç., & Demir, A. (2009). Psychometric evaluation of Perceived Stress Scale for Turkish University students. *Stress and Health*, *25*(1), 103–109. https://doi.org/10.1002/smi.1218

Roberti, J. W., Harrington, L. N., & Storch, E. A. (2006). Further psychometric support for the 10-item version of the perceived stress scale. Journal of Counseling Association, 9, 135e147

Roberts, T. G., Conner, N. W., & Jones, B. L. (2013). An Experiential Learning Framework for Engaging Learners During Study Abroad Experiences. *NACTA Journal*, *57*(3a), 28–35. http://www.jstor.org/stable/nactajournal.57.3a.28

Schlatter, S., Schmidt, L., Lilot, M., Guillot, A., & Debarnot, U. (2021). Implementing biofeedback as a proactive coping strategy: Psychological and physiological effects on anticipatory stress. Behaviour Research and Therapy, 140, 103834. https://doi.org/10.1016/j.brat.2021.103834

Shaffer, F., & Ginsberg, J. P. (2017). An Overview of Heart Rate Variability Metrics and Norms. *Frontiers in public health*, *5*, 258. https://doi.org/10.3389/fpubh.2017.00258

Taelman, J., Vandeput, S., Spaepen, A., & Van Huffel, S. (2009). Influence of Mental Stress on Heart Rate and Heart Rate Variability. In J. Vander Sloten, P. Verdonck, M. Nyssen, & J. Haueisen (Eds.), 4th European Conference of the International Federation for Medical and Biological Engineering (pp. 1366–1369). Springer. https://doi.org/10.1007/978-3-540-89208-3_324

Tarvainen, M. P., Lipponen, J. A., Niskanen, J. P., & Ranta-Aho, P. O. (2018). User's Guide. https://www.kubios.com/downloads/Kubios_HRV_Users_Guide.pdf

Walker, L. A. (2019). *Environmental recordings of normal adults' heart rate for five consecutive days during all waking hours* (dissertation).

Williams D. R. (2018). Stress and the Mental Health of Populations of Color: Advancing Our Understanding of Race-related Stressors. Journal of health and social behavior, 59(4), 466–485. https://doi.org/10.1177/0022146518814251

Wingenbach, G., Chmielewski, N., Smith, J., Pina Jr., M., & Hamilton, W. (2006). Barriers to international experiential participation. *Journal of International Agricultural and Extension Education*, *13*(3). https://doi.org/10.5191/jiaee.2006.13306

Zahniser, S., Taylor, J. E., Hertz, T., & Carlton, D. (2018, November). *Farm Labor Markets in the United States and Mexico pose challenges for U.S. agriculture*. USDA ERS. https://www.ers.usda.gov/publications/pub-details/?pubid=90831

Tables and Figures

Table 3.1 Participant Demographics

Characteristic	# of Participants	% of Participants
Sex		
Male	2	16.7
Female	10	83.3
Ethnicity		
Caucasian	7	58
Non-Caucasian	5	42
Prior Abroad Experience		
< 2 times	8	66.6
≥ 2 times	4	33.4
Spanish Comprehension		
Minor	8	66.6
Major	4	33.4

Table 3.2 Summary Statistics of Stress Index and Perceived Stress Surveys

Variable	N	Mean	Standard Deviation	Minimum	Maximum
SI	154	12.9	6.3	1.43	43.9
PSS	156	10.9	6.1	0	28.0

Note: Overall summary statistics for participant Stress Index (SI) and Perceived Stress Scores (PSS) over a short-term study abroad program

Table 3.3 Study abroad and demographics on student perceived stress scores

Variable	Coefficient	Standard Error	P-Value
Ethnicity			
Caucasian	15.3	1.1	<0.01
Non-Caucasian	8.3		
Abroad Experience			
< 2 times	11.8	1.1	0.96
≥ 2 times	11.8		
Spanish Comprehension			
Major	13.0	1.1	0.13
Minor	10.6		
Phase			
PRE	14.4	0.9	<0.01
ABRD	9.2		

Note. Abroad experience consisted of two categories, those that had been abroad twice or more, (≥ 2 times) and those that had been abroad once, or not at all (<2 times). Spanish Comprehension was based off participant ranking of their Spanish-speaking knowledge and categorized as minor comprehension or major comprehension. Phase consisted of measurements prior to departure (PRE: 5 measurements taken in the semester prior to going abroad, taken every third week of the fall semester) and while abroad (ABRD; days 1-10). Statistical significance was determined when (P < 0.05).

Table 3.4 Study abroad and demographics on student stress index

Variable	Coefficient	Standard Error	P-Value
Ethnicity			
Caucasian	12.0	1.1	0.12
Non-Caucasian	14.7		
Abroad Experience			
< 2 times	15.3	1.2	0.03
≥ 2 times	11.5		
Spanish Comprehension			
Major	13.8	1.2	0.06
Minor	12.9		
Phase			
PRE	11.9	1	0.02
ABRD	14.9		

Note. Abroad experience consisted of two categories, those that had been abroad twice or more, (≥ 2 times) and those that had been abroad once, or not at all (<2 times). Spanish Comprehension was based on participant ranking of their Spanish-speaking knowledge. Phase consisted of measurements prior to departure (PRE: 5 measurements taken in the semester prior to going abroad, taken every third week of the fall semester) and while abroad (ABRD; days 1-10). Statistical significance was determined when (P < 0.05).

