

MODULATIONS OF SALIVARY CORTISOL LEVELS, BLOOD PRESSURE, AND HEART
RATE AFTER HUMAN-DOG INTERACTIONS IN UNDERGRADUATE STUDENTS AT
THE UNIVERSITY OF ARIZONA

By

JONAH ASHER WACHS

A Thesis Submitted to The W.A. Franke Honors College

In Partial Fulfillment of the bachelor's degree
With Honors in

PHYSIOLOGY AND MEDICAL SCIENCES

THE UNIVERSITY OF ARIZONA

MAY 2025

Approved by:

Dr. Lucinda L. Rankin, PhD
Department of Physiology

Acknowledgments

This project could not have been completed without the constant guidance and support of Dr. Cindy Rankin, PhD, from the University of Arizona College of Medicine – Tucson, Department of Physiology. Additionally, the assistance from the University of Arizona Emergency Medical Services to take all vital measurements helped this project be completed in an accurate and consistent manner.

Pet Partners of Southern Arizona was an enduring supporter of this project, providing communication throughout the year, as well as recruitment of both dogs (Poppy, Bernie, Zona and Spencer) and their handlers to partake in this project. None of this would have been accomplished without all their help. A special thank you to Diane Alexander, one of the directors at Pet Partners of Southern Arizona, for coordinating with this project.

Lastly, thank you to my mom, dad, sister, all my supporting friends and family, and of course, my own dog, Dodge, for their support throughout my journey here at the University of Arizona.

Bear Down!

Jonah A. Wachs

Abstract

Undergraduate student stress has increased over the last few decades. With it becoming progressively more competitive to matriculate into graduate/professional schools, or find a job post-grad, college students are experiencing heightened stress primarily due to worries about future plans, academic rigor, and busy workloads. Stress is a natural physiological response to a stimulus that the body perceives as dangerous. While thought of as negative, a proper stress response is vital to human life. When encountering threatening stimuli, the body releases hormones including cortisol, epinephrine, and norepinephrine as signalers to react. When this response is controlled, the body adapts to stressful encounters and reacts accordingly. When this response undergoes hyperactivity, the body is negatively affected and conditions including Generalized Anxiety Disorder and Post-Traumatic Stress Disorder can arise. To mitigate this, students report methods such as physical activity and interacting with supporting family/friends. Interestingly, students also report that interacting with animals have helped mitigate stress. Studies have shown that interactions with therapy dogs reduced participant stress in military veterans, nursing students, and college students. This study will investigate whether these interactions have modulations on physiological stress variables including salivary cortisol concentrations, heart rates, and blood pressures to determine their potential to mitigate stress.

Introduction

Stress in undergraduate students has been on the rise over the recent years. With increasing amounts of workloads, overwhelming schedules that include not just coursework, but extra-curricular activities, research, volunteering, and working, college students today are facing many more responsibilities than just completing their degrees. With this increase in stress comes worries about how chronic stress may affect students' performance in coursework, and their overall health. While a properly working stress-response is necessary for survival, too much stress can become worrisome and harm the body, such as hippocampal damage, which is the learning and memory center of the brain (Kim et al., 2015).

The importance of this study was to investigate if interactions with therapy dogs could help reduce stress levels in undergraduate students. The first leg of this study was done to understand the current stress levels of undergraduates at the University of Arizona, as well as gauge their perspectives on if interactions with therapy dogs a potential way to mitigate stress may be. Following this survey, the second arm of the study investigated the physiological parameters of stress before and after a cohort of students interacted with therapy dogs on campus. These parameters included blood pressures, heart rates, and salivary cortisol concentrations. The changes in these parameters were then compared to a control group, who did not interact with a therapy dog, to see if these interactions provide some sort of physiological stress relief. Additionally, all participants completed a pre- and post-interaction survey to gauge their perceived stress before and after the interaction.

The resulting data of this project demonstrated that the subjects who interacted with a therapy dog for 30-minutes had a markedly larger decrease in their heart rate and salivary cortisol concentration from before and after the interaction compared to the control participants.

This preliminary data is promising to support the idea that therapy dog interactions on college campuses may be an efficient and cost-effective way for higher education institutions to promote self-care and wellness while in undergraduate.

Background

Student stress

It is important to understand the factors that cause undergraduate student stress. One of the most frequently reported reasons students feel they are stressed is due to academic factors and performance (Beiter et al., 2015; Khanal and Shrestha, 2021). With increasing competitiveness for admission to graduate schools and professional schools, and successful job applications following college graduation, many students feel the increased pressure to succeed in all undergraduate coursework. Due to this internalized pressure, stress levels among this population continues to rise, as students are worried about failure and their future. In a survey conducted at Franciscan University in Ohio, two of the top reasons students reported feelings of increased stress were due to post-graduate plans and pressure to succeed. Additionally, this study found that Franciscan University Counseling Center has seen a 231% yearly increase in visits from undergraduate students in just 4 years, with a 173% increase in yearly clients (Beiter et al., 2015). These numbers have a twofold importance as they show the drastic increase in mental health concerns over the recent years, as well as the willingness for students to reach out for help when dealing with mental health related issues.

Beyond academic and post-graduate plans, stress levels among college students seems to be on the rise due to increase workload and limited personal time. When considering these two factors and their relationship to stress, sleep is an important variable that must be discussed. Poor

sleep quality and insomnia have been shown to be interlinked with undergraduate student stress (Gardani et al., 2022). One potential explanation for this is due to students feeling as though they are unable to catch up with the loads of work they are being assigned. A cross-sectional study of first to fourth year dental students reported that many students felt overwhelmed by the amount of required work and studying, feeling that they were unable to catch up on their workload (Gardani et al., 2022). Feelings such as these can lead to students not prioritizing their mental and physical health, sacrificing important health contributions such as physical exercise and sleep.

Physiology of Stress

Stress is a natural physiological response to stimuli that the body perceives as dangerous or harmful. While thought of as a negative emotion, a proper stress response is vital to human life and the ability to adapt to different environments. When encountering a threatening stimulus, the body releases hormones such as cortisol, epinephrine, and norepinephrine as signalers to react in a certain fashion. Without these mechanisms, the human body would fail to thrive in times of threat and danger. The normal stress response is controlled through the Hypothalamic-Pituitary-Adrenal Axis (HPA Axis), (refer to Figure 1), which links the roles of the hypothalamus, the pituitary gland, and the adrenal cortex to elicit a stress response in the body.

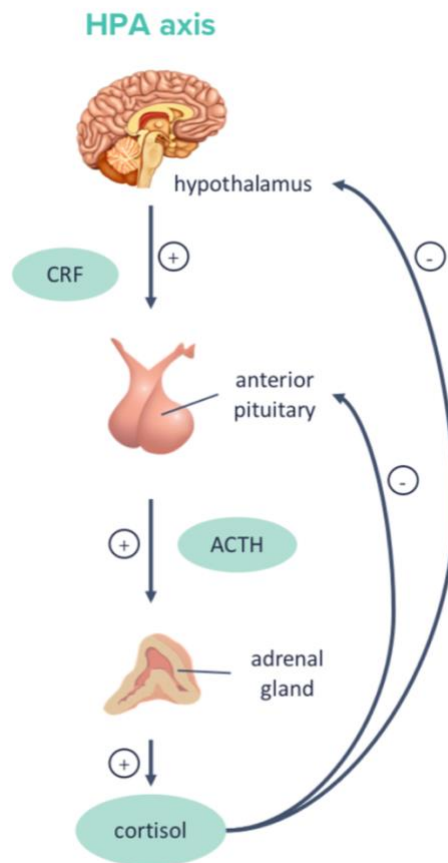


Figure 1 – Diagram of the HPA axis and its mechanism of action.

When this axis is controlled, the body can properly adapt to stressful encounters and react accordingly. When this axis demonstrates hyperactivity, the body undergoes worrisome modulations that can lead to numerous clinical outcomes such as Generalized Anxiety Disorder (GAD) and Post-Traumatic Stress Disorder (PTSD) (Ben-Azu et al., 2023; Juruena et al., 2020).

While maintaining a stress response is important for survival, it is also important to control levels of stress in individuals to limit risk of HPA Axis overdrive. The undergraduate college student population is a specific subgroup that has demonstrated large rises in stress levels over the past few years, with increases in stress levels and mental health disorders including anxiety, depression, and increased rates of suicide and suicide attempts (Beiter et al., 2015;

Eisenberg et al., 2007). Reducing undergraduate student stress levels is of main interest in this study.

Physiology of Cortisol

Cortisol is a hormone that is secreted in response to stress stimuli. It also plays a role in metabolism regulation, inflammation, and activation of the immune system (Thau et al., 2023). Cortisol is synthesized in the adrenal glands which sit on the top of the kidneys and is responsible for activating the Sympathetic Nervous System (SNS). The SNS is known for its role in promoting the “fight or flight” response, which provides a variety of modulations around the human body.

Cortisol is built from a molecule of cholesterol (refer to Figure 2). Activation and inhibition of cortisol secretion is regulated by the Hypothalamic-Pituitary-Adrenal Axis (HPA Axis), which works as a negative feedback loop to control how much cortisol is circulating in the blood stream.

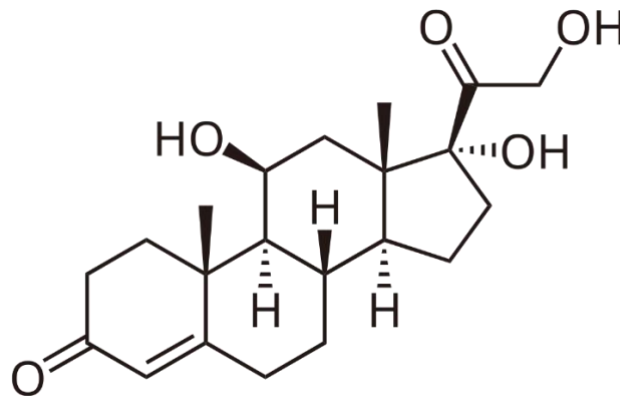


Figure 2 – Skeletal structure of cortisol, build from a cholesterol molecule.

The production of cortisol is stimulated through a stressful stimulus being perceived by a subject. As seen in Figure 3, once this stimulus has been processed, the paraventricular nucleus of the hypothalamus secretes a signaling molecule called corticotropin-releasing factor (CRF) (Smith and Vale, 2006). CRF then makes its way through the hypophysial portal system to act on the anterior pituitary gland to synthesize and release adrenocorticotropic hormone (ACTH). ACTH then travels way through the blood stream to activate cortisol synthesis in the zona fasciculata layer of the adrenal cortex in the kidneys. Once activated, cortisol stimulates the SNS to activate a response to react to the stressful stimulus that was perceived, including increasing blood pressure and heart rate, pupillary dilation, decreased peristalsis, increased glycolytic reactions, etc. (Waxenbaum et al., 2023). Increases in blood pressure and heart rate enable blood flow to critical organs, pupillary dilation improves vision, decreasing peristalsis allows the body to focus its energy on the stressful stimulus, and increased glycolytic reactions allow for metabolism to speed up, providing more energy for the body to react. Through these perturbations, the body can now react properly to the stimuli that it is being exposed to allowing the subject to react accordingly.

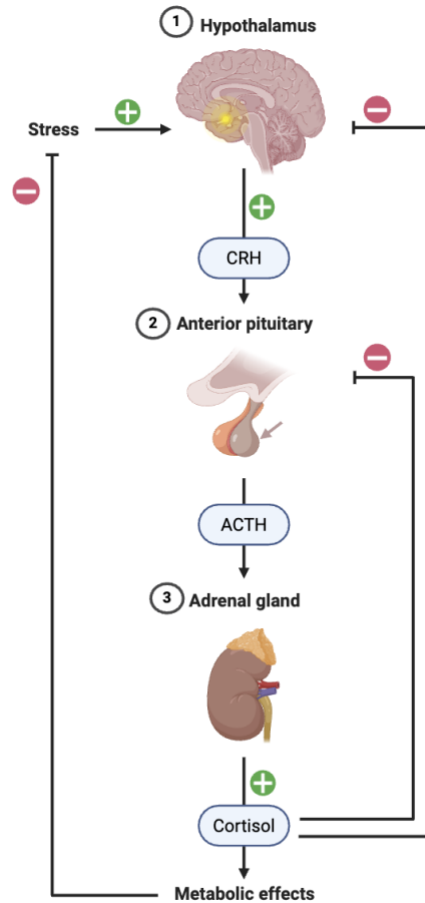


Figure 3 – Diagram showing the components of the HPA Axis and its mechanism of action. The green circles with a ‘+’ indicate activation arrows, whereas the red circles with a ‘-’ sign indicate inhibition arrows.

While these stress responses are vital to survival, hyperactive stress states lead to hypersecretion of cortisol which can be detrimental to one’s health leading to pathological and immunocompromised states. Patients with hypercortisolism have been associated with an increased risk for depression. It has also been reported that those with increased elevations of glucocorticoids in their circulation are at risk for damage to the hippocampus, the area in the brain responsible for learning and memory (Qin et al., 2016). These subsequent effects of hypercortisolism prove to be damaging to individuals, as the chronic levels of stress cause for abnormal adverse effects. Interestingly, hypersecretion of cortisol can lead to issues relating to

the immune system and individual's immune responses. Additionally, chronically elevated blood pressure and heart rate can pose risks to cardiovascular health, and even lead to cardiovascular events such as myocardial infarctions or strokes (Richards et al., 2002; Picariello et al., 2011).

Cortisol is typically seen to provide anti-inflammatory effects due to its inhibition of the production of pro-inflammatory cytokines, such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF- α), and interference with the NF- κ B pro-inflammatory pathway (O'Donovan et al., 2015; Dong et al., 2018). While this is beneficial to control inflammation in the body, chronic secretion of cortisol allows the immune system to build up a tolerance and start to resist the anti-inflammatory cytokines that are being produced (Morey et al., 2015). Once this occurs, the immune system begins working in overdrive, leading to autoimmune disorders.

Ways Students Destress

The trend for increasing levels of stress worldwide has brought into light the concept of self-care. Many individuals are beginning to practice habits to increase relaxation, decrease stress, and promote feelings of self-worthiness and approval.

One of the most common forms used to reduce stress is physical exercise. This is a method many use to relieve their minds from day-to-day stress. A study conducted with college students that tracked participants stress, emotional experiences, physical activity, and eating habits found that those students who had high levels of physical activity subsequently had lower levels of reported stress. Alternatively, those who had low levels of physical activity demonstrated higher levels of stress (Schultchen et al., 2019). Furthermore, a meta-analysis longitudinal study that followed both children and adolescents found a significant association between physical activity and lower levels of physiological ill-being (such as depression, anxiety,

stress, etc.). This study continued to report that greater amounts of sedentary behavior has been shown to increase the risk of physiological ill-being states (Rodriguez-Ayllon et al., 2019). These findings provide further support for the positive effects and influences that physical activity can have on an individual's mental health, reinforcing why physical activity is a popular destressing activity.

Beyond physical activity, students have reportedly been turning to mobile device platforms to decrease stress levels. With improvements in technology, there are numerous applications that have been created specifically for lowering stress and relaxation. A new mobile device meditation app called "Calm" has been being used by students who have reported feeling significant drops in their overall stress. These students also mentioned their favorability in continuing to use "Calm" in the future (Huberty et al., 2019). Innovations like these, and the positive reactions they have received, further demonstrate students' willingness to try new methods to decrease stress levels.

Physiological Benefits of Human-Dog Interactions

Dogs are commonly known as "human's best friend". While this may be a common belief, there is scientific evidence that backs up this claim. Numerous studies have reported that human interactions with therapy dogs have been shown to have widespread positive effects on the study participants. In a study by Krause-Parello et al (2016) working with the Denver Veteran's Association, military veterans were paired with therapy dogs to test the effects of these interactions. The participants' blood pressure, heart rate, and salivary cortisol levels were taken pre and post interaction, with the results demonstrating a significant decrease in all three parameters (Krause-Parello et al., 2016). Further studies have confirmed these findings in

different populations such as nursing students, college students, and individuals with psychological disorders (Hall and Duke, 2021; Maujen et al., 2015; Wood et al., 2017, respectively). All these studies reinforced the beneficial changes: decreased blood pressures, heart rates, and cortisol levels, as well as decreased negative symptoms presented by the schizophrenic patients in the Wood et al study which included participants with psychological disorders. These results demonstrate the potential beneficial effect that therapy dogs can have on human subjects, and the potential upside of implementing interactions with therapy dogs for students on college campus to help relieve the dangers of chronic stress levels.

Interestingly, humans are not the only ones that benefit from these interactions. It has been shown that the therapy dogs themselves experience beneficial effects from these human-dog interactions. A 2003 study, investigating the neurophysiological correlation between humans and dogs, found that after just about 5-24 minutes, beta-endorphin levels, oxytocin levels, prolactin levels, beta-phenylethylamine all increased in both the human and dog subjects (Odendaal and Meintjes, 2003). All these molecules have been shown to have positive effects on the body including increasing in learning, memory, blood pressure regulation, and feelings of connection.

Additionally, blood pressures were taken in all human and dog participants in this study, with both human and dog subjects demonstrating significant decreases in mean arterial blood pressure post human-dog interaction. It is noted that while human cortisol levels showed a decrease in this study, cortisol levels in the canine subjects increased. This may be due to the dog being initially overly stimulated, as they were introduced to an unfamiliar face, as well as being subjected to these physiological parameters being measure. This study does point towards the direction that these interactions, between human and dogs, may have a bidirectional beneficial

effect, further supporting the idea that they may be effective in reducing stress and cortisol levels among undergraduate students.

Certification to Become a Therapy Dog

While any dog can become a therapy dog, there are certain guidelines and protocol that an owner and their dog must pass before their canine becomes certified. First many facilities will not allow dogs under the age of 1 to become certified. This is since before the age of 1, the dog has not reached adulthood and still has room for physical growth and maturity. Beyond this, many organizations will require a dog to complete and pass the American Kennel Club Canine Good Citizen (CGC) Test. The CGC Test is a standardized 10-skill tests that examines the obedience of a dog, such as tasks including accepting a stranger, walking through a crowd, coming when called, reaction to another dog, reaction to a distraction, etc. For owners who want to have their dog become a certified therapy dog, they will have to pass these tests before obtaining certification.

Once the CGC has been completed and passed, many owners will enroll in courses to learn how to better train their dog. While not mandatory, these courses enable an owner and dog to build a stronger connection before going out in the field.

Beyond this, the last step is to register them with a national therapy dog organization to become a national certified therapy dog. These canines can enter places where those who need physical or emotional rehabilitation are located. This includes hospitals and rehab facilities. Many therapy dogs also visit places of employments, schools, and universities.

The organization that collaborated with this study was Pet Partners of Southern Arizona. For this organization specifically, some of the requirements for a dog to become a certified

therapy dog include being comfortable while surrounding by people, knows how to respect boundaries (will not jump on people), comfortable being touched, able to resist food, and much more. Additionally, Pet Partners of Southern Arizona provides guidelines for the handlers of therapy dogs before they can become certified. A few of these include being a proactive activate for their dog, develops a relationship with their dog, prepares themselves and their dog for each visit, assesses each visit before, during, and after, being aware of their dog's own stressors and fears, and more (Pet Partners of Southern Arizona, 2023). This group often visits the University of Arizona Campus at the end of each semester to help students destress around the time of final examinations.

Methods

To determine the potential benefit of interacting with dogs as a method to reduce student stress, there were 2 arms of this study: 1) an anonymous survey to gauge undergraduate students' stress and perspective on the benefit of working with dogs and 2) measure the stress-related physiological parameters in students before and after interacting with dogs. This study was approved by the Institutional Review Board (IRB) to be conducted at the University of Arizona Main Campus in Tucson, Arizona.

Aim 1: the first portion of this study included gauging undergraduate students' perception of their stress levels while enrolled at the University of Arizona, as well as their current feelings toward the use of therapy dogs as interventions to lower student stress levels. A Qualtrics survey was sent out to the Current Topics in Physiology course (PSIO 489) at the University of Arizona for students to fill out (n=82, 31 male and 51 female). This survey was completely anonymous and was used to further provide support for the following part of the study.

Aim 2: The second part of this study was to determine if there is a physiological response in undergraduate students to interaction with a therapy dog. This was done by measuring undergraduate students heart rates, blood pressures, and salivary cortisol levels before and after interacting with a certified therapy-dog for a set amount of time.

Participants for this part of the study (n=22, 4 male, 17 female, one preferred not to share) were recruited through online flyers sent out via email to students across a variety of disciplines at the University of Arizona Undergraduate campus. These flyers included a QR-code for participants to scan and sign up. Once signed up and agreeing to the study, participants attended the Human-Dog interaction portion of the study, where they completed a survey and had various stress-related physiological parameters measured, both before and after the human-dog interaction.

Participants checked in at the designated location of testing, the Student Union Memorial Center, in the Santa Cruz and San Pedro Classrooms. A volunteer worker checked each participant in and assigned a random letter to each participant to anonymize all individuals and their results. All participant information was kept in an accordion folder, with each respective de-identifier placed on a tab within the folder. 10 participants checked in at each hour time slot, with the group of 10 divided into two smaller groups of 5. Each group of 5 had a participant chosen at random, via a wheel spin containing all 5 participants de-identifiers on it, to act as a control of the study. This participant followed identical check in and vital measurement protocol as all other participants but did not interact with a therapy dog. Instead, they sat outside the classrooms with the dogs, and were blinded to any dog interactions. Since many of the control subjects were disappointed that they could not interact with the dogs initially, all controls were promised the opportunity to interact with the therapy dogs after the conclusion of the study. For terminology

sake, “subjects” were the participants who interacted with the therapy dogs and “controls” did not.

After the initial check-in, all participants filled out a pre-interaction survey to gauge their current perceived stress levels, as well as to provide insight into their feelings toward therapy dog interventions before interacting with a therapy dog. Once completed, participants had their heart rates and blood pressures taken by a University of Arizona Emergency Medical Services Staff Member. This was followed by each participant placing a Salivary Oral Swab, provided by Salimetrics, underneath their tongue for 1-2 minutes. This swab was placed in each participant’s respective test-tube vial, marked with their de-identifier letter on it, followed by the letter A, indicating this was the pre-interaction swab. These tubes were placed directly on ice for remainder of the experiment.

The subject participants then entered a room containing a single certified therapy dog and the therapy dog’s handler from Pet Partners of Southern Arizona. There were 4 subjects for each therapy dog. In the room, subjects were able to interact with the therapy dogs in any way they wanted, included petting, playing, cuddling, talking, etc. The handlers were also able to execute tricks with the dogs to show off to the subjects. All subjects were in the room with a therapy dog for approximately 25-30 minutes, to allow the sufficient time for any observed change in salivary cortisol levels (Naumova et al., 2014).

