Sustained Effects of Animal-Assisted Crisis Response on Stress in School Shooting Survivors

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Animal-assisted crisis response (AACR) is an intervention that harnesses the human-animal bond for therapeutic benefit through specially trained animal-handler teams deployed to provide comfort following a mass traumatic event. During the months and years following the shooting at Marjory Stoneman Douglas High School on February 14, 2018, therapy animals joined the campus community to promote healing and stress reduction. The purpose of this quantitative study was to examine the sustained effects on bonding and stress in a sample of survivors of the tragedy who participated in animal-assisted crisis response. Data was collected through a quasi-experimental study of three intervention groups (i.e., discussion of AACR, viewing photos related to AACR, and engaging with therapy animals). Cortisol analysis indicated a reduction in stress post-intervention across groups with the largest difference in the therapy animal interaction group. Implications for AACR and addressing the psychological effects of mass traumas are provided.

Keywords: animal-assisted crisis response, animal-assisted intervention, human-animal bond, therapy animals

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The authors would like to thank the City of Parkland and Mayor Rich Walker, Canine-Assisted Therapy Inc., and Judy Beldon-Feldman.
In the wake of a crisis, there are several possible psychological and physiological reactions that an individual may experience, including changes in sleep patterns, body aches, isolation (Substance Abuse and Mental Health Services Administration, 2021). Traditionally, affected individuals are encouraged to speak with crisis hotlines that are staffed with mental health professionals who are equipped with crisis-specific training (e.g., suicide prevention) (Greenstein, 2017). According to the National Alliance on Mental Illness (n. d.), in addition to this form of support, trauma-informed and recovery-focused crisis stabilization programs, such as Psychological First Aid (PFA; Brymer et al., 2006), are effective in providing care to the impacted individuals. Built upon the concept of human resilience, PFA is an evidence-informed approach that aims to reduce acute stress symptoms and facilitate recovery following exposure to a traumatic event such as a natural disaster, public health emergency, or personal crisis (Brymer et al., 2006). Specifically, PFA utilizes five elements of psychological response to inform and guide helpers to connect, stabilize, educate, and assist survivors of disaster and crisis. This is achieved through providing safety, emotional support, information, and access to social support systems (Brymer et al., 2006).

In recent years, a complementary modality known as animal-assisted crisis response (AACR) has been added to the list of resources available to those who have survived a traumatic event. AACR is defined as a form of animal-assisted activities that provides comfort to those who have been affected by natural, human-caused, or technological disasters (Pet Partners, 2021). It is important to note that AACR is not a form of professional mental health treatment; rather, it is used to complement traditional methods of crisis intervention (Bua, 2013; Robinson, 2004). This method of crisis response aims to provide individuals a safe environment and time with a trained and registered therapy animal. Handlers of the therapy animals are required to undergo training, evaluation, and continuing education practices to ensure they can adequately respond in emotionally charged environments (Lackey & Haberstock, 2019). Although there is minimal research on the effects of AACR, available studies indicate a reduction in psychological and physiological symptoms as measured from before and after an interaction with a therapy animal (Eaton-Stull & Flynn, 2015; Eaton-Stull & Sewall, 2019). To date, AACR has been incorporated to facilitate healing for individuals who have experienced a crisis such as grief, suicide, a mass shooting, or natural disaster (Eaton-Stull & Flynn, 2020). During the months and years following the shooting at Marjory Stoneman Douglas High School on February 14, 2018, therapy animals joined the campus community to promote healing and stress reduction. Their unique bond with these therapy animals provides an opportunity to understand more strongly the relationships and impacts of AACR.