Table 3.5 Trial and time period on student perceived stress

Variable	LS Means	Standard Error	P-Value
Trial			
Preliminary	18.9	1.2	<0.001
Present	12.2	0.9	
Period			
PRE	19.8	0.9	<0.001
ABRD	11.2	0.7	

Note. Trial consisted of two repetitions, Preliminary (Lawrence et al., 2024) took place in December 2022, and Present, the present study took place in January 2024. Period consisted of the time period leading up to going abroad (PRE) and measurements taken while abroad (ABRD). Statistical significance was determined when (P < 0.05).

Figure 3.1 Stress Index Formula

$$SI = \frac{AMo * 100\%}{2Mo * MxDMn}$$

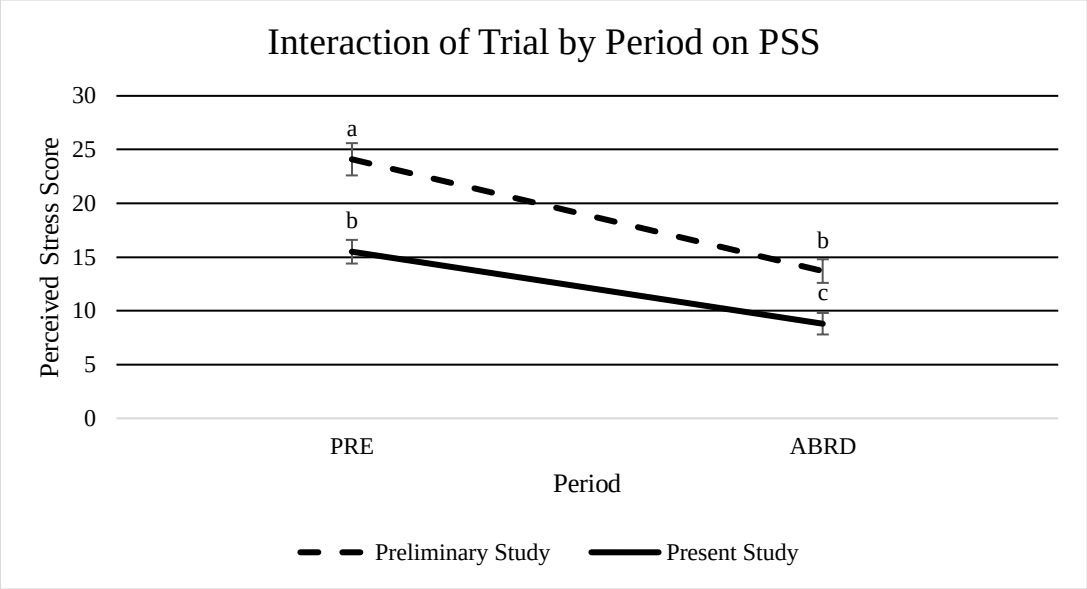
Note. Formula utilized to calculate the Baevsky Stress Index. All values included are calculated from Heart Rate Variability metrics, where AMo is the mode amplitude, Mo is the mode interbeat interval, and MxDMN is the variation scope that reflects the degree of interval variability (Baevsky, 2019).

Figure 3.2 Modified Perceived Stress Survey

1.) In the past 24 hours, how often have you been upset because of something that happened unexpectedly?
2.) In the past 24 hours how often have you felt that you were unable to control the important things in your life?
3.) In the past 24 hours, how often have you felt nervous and stressed?
4.) In the past 24 hours, how often have you felt confident about your ability to handle your personal problems?
5.) In the past 24 hours, how often have you felt that things were going your way?
6.) In the past 24 hours, how often have you found that you could not cope with all the things that you had to do?
7.) In the past 24 hours, how often have you been able to control irritations in your life?
8.) In the past 24 hours, how often have you felt that you were on top of things?
9.) In the past 24 hours, how often have you been angered because of things that happened that were outside of your control?
10.) In the past 24 hours, how often have you felt difficulties were piling up so high that you could not overcome them?

Note: Modified perceived stress survey from Cohen et al., (1983), as previously described by Lawrence et al. (2024).

Figure 3.3 Interaction of trial and time period on student perceived stress



Note. This figure illustrates the interaction effect of trial by period on participant percieved stress (P = 0.04). The trials include the preliminary study, completed by Lawrence et al., (2024) in December 2022 and the present study. Period includes PRE, which were measurements taken prior to going abroad, and ABRD which were measurements taken while participants were in Mexico studying abroad. ^{abc} *Letters that differ are statistically different from one another (P < 0.05).*

CHAPTER IV: EVALUATING STUDENT STRESS IN AN ANIMAL SCIENCE COURSE WITH UNSUPERVISED LIVESTOCK EXPERIENCE

Abstract

In recent years, Animal Science demographics have been shifting from many students having an abundance of animal experience towards a majority of students having little to no prior animal experience. It's important to note this demographic shift and to consider how this shift could be impacting student mental health. Throughout a semester long parturition management course with unsupervised animal experiences, physiological and psychological stress data were collected along with student demographic data and prior animal experience levels. Caucasian participants were more psychologically stressed than non-Caucasian participants ($P = 0.04$). Participants with beginner level animal experience tended to have higher stress levels than participants with mid-level animal experience ($P = 0.08$). However, physiological stress results showed no differences among demographic variables nor prior animal experience. Future studies should investigate student stress in introductory animal courses to better understand their initial stress when working with animals at the collegiate level.