After the interaction, subjects were checked out of the room and once again had their heart rate and blood pressures taken by the same University of Arizona Emergency Medical Services Staff member. Controls followed these same procedures. While doing this, participants put another Salivary Oral Swab from Salimetrics under their tongue for 1-2 minutes for the post-interaction salivary sample. These swabs were then placed in a test-tube with each participant’s

de-identifier on it, followed by the letter B, indicating this was the post-interaction swab. These samples were placed directly on ice after collection. Participants then completed a post-interaction survey to gauge their perceived stress levels after the interaction, as well as to judge attitudes regarding human-dog interactions as stress interventions now that all participants had interacted with a therapy dog. Once completed, participants were then checked out of the study.

All vital measurements and surveys were kept anonymized in the accordion folder. All salivary samples were stored in a -20°C freezer for 2 days, until they were shipped on dry ice to the Salimetrics for analysis. Cortisol concentration was determined via Salimetrics using an enzyme-linked immunosorbent assay (ELISA) to quantify the cortisol in each participant's saliva, with an assay range of $0.012\text{-}3.0\ \mu\text{g/dL}$ and a sensitivity of $0.007\ \mu\text{g/dL}$. Salimetrics performed the assay and sent the results back to the Principal Investigator and the Project Coordinator of the study. All subsequent data analysis was performed by the Principal Investigator.

Results

General Stress Survey (Current Topics in Physiology Course Survey)

Demographic Information of General Stress Survey Respondents

The General Stress Survey was given to undergraduate students enrolled in the Current Topics in Physiology Course at the University of Arizona consisted of 82 total participants. The survey was given the first week of class, before the first topic of the course which was focused on 'the benefit of dogs' to reduce bias and background information that might influence the students' answers. Of these 82 participants, 74 declared they were in their Senior Year of undergraduate (4th year), 7 declared they were in their Junior Year of undergraduate (3rd year), and one declared that they were neither a Senior nor a Junior in undergraduate. 31 of the respondents were males, while 51 of the respondents were female. All respondents were required to have been 18 years of age or older at the time of the survey to eliminate requiring consent from minors. 6 respondents were ages 18-20, 72 respondents were aged 21-24, and 4 respondents were 25 years or older. After collecting demographic information, the survey included all the questions and results as listed below.

General Stress Survey Questions, Responses, and Results

Question #1

How would you describe your normal stress level?

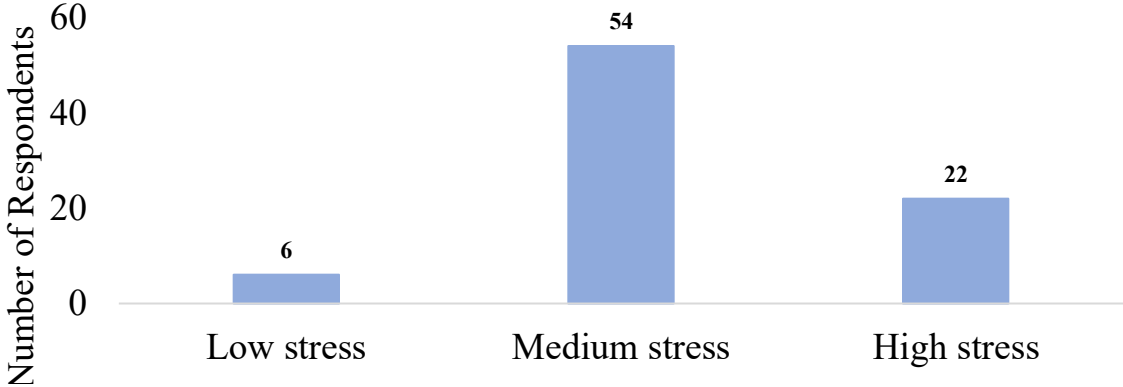


Figure 4 – Student ratings of normal stress.

As seen in *Figure 4*, majority of students (93%) who filled out this survey rate their daily stress levels as either moderate or high.

Question #2

Since coming to the University of Arizona, how have you seen your stress levels change?

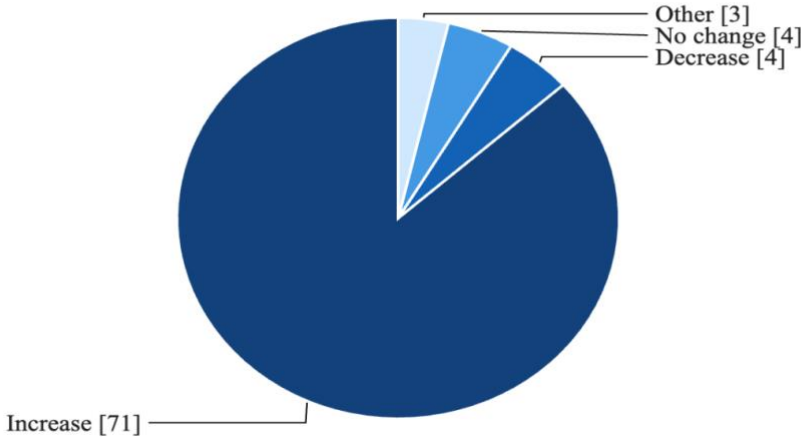


Figure 5 – Students’ perception on change of stress levels since beginning undergraduate.

This graph in *Figure 5* shows that since coming to the University of Arizona, majority of students (87%) perceived that their stress levels have increased since beginning their undergraduate degree.

Question #3

Which of the following activities affect your daily stress levels? (select all that apply).

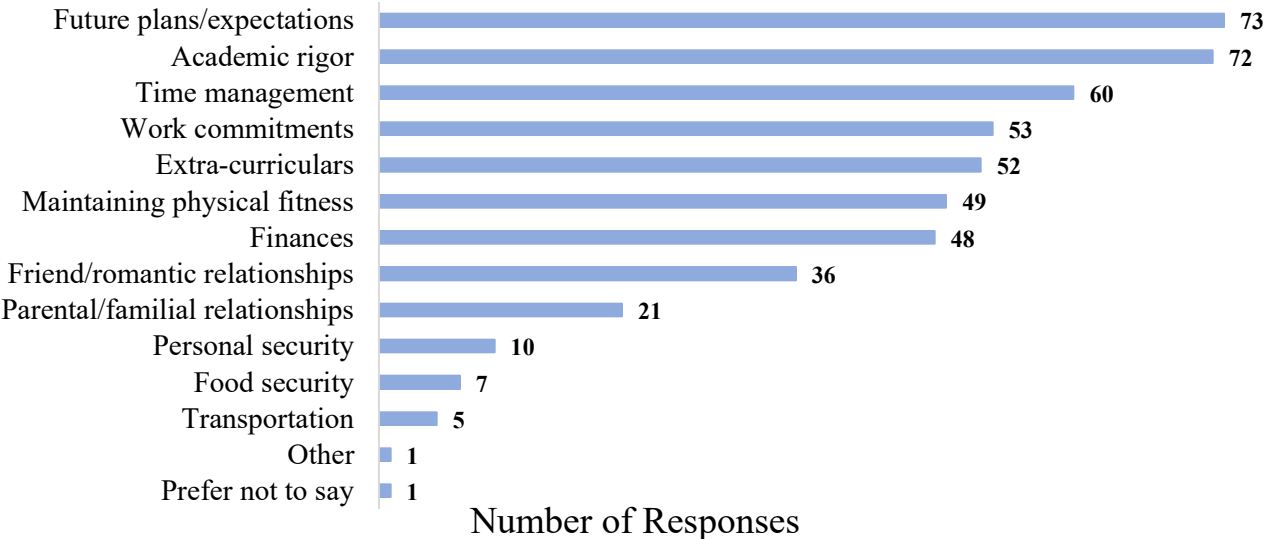


Figure 6 – Students rate which activities affect their stress the most.

Future plans/expectations, academic rigor, and time management are seen to be the highest causes of daily stress in this population.

Question #4

Which one factor has the greatest/primary impact on your stress? (Choose one)

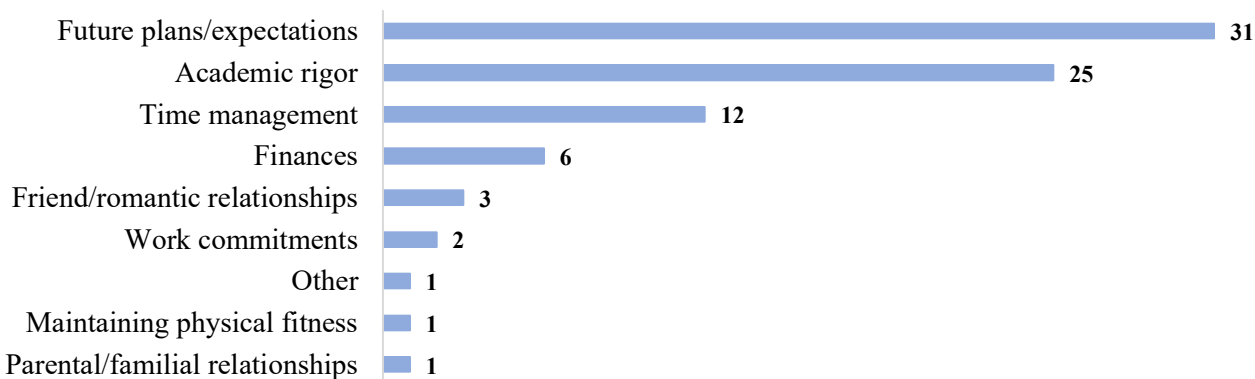


Figure 7 – Students rate which *one* factors has the greatest impact on their stress.

When asked to determine the one factor that greatest impacts students' stress levels, future plans and expectations are the most demanding on student stress.

Question #5

Outside of schoolwork, which activities increase your stress levels? (Select all that apply)

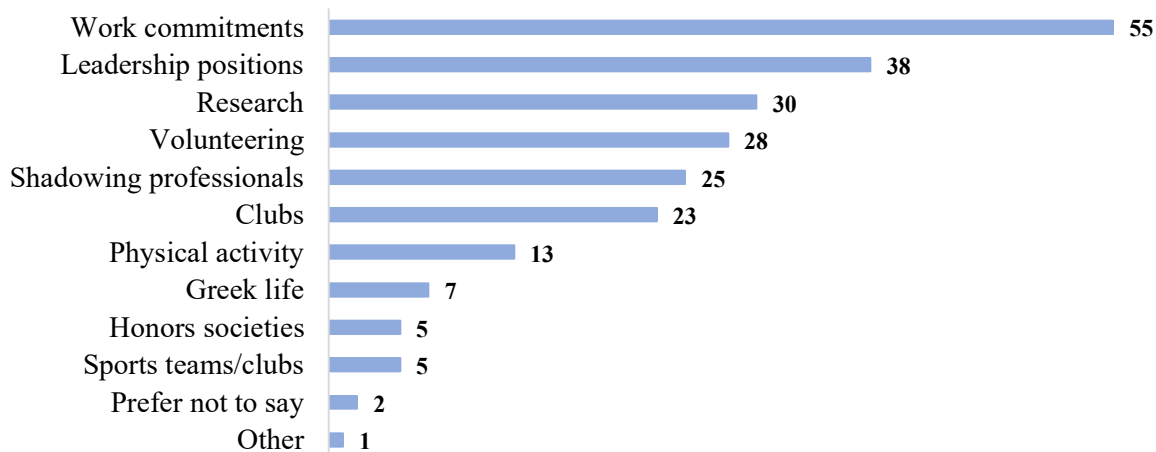


Figure 8 – Students rate what provides them the most stress outside of coursework.

Beyond academics, work commitments and various leadership positions have the highest impact on respondent stress levels. These may be demanding on students due to them being viewed as important and valuable.

Question #6

When you feel stressed, what do you do? (Select all that apply)

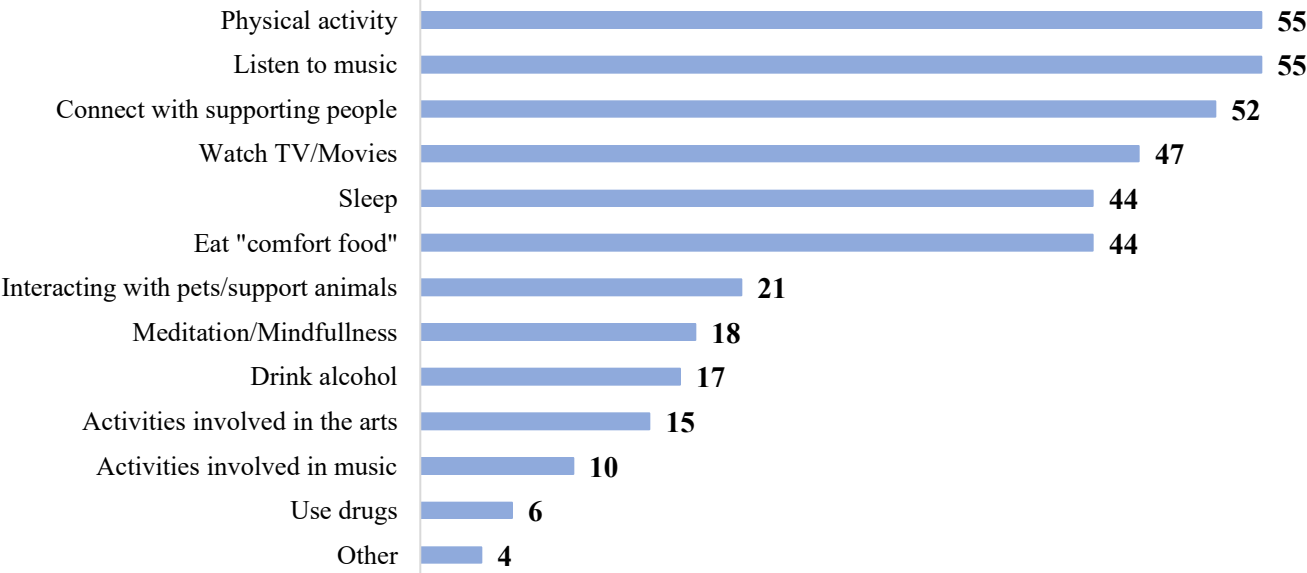


Figure 9 – Students share their common relaxation methods when stressed.

Physical activity, listening to music, and connecting with supportive people are the top three selected options that students turned to when feeling stressed. There are many other that are close behind these three choices, such as watching TV and movies, sleeping, eating “comfort food”, and interacting with pets or support animals.

Question #7

“Of those listed in the previous question, which method to reduce your stress do you turn to the most frequently? Briefly explain why. If you prefer not to say, please write ‘Prefer not to say’.”

The most frequently provided answers to this question included listening to music due to its accessibility, physical activity due to it acting as a distractive measure to stressful thoughts/emotions and connecting with both supporting friends and pets due to the feeling of having support and affection from others.

Question #8

In the past two weeks, would you describe your stress levels as:

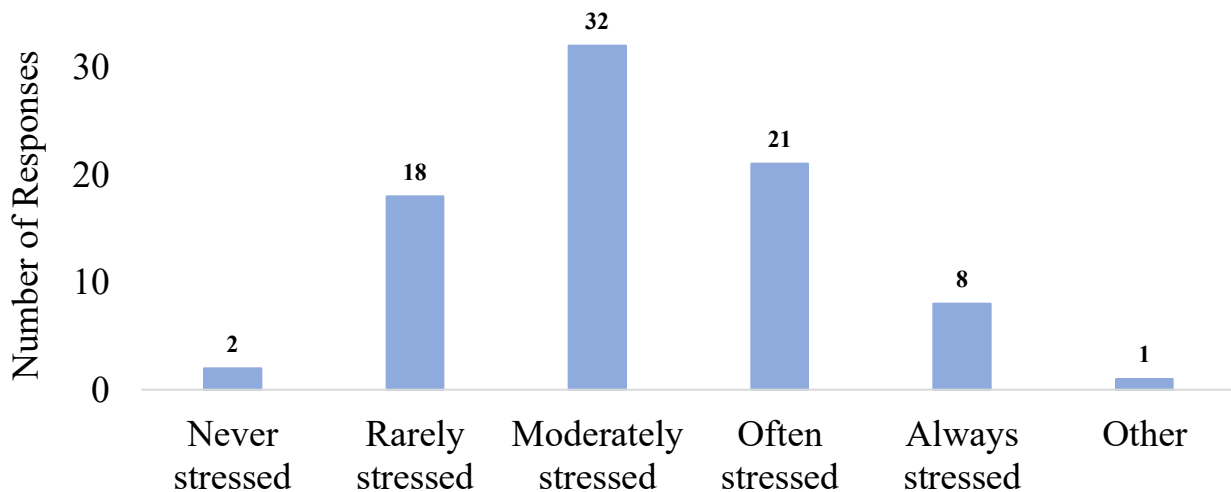


Figure 10 – Students rate their stress levels in the last two weeks prior to taking the survey.

Over half of the respondents (60%) reported that they have moderately-to-often stress levels in the past two weeks prior to taking this survey. This data demonstrates the potential need for new

interventions or methods on college campuses to help undergraduate students decreases their stress levels.

Question #9

In the past two weeks, would you describe your feelings regarding your levels of responsibilities and your schedule as:

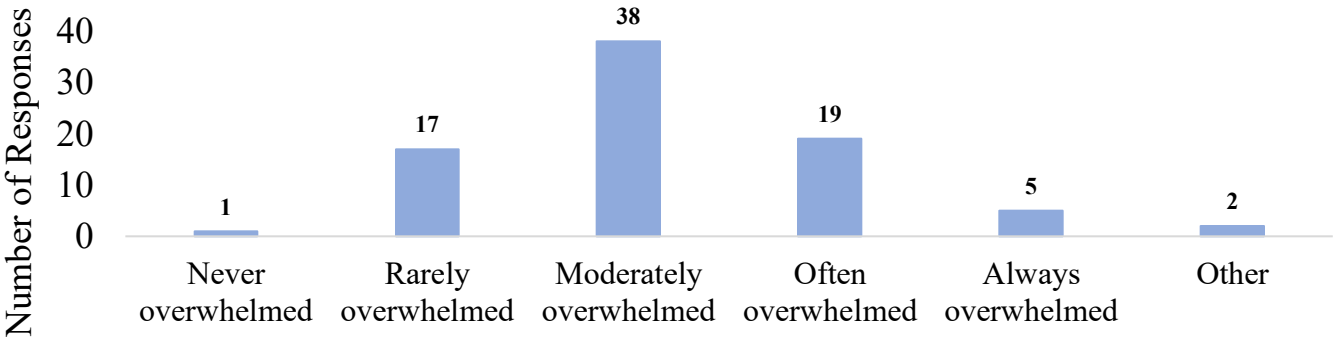


Figure 11 – Students gauge how overwhelmed they feel about their schedules and responsibilities.

Majority of the respondents (76%) are moderately, often, or always overwhelmed with their schedule and the number of responsibilities they have.

Question #10

In the past two weeks, how would you describe your ability to cope with stress?

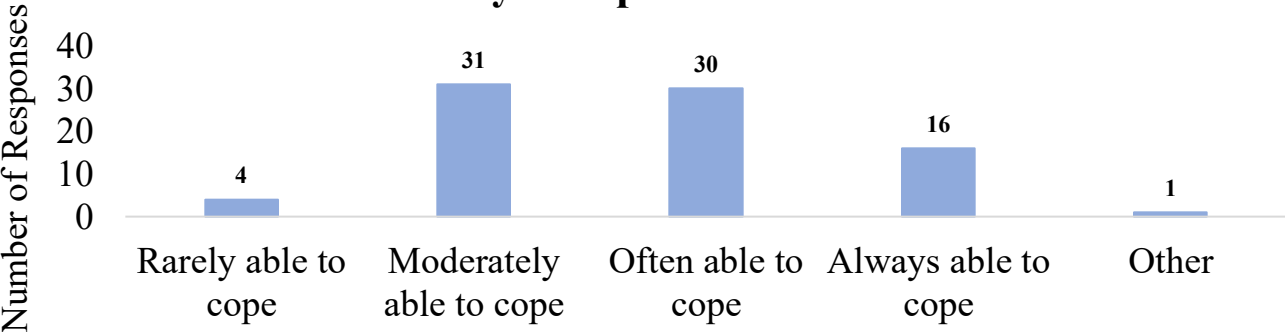


Figure 12 – Students rate their coping abilities to stress in the two weeks prior to taking this survey.

Over half the students in this study (94%) reported that they feel they are moderately, often, or always able to cope with their stress in the two weeks prior to taking this survey.

Question #11

In the past two weeks, how would you describe your activity levels?

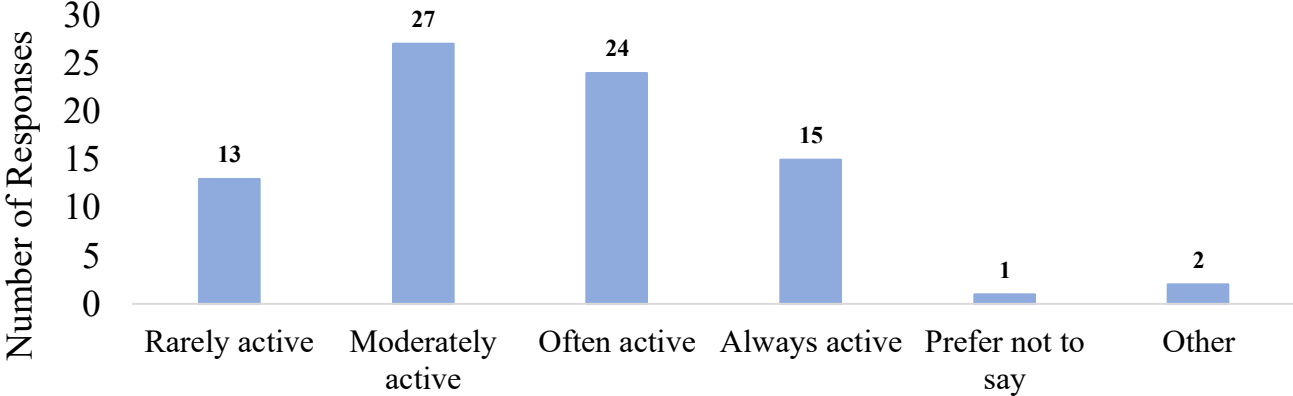


Figure 13 – Students rate their activity levels for the two weeks prior to taking this survey.

Only 48% of the students reported being either often active or always active in the two weeks prior to taking this survey. That means over half of the students in this study are moderately to rarely active, if active at all.

Question #12

How successful do you think you are in academics?