Keywords: Animal Science, Stress, heart rate variability, perceived stress

Evaluating Student Stress in an Animal Science Course With Unsupervised Livestock Experience

Student stress at the university level is a long-studied topic. In a literature review completed by Robotham and Julian (2006), several categories of stressors were identified such as examinations, financial pressures, transitioning to university, study-related stressors, as well as a variety of other categories for students at the university level. Another study from Yikealo et al. (2018) found that a majority of students in their study had moderate to high levels of stress as a

result of various causes. The American College Health Association (2015) reported that 42.8% of students experienced more than average stress levels and 37.3% of students felt they experienced average stress levels in college.

The Animal Science field in undergraduate programs has seen a shift from students that have hands-on experience prior to attendance, to students that have little to no large animal experience at all (Boerngen and Rickard, 2020; Buchanan, 2008; Bundy et al., 2019). In the early days of Animal Science, articles make frequent reference to "men teaching boys", but as time went on there was a shift from this to a demographic with more female students (Bucanan, 2008). Buchanan (2008) stated that since 1983, there has been a continuation of this shift where there are more urban students, females, and students with future plans that differ from returning to a family farm. Some research has continued investigating this change, such as Boerngen and Rickard (2020) who examined student perception of their background in an introductory agriculture course. In this paper, the authors reported the perceptions that students have of their backgrounds and where they fall in a more defined manner of what a "farm background" can entail (Boerngen & Rickard, 2020). Bundy et al. (2019) looked at the addition of an introductory animal handling course and its effects on student comfort level with large animals, as well as if student demographics played a role in student performance. They found that students that had farm backgrounds outscored students that did not in course pre-exams, however, their background had no impact on their post exam scores (Bundy et al., 2019).

Generally, stress can be measured in different ways depending on the context and goal of the measurement, including both physiological and psychological stress. One way to measure psychological stress is through the Perceived Stress Survey (PSS), which is a commonly utilized and well proven measure of the extent to which respondents perceive their life's predictability,

level of control and overloading (Cohen et al., 1983). This survey consists of 10 Likert-scale questions that are then scored for an overall stress score of the survey. There are a wide variety of studies that have used this specific survey as a tool to determine stress levels in different populations (Anwer et al., 2020; Denovan et al., 2019; Maroufizadeh et al., 2018; Torales 2011). Validity and accuracy of this survey have been proven in studies over time and different researchers have continued to support its accuracy and applicability in different populations and in comparison to other similar scales (Juarez-Garcia, 2021; Lee, 2012; Taylor, 2015).

An additional mechanism for measuring stress is heart rate variability (HRV), which has been shown to measure the physiological stress response. Heart rate variability measures the changes in time intervals between consecutive heart beats and has been said to reflect regulation of the autonomic nervous system, which in turn can portray stress levels (Shaffer & Ginsberg, 2017). Kim et al. (2018) noted that, in most studies, HRV measurements changed when the stressor was introduced and reflected changes in the parasympathetic nervous system. Heart rate variability values are inversely related to stress levels (Kim et al. 2018). The nervous system is divided into two different sections, the sympathetic and parasympathetic systems. The sympathetic system is dominant during "fight or flight" situations and the parasympathetic nervous system is dominant during "rest and digest" circumstances (Tindle and Tadi, 2022).

To the author's knowledge, there have been no studies investigating student stress levels in the animal science discipline. The purpose of the present study was to investigate student psychological and physiological stress in an animal science course to determine effects of prior animal experience and demographic data on student stress.

Methods

The Illinois State University Institutional Review Board approved all study experimental methods prior to conducting the study (IRB: 2022-172). This study took place in a Parturition Management course (AGR 236) at Illinois State University in spring semester of 2023. In this class, students are responsible for taking material that is presented to them in class and applying it during unsupervised six-hour shifts at the Illinois State University farm in Lexington, Illinois. Shifts at the farm occur between the hours of 18:00 to 0:00 and 0:00 to 06:00 every night throughout the majority of the semester. Students are asked to assist pregnant mothers, as needed, through the process of parturition (birth) in sheep (lambing), pigs (farrowing), and cattle (calving). They then process any newborns and keep records. The study was introduced in the first class session of the semester, where students were given consent forms and demographic surveys. To be eligible for the study, participants were required to be studying Pre-Veterinary Medicine (PVM), Animal Industry Management (AIM) or Animal Science (ANSC). Student participation was voluntary and did not affect their grades in the course. The professor did not have access to data from the study until all data had been de-identified and final grades had been submitted.

Study Participants

Results of the participant demographic surveys are summarized in Table 1. This survey consisted of questions including age, ethnicity, academic sequence, academic classification, hometown population, and level of large animal experience. The demographic survey was a hard copy survey that was later transcribed into a protected spreadsheet. All participants were classified as either juniors or seniors with ages ranging from 19-27 years old and estimated hometown populations ranging from rural to greater than 160,000. There was one male and 15

female participants, with 12 being Caucasian and four non-Caucasian, and a range of no prior large animal experience to advanced large animal experience (n =16).

Study Design

The present study was divided into two time periods for each of the species: baseline which occurred on campus prior to the first shift for each species, and on-shift which took place at the Illinois State University Farm immediately prior to their first shift for each species (Figure 1). The goal of the baseline measurements was to capture student stress levels outside of the course and took place throughout the day, in an office on campus. Baseline measurements took place on week zero of the study (prior to starting lamb watches), week four of the study (between lamb and calf watch), and week eight of the study (between calf and piglet watch). Additionally, a post-shift baseline measurement was taken on week 12 of the study (after completion of all watch shifts). Lamb watch was the first species shifts, followed by calf watch, then piglet watch, however, the calving window was significantly longer than the other species, so some participants continued to have calf watch shifts after the piglet watch portion. On-shift measurements were taken at the Illinois State University farm on their first shift (first lamb watch shift; week one of the study), seventh shift (first calf watch shift; week five of the study) and 14th shift (first piglet watch shift; week nine of the study), 15 to 30 minutes prior to the start of their shifts.

Study Implementation

Measurements were taken in the same manner in each meeting. For this, participants were asked to sit in a chair and fill out a PSS survey, allowing their heart rate to slow to a resting rate. The PSS survey was modified, this included changing the time period from "*In the past month*…" to "*In the past week*…" (See Figure 2; as previously described by Lawrence et al.,

2024). After completion of the PSS survey, participants were given the HRV chest strap (Polar H9, Polar Electro, Kempele, Finland) that was lubricated with water, and placed on the bare skin just below their sternum. A smart phone app (Elite HRV Inc., Asheville, NC, USA) was utilized to connect to the HRV chest strap via Bluetooth to a smart device for collecting heart rate data. This app also gave the participants breathing cues to keep the heart rate at a resting, consistent rate. This HRV data was collected over a period of 2.5 minutes and recorded. When data was collected, all participants were assigned a number that was connected to their demographic data, allowing for the correlation between participant demographics and stress levels, while keeping participant data de-identified. After completion of both the HRV and the PSS survey, the surveys were scored. The survey utilizes 10 Likert scale questions with options from 0-4 and is scored by adding the scores of the questions. There were four "negative" questions where the scores were reversed, and the remaining six "positive" questions were added as is. For the questions that required reverse scoring, responses of a 4 were counted as a 0, responses of a 3 were counted as a 1, responses of 2 were left, responses of 1 were counted as 3, and responses of 0 were counted as 4. The scores of this survey can range from 0-40, with 0 being no perceived stress to 40 being the highest perceived stress score.

Statistical Analysis

Data were analyzed utilizing the mixed procedure of SAS (version 9.4; Cary, NC 27513), with a statistical difference determined when $P < 0.05$. Two models were utilized to analyze these data: one with HRV and other with PSS as the dependent variables. Both models utilized the independent variables ethnicity (Caucasian, non-Caucasian), age, experience level (novice, beginner, mid-level, advanced), and animal species (baseline, lamb, calf, piglet). A repeated measures statement was utilized with participant as the subject. Tukey adjustments were used for

pairwise comparisons, when appropriate. Residual panels were analyzed for normality and homogeneity of variance assumptions.

Results

Summary statistics of the data are included in Table 2. Throughout the whole study, the average PSS scores were: overall, 15.5 ± 7.7 (mean ± standard deviation); baseline, 15.6 ± 7.7; lamb, 15.1 ± 8.3; calf, 14.6 ± 7.2; and piglet, 16.3 ± 8.3. The average HRV results were: overall, 57.7 ± 10.7; baseline, 57.3 ± 10.5; lamb, 58.6 ± 10.4; calf, 59.3 ± 13.7; and piglet 56.9± 8.9.

The PSS results are summarized in Table 3. Main effects of species and age were not different ($P \geq 0.17$). Ethnicity had an affect on PSS ($P = 0.04$), where Caucasian participants (16.5 ± 1.7) had higher perceived stress scores than the non-Caucasian participants (8.7 ± 3.0). Prior animal experience tended to differ ($P = 0.08$), where participants with beginner level experience (17.0 ± 2.0) tended to have higher perceived stress scores than participants with mid-level experience (7.4 ± 2.9; $P = 0.01$). However, all other pairwise comparisons within experience level were not different ($P \geq 0.18$).

Model findings concerning HRV are summarized in Table 4. Overall, there were no effects of the independent variables including experience level, animal species, ethnicity, and age ($P \geq 0.12$). Prior animal experience had numerical differences where participants with beginner experience (53.5) had the lowest HRV, followed by novice, mid-level, and advanced experience levels (59.2, 61.4, 63.2).