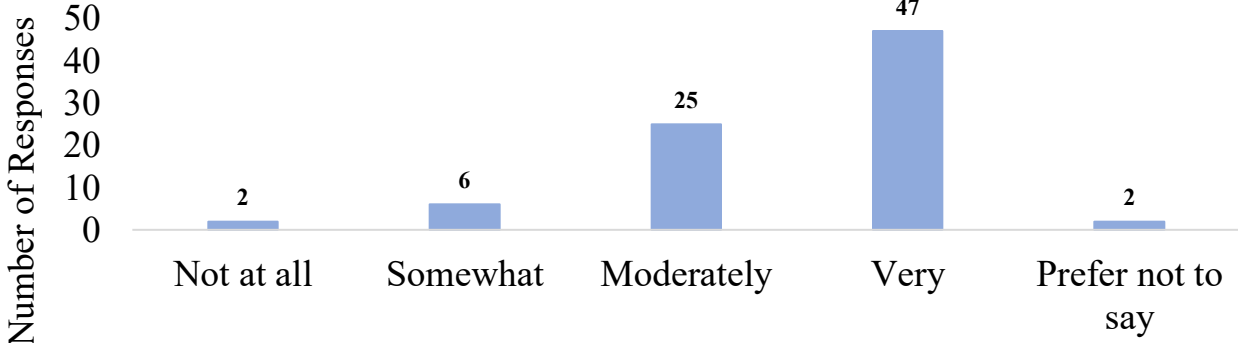


Figure 14 – Students rate their perception of how well they perform academically.

Over half (57%) of the students in this study believe they are very successful in their academics, with another 30% of students believing they are moderately successful in their academics.

Question #13

Do you feel like you have support from the university resources? (ThinkTank, Supplemental Instruction, SALT center, DRC, Campus Health, CAPS, etc.)

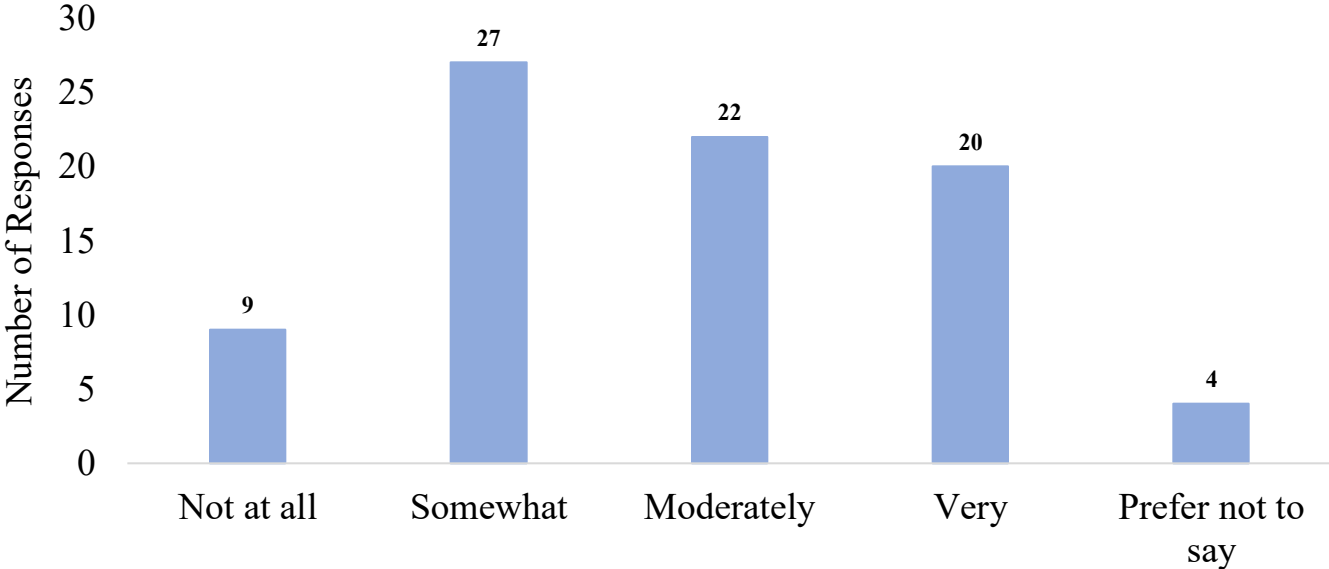


Figure 15 – Respondents report how well supported they feel by university provided resources.

Less than a quarter of the students (24%) reported feeling very supported by university provided resources, with only another 28% feeling moderately supported. With data in mind, it can be reasoned that many of the current methods on campus may not be reaching undergraduate students with the hopes in mind. This further supports the idea that new methods, such as therapy dog interactions, may be needed to help students.

Question #14

Which of the following has been the most helpful to you during your time at the University of Arizona? Select one.

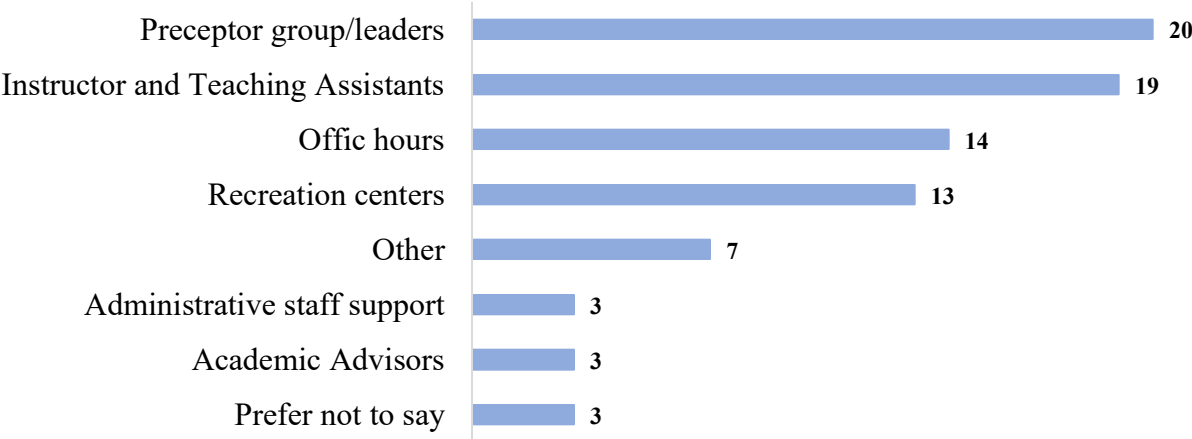


Figure 16 – Students select which resources have been the most helpful to them while in undergraduate.

Majority of respondents felt that preceptors and Teaching Assistants have been the most helpful during their time in undergraduate.

Question #15

Do you feel like you have a support system of people to help you cope with stress?

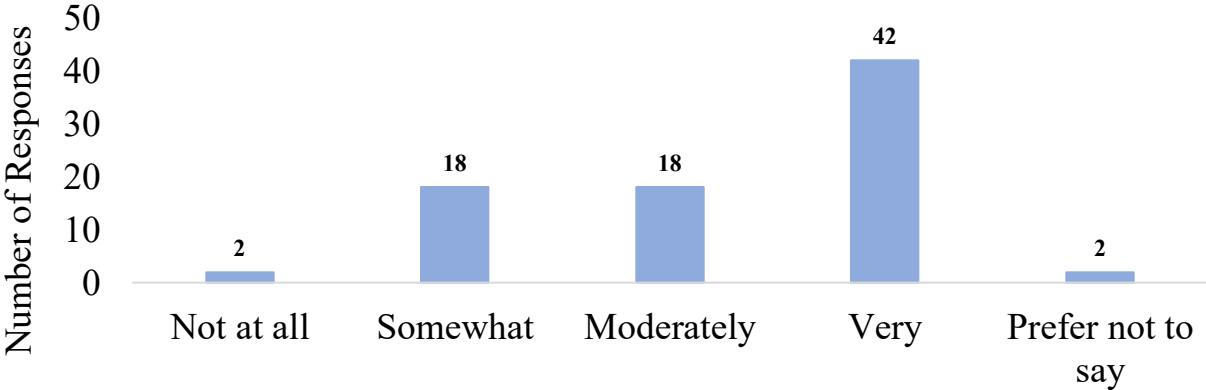


Figure 17 – Students rate whether they feel they have a support system to help cope with stress.

Over half of the students in this study (51%) reported having a very strong support system they can rely on to help cope with stressors, with another 22% reported they have a moderately strong support system to rely on.

Question #16

**What kind of support systems do you use when stressed?
(Select all that apply)**

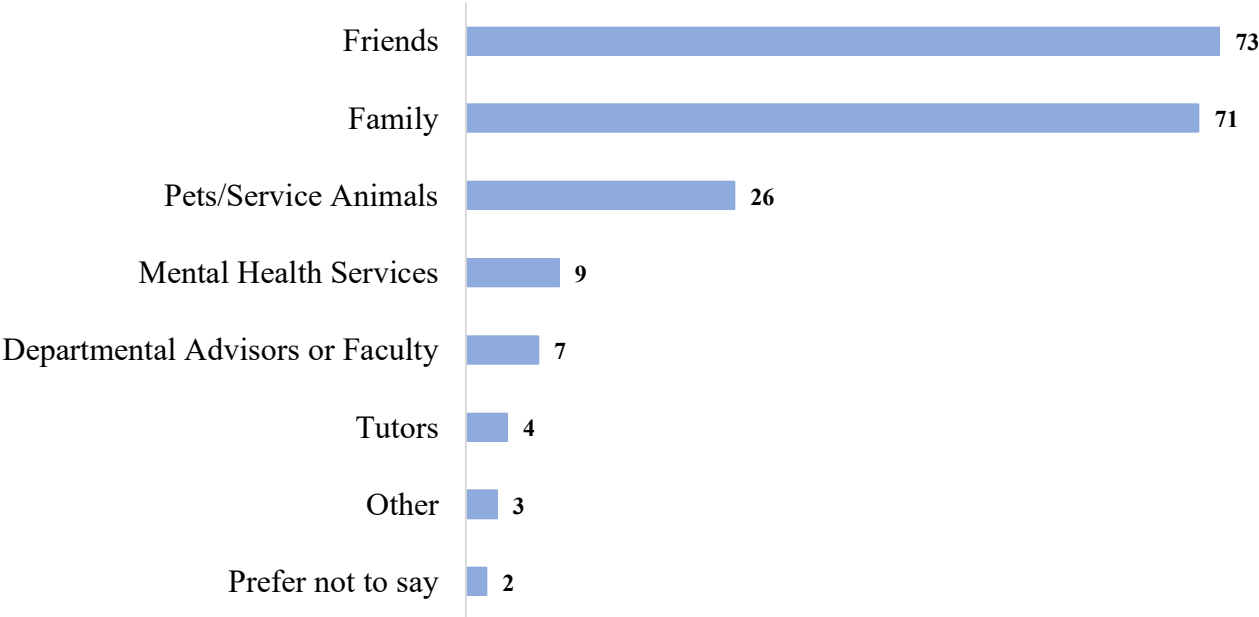


Figure 18 – Students share what support systems they most heavily rely on when stressed.

Students report going to their friends and family as support systems when they feel stressed. Interestingly, the third most common selection was students going to pets and service animals as support systems when stressed. This is promising evidence that many students do rely on service animals, whether they are dogs or another animal, to help them during stressful times and hardships.

Question #17

Have you ever attended an event on campus aimed at reducing stress?

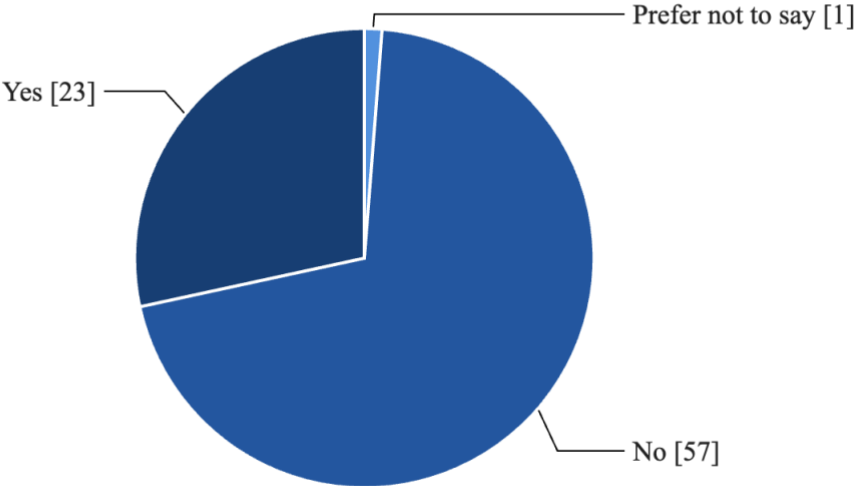


Figure 19 – Students share whether they have attended on on-campus event to reduce stress.

Majority of students (70%) reported they have never attended an on-campus event that focused on mitigating stress, with only 28% sharing that they have.

Question #18

If yes to the previous question, did this event help to reduce your stress?

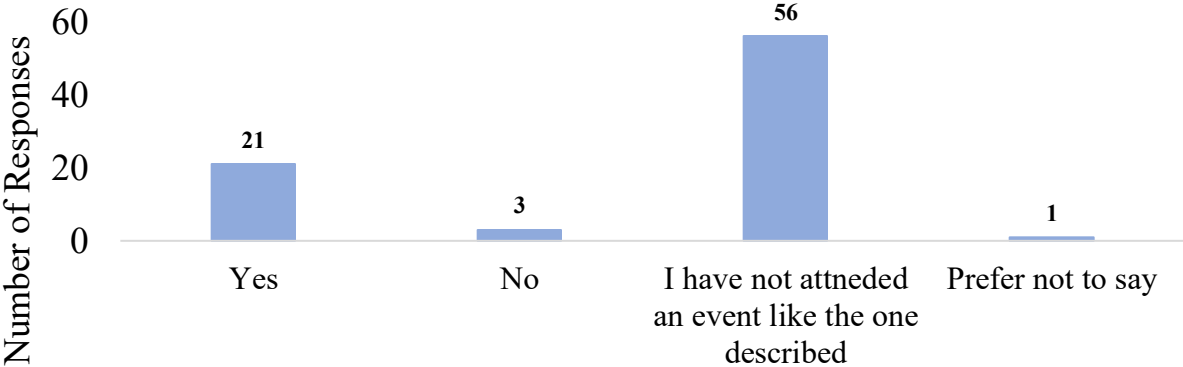


Figure 20 – Students share whether an on-campus event has helped them reduce their stress.

Of the students who have attended events on-campus to reduce stress, majority (88%) reported that this event did help them to reduce their stress levels.

Question #19

There are therapy dogs that visit campus during finals and other times. Would you go visit these animals?

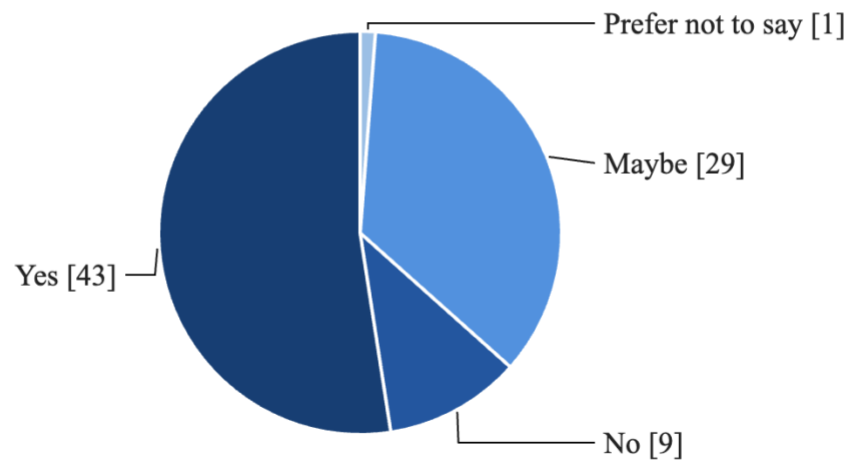


Figure 21 – Students share whether they would visit a therapy dog on campus.

A total of 88% of the respondents (52% “yes” and 35% “maybe”) shared that they would at least be open to the idea of visiting therapy dogs that visit campus. Interestingly, only 11% of students said “no” to a potential such visit. With such a small percentage of the respondents saying “no” to this idea, it creates more reasoning to believe that undergraduate students value interactions with dogs and would be interested in testing to see if these interactions can help them to reduce their stress.

Question #20

Do you believe that interactions with dogs can help to reduce your stress levels?

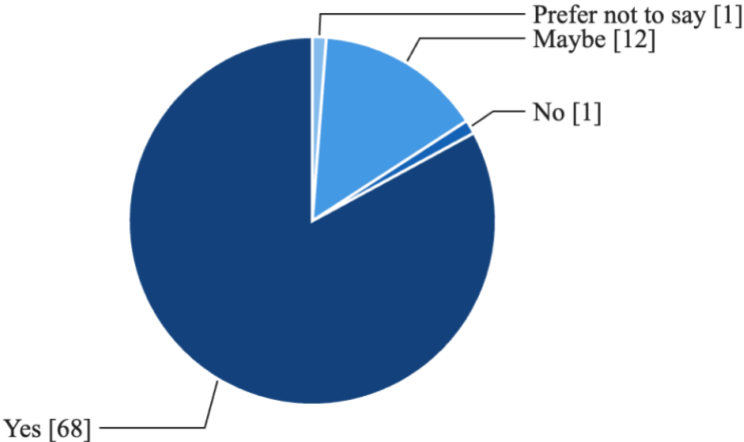


Figure 22 – Students share whether they believe interactions with dogs can reduce their stress.

Over 80% of respondents reported that they believe interactions with dogs can help to reduce their stress levels.

Question #21

What was your experience with dogs like while growing up?

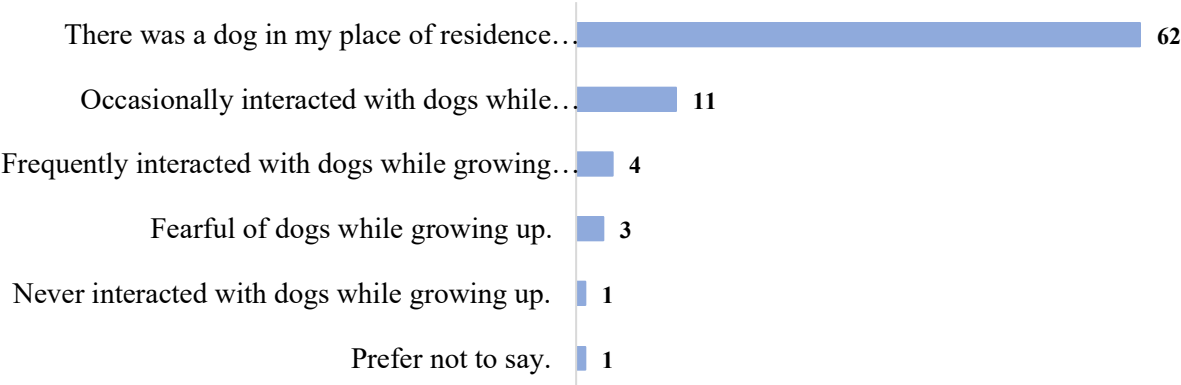


Figure 23 – Students share their childhood experiences with dogs while growing up.

Almost all respondents (89%) either had a dog in their place of residence while growing up or occasionally interacted with a dog while growing up.

Question #22

What is your experience with dogs during your time at the University of Arizona

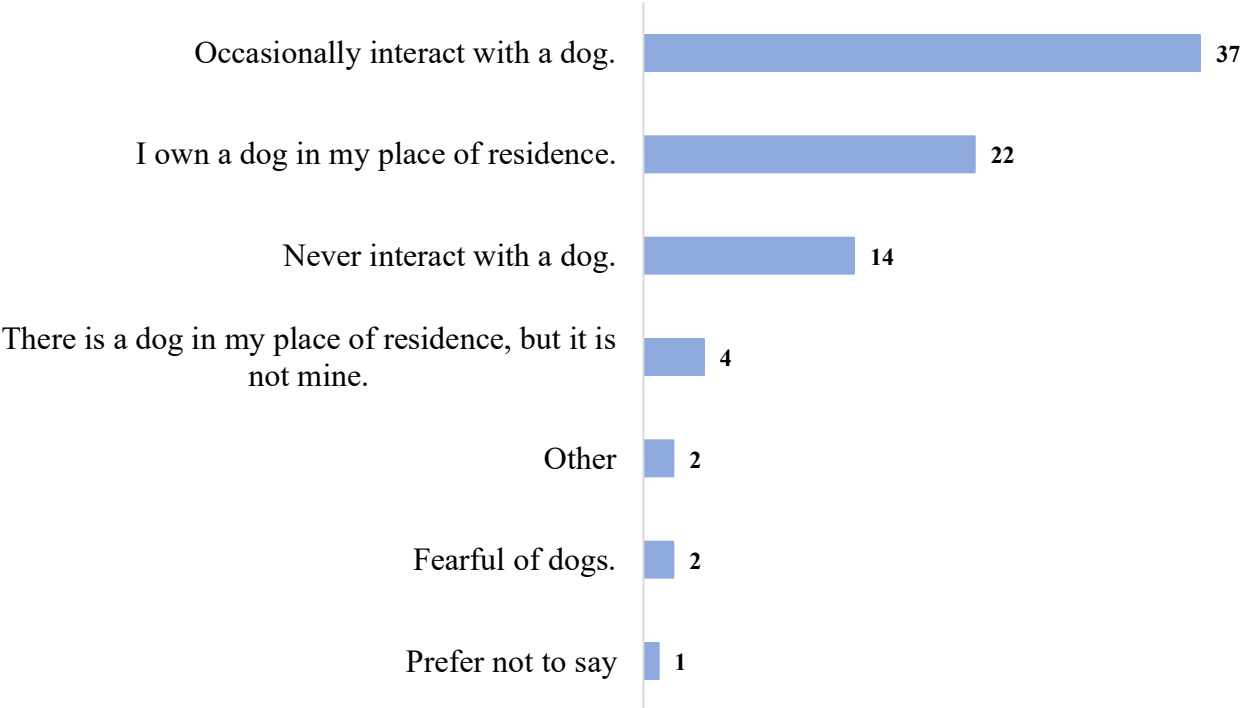


Figure 24 – Respondents share their experiences with dogs while in undergraduate.

Respondents report that majority either occasionally interact with a dog during their time in undergraduate (45% of respondents) or own a dog in their place of residence while in undergraduate (27% of respondents). These totals add up to 72% of respondents either occasionally interacting with a dog or owning a dog while in undergraduate. This high percentage shows the positive attitudes of dogs in undergraduate students.

Question #23

Do you believe dogs help improve your sense of well-being?