Discussion

In the parturition management course for the present study, the first species that participants interacted with was sheep. They had two lectures prior to the first set of unsupervised watch shifts that showed them what to expect and look for, as well as what would

be expected of them. It is intuitive that their first animal shift would be the most stressful, and over time their confidence would build. Anecdotally, calf watch was expected to cause a high level of stress due to the size and danger associated with cattle, particularly around calving time, but the current results did not support this idea. Results of the present study show that animal species did not play a role in student stress levels. The PSS results for all 3 species and the baseline (see Table 2) fall into the moderate stress category (14-26; Graves et al. 2021). This means that throughout the study, participants did not reach a point of severe perceived stress, but with no difference between their baseline measurements, this is likely where their stress is on average.

Ethnicity results of the present study were similar to other studies involving perceived stress. Lawrence et al. (2024) looked at student stress levels while studying abroad and found that Caucasian participants were more stressed than non-Caucasian participants. Those results are similar to the present study, in that Caucasian participants had higher perceived stress values than the non-Caucasian participants. Anderson (2004) reported contradictory results, where Caucasian participants were the least stressed of the ethnicities they observed. This was also noted in a study completed by Sternthal (2011), they found Caucasian participants were the least stressed. Differences between the present study and conflicting studies could be due to a relatively low number of participants and an imbalance between the number of Caucasian (12) and non-Caucasian (4) participants in the present study. Additionally, the study completed by Sternthal (2011) was composed of participants of a variety of ages that averaged 43.84 years, with 3105 participants. When compared to the present study, which had an average age of 21.63 years and 16 total participants, it is a challenge to make generalizations with this population. The present study results came from a participant pool that was not reflective of the general

population, making it difficult to compare the results to other studies that have larger participant numbers and are more representative of the general population. Current study demographics, however, were representative of the animal science field (Bundy et al. 2019; Boerngen & Rickard 2020).

Participant experience levels were based upon self-reporting with the range from no experience to an advanced level of prior animal experience. To be admitted into this course, students were required to take the prerequisite Introduction to Animal Science course, so all students had a minimum experience level coming from the prerequisite course. However, there was a time period where a lab section was not required due to the global pandemic restrictions, so it is possible that some students did not have any prior large animal handling experience. Participants ranked their own experience, making experience level subjective, which could have caused variation.

A study completed by Adams et al. (2015) looked at student backgrounds and their perceptions of livestock practices. This study surveyed two sections of students, the first section had 30% with no prior livestock experience (310 students total), and the second section had 26% with no livestock experience (328 students total), whereas the remainder of the students in each section reported having experience in one of the following species: horses, cattle, poultry, swine, sheep, or goats. The present study had 12.5% of the participants that reported no experience, and 43.8% of them reporting beginner level experience, accounting for more than half of the participants in the study. Another study completed by Rickard et al. (2017), reported that 77.8% of their students in an animal management program had farm or ranch experience outside of their home. They also reported that 17.1% of animal science students, and 11.1% of their pre-veterinary science students had farm or ranch experience outside their home. This finding is

larger than the present study, which found just under half of the participants had on farm experience. Lastly, a study completed by Bundy et al. (2019) evaluated student experience with livestock prior to their introductory course and found that 56.3% of their students did not have experience handling beef cattle, 59.8% sheep and 48.3% swine. These findings agree with the present study, however, the present study did not count for individual species.

The present study found lower results in comparison to others that have utilized PSS in college aged participants. Table 5 compares PSS results from the present study to similar studies. The overall average score of the present study was 15.5 ± 7.7. A study completed by Adamson et al. (2020) reported that their participants ages 18-24 had an average perceived stress score of 20.1 ± 7.3, and their participants that had "some college experience" had an average score of 19.7 ± 7.5. This study observed perceived stress in participants of varying ages during the COVID-19 pandemic, in connection with their demographics, so there may be a slight increase in stress score, due to stress caused by COVID-19. Shaw et al. (2017) evaluated perceived stress in college students and found an average of 17.9 ± 7.2. Lastly, a study completed by Cohen and Janicki-Deverts (2012), evaluated PSS among different demographics in 1983, 2006, and 2009. This study reported in 2009 that average PSS in participants less than 25 years of age was 16. 8 ± 6.9. Overall, the present study had a lower score than the studies above, which may have been due to the range of ages (19-27), or the differences in what the studies were looking at in comparison to the present study. The present study also adjusted the time period of the PSS to a shorter time period, which may also explain these differences.

Some studies take their participants' PSS and allocate them to 3 categories; mild 0-13, moderate, 14-26, and severe 27-40 (Graves et al., 2021; Table 6). Graves et al. (2021) examined gender differences in PSS in college students and found that a majority of their respondents fell

within the moderate stress category, followed by severe, while present study had a majority of respondents in the mild stress category. Differences between the two may be due to adjustments made in the present study where the time period was not the same. They could also be due to the study completed by Graves et al. (2021) having more males (35.5%) in comparison to the present study (6%).

Throughout the entire study, there were no differences in physiological stress between species, or demographic variables included in the model. This could be explained by the timing of shifts, and the idea that HRV measurements are ideally taken in the morning and at the same time every day (Vila, 2019). The nature of this class did not allow for measurements to be taken consistently, in the morning with shifts occurring overnight, which could also partially explain the present results.

Heart rate variability was also not different between ethnicities in the present study. This is similar to those reported by Lawrence et al. (2024), a study that also found similar results in regards to ethnicity between their participant's HRV in a study abroad program. However, results of the present study differ from a study completed by El-Wazir (2019) where they reported that, due to genes involved in cardiac function, there are generally differences between different ethnic groups. For example, that study suggested that, in general, HRV is higher in African Americans than those of European descent (El-Wazir, 2019). A difference in the present study is that those that fell into the non-Caucasian category did not identify as African American, which is the most prominently studied non-Caucasian ethnicity. Additionally, there were no significant differences between experience level in terms of HRV. This could have been due to previously mentioned reasons, or it could be due to participants in the study being under similar amounts of physiological stress.

At Illinois State University, there are many students that come with little to no prior animal experience. In Introductory Animal Science courses, students often have their first interaction with livestock species. These initial interactions may play a vital role in a student's decision to continue studying in animal sciences or pursuing that career field. The present study investigated student stress in an upper-level animal science course, where all students enrolled previously had taken the introductory animal science prerequisite. Future research in introductory level animal science courses are important to pursue to investigate the initial student stress in animal science.

Summary

In summary, the species of animal that participants were working with had no impact on their stress levels. Participant demographics played a role in their perceived stress levels throughout the study. However, there were no differences in physiological stress. Some limitations include a small, unbalanced participant pool, as well as differential timing due to the shifts taking place overnight. Future research is needed in student stress in animal science, specifically, in introductory level courses where students are first interacting with animals at the collegiate level.

References

Adams, A. L., Holub, G. A., Ramsey, W. S., & Friend, T. H. (2015). Background Experience Affects Student Perceptions of the Livestock Industry. *NACTA Journal*, *59*(1), 24–27.

Adamson, M. M., Phillips, A., Seenivasan, S., Martinez, J., Grewal, H., Kang, X., Coetzee, J., Luttenbacher, I., Jester, A., Harris, O. A., & Spiegel, D. (2020). International Prevalence and Correlates of Psychological Stress during the Global COVID-19 Pandemic. *International journal of environmental research and public health*, *17*(24), 9248. https://doi.org/10.3390/ijerph17249248

American College Health Association. (2015). The American College Health Association National College Health Assessment (ACHA-NCHA), Spring 2023 Reference Group Report.

Anderson, N. B., & Bulatao, R. A. (2004). *Understanding racial and ethnic differences in health in Late life: A research agenda*. National Academies Press.

Anwer, S., Manzar, MD. Dilshad., Alghadir, Ahmad. H., Salahuddin, Mohammed. & Hameed, Unaise. Abdul. (2020) Psychometric Analysis of the Perceived Stress Scale Among Healthy University Students. *Neuropathic disease and treatment, 16,* 2389-2396. https://doi.org/10.2147/NDT.S268582

Boerngen, M. A., & Rickard, J. W. (2020). Assessment and perception of student farm background in an introductory agriculture course. *Natural Sciences Education*, *49*(1). https://doi.org/10.1002/nse2.20013

Bright lights, big cities and mental health. (2023). *Nature Mental Health*, *1*(11), 811–812. https://doi.org/10.1038/s44220-023-00171-4

Buchanan D. S. (2008). ASAS Centennial Paper: animal science teaching: a century of excellence. Journal of animal science, 86(12), 3640–3646. https://doi.org/10.2527/jas.2008-1366

Bundy, J. M., Sterle, J. A., Johnson, A. K., & Krahn, G. T. (2019). The impact of an introductory animal handling course on undergraduate students who lack previous livestock handling experience. *Journal of Animal Science*. https://doi.org/10.1093/jas/skz095

Cohen, S., & Janicki-Deverts, D. (2012). Who's stressed? distributions of psychological stress in the United States in probability samples from 1983, 2006, and 20091. *Journal of Applied Social Psychology*, *42*(6), 1320–1334. https://doi.org/10.1111/j.1559-1816.2012.00900.x

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*(4), 385-396. https://doi.org/10.2307/2136404

Cohen, S., Kamarck, T., & Mermelstein, R. (1994). Perceived stress scale. *Measuring stress: A guide for health and social scientists*, *10*(2), 1-2.

Denovan, A., Dagnall, N., Dhingra, K., & Grogan, S. (2019). Evaluating the Perceived Stress Scale among UK university students: implications for stress measurement and management. *Studies in Higher Education, 44*(1), 120-133. 10.1080/03075079.2017.1340445

Duong, H. T. H., Tadesse, G. A., Nhat, P. T. H., Hao, N. V., Prince, J., Duong, T. D., Kien, T. T., Nhat, L. T. H., Tan, L. V., Pugh, C., Loan, H. T., Chau, N. V. V., Minh Yen, L., Zhu, T., Clifton, D., & Thwaites, L. (2020). Heart Rate Variability as an Indicator of Autonomic Nervous System Disturbance in Tetanus. *The American journal of tropical medicine and hygiene*, *102*(2), 403–407. https://doi.org/10.4269/ajtmh.19-0720

Graves, B. S., Hall, M. E., Dias-Karch, C., Haischer, M. H., & Apter, C. (2021). Gender differences in perceived stress and coping among college students. *PLOS ONE*, *16*(8). https://doi.org/10.1371/journal.pone.0255634