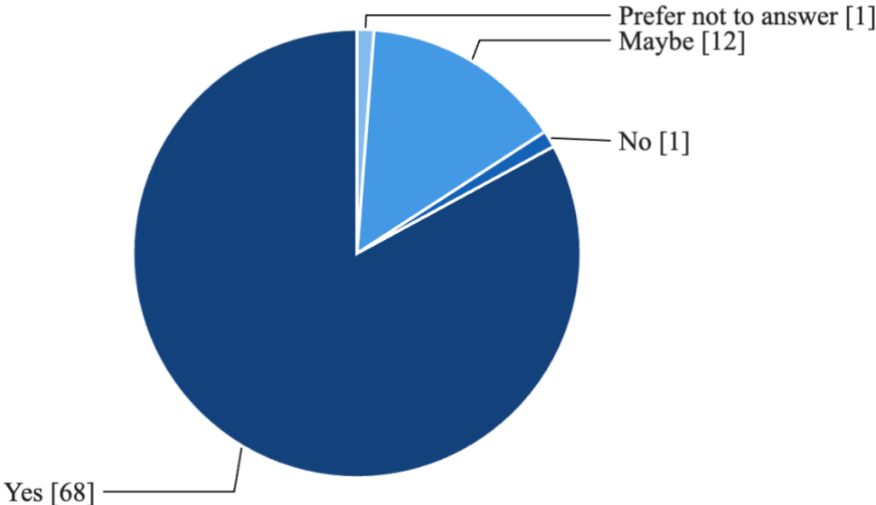


Figure 25 – Students share whether they believe dogs help their sense of well-being.

Over 80% of respondents reported that they believe dogs help improve their sense of well-being.

Question #24

If you have interacted with a dog in the past, how would you describe the emotion you felt after the interaction? (Select all that apply)

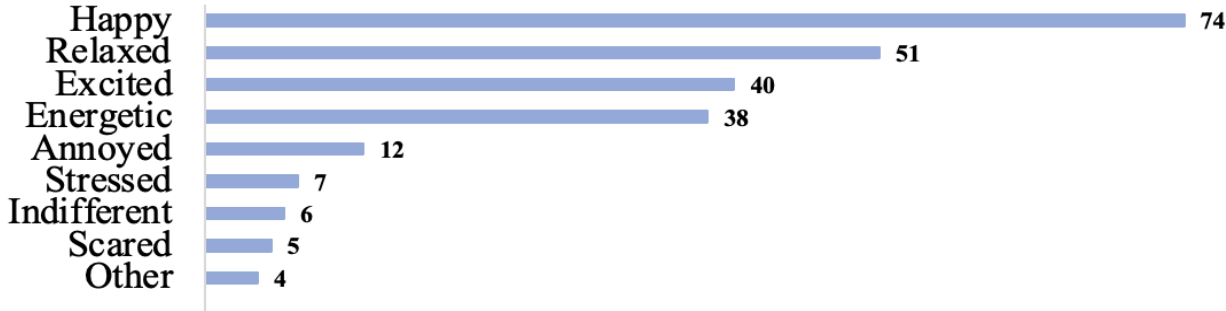


Figure 26 – Students share how they felt in the past after interacting with a dog.

After a past interaction with a dog, the most selected feelings from the respondents were happy, relaxed, excited, and energetic, with these four options making up of 90% of the selected emotions.

Question #25

Today, do you regularly interact with a dog?

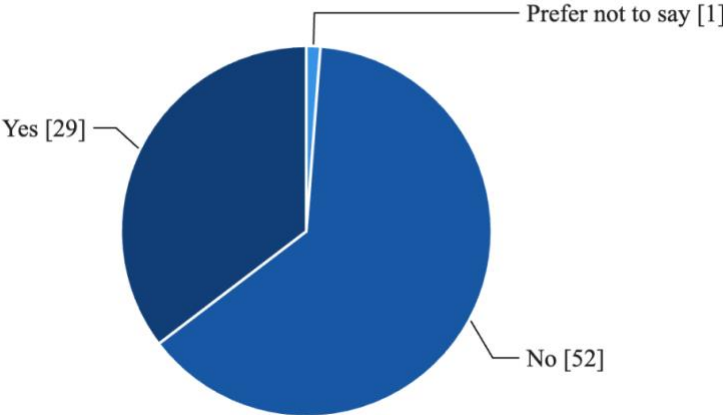


Figure 27 – Students share whether they regularly interact with a dog while in college.

Over half of the college students in this study (63%) do not regularly interact with a dog.

Question #26

Today, do you have any interactions with any animals regularly? (dog, cat, bunny, hamster, etc.)

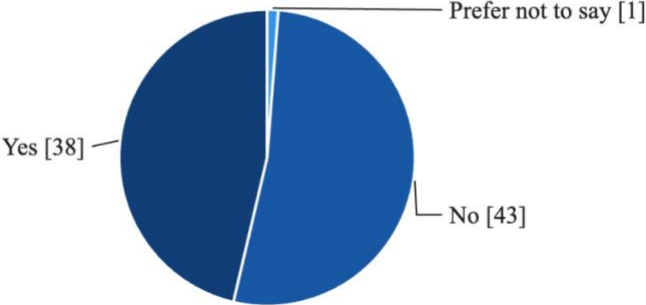


Figure 28 – Students share whether they interact with any animals while in college.

This graph demonstrates that most participants do not have an interaction with any animals regularly while in undergraduate. Of the participants who do regularly interact with animals while in college, the most common animals listed were dogs and cats, followed next by bunnies.

Human-Dog Interaction Portion of Study

Demographic Information of Human-Dog Interaction Subjects and Controls

All participants in this study were undergraduate students enrolled at the University of Arizona. There were a total 22 participants, with 4 being controls, and 18 subjects interacting with the therapy dogs. ‘Participants’ refer to all who responded in the study, ‘subjects’ refers to those interacting with the dogs, and ‘controls’ will not interact with the dogs but will have all other measurements and surveys done exactly as the subjects. Of the 22 total participants, 17 were female, 4 were male, and one preferred not to share. Of this group, 11 participants were between the ages of 18-20, 9 participants were between the ages of 21-24, and 2 were ages 25 and older. Furthermore, 18 out of 22 of the participants declared they were majoring in STEM (science, technology, engineering, and mathematics) major, whereas 4 participants were non-STEM majors. After collecting demographic information, the participants filled out the pre-interaction survey. The results from the survey are given below.

Pre-Dog Interaction Survey

NOTE: for many of the questions of the Pre- Interaction Survey, the data for control and subjects is combined, since the survey was completed before they were divided into control and subject groups.

Question #1

Description of Normal Stress Levels

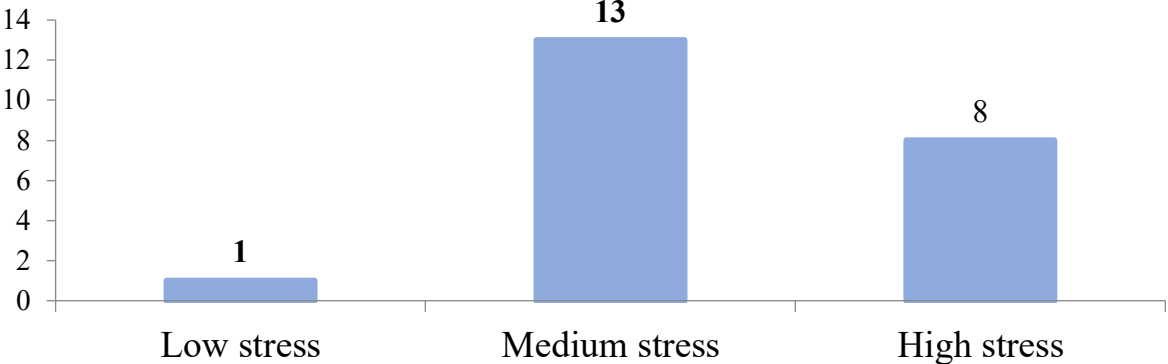


Figure 29 – Subjects share their normal stress levels.

Majority of participants in this study (95%) report that they are normally under medium-to-high stress, indicating the need to find a way to help students reduce stress.

Question #2

Rank your current stress on a scale from 1 (least stress) to 10 (most stressed)

Rank Your Current Stress Levels from 1 (low) to 10 (high)

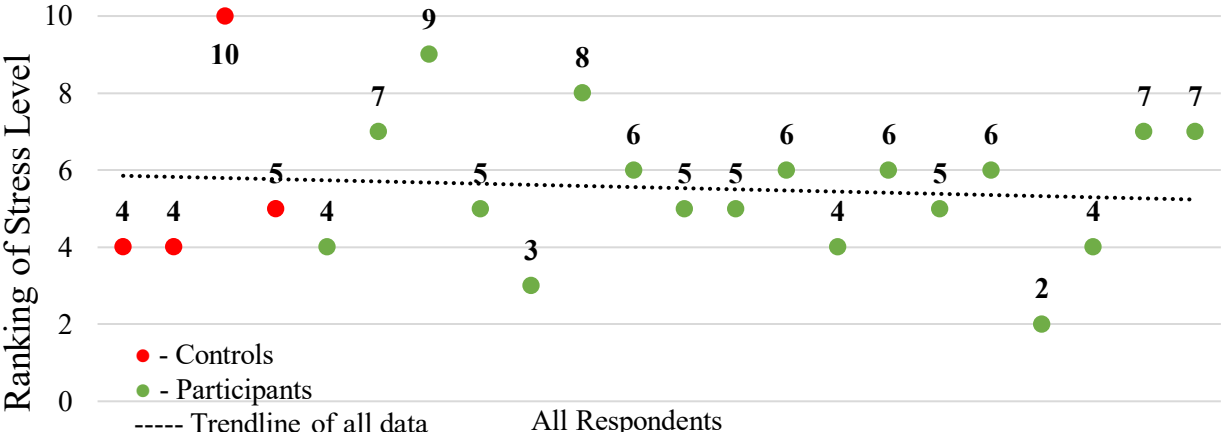


Figure 30 – Rankings of subjects’ stress levels from 1 (low) to 10 (high).

This graph demonstrates that while some participants said they have higher or lower stress, majority of subjects had stress levels around 5-6, corresponding to the trendline location. It is interesting to note that the controls and participants each averaged around the same pre-session stress levels, with there were some outliers who reported being very highly stressed in each of the two groups.

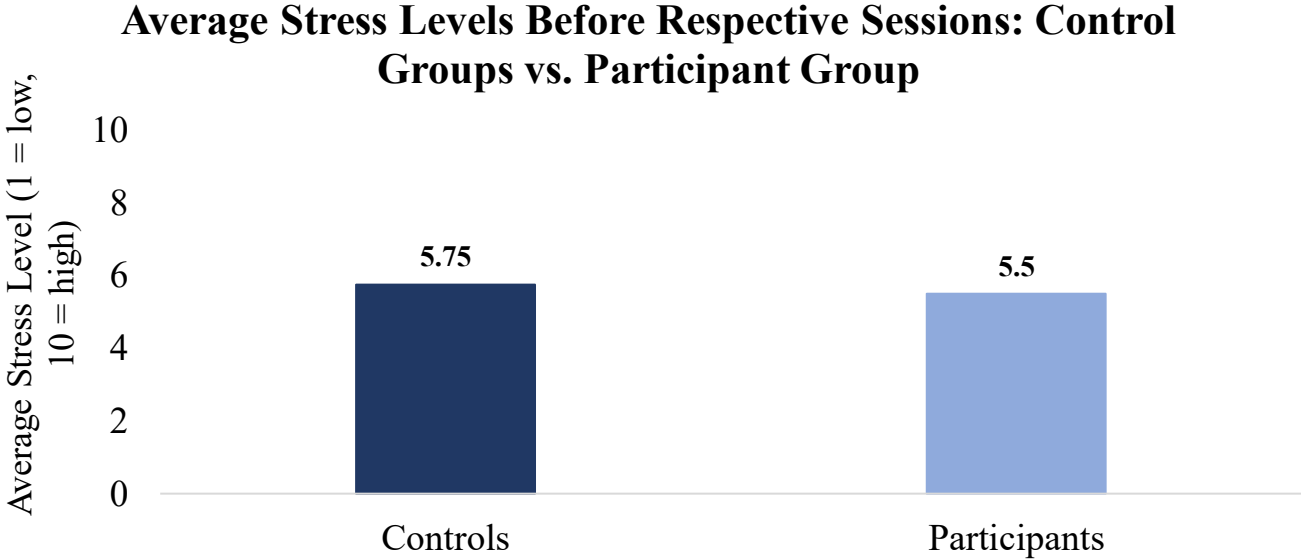


Figure 31 – Average stress level of control group and subject group before their respective sessions.

The average stress level of the control group and the subject group before their respective sessions do not differ much, with the control group average being 5.75 and the subject group average being 5.50. This reinforces the similarity of the composition of the two groups.

Question #3

Choose all the following emotions you currently feel (select all that apply).

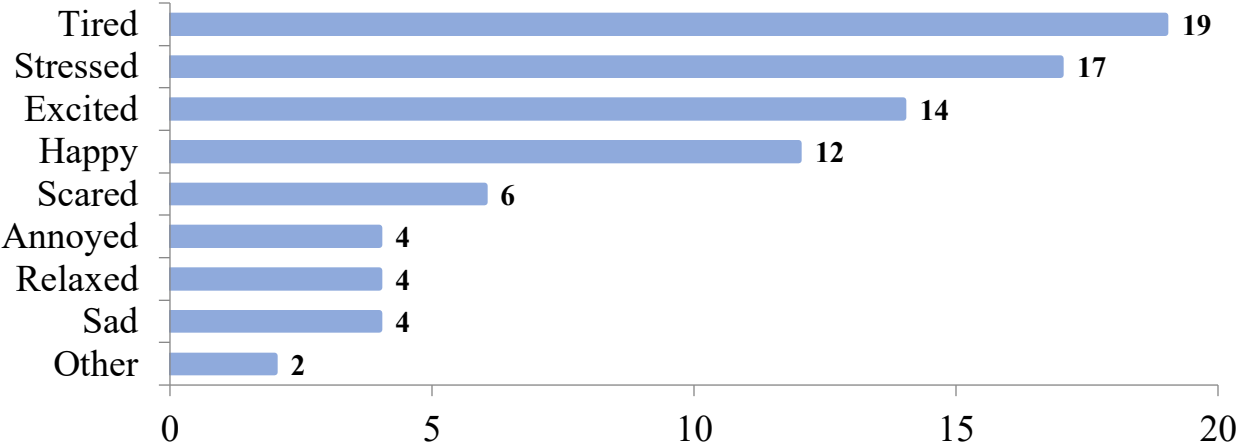


Figure 32 – Participants share their emotions before either a control or subject session

This graph demonstrates that majority of respondents felt tired, stressed, and excited before their respective session, as these selections comprised of 61% of the selected emotions.

Question #4

There are therapy dogs that visit campus during finals and other times. Would you go visit these animals?

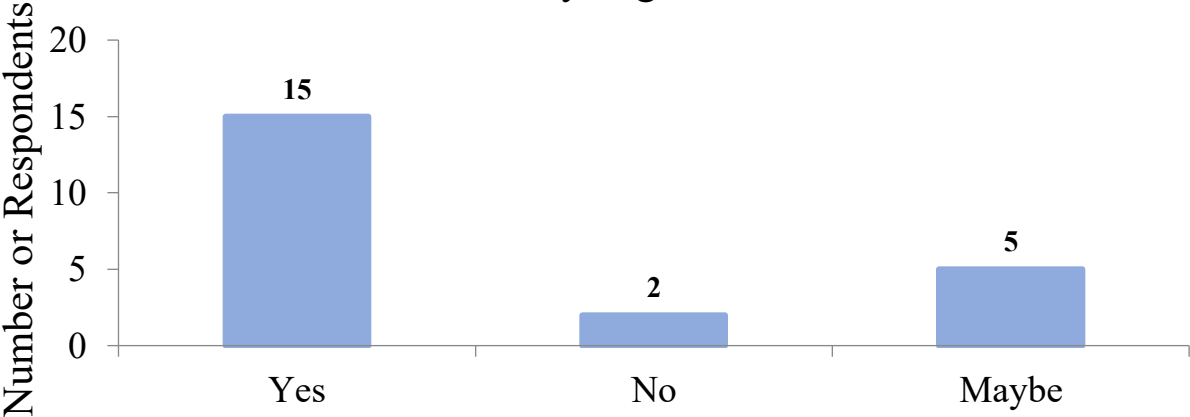


Figure 33 – Subjects share whether they would be willing to visit therapy dogs on campus around the time of final exams.

Over half of the participants (68%) in this study reported that they would be willing to visit therapy dogs that visit campus during the time of final exams.

Question #5

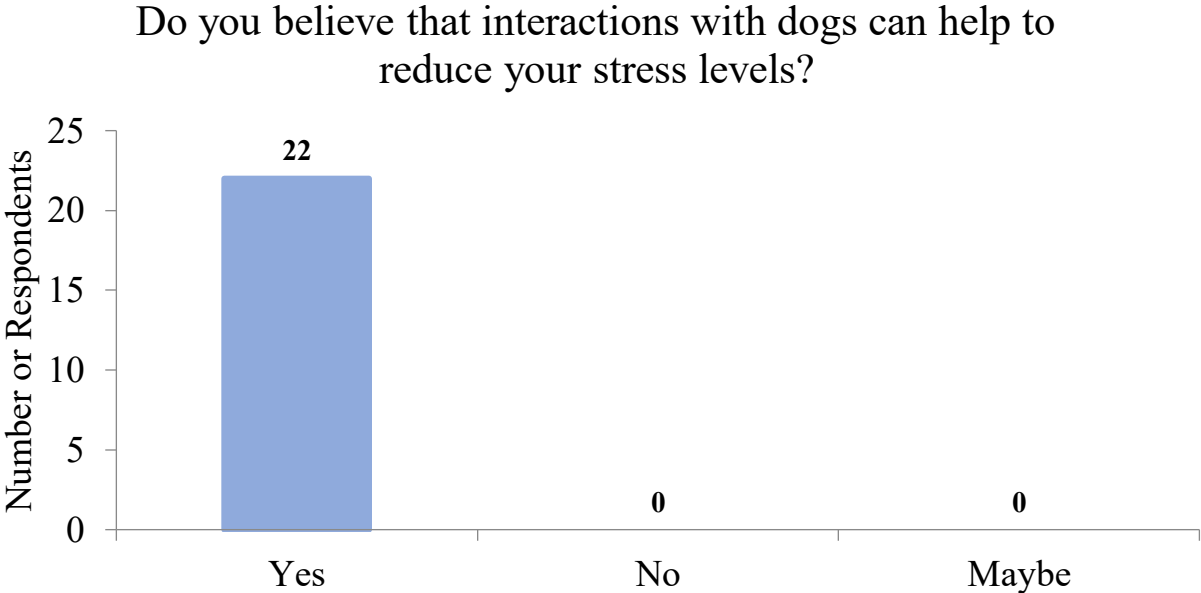


Figure 34 – Participants share their beliefs on if interactions with dogs can reduce stress.

Before each respective session, 100% of the participants, regardless of if they became a control or subject, said that they believe interactions with a therapy dog can help reduce stress, again reinforcing the similarity of the two populations.

Question #6

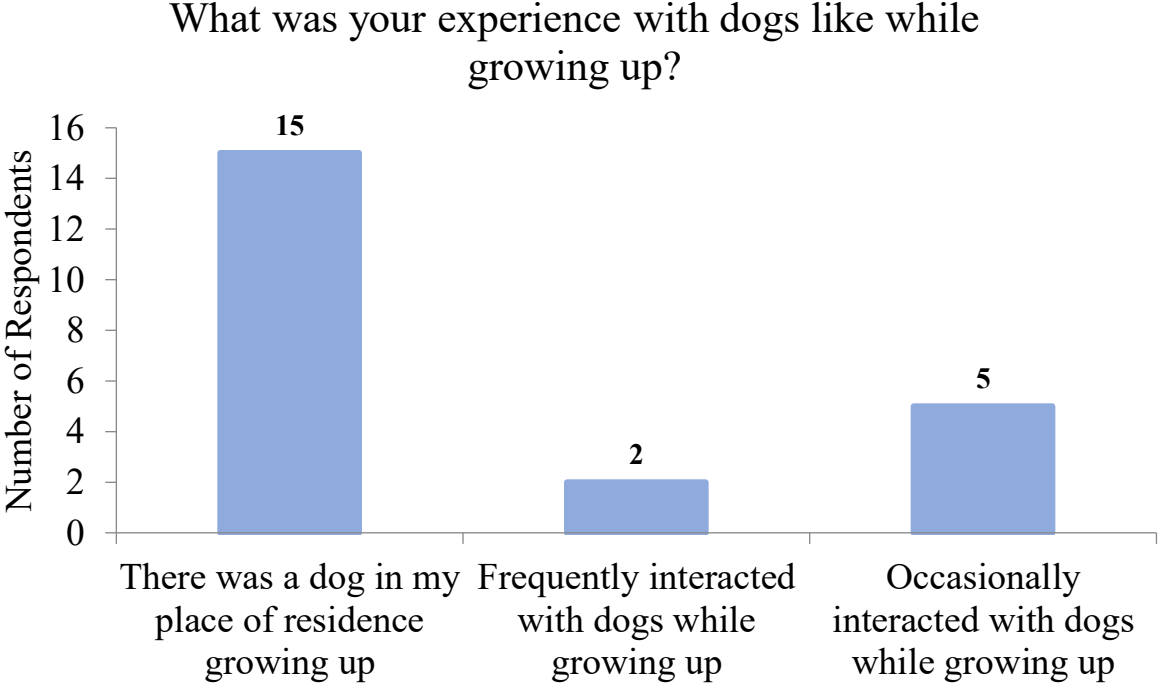


Figure 35 – Subjects share their experiences with dogs while growing up.

This data shows that most of the participants in this study had a dog in their place of residence while growing up, and those who did not, still had many interactions with a dog while growing up. There was an option to select “never interacted with a dog while growing up”, but not a single subject chose this option. Looking at this data, it is not surprising to see that majority of the participants in this study have had past interactions with dogs, as it can be reasoned that all participants who signed up for this study most likely have positive attitudes towards dogs.

Question #7

What is your experience with dogs during your time at the University of Arizona?