Gruebner, O., Rapp, M. A., Adli, M., Kluge, U., Galea, S., & Heinz, A. (2017). Cities and Mental Health. *Deutsches Ärzteblatt International*. https://doi.org/10.3238/arztebl.2017.0121

Hendrawan, R. E., Purnomo, J. A., Djoemadi, F. R., Pratono, A. H., & Santoso, T. I. (2019). Dispute settlement on Pig Products: Case Study of European and Russian Trade. *Proceedings of the Social and Humaniora Research Symposium (SoRes 2018)*. https://doi.org/10.2991/sores-18.2019.140

Juarez-Garcia, A., Merino-Soto., Brito-Ortiz, J. F., Nava-Gomez, M. E. & Monroy-Castillo, A. (2021) Is the perceived stress scale (PSS) Unidimensional and invariant? A Bifactor analysis in Mexican Adults. *Current Psychology 42*, 7252-7266. https://doi.org/10.1007/s12144-021-02067-x

Lawrence, J., Barrowclough, M., & Lugar, D. (2024). Study Abroad Programs and Student Stress: An Animal Science Curriculum Case Study. *NACTA Journal*, *68*(1). https://doi.org/10.56103/nactaj.v68i1.169

Lee, Eun-Huyn. (2012) Review of Psychometric Evidence of the Perceived Stress Scale. *Asian Nursing Research, 6.* 121-127 https://doi.org/10.1016/j.anr.2012.08.004

Manzar, M. D., Salahuddin, M., Peter, S., Alghadir, A., Answer, S., Bahammam, A. S., & Pandi-Perumal, S. R. (2019) Psychometric properties of the perceived stress scale in Ethiopian university students. *BMC Public Health 19*(41). https://doi.org/10.1186/s12889-018-6310-z

Rickard, J. W., Boerngen, M. A., Lorenz, S. M., & Baker, E. (2017). Assessing student demographics in a Non-Land-Grant University Department of Agriculture. *Natural Sciences Education*, *46*(1), 170021. https://doi.org/10.4195/nse2017.09.0021

Robotham, D., & Julian, C. (2006). Stress and the higher education student: a critical review of the literature. *Journal of Further and Higher Education 30(*2). 107-117. DOI: 10.1080/03098770600617513

Shaffer, F., & Ginsberg, J. P. (2017). An overview of heart rate variability metrics and norms. *Frontiers in Public Health*, *5*. https://doi.org/10.3389/fpubh.2017.00258

Shaw, M. P., Peart, D. J., & Fairhead, O. J. (2017). Perceived stress in university students studying in a further education college. *Research in Post-Compulsory Education*, *22*(3), 442–452. https://doi.org/10.1080/13596748.2017.1362534

Sternthal, M. J., Slopen, N., & Williams, D. R. (2011). *Racial Disparities in Health How Much Does Stress Really Matter?* Du Bois Review: Social Science Research on Race, *8*(1), 95-113. https://doi.org/10.1017/s1742058x11000087

Taylor, J. M. (2015). Psychometric analysis of the Ten-Item Perceived Stress Scale. *Psychological Assessment, 27*(1), 90–101. https://doi.org/10.1037/a0038100

Tindle, J. & Tadi, P. (2022). Neuroanatomy, Parasympathetic Nervous System. *StatPearls Publishing.*

Torales, J., Ríos-González, C., Barrios, I., O'Higgins, M., González, I., García, O., Castaldelli-Maia, J. M., & Ventriglio, A. (2020). Self-perceived stress during the quarantine of COVID-19 pandemic in Paraguay: An exploratory survey. *Frontiers in Psychiatry, 11*. https://doi.org/10.3389/fpsyt.2020.558691

Trivedi, S., Clark, J. C., Long, L., Daniel, G. A., Anderson, S. M., & Zheng, Y. (2023). Assessing the mental wellbeing and help-seeking behaviors of pre-veterinary undergraduates at a land-grant institution. *Journal of Veterinary Medical Education*. https://doi.org/10.3138/jvme-2022-0096

Vila, X. A., Lado, M. J., & Cuesta-Morales, P. (2019). Evidence based recommendations for designing Heart Rate Variability Studies. *Journal of Medical Systems*, *43*(10). https://doi.org/10.1007/s10916-019-1437-8

Yikealo, D., Yemane, B. and Karvinen, I. (2018) The Level of Academic and Environmental Stress among College Students: A Case in the College of Education. Open Journal of Social Sciences, 6, 40-57. https://doi.org/10.4236/jss.2018.611004

Figures and Tables

Table 4.1 Summary Of Participant Demographics

Characteristic	# of students	% Students
Sex		
Female	15	94
Male	1	6
Ethnicity		
Caucasian	12	75
Non-Caucasian	4	25
Age		
19	1	6
20	6	38
21	3	19
22	3	19
25	1	6
26	1	6
27	1	6
Major		
Pre-Veterinary Medicine	8	50
Animal Industry Management	3	19
Animal Science	5	31
Year in School		
Junior	8	50
Senior	8	50
Hometown Population		
Rural (<10,000)	4	25
Small (10,001-20,000)	3	19
Mid-sized (20,001-40,000)	4	25
Large (40,001+)	5	31
Animal Experience Level		
Novice (no experience)	2	13
Beginner (little experience)	7	44
Mid-Level (some experience)	4	25
Advanced (moderate experience)	3	19