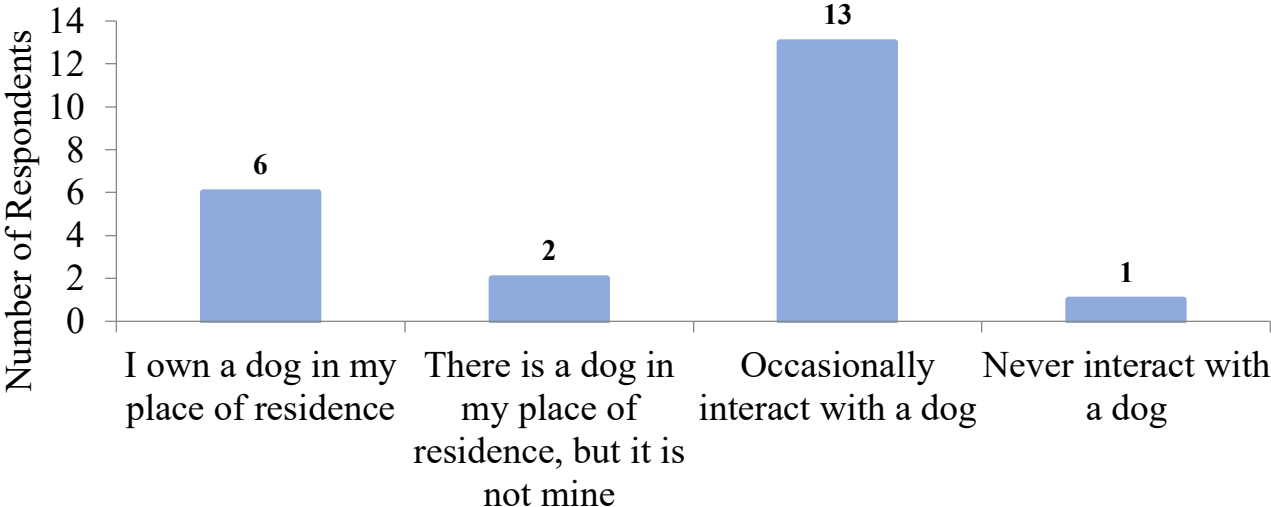


Figure 36 – Participants share whether they interact with dogs while in college.

Only 27% of the participants in this study had a dog in their place of residence while in college. Although this was the case, majority (68%) of the participants still find a way to continue to interact with a dog while in undergraduate.

Question #8

Do you believe dogs help improve your sense of well-being?

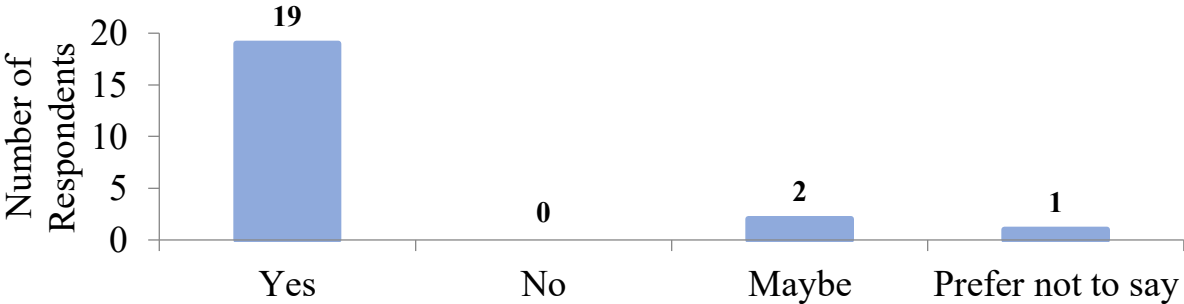


Figure 37 – Participants share if they believe interactions with dogs improve their worth of self-being.

Almost all the participants in this study (86%) believe that interactions with dogs can help to improve their sense of well-being.

Question #9

If you have interacted with a dog in the past, how would you describe the emotion you felt after the interaction?
Select all that apply.

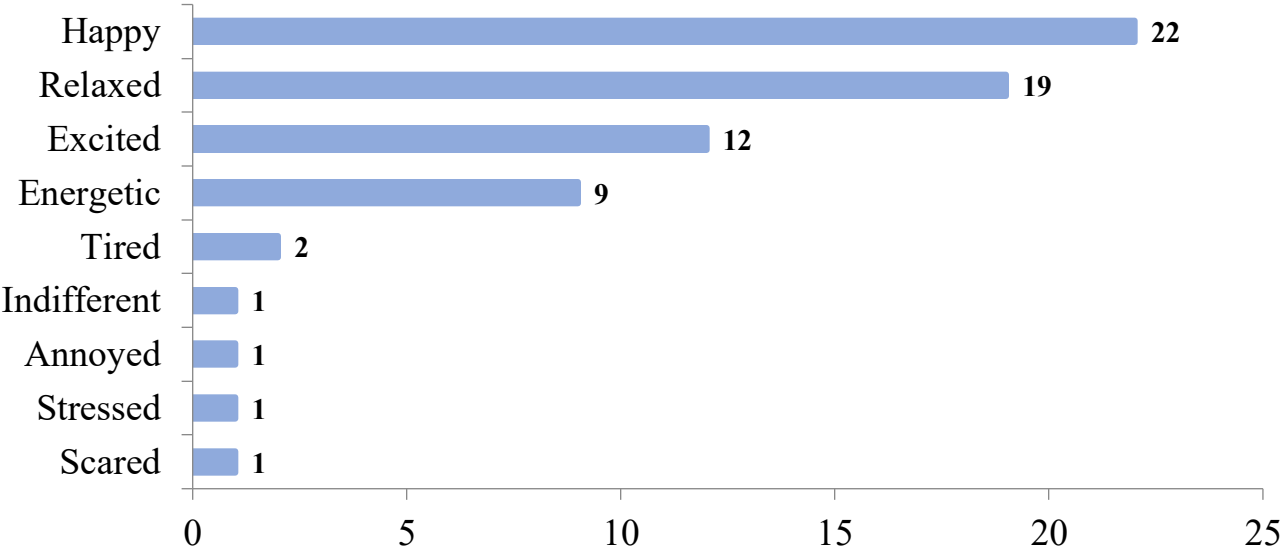


Figure 38 – Participants share their emotions after past interactions with a dog.

After past interactions with dogs, a majority of the participants reported feeling positive emotions after their interaction. These emotions included happy, relaxed, and excited, which comprised of 78% of all the emotions selected.

Question #10

Today, do you regularly interact with a dog?

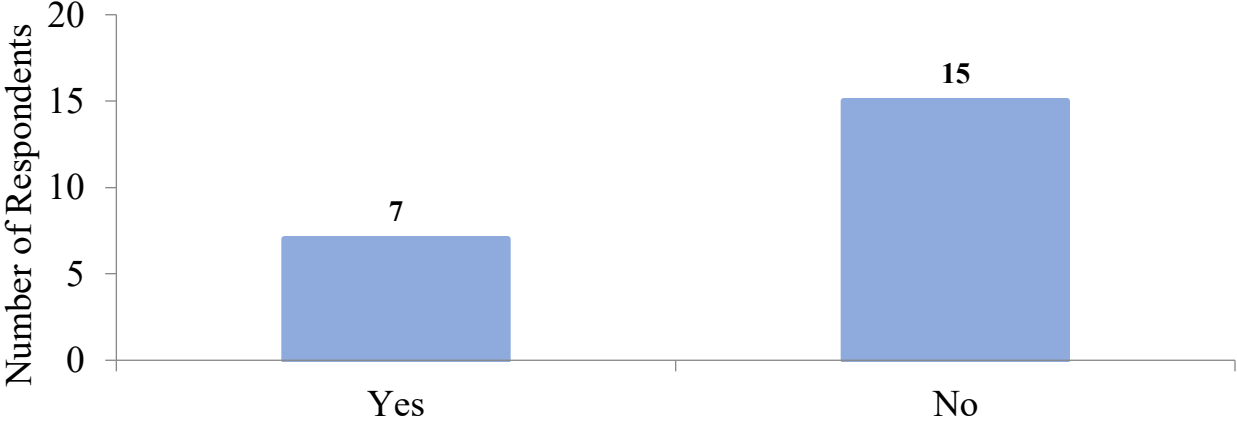


Figure 39 – Participants share whether they interact with a dog regularly while in undergraduate.

Over half of the participants in this study (68%) do not regularly interact with a dog during their time in undergraduate studies.

Question #11

Do you have interactions with any animals regularly?
(cat, bunny, hamster, etc.)

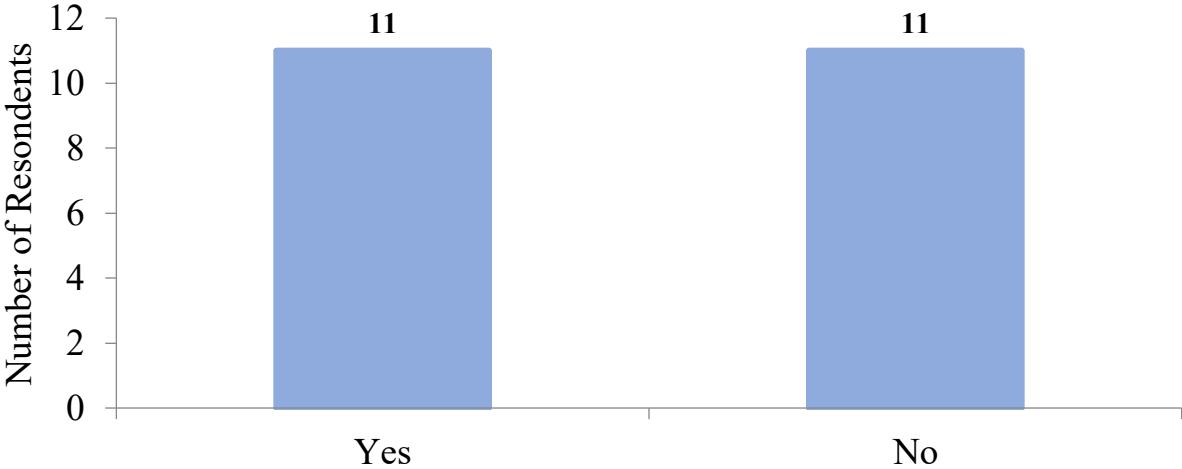


Figure 40 – Participants share whether they regularly interact with *any* animal while being in college.

50% of the participants reported that they interact with some animal regularly while being in college, whether that be a dog or another animal. The other 50% of the participants reported that they do not regularly interact with *any* animal while in college. This data reinforces the fact that many undergraduate students still lack the ability to have any kinds of interactions with animals while in college.

Post-Dog Interaction Survey

Question #1

“Now that you have interacted with a therapy dog, re-rank your current stress on a scale from 1 (least stress) to 10 (most stressed)”

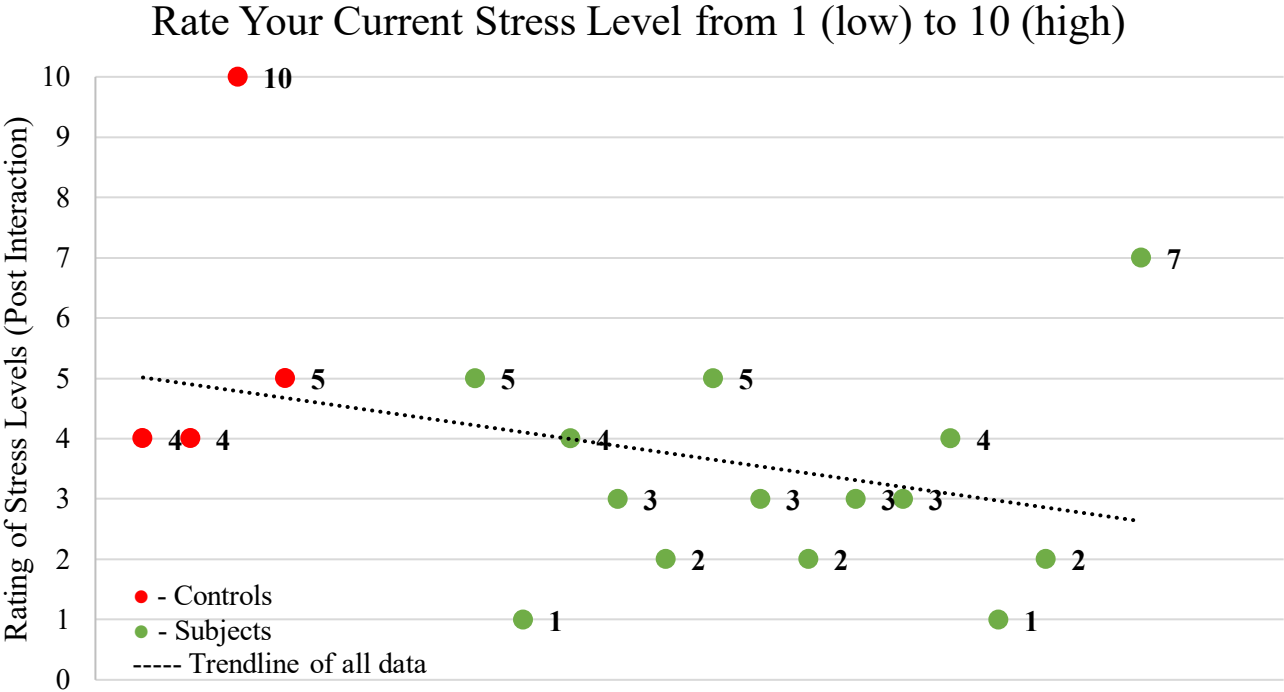


Figure 41 – Participants share their stress levels after either a control session or therapy dog interaction.

This graph demonstrates that majority of the subjects who interacted with a therapy dog now have a lower level of stress, as now the mode post-stress data is 3 compared to 5.5 in the pre-

interaction data. (Refer also to following Figure 42). This graph also shows that there are less high-stress outliers for the subject group, with only one subject reporting to have a stress value greater than 5.

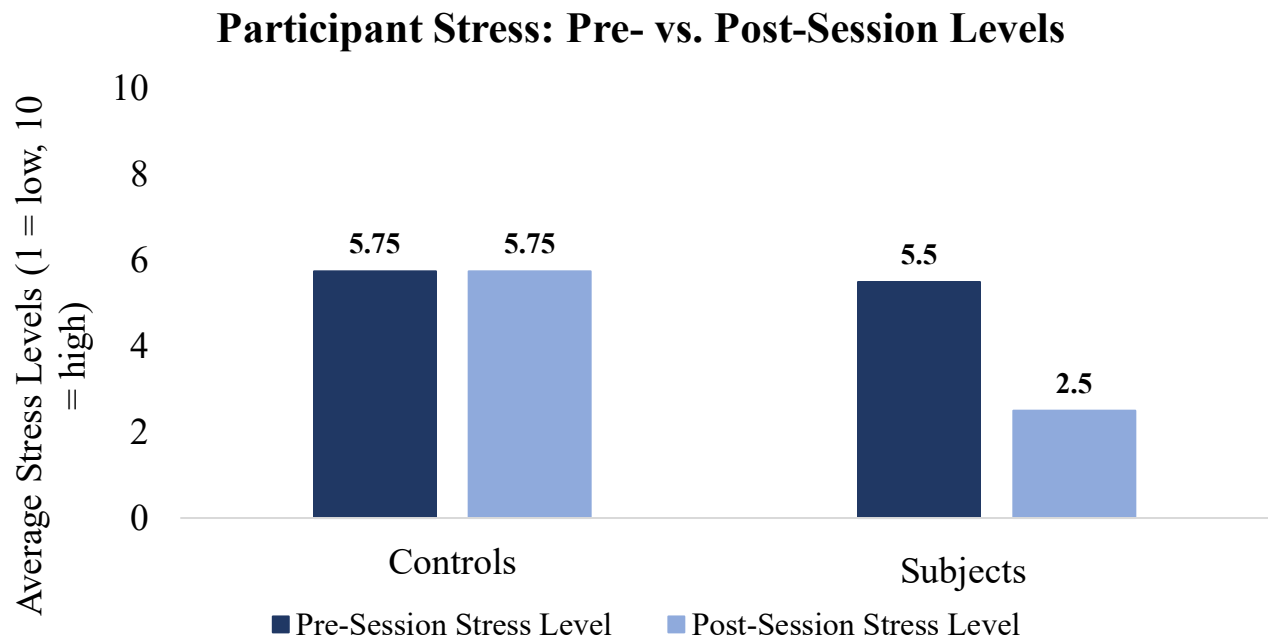


Figure 42 – Averages of the control and subject groups after their respective sessions.

This graph shows further analyzes of the data from Question #1 and demonstrates that the average reported stress level in the subjects decreased but that there was no change in the control group. The average stress level of the control group in the post-session was 5.75 (SD= 2.5) and the average stress level of the subject group in the post-interaction survey was 2.5 (SD=1.6). This data demonstrates that not only did the average perceived stress level decrease in the subject group and not in the control group, but with a lower calculated SD, the subject group had less variability in their perception of stress levels than the control group. These calculations show that the subject that interacted with the therapy dogs did perceive their stress levels to decrease,

whereas the control participants who did not interact with a therapy dog did not notice any change in their stress levels.

Question #2

After your dog interaction, choose all the following emotions you currently feel. (Select all that apply).

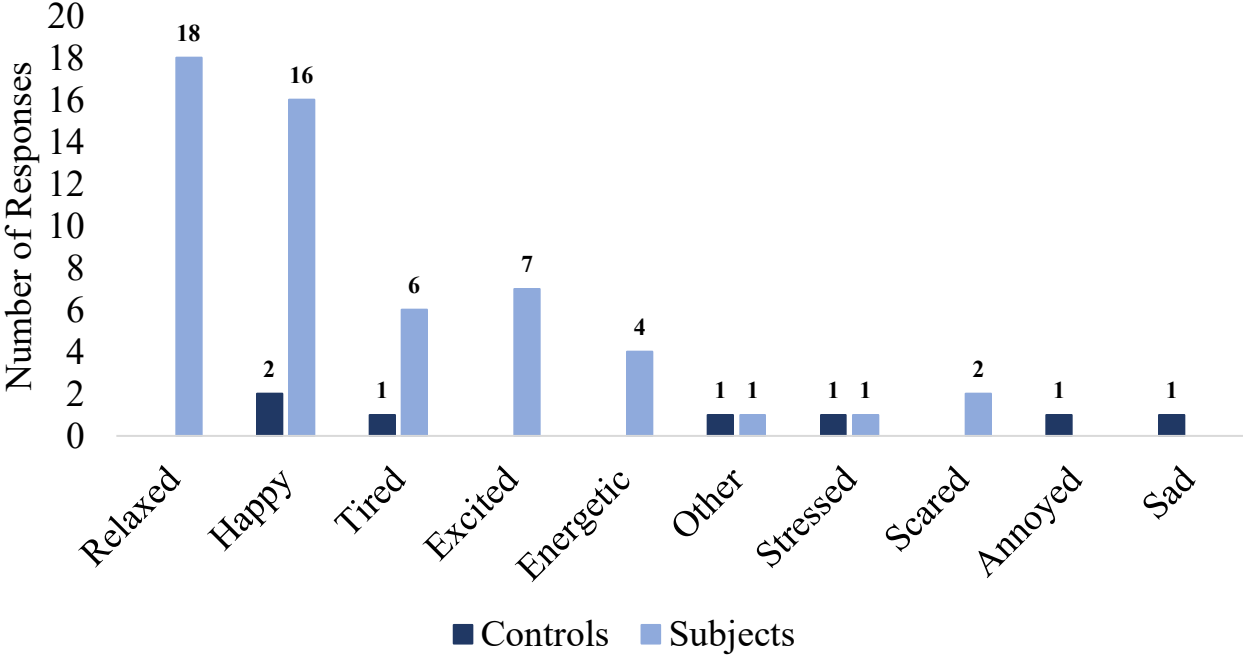


Figure 43 – Participants shared their emotions after either the control session or therapy dog interaction.

Compared to the controls, who did not interact with a dog, most subjects stated that they felt relaxed, happy, and excited after interacting with a therapy dog. This trend does not hold with the control group, who reported various other emotions including stressed and tired. Once again, this data demonstrates that the subjects who interacted with a therapy dogs reported feeling much more positive emotions compared to the control participants who did not interact with a therapy dog.

Question #3

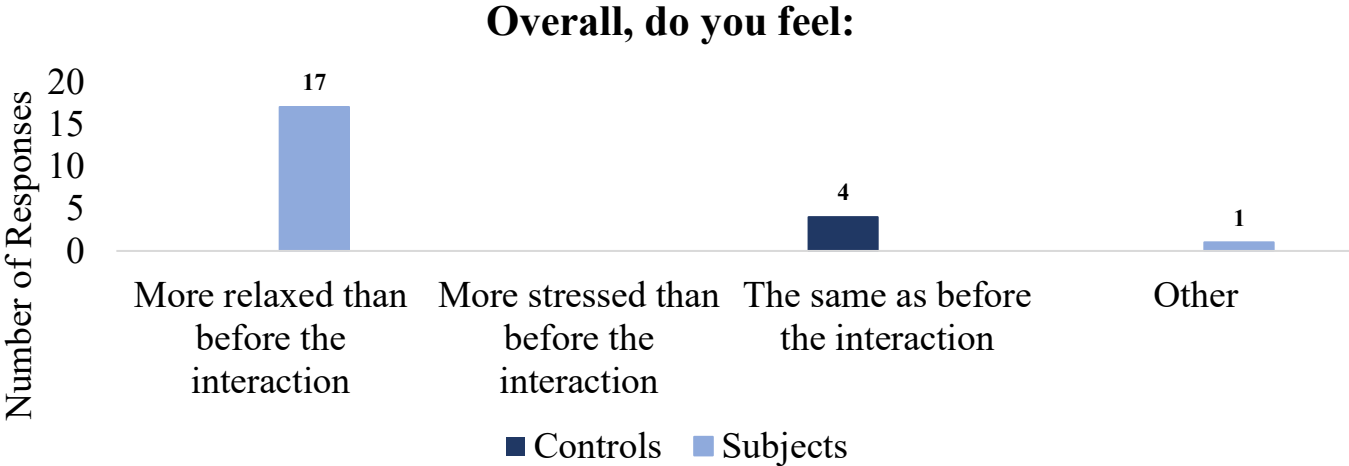


Figure 44 – Survey data regarding how the participants felt after the study.

Of the participants, all the responses for ‘More relaxed’ were from the subjects, whereas all of the ‘same as before’ were controls. Almost the entirety of the subjects (94%) reported they felt more relaxed after the interaction with the therapy dog than before. The 4 who reported they felt the same were all controls.