Note. Participant demographics and the percentage of each demographic in the overall population of the present study

Table 4.2 Summary Statistics

Measurement	Variable	N	Mean	Standard Deviation	Minimum	Maximum
Overall	HRV	111	57.5	10.7	30	89
	PSS	111	15.5	7.7	1	35
Baseline	HRV	64	57.4	10.5	30	75
	PSS	64	15.6	7.7	2	30
Lamb	HRV	16	58.6	10.4	45	80
	PSS	16	15.1	8.3	4	35
Calf	HRV	16	59.3	13.7	36	89
	PSS	16	14.6	7.2	3	25
Piglet	HRV	16	56.9	8.9	43	75
	PSS	16	16.3	8.3	1	3

Note. Summary Statistics of participant Perceived Stress (PSS) and Heart Rate Variability (HRV) scores throughout the study and overall including the number of measurements, mean, standard deviation, minimum and maximum

Table 4.3 Effect Of Demographic Variables and Animal Species On Perceived Stress

Variable	Level	Estimate	Standard Error	P-Value
Prior Animal Experience	Novice (None)	13.7	3.4	0.08
	Beginner	17.0[x]	2.0	
	Mid-Level	7.4[y]	2.9	
	Advanced	12.4	3.2	
Species	Baseline	12.5	1.6	0.80
	Lamb	13.7	2.4	
	Calf	12.7	2.0	
	Piglet	11.6	2.2	
Ethnicity	Non-Caucasian	8.7[a]	3.0	0.04
	Caucasian	16.5[b]	1.7	

Note: Prior animal experience, species, and ethnicity effects on participant Perceived Stress (PSS) in an unsupervised animal science course. Estimates represent the LS means. [ab] *Estimates within each variable with differing letter superscripts are different (P < 0.05).* [xy] *Estimates within each variable with differing letter superscripts tend differ (P < 0.10).*

Table 4.4 Effect Of Demographic Variables and Animal Species On Heart Rate Variability

Variable	Level	Estimate	Standard Error	P-Value
Prior Animal Experience	Novice (None)	59.2	4.1	0.12
	Beginner	53.5	2.4	
	Mid-Level	61.4	3.5	
	Advanced	63.2	3.9	
Species	Baseline	58.4	1.9	0.70
	Lamb	59.7	2.4	
	Calf	61.5	4.4	
	Piglet	57.7	2.6	
Ethnicity	Non-Caucasian	58.4	3.6	0.63
	Caucasian	60.3	2.1	

Note: Prior animal experience, species, and ethnicity effects on participant heart rate variability in an unsupervised animal science course. Levels with variables were considered different when $P < 0.05$.

Table 4.5 Perceived Stress Scale Mean Score Comparisons

	Average	Standard Deviation
Present Study	15.5	7.7
Adamson et al. 2020	20.14	7.26
Shaw et al. 2017	17.90	7.0
Cohen and Janicki-Deverts 2012	16.78	6.86

Note: Perceived Stress Scores in college aged students in different studies in comparison to the present study

Table 4.6 Perceived Stress Scale Categorical Score Comparison

	Mild (0-13)	**Moderate (14-26)**	**Severe (27-40)**
Current Study	42 (43)	50 (52)	5 (5)
Graves et al. 2021	6 (1.4)	348 (82.3)	69 (13.3)

Note: Number of responses (percent of the total responses) that fall

Figure 4.1 Timeline Of Measurements

Note: At each time period, Perceived Stress Surveys were given, and Heart Rate Variability data was collected. The Baseline measurements were taken in a controlled setting on campus, the species measurements (lamb, calf, and piglet watch) were taken at the farm prior to students having a shift of observing animals in a Parturition Management Course.

Figure 4.2 Modified Perceived Stress Survey

In the past week, how often have you been upset because of something that happened unexpectedly?
In the past week, how often have you felt that you were unable to control the important things in your life?
In the past week, how often have you felt nervous and stressed?
In the past week, how often have you felt confident about your ability to handle your personal problems?
In the past week, how often have you felt that things were going your way?
In the past week, how often have you found that you could not cope with all the things that you had to do?
In the past week, how often have you been able to control irritations in your life?
In the past week, how often have you felt that you were on top of things?
In the past week, how often have you been angered because of things that happened that were outside of your control?
In the past week, how often have you felt difficulties were piling up so high that you could not overcome them?

Note: Students that participants in the study were given this 10-question Likert scale survey that was adapted from the Perceived Stress Scale (Cohen et al. 1983). They were given this a total of 7 times, 4 baseline measurements that had 3 experimental measurements that took place on-farm in a Parturition Management course. The directions of the survey as students to choose one of the following that they felt best fit them: 0 - never 1 - almost never 2 - sometimes 3 - fairly often 4 - very often. Questions 4, 5, 7, and 8 had reverse scoring where 0 = 4, 1 = 3, 2 = 2, 3 = 1, 4 = 0. All other questions were added as they were, to the reversed scored questions for a final total out of 40.