Question #4

**During the interaction with the dog, did you feel ...
(select all that apply):**

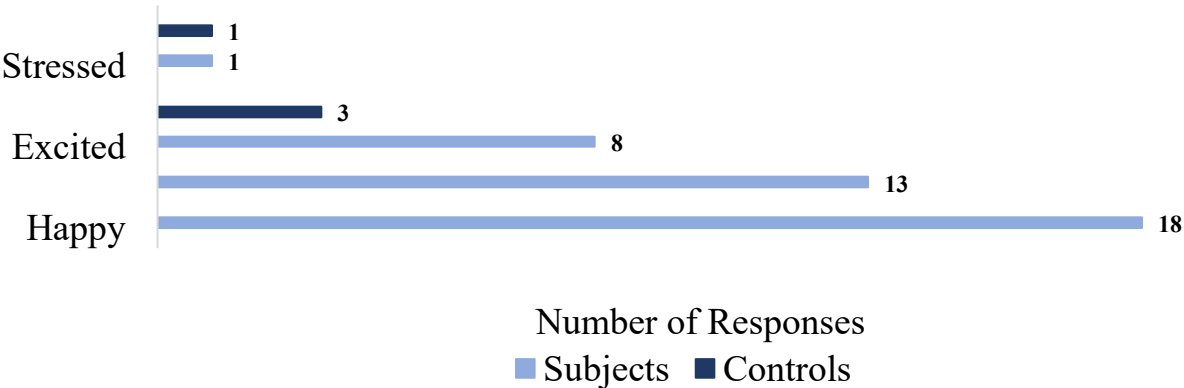


Figure 45 – Participants report how they felt during either the control session or dog interaction.

This graph demonstrates that the subjects who interacted with the therapy dogs reported feeling happy, relaxed, and excited during the interaction. Compared to the controls who did not report these emotions, this shows that the subjects had positive emotions during the interaction.

Question #5

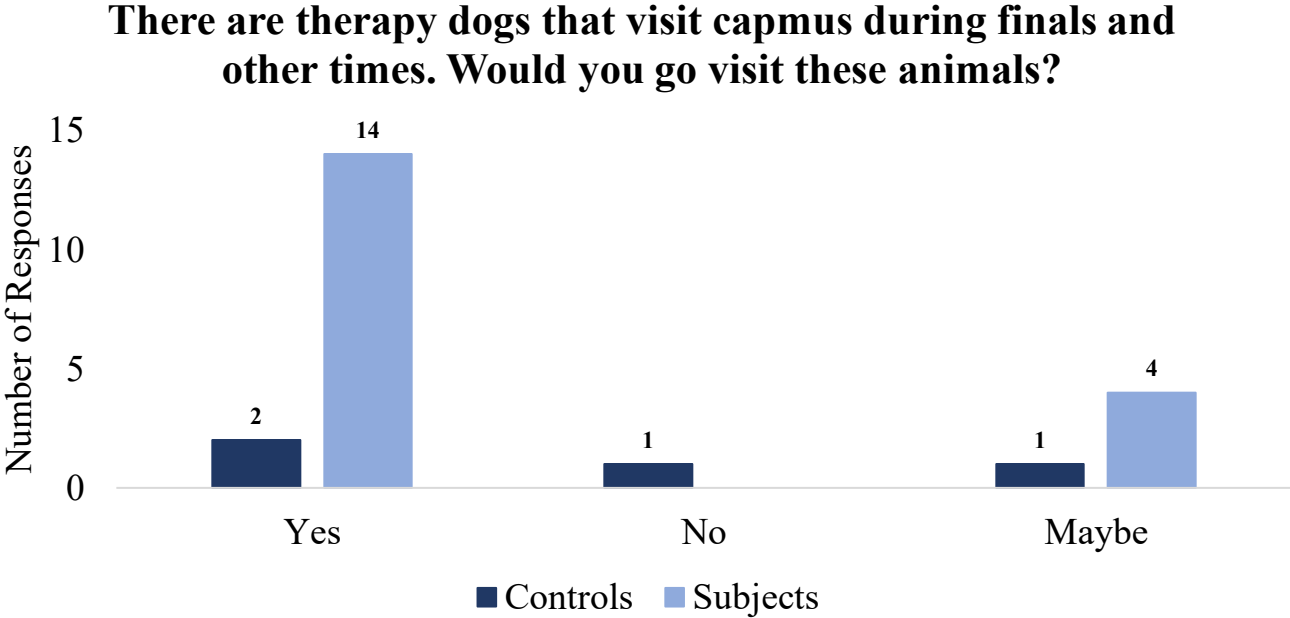


Figure 46 – Graph showing participants attitudes towards visiting therapy dogs that visit college campus.

All the subjects that interacted with a therapy dog reported that they would or maybe would visit therapy dogs that come to campus during and around final exams. The only response of “no” came from a control participant who did not interact with a dog. This finding supports the goal of this study of increasing therapy dogs on campus for undergraduate students to interact with, as

majority of the students who did interact with a therapy dog in this study reported that they would like to do it again if the opportunity presented itself on campus.

Question #6

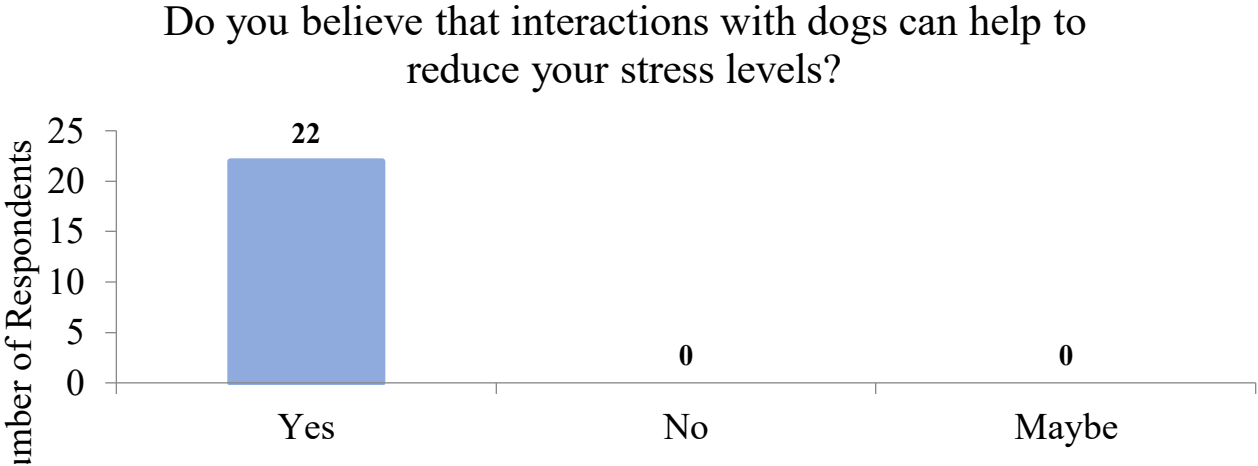


Figure 47 – Participants attitudes regarding if interactions with dogs can reduce stress.

All the participants in this study, regardless of if they were a control or a subject, believe that interactions with dogs can reduce stress.

Question #7

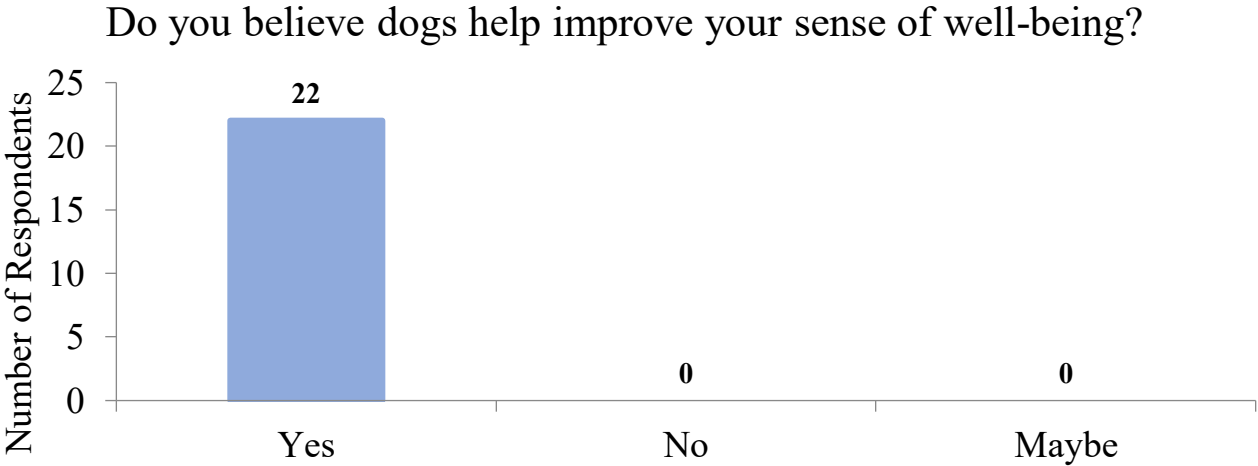


Figure 48 – Demonstrates how participants feel that dogs affect their sense of well-being.

100% of the participants in this study believe that interacting with dogs helps to improve their sense of well-being.

Question #8

Do you believe interactions with dogs can be a useful way to reduce your stress levels?

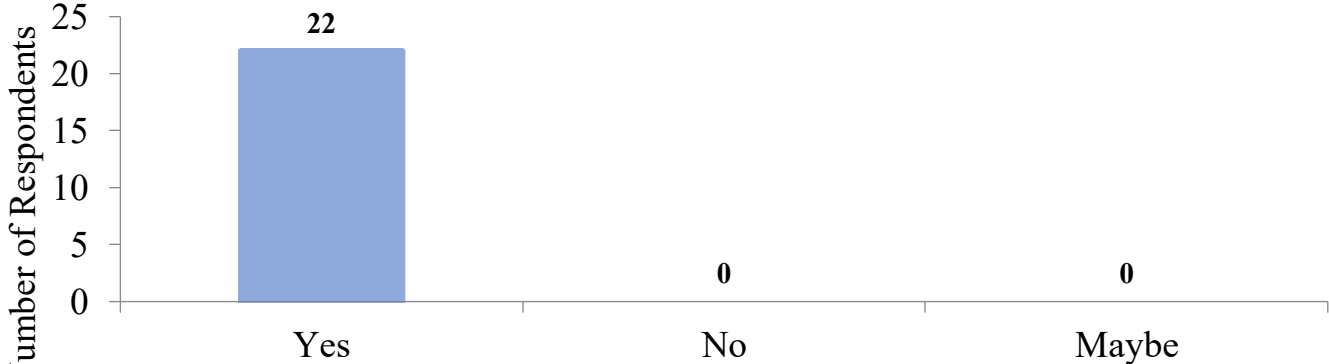


Figure 49 – Participants share whether they believe interactions with dogs are an effective way to reduce stress.

All the participants in this study, regardless of whether they were a control or subject, believe that interactions with dogs can be a useful and effective way to reduce their stress.

Question #9

Next time you are stressed, would you consider interacting with a dog if one is available to help mitigate your stress?

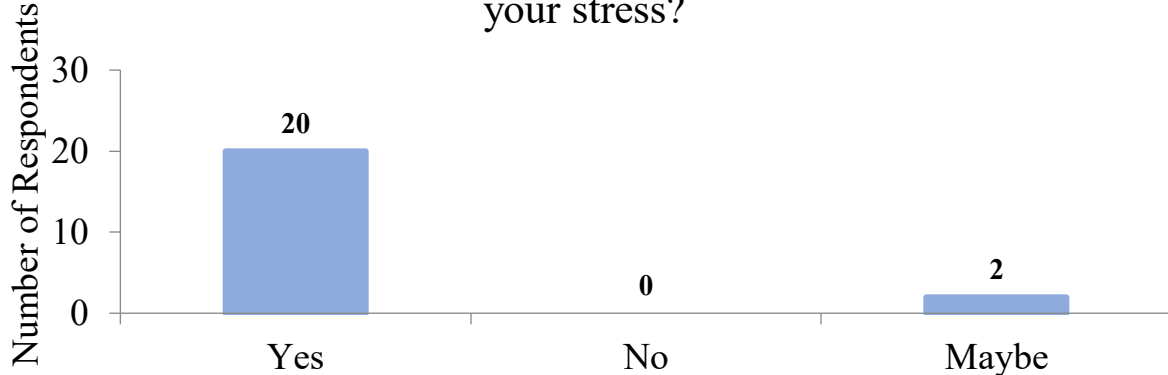


Figure 50 – After interacting with dogs, almost all participants now said they would consider interacting with a dog to help with their stress.

This data demonstrates the positive feelings that almost all participants in this study have regarding interactions with dogs helping to mitigate their stress. The 2 “maybe” responses did come from the subject group but still shows that all participants are open to these types of interactions to reduce stress.

Question #10

Overall, do you think your interaction with the dog brought upon a:

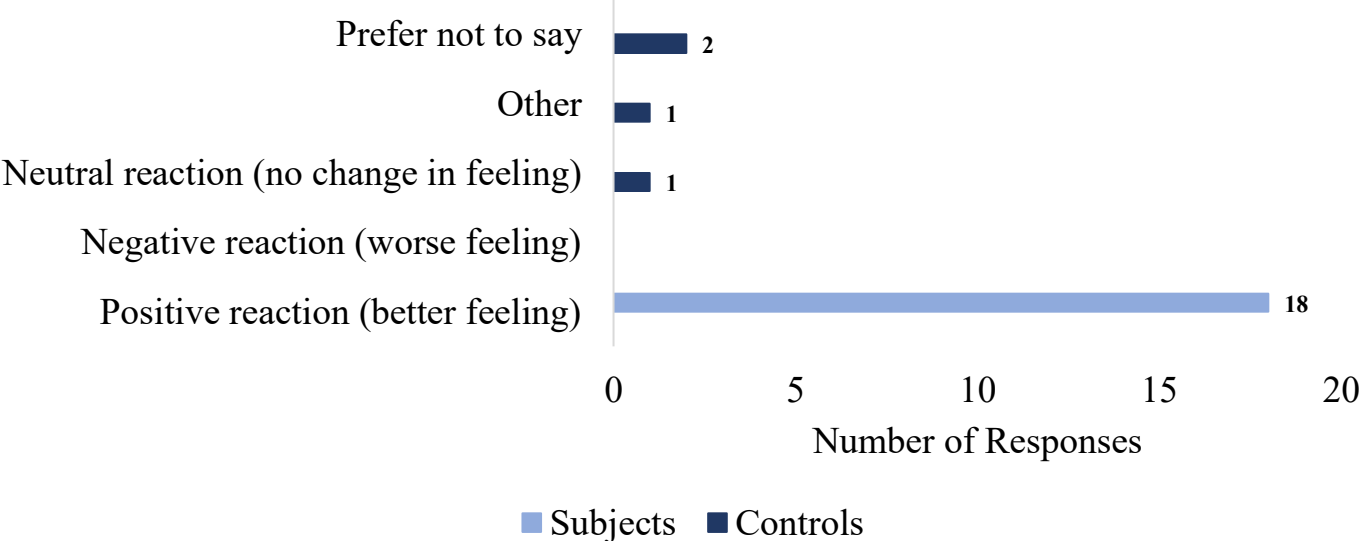


Figure 51 – Subjects gauging whether they felt this experience was a positive, negative, or neutral one.

All the subjects that interacted with a therapy dog reported that they felt this experience provided them a positive reaction and that they felt better emotionally than before the interaction. The controls either answered this question by stating they felt a neutral reaction (no change in feeling), other, or preferring to not say.

Comparison of reported stress levels between Pre-Interaction and Post-Interaction Survey

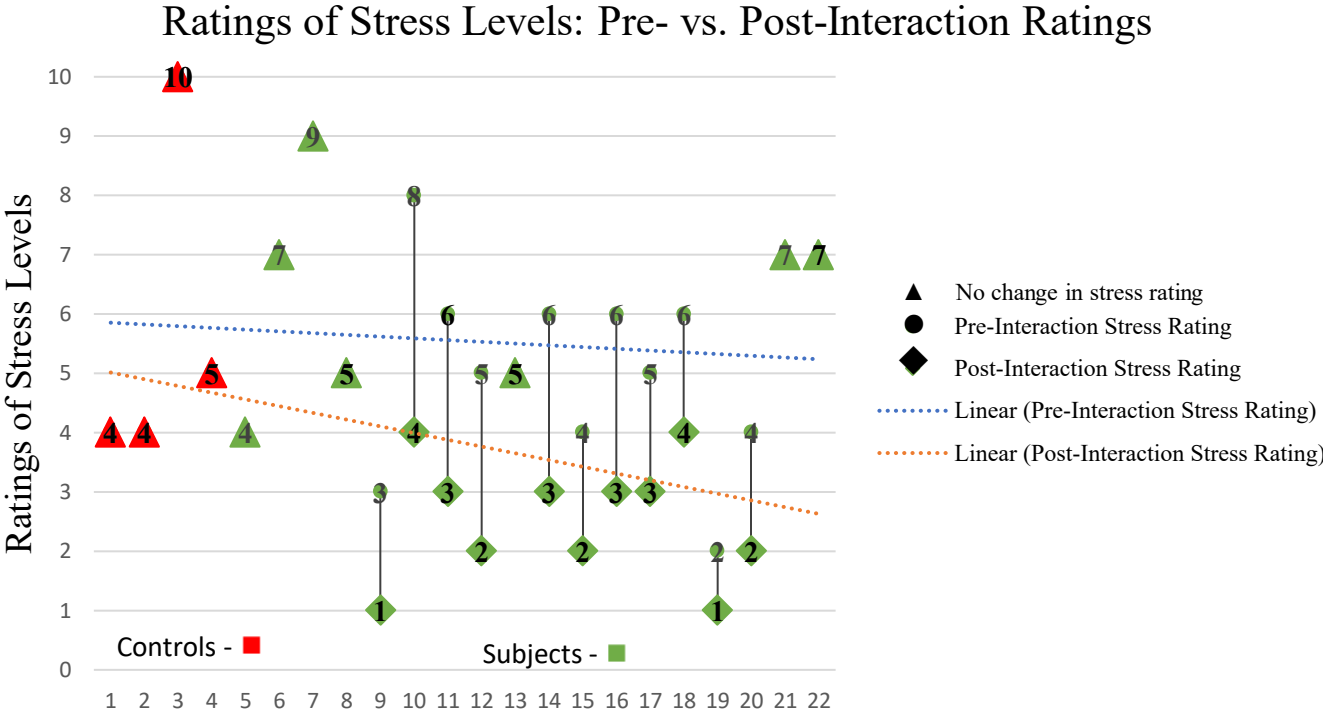


Figure 52 – Graphical data showing the controls and participants pre- and post- stress levels.

This graph demonstrates that compared to the controls, who all reported no change in their perceived stress levels before and after their control session, a majority of subjects reported a decreased perceived stress level after their interaction with a therapy dog. Additionally, the decrease in the observed trendlines demonstrates an overall decrease in participant reported stress levels.

Changes in Blood Pressure in Dog-Interaction Participants

To determine the change in blood pressure of all participants, the mean arterial pressure (MAP) was calculated before and after the dog-interaction for each subject. For controls, the MAP was calculated before their control period and after their control period. All MAP calculations were then averaged for the control group and the participant group respectively. The results are shown below.

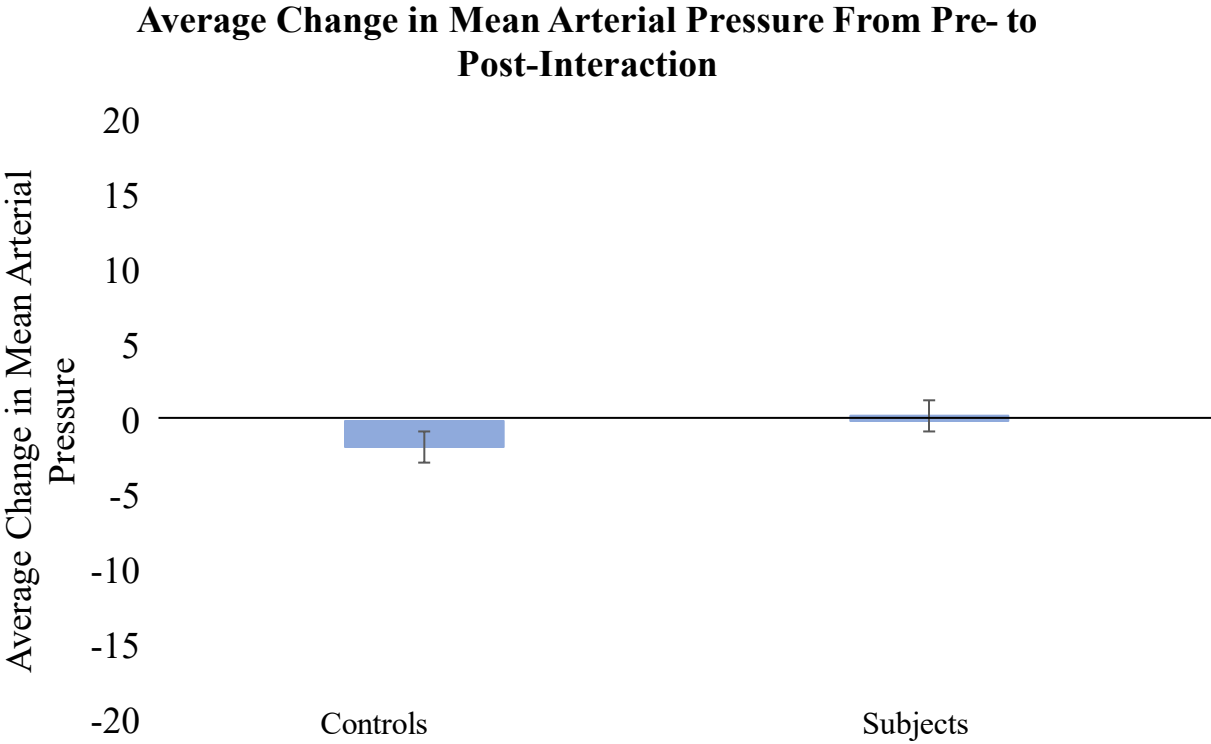


Figure 53 – Average change in MAP of both groups.

None of the MAP measurements, whether subject or control, exhibited a substantive change, as demonstrated in the graph above. Both the control group and the subject group had little variation in their blood pressures.

Changes in Heart Rate in Dog-Interaction Participants

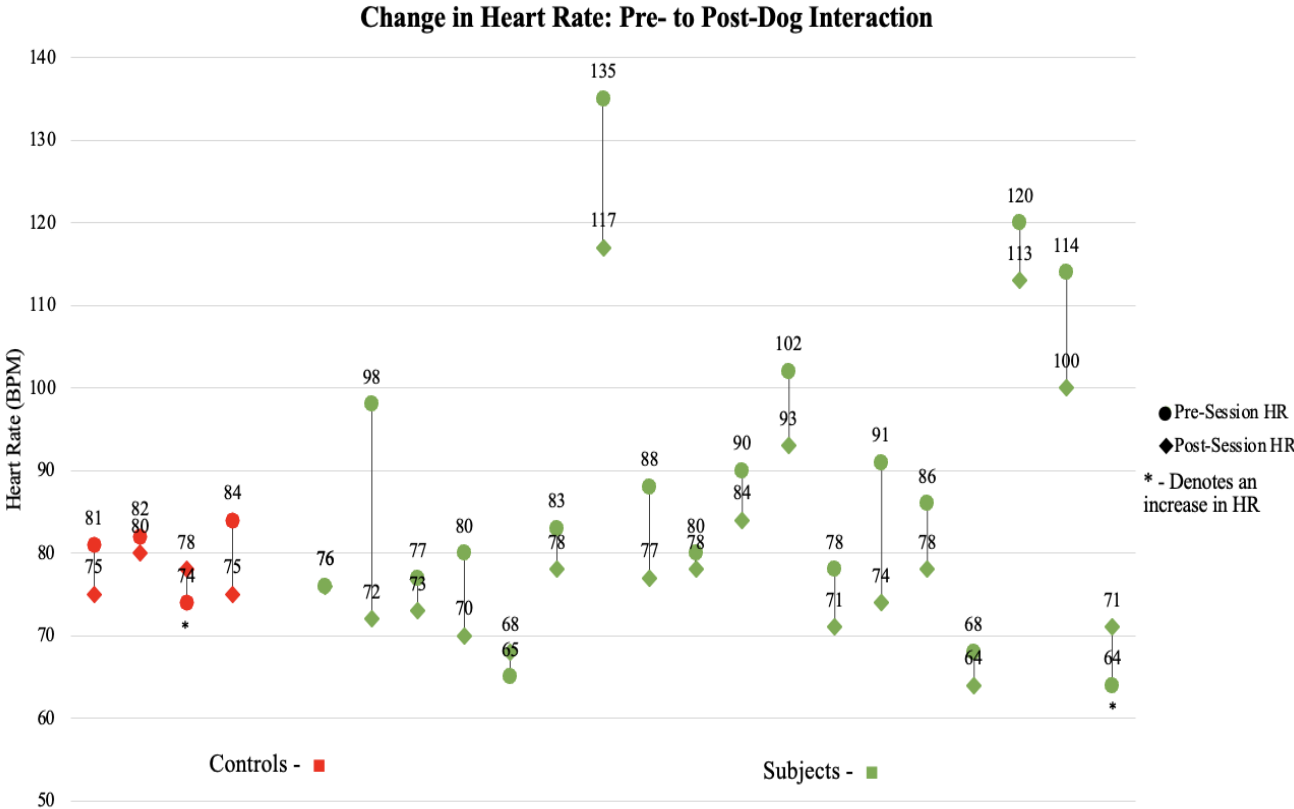


Figure 54 – Graphical data showing each individual participant’s change in heart rate.

This graph demonstrates that most of the subjects’ heart rates had a larger decrease than the controls’ heart rates. This can be seen as the lines connecting the circles (pre-respective session HR) to the diamonds (post-respective session HR) are mostly longer for the subjects than for the controls. If no line is seen, that means that participant’s heart rate did not change between the two sessions.

Average Change in Heart Rate From Pre- to Post-Dog Interaction

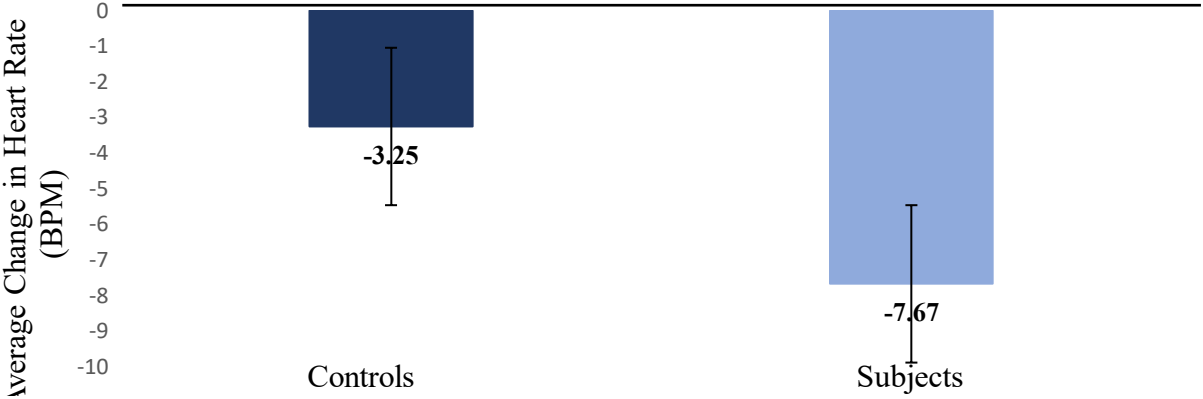


Figure 55 – Demonstrates the average change in heart rate of both the control and the subject groups.

On average, the heart rates for the subjects who interacted with a dog decreased more than twice as much as the controls who did not interact with the therapy dogs.

Change in Average Heart Rate: Pre- vs. Post-Session Readings

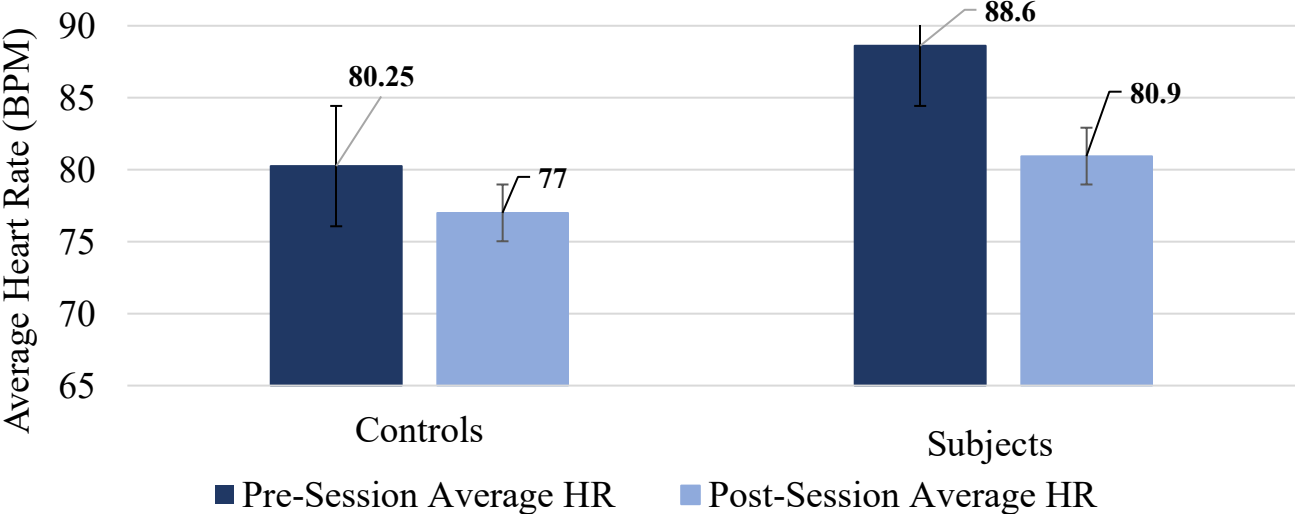


Figure 56 – Averages of the control and participant groups’ heart rates after their respective sessions.

This graph demonstrates more clearly the larger decrease in the average heart rate of the subject group who interacted with therapy dogs compared to the control group who did not interact with therapy dogs. As shown in the graph, the control group average dropped from 80.25 BPM to 77 BPM after the control session without therapy dog interactions, whereas in the subject group, the average dropped from 88.6 BPM to 80.9 BPM after therapy dog interactions.

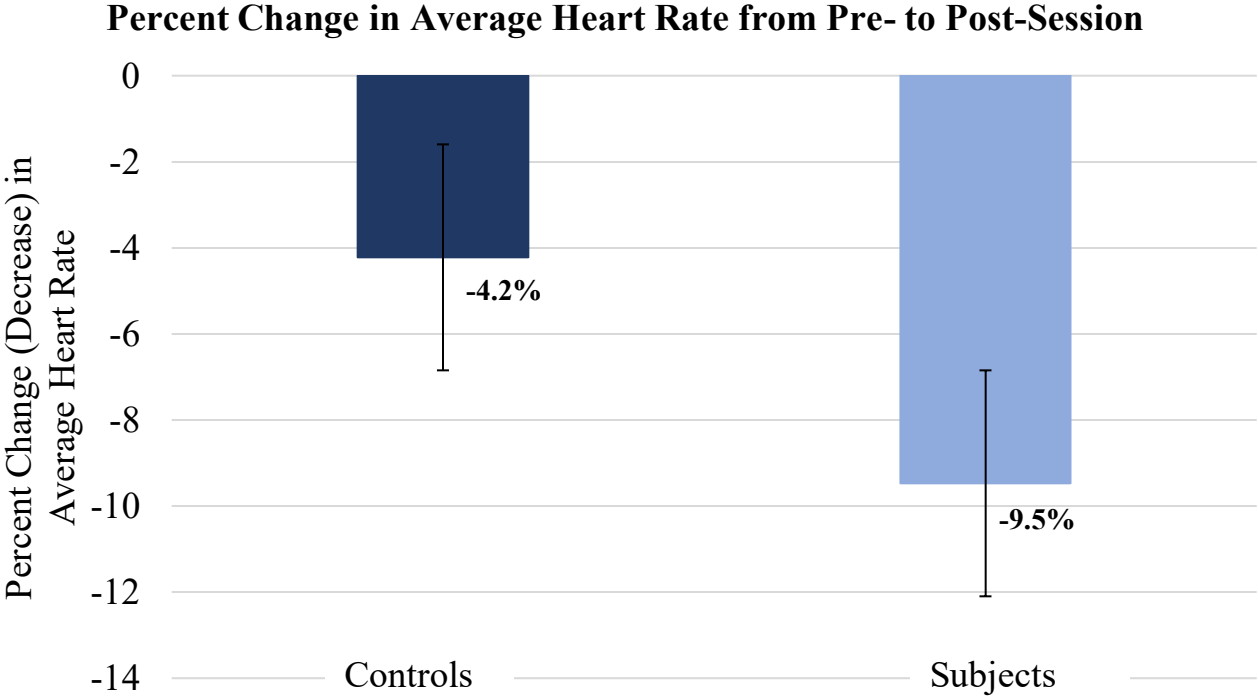


Figure 57 – Demonstrates the percent change in the average heart rates between both subject groups.

This graph show that compared to the control group, the percent change of the average heart rate for the subjects that interacted with the therapy dogs was more than twice that change of the control group.

Changes in Salivary Cortisol Concentration in Dog-Interaction Participants

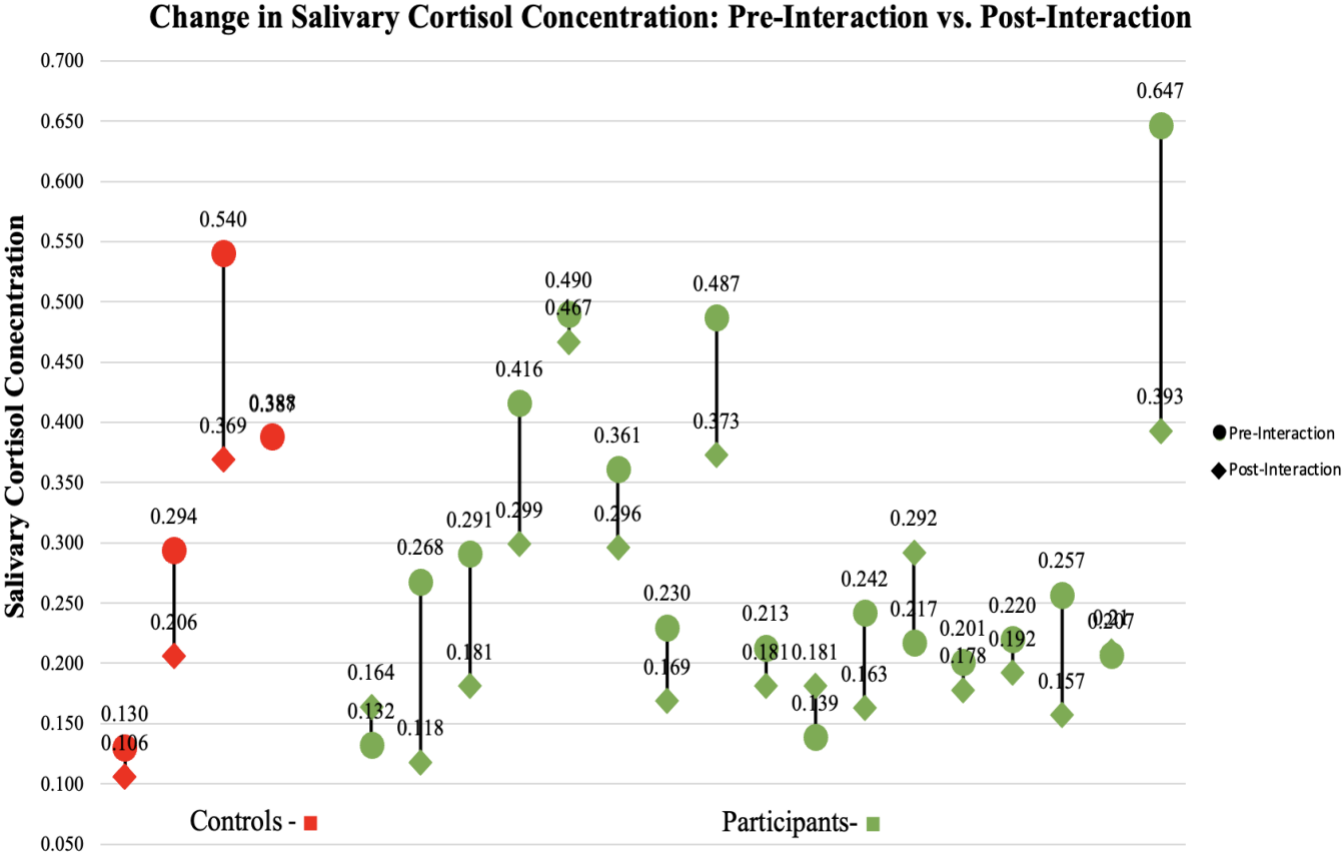


Figure 58 – Graphical data of all participants’ salivary cortisol concentration: pre- and post-session

This graph demonstrates that while both groups showed a decrease in their overall salivary cortisol concentration, the subjects that interacted with the therapy dogs had larger changes, as denoted by the longer lines between points. It should be noted that there are two outliers in this data, with one being a control participant, whose pre-session salivary cortisol concentration was 0.540, and the other being a subject participant, whose pre-interaction salivary cortisol concentration was 0.647. Both these outliers were excluded from the corresponding analysis of the percent change in average salivary cortisol concentration to make the data more accurate and reliable to the rest of the participants in the study.

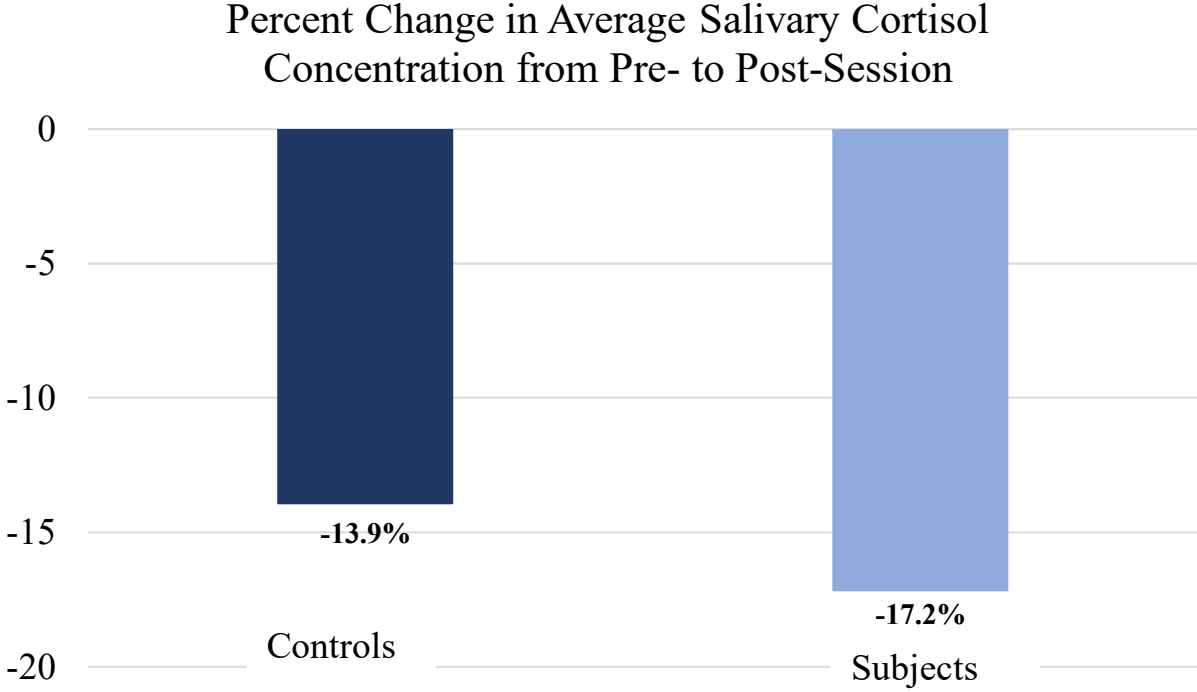


Figure 59 – Graph showing the average percent change of salivary cortisol concentration in both the control and the subject groups (*outliers were eliminated in this calculation for having abnormally high cortisol concentrations. This included 2 specific participants, one from the control group and one from the subject group. Refer to Figure 58)

Although both groups demonstrated an average decreased salivary cortisol concentration, the subjects who interacted with the therapy dogs had a larger decrease in the average salivary cortisol concentration compared to the control group.

Discussion

Through survey and experimental data, interactions with therapy dogs prove to be a beneficial way for undergraduate college students to mitigate stress levels. With the majority of participants in both the survey and the human-dog interaction study expressing their affection towards interactions with dogs, the idea that this intervention can help students relax is further supported. Increasing stress levels among college students over the past few years has made finding a method like this one to help students destress extremely important.

Students Have Positive Attitudes Towards Therapy Dogs Mitigating Stress

The goal of the first leg of the project (General Stress Survey) was to gauge the average stress levels among undergraduate students at the University of Arizona. By surveying a combination of male and female participants in this population, it led to the conclusion that majority of students, regardless of gender, reported having medium-to-high stress. As explained above, while a normal physiological stress response is vital for healthy bodily function, too much or chronic experiencing of this response can have detrimental effects on the human body, with one of them being impaired learning capabilities (Krause-Parello et al., 2016). This makes it important for universities around the country to find ways to help students decrease these levels for them to better focus on their studies. Additionally, **Question #2**, asking respondents to gauge how their stress has changed since beginning college, demonstrated that over 86% of respondents felt that since beginning undergraduate studies, they have seen their stress levels increase. This once again supports the idea that college is a stressful time in an individual's life and there needs to be more ways for students to receive support, with majority of students stating they rely on physical activity and supporting relationships to get them through stressful times.

When understanding why undergraduate students are stressed in the first place, it became clear that future plans and expectations play the most dominant role. Many students feel that every decision they make in college will have lasting effects on their future. On top of this, students feel the need to participate in numerous activities outside the classroom while in college including work, clubs, volunteering, and research. The main reason for this may either be for financial reasons, or due to motivations to increase their competitiveness for secondary school or job applications for after graduation. This relates to the idea that future plans have a heavy weight on college students as they are constantly thinking about the future and what is next. While it is essential to have a foundational plan for your future, too much or constant focus on this can increase stress loads, which once again, can hinder academic performance.

Understanding the magnitude of stress students experience, it was then asked what methods students use to help mitigate their own stress levels. The overwhelming number of responses included physical activity, listening to music, and connecting with supporting individuals. These results are not surprising as it is known that physical activity reduces stress via endorphin release (Hall and Duke, 2021), while listening to music and having companionship can help individuals feel supported and less lonely. What *was* interesting about this question was that interacting with pets and support animals was chosen a total of 21 times. While this was not the top choice, it does demonstrate that numerous respondents felt that interactions with animals are one of their first methods they go to when they feel overwhelmed or stressed. This plays a role in this project as there is reason to believe that undergraduate students tend to rely on support animals to get them through stressful times.

Through this survey, it was also important to gauge how well undergraduate students believed they were at coping with their stress to see if a new intervention on campus would be

necessary. Many respondents reported that they are often able to cope, but about 43% of respondents reported that they are “rarely” or “moderately” able to cope with their stress during college. This number is concerning, as it is nearing half of respondents recognizing that they have challenges with handling their stress levels. This proves that a new intervention on college campuses may be necessary for students who are continually stressed.

When asked a follow-up question regarding how well supported students feel by campus resources, once again about 60% of students reported only feeling “somewhat” or “moderately” supported by university resources, and 11% of respondents reported feeling “not at all” supported by university resources. This total adds up to 71% of respondents who feel that they are not fully supported by university resources, reinforcing the need for further interventions.

Students were also asked whether they had attended a campus event which aimed at reducing student stress. Unfortunately, 70% of respondents reported that they had never attended such an event. While this may be due to personal reasons, such as not wanting to spend their time in this manner, or stigmas associated with this type of events, another idea that may play a role in low attendance is lack of advertisement. Although many of these events are shared with the university via emails and flyers, many of them go unnoticed or ignored by undergraduate students who may feel they are a waste of time. The goal of this study is to not only show undergraduate faculty and staff the importance of stress-reducing events, but to also show undergraduates that stress-reducing events have positive cognitive, emotional, and physiological effects on the body.

This idea can be backed up by the follow-up question in this survey, which asked students who have attended stress-reducing events, to determine if they helped. Of these respondents, an overwhelming 91% of them reported that these events were able to reduce their

overall stress. This number demonstrates that while these types of events may not have high attendance, they do have high efficacy.

The last part of the General Stress Survey was investigating undergraduate students' perceptions toward therapy dogs and whether they think they are beneficial for stress reduction. When asked if students would visit therapy dogs who come to the University of Arizona campus, 52% of respondents agreed they would visit, with another 35% saying that they "maybe" would attend. What was important in this finding was that only 11% of respondents reported that they would *not* visit these dogs. The data collected from this question demonstrates that 87% of these respondents (combination of "yes" and "maybe" responses) are at least interested in the idea of visiting therapy dogs on campus and would be open to this opportunity.

It was then asked if these respondents believe that interactions with dogs can help reduce stress, with 83% of respondents saying "yes", 15% of respondents saying "maybe", and only 1% of respondents saying "no" (the other 1% preferred not to answer). This supports the idea that undergraduate students have strong attitudes about the ability for therapy dogs to reduce stress.

With all this data, there are hopes that undergraduate institutions recognize the value that therapy dogs can provide for undergraduate students. As demonstrated in this survey, stress is a very prominent part of the college experience, with students constantly worrying about their future and challenging coursework. This survey provides insight into undergraduate student perceptions towards therapy dogs, and that majority of students have high attitudes regarding dogs in their ability to reduce stress.

Emotional and Sense of Well Being Impacts of Interactions with Therapy Dogs

Before beginning the physiological parameter testing of human-dog interactions, it was important to understand the stress levels of the participants beforehand, as well as their perceptions towards dogs. With a limited sample size (n=22) due to constrained recruitment time, this population provided preliminary data for a subsequent larger study hopefully to be undertaken the following year.

Before the interaction with a therapy dog or a control session, all participants and controls were asked to record their stress levels as either low, medium, or high. Based on the survey data, 36% of respondents said they had “high stress”, 59% reported having “medium stress”, and 5% reported having “low stress”. This data shows that majority of subjects in this study had medium-to-high stress, with no substantive difference between subjects and controls. All subjects and controls were then asked to rank their stress levels before the interaction on a scale of 1 (low) to 10 (high). The most common ranking was 6, which corresponds with medium stress. It was interesting to note that compared to the controls, the subject’s pre-interaction stress levels were ranked slightly higher, with the mean of the control group being 4 and that mode the participant group being 5.5.

When asked about emotions before the interaction, the three most common answers were “tired”, “stressed”, and “excited” for all students involved. Of these three answers, “tired” and “stressed” were the top two options selected. These emotions back up the previous survey’s conclusion that majority of undergraduate students’ report being constantly stressed-out during college.

When followed up with asking if subjects would visit therapy dogs around final examination season before the therapy dog interaction, 68% of respondents said “yes”, 23% of

respondents said “maybe”, and only 9% of respondents said “no”. This supports the idea that majority of undergraduate students are open to the idea of interacting with therapy dogs during stressful times. The next question in this survey reinforces this finding as 100% of respondents reported that they feel interactions with dogs can reduce stress. This is not surprising as it is most likely that all the participants in this study enjoy dogs, or they would not have signed up. Furthermore, the recruitment flyers for this study included pictures of dogs and puppies, which may have increased the likelihood of participants stating that they feel dogs can reduce stress.

This part of the study also gauged how often the subjects are around dogs during their time in undergraduate. Since 100% of respondents reported that they believe dogs can reduce stress, it was valuable to see if these respondents have access to dogs while in college. Unfortunately, only 36% of respondents either own a dog or have one in their place of residence. Additionally, only 32% of respondents reported having regular interactions with a dog while in college. Both percentages show that there is a lack of availability on college campuses for students to interact with dogs. This is unfortunate, as through this study, it is clear that undergraduate students value time spent with dogs.

Subjects Felt Less Stressed After Interaction with a Therapy Dog

The post-therapy dog interaction survey provides promising evidence that undergraduate students feel less stressed after interacting with a dog. Compared to controls, whose rating of their stress levels did not change after not interacting with a therapy dog, subjects who interacted with a therapy dog demonstrated a decreased rating of their stress level. The mean for the subjects who interacted with a therapy dog went from a 5.5 before the interaction, to a 4 after the interaction. Additionally, after the interaction, when asked to describe emotional feeling, the top

two answers were “relaxed” and “happy”. When compared to the pre-interaction survey, which had the top two answers being “tired” and “stressed”, this is promising evidence to show that undergraduates emotionally feel much better after interacting with a dog.

In addition, 94% of the subjects reportedly feeling more relaxed after the interaction than beforehand. The remaining part of this survey continued to demonstrate that students have high attitudes regarding therapy dogs as ways to mitigate stress. All subjects, and controls alike, reported that they believe dogs can help reduce stress levels and improve their sense of well-being. Additionally, 91% of all respondents to this survey, regardless of if they were a control or a subject, reported that they would consider interacting with a dog if one is available next time they are stressed.

The biggest takeaway from this survey is that almost all subjects reported that they felt much less stressed after interacting with a therapy dog compared to before the interaction. Interestingly, the controls who did not interact with therapy dogs, did not indicate a change in their rating of stress, as each of the controls’ surveys had the same ratings on both pre and post survey for their perceived stress level.

Regardless of this, even though controls did not interact with therapy dogs, all 22 participants in this study reported that they believe interactions with dogs can help to mitigate stress. Furthermore, all subjects said they believe dogs improve their sense of well-being, and they would be open to visiting therapy dogs on campus if available, next time they are stressed out.

This survey data demonstrates the need for increased therapy dog visits on campus. This is a cost-effective way for college institutions to fight the increasing stress levels in undergraduate students. While many institutions provide student discounts on gym memberships,

or even meditation/mental health counseling discounts, these methods still provide financial barriers to students who cannot afford such services. By incorporating therapy dog visits on campus, this will allow students to destress without any financial burden.

Physiological Impact of Interactions with Therapy Dogs

Subjects' Blood Pressures Did Not Vary After Interaction with Therapy Dogs

There was little to no change in the blood pressures in either the subjects or the controls. While this was not the expected trend, these findings are not too surprising. Due to the younger age of all participants in this study, with only 2 subjects reporting to be aged 25 years or older, a significant change in participants' blood pressures is not normal for this age group (18-24) given the minimal physiological stress they were exposed to, in contrast to that of exercise. As individuals get older in age, fluctuations in blood pressure tends to become a more common trend, due to increased arterial stiffness (Maujean et al., 2015). With this idea in mind, it makes sense that since this study's population was limited to younger age adults, there is not a large variation in the blood pressure readings.

Heart Rates Decreased after Interaction

The controls and the subjects in this study both demonstrated a decrease in their average heart rates per group between the pre- and post- readings of their respective sessions (either the control session or the therapy dog interaction). Although this is the case, what *was* interesting was that the average subjects' decrease in heart rate from pre- to post-therapy dog interaction was more than double the BPM that of the controls' average change in heart rate from pre- to post-control session. Additionally, looking at the percent change, **Figure 57** demonstrates that

this value was twice that of the control group in the subject group. This finding demonstrates the effects that interactions with therapy dogs can have on cardiovascular health due to decreases in stress responses in the body.

Control Group Demonstrated Decreased Heart Rates

Before further investigating the results from the subject group, it is important to explore why the control groups' heart rates also decreased. Due to the control group being undergraduate students who also reported medium-to-high stress, these students were granted the opportunity to sit in a chair outside with no distractions or thoughts regarding coursework, exams, extra-curriculars, etc. Due to this, it can be reasoned that these controls had the opportunity to rest their minds and have a 30-minute break in their day of relaxation and reflection. Therefore, the controls' heart rates may have demonstrated a decrease due to them being free of various stressors they encounter throughout their day.

Additionally, after all controls were randomly selected, they were promised the opportunity to interact with one of the therapy dogs after the conclusion of the study to promote fairness in the project. With just this thought in mind, controls may have begun to think about this interaction, which may have also led to a decrease in their heart rates. This could also provide more support for the efficacy of therapy dogs, as there is potential that even just the thought of an interacting with a dog can promote relaxation and a decreased stress response in the body.

Participant Group Demonstrated a Greater Decrease in Heart Rate After Therapy Dog Interaction

While the control group average heart rate did decrease despite not interacting with a therapy dog, the subject group average heart rate decreased more than double that of the control group after interacting with a therapy dog. This can be seen on *Figure 54*, by the increased distance between the subjects' pre- and post- heart rates compared to the control group. Additionally, by looking at *Figure 55*, this observed trend can be seen. The average decrease for the control group between their pre- and post-control session was -3.25 BPM, whereas for the subject group, the average decrease between their pre- and post-therapy dog interaction was -7.67 BPM.

This finding supports the expected result of therapy dog interactions on student heart rate measurements. Not only did these interactions affect the emotional states of the students, demonstrated in the pre- and post-interaction surveys, but these interactions also affected the natural stress response that is observed in the body. When the human body begins to feel stressed, cortisol is released, along with other hormones such as epinephrine and norepinephrine. Both these hormones are active in the SNS, and cause increased cardiac activity, which raises one's heart rate. What happened in this study after subjects interacted with therapy dogs was the opposite. Instead of activating the stress response described above, these interactions inhibited the SNS response, causing a reduction in the participants' heart rates.

This observed trend demonstrates the potential value of having therapy dogs on college campuses. A decrease in subjects' heart rates after interactions with therapy dogs provides additional support for an increase in therapy dogs on college campuses. The students in this study only interacted with a therapy dog for a 30-minute session, which is a brief period. This

idea lends together with the hopes of having these brief interactions on college campuses to mitigate stress in undergraduate students.

Salivary Cortisol Concentrations Decreased

Both the control group and the subject group demonstrated decreased salivary cortisol concentrations after their respective session (control session and therapy dog interaction). While this was the case, the subject group had a larger average decrease compared to the control group. Due to a small sample size, this change between the two groups was not as drastic as expected, but it does provide great initial data to support the hypothesis that interactions with therapy dogs can decrease stress in humans, as shown via a decrease in cortisol, the stress hormone.

Control Group Demonstrated Decreased Salivary Cortisol Concentration

After participating in the control session of sitting outside, completely blinded to the therapy dogs, the average control group salivary cortisol concentration showed a decrease. While this was not entirely expected, it is not too surprising. As mentioned earlier, the control subjects were still undergraduate students who reported having medium-to-high stress. With the opportunity to sit outside without distractions and a break from challenging coursework and exams, these students were provided a time to relax and take a break from their daily tasks. This could explain this observed decrease in salivary cortisol concentration, as this relaxation and mental rest may have inhibited stress within the body.

Similar to the reasoning underlying the slight decrease in heart rate for the controls, the anticipation and knowledge that they would be able to interact with the therapy dogs may have influenced these post cortisol levels. Just the thought of interacting with a dog may provide

enough emotional support to slightly lower cortisol levels in the body and decrease stress in students

Participant Group Demonstrated a Larger Decrease in Salivary Cortisol Concentration After Therapy Dog Interaction

The subjects in this study who interacted with therapy dogs showed a larger decrease in their salivary cortisol concentration after interacting with a therapy dog compared to the control group who did not interact with a therapy dog. This is visible in *Figure 58*, where the subjects have a larger distance (i.e., larger decrease) between their pre- and post-interaction salivary cortisol compared to the decreases for controls between their pre- and post-control session salivary cortisol. Additionally, as expressed in *Figure 59*, when the two outliers were removed for having extremely high salivary cortisol concentrations before the study, (one control participant and one subject participant) the average decrease in the subject group salivary cortisol concentration was larger than in the control group.

Although the change was not drastic, this finding supports the hypothesis that interacting with therapy dogs will decrease stress in undergraduate students thus lowering cortisol levels in the body because of less stress. Cortisol is released in response to stress and is primarily responsible for promoting the physiological changes to address or adapt to the stressful stimulus. By providing an avenue to students to reduce their stress, even such a short term one as interacting with dogs, thus lowering the amount of this hormone, students' physiological stress response will be reduced, and hopefully better able to focus on their studies.

This preliminary data demonstrates the potential that increasing therapy dogs on college campuses can have. Just a short, 30-minute interaction led to this decrease in student cortisol

levels, showcasing the value that interactions with dogs can have on humans. If more therapy dogs are present on college campuses, interactions like these could become more common and provide students with much needed mental breaks from their busy, challenging workloads.

Limitations

While the data from this study indicates positive trends of therapy dogs reducing student stress, it is important to consider some of the limitations in this project. Beginning with the General Stress Survey, which was given to an upperclassman physiology course at the University of Arizona, this sample size contains undergraduate students all in science heavy majors. 90% of these respondents were students in the Physiology and Medical Sciences major, with the other 10% being from other science specific majors, such as Biology. These students may have had prior background knowledge regarding the stress response in the body, and how interactions with therapy dogs may affect this. This could have skewed the data, as these students know more about the cortisol's role in the human body. It is important to note that this survey was given out to the course before any studies or information regarding human-dog interactions was discussed.

Regarding the therapy dog interaction leg of this study, due to time constraints, only 22 participants were able to be recruited in this study. Furthermore, out of these 22 participants, only 4 of them were male, with 3 out of these 4 males being randomly assigned to the control group. Due to both the limited sample size, as well as the uneven distribution of male versus female participants, it was not possible to provide statistically significant data for this portion of the study. However, the trends do persist that interactions with therapy dogs did reduce stress levels via emotional and psychological avenues, as demonstrated by the pre- and post-interaction

surveys, as well as via physiological metrics, particularly the more prominent decrease in heart rate and salivary cortisol concentrations in the participants compared to the controls.

Furthermore, the dogs that were available to interact with the participants were all different dog breeds. Different types of dog breeds may have had stronger or weaker effects on the participants. For example, it may be anticipated that the subjects who interacted with the golden retriever saw more dramatic decreases in their heart rates and salivary cortisol concentrations compared to the subjects who interacted with the chihuahua. As this was not focused or reported in this round of the study, there is not a conclusive way to tell. This would be an interesting additional focus for the potential next phase of this study.

Conclusions

Taken together, this data indicates that not only do undergraduate students have strong attitudes and affection towards interacting with therapy dogs, but their body's physiological response to these interactions aligns with their perceived emotions. It has become clear that students on the University of Arizona campus have medium-to-high stress levels, and that their on-campus relief needs are not fully being met. Based on the data from this project, both the General Stress Survey, as well as the pre- and post-interaction surveys demonstrate that the students believe in human-dog interactions as a viable way to reduce stress. Furthermore, as seen via a stronger decrease in the subjects' heart rates, as well as their salivary cortisol concentrations compared to the controls, these interactions prove to provide physiological relief from the stress response seen in the body.

These findings further support the idea of having therapy dogs on campus to help students reduce their stress. With the participants interacting with the therapy dogs for just a 30-

minute timespan, their physiological stress levels showed a beneficial decrease. This data suggests that offering a relatively simple and inexpensive resource such as having therapy dogs on campus for students to interact with between classes or before exams may provide a much-needed bit of relief during a busy, stressful day of being a college student.

Future Directions

Although this study had a limited sample size, it will serve as an excellent pilot for a larger scale project. Having more time to recruit subjects, it is hoped that the data from the larger sample size will provide significant results to reinforce the findings of the present study.

All this is in hopes of providing supportive evidence for institutions to provide more opportunities for undergraduates to interact with dogs while on campus. Student stress has become a nationwide phenomenon, with increasing efforts around the country to help young individuals ensure they are properly taking care of their mental health. This pilot data demonstrates that interactions with therapy dogs can fulfill this task, providing an avenue to physiologically decrease stress in a small cohort at the University of Arizona.

References

- Kim, Eun Joo, et al. “Stress Effects on the Hippocampus: A Critical Review.” *Learning & Memory*, vol. 22, no. 9, 18 Aug. 2015, pp. 411–416, <https://doi.org/10.1101/lm.037291.114>.
- Khanal, Sunita, and Sujita Shrestha. “Perceived Stress among Undergraduate Students in a Dental College: A Descriptive Cross-Sectional Study.” *Journal of Nepal Medical Association*, vol. 59, no. 241, 11 Sept. 2021, pp. 892–896, <https://doi.org/10.31729/jnma.6446>.
- Gardani, M., et al. “A Systematic Review and Meta-Analysis of Poor Sleep, Insomnia Symptoms and Stress in Undergraduate Students.” *Sleep Medicine Reviews*, vol. 61, no. 101565, Nov. 2022, p. 101565, <https://doi.org/10.1016/j.smr.2021.101565>.
- Benneth Ben-Azu, et al. “Geraniol Attenuates Behavioral and Neurochemical Impairments by Inhibitions of HPA-Axis and Oxido-Inflammatory Perturbations in Mice Exposed to Post-Traumatic Stress Disorder.” *Journal of Psychiatric Research*, vol. 168, 27 Oct. 2023, pp. 165–175, <https://doi.org/10.1016/j.jpsychires.2023.10.057>. Accessed 11 Dec. 2024.
- Juruena, Mario F., et al. “The Role of Early Life Stress in HPA Axis and Anxiety.” *Advances in Experimental Medicine and Biology*, vol. 1191, no. 1191, 2020, pp. 141–153, https://doi.org/10.1007/978-981-32-9705-0_9.
- Beiter, R., et al. “The Prevalence and Correlates of Depression, Anxiety, and Stress in a Sample of College Students.” *Journal of Affective Disorders*, vol. 173, no. 1, 1 Mar. 2015, pp. 90–96, www.sciencedirect.com/science/article/abs/pii/S0165032714006867, <https://doi.org/10.1016/j.jad.2014.10.054>.
- Eisenberg, Daniel, et al. “APA PsycNet.” *Apa.org*, 2025, psycnet.apa.org/fulltext/2007-19519-005.pdf?auth_token=6a587c29b625baa56ba21c4741171494df622375. Accessed 5 May 2025.
- Thau, Lauren, et al. “Physiology, Cortisol.” *National Library of Medicine*, StatPearls Publishing, 28 Aug. 2023, www.ncbi.nlm.nih.gov/books/NBK538239/.
- Smith, Sean M, and Wylie W Vale. “The Role of the Hypothalamic-Pituitary-Adrenal Axis in Neuroendocrine Responses to Stress.” *Dialogues in Clinical Neuroscience*, vol. 8, no. 4, Dec. 2006, pp. 383–395, pmc.ncbi.nlm.nih.gov/articles/PMC3181830/, <https://doi.org/10.31887/dcns.2006.8.4/ssmith>.
- Waxenbaum, Joshua A, et al. “Anatomy, Autonomic Nervous System.” *Nih.gov*, StatPearls Publishing, 24 July 2023, www.ncbi.nlm.nih.gov/books/NBK539845/.

- Qin, Dong-dong, et al. "Prolonged Secretion of Cortisol as a Possible Mechanism Underlying Stress and Depressive Behaviour." *Scientific Reports*, vol. 6, no. 1, 22 July 2016, <https://doi.org/10.1038/srep30187>.
- Richards, A.Mark, et al. "Antecedent Hypertension and Heart Failure after Myocardial Infarction." *Journal of the American College of Cardiology*, vol. 39, no. 7, Apr. 2002, pp. 1182–1188, [https://doi.org/10.1016/s0735-1097\(02\)01737-0](https://doi.org/10.1016/s0735-1097(02)01737-0). Accessed 10 Sept. 2022.
- Picariello, Claudio, et al. "The Impact of Hypertension on Patients with Acute Coronary Syndromes." *International Journal of Hypertension*, vol. 2011, no. 1, 2011, pp. 1–7, www.hindawi.com/journals/ijhy/2011/563657/, <https://doi.org/10.4061/2011/563657>.
- O'Donovan, Aoife, et al. "Clinical Anxiety, Cortisol and Interleukin-6: Evidence for Specificity in Emotion–Biology Relationships." *Brain, Behavior, and Immunity*, vol. 24, no. 7, Oct. 2010, pp. 1074–1077, <https://doi.org/10.1016/j.bbi.2010.03.003>.
- Dong, Junsheng, et al. "Cortisol Inhibits NF-KB and MAPK Pathways in LPS Activated Bovine Endometrial Epithelial Cells." *International Immunopharmacology*, vol. 56, Mar. 2018, pp. 71–77, www.sciencedirect.com/science/article/pii/S1567576918300213?via%3Dihub, <https://doi.org/10.1016/j.intimp.2018.01.021>.
- Morey, Jennifer N, et al. "Current Directions in Stress and Human Immune Function." *Current Opinion in Psychology*, vol. 5, no. 1, Oct. 2015, pp. 13–17, www.ncbi.nlm.nih.gov/pmc/articles/PMC4465119/, <https://doi.org/10.1016/j.copsyc.2015.03.007>.
- Schultchen, Dana, et al. "Bidirectional Relationship of Stress and Affect with Physical Activity and Healthy Eating." *British Journal of Health Psychology*, vol. 24, no. 2, 22 Jan. 2019, pp. 315–333, <https://doi.org/10.1111/bjhp.12355>.
- Rodriguez-Ayllon, María, et al. "Role of Physical Activity and Sedentary Behavior in the Mental Health of Preschoolers, Children and Adolescents: A Systematic Review and Meta-Analysis." *Sports Medicine*, vol. 49, no. 9, 16 Apr. 2019, pp. 1383–1410, link.springer.com/article/10.1007/s40279-019-01099-5, <https://doi.org/10.1007/s40279-019-01099-5>.
- Huberty, Jennifer, et al. "Efficacy of the Mindfulness Meditation Mobile App "Calm" to Reduce Stress among College Students: Randomized Controlled Trial." *JMIR MHealth and UHealth*, vol. 7, no. 6, 25 June 2019, p. e14273, mhealth.jmir.org/2019/6/e14273/, <https://doi.org/10.2196/14273>.
- Krause-Parello, Cheryl A., et al. "Effects of a Facility Dog on Hospitalized Veterans Seen by a Palliative Care Psychologist: An Innovative Approach to Impacting Stress Indicators." *American Journal of Hospice and Palliative Medicine®*, vol. 35, no. 1, 28 Nov. 2016, pp. 5–14, <https://doi.org/10.1177/1049909116675571>.

- Hall, Deborah, and Gloria Duke. "Therapy Dog Effects on Nursing Student Stress." *Nurse Educator*, vol. Publish Ahead of Print, 16 Dec. 2020, <https://doi.org/10.1097/nne.0000000000000953>.
- Maujean, Annick, et al. "A Systematic Review of Randomized Controlled Trials of Animal-Assisted Therapy on Psychosocial Outcomes." *Anthrozoös*, vol. 28, no. 1, Mar. 2015, pp. 23–36, <https://doi.org/10.2752/089279315x14129350721812>.
- Wood, Emily, et al. "The Feasibility of Brief Dog-Assisted Therapy on University Students Stress Levels: The PAWS Study." *Journal of Mental Health*, vol. 27, no. 3, 6 Oct. 2017, pp. 263–268, <https://doi.org/10.1080/09638237.2017.1385737>.
- Odendaal, J.S.J, and R.A Meintjes. "Neurophysiological Correlates of Affiliative Behaviour between Humans and Dogs." *The Veterinary Journal*, vol. 165, no. 3, May 2003, pp. 296–301, www.sciencedirect.com/science/article/pii/S109002330200237X, [https://doi.org/10.1016/s1090-0233\(02\)00237-x](https://doi.org/10.1016/s1090-0233(02)00237-x). Accessed 17 Sept. 2019.
- Pet Partners of Southern Arizona. "Becoming a Pet Therapy Team." *Petpartnerssoaz.org*, 2025, www.petpartnerssoaz.org/becoming-a-pet-therapy-team. Accessed 5 May 2025.
- Naumova, Ella A., et al. "Dynamic Changes in Saliva after Acute Mental Stress." *Scientific Reports*, vol. 4, no. 1, 8 May 2014, <https://doi.org/10.1038/srep04884>. Accessed 27 Mar. 2020.