Human-Animal Bond

AACR is focused on providing support and comfort for survivors of crisis events by leveraging the human-animal bond (Gordon, 2013). The American Veterinary Medical Association (2021) defines the human-animal bond as “a mutually beneficial and dynamic relationship between people and animals that is influenced by behaviors essential to the health and wellbeing of both” (para 1). Research has demonstrated the positive effects the human-animal bond can have on humans’ physiological responses to stress (Handlin et al., 2019; Human-Animal Bond Research Institute, 2020; Levin et al., 2013), and these
findings may be consistent with stress induced following crisis events. One neurobiological pathway that is likely involved in this process is the hypothalamic-pituitary-adrenal (HPA) axis, which regulates the body’s stress response (Kirschbaum & Hellhammer, 1989). To measure activation of the HPA axis, researchers often take salivary cortisol samples as salivary cortisol is considered a reliable measure of physiological stress in human and non-human animals (Balters et al., 2020). At the time of an aversive event, stress produces a variety of behavioral and physiological responses to enable individuals to protect themselves by adapting to the situation. Immediately following the aversive event, the HPA axis is activated, which causes an increase in corticosteroids. Severe stress, such as during and in the aftermath of a crisis event, can cause the HPA axis to become dysregulated, which can lead to an excessive release of corticosteroids. Due to the ongoing development of children and adolescents’ brains, this population is particularly vulnerable to the effects of hormone overproduction and dysregulation of the HPA axis (Suzuki et al., 2014).

Childhood trauma is associated with longstanding effects on cortisol responses to stress in adulthood (Suzuki et al., 2014). While childhood trauma can have a significant impact on regulation of cortisol and the HPA-axis, research has demonstrated that human-canine interaction can positively influence HPA-axis and cortisol activity (Rodriguez et al., 2018). Adults have been shown to secrete less cortisol when interacting with dogs, suggesting that dogs have a calming effect on humans through this bonding experience (Odendaal & Meintjes, 2003). Furthermore, the simple presence of dogs may have a stronger effect than interactions with other humans during or after aversive events. Beetz et al. (2011) found that children interacting with a real dog exhibited lower salivary cortisol levels during stressful situations than children that interacted with a friendly human or a toy dog. Moreover, these researchers found that increased interaction with the dog through petting/stroking resulted in less pronounced stress responses; which suggests that the stress-reducing effect of the dog depended on the child’s engagement with the dog through sensory contact (Beetz et al., 2011). These findings are supported by prior research that found animate touch, specifically via petting both hard-shelled animals (e.g., turtles) and soft animals (e.g., rabbits) as opposed to petting a toy turtle and rabbit, can result in reduced levels of state-anxiety, a type of anxiety experienced in response to a situation perceived to be threatening or dangerous (Shiloh et al., 2003; VandenBos, 2007). Additionally, Polheber and Matchock (2014) found that college students who spent time with a therapy trained dog before engaging in a stressful task had lower levels of cortisol after and a lower heart rate during the stressful event compared to participants that were accompanied by a human friend. In this body of literature, the human-animal bond component to human-animal interactions appears to significantly improve one’s physiological response to stress after experiencing a stressful or traumatic event as measured by salivary cortisol samples.

In addition, humans can experience positive physiological benefits from interacting with dogs as the interaction initiates the release of oxytocin, a hormone associated with the feeling of comfort and well-being (O’Haire et al., 2019). Oxytocin can facilitate positive effects of social interaction (i.e., increased trust) and inhibit stress-related activity (i.e., posttraumatic stress symptoms including hyperarousal, anxiety, and interpersonal difficulties) (MacDonald & MacDonald, 2010). It has been found in previous research that children who were accompanied by a dog to a doctor’s visit experienced less behavioral distress, lower systolic blood pressure, lower heart rate, and reduced cortisol than children who were not accompanied by a dog (Nagengast et al., 1997; Vincent, 2019). Altogether,
the current research suggests that children and adolescents can experience beneficial effects through human-animal interactions following exposure to a stressful event.

**Animals and Adolescents**

Owning a pet during adolescence can not only provide a sense of comfort, but it has been found that attachment to these pets foster a deeper sense of trust in the adolescent (Piper & Uttley, 2019). This can assist in relationship building and the ability to socialize for the individual as they move into adulthood. The human-animal bond can also positively impact adolescents’ development. For example, pet ownership during adolescence has been associated with higher levels of self-esteem, autonomy, and self-concept (Purewal et al., 2017). Caring for a pet during adolescence can also be seen as a buffer against feelings of loneliness, which can further moderate suicidal ideation and behavior (Black, 2009). As emotional support is a significant factor in how effectively an adolescent can manage a challenging situation and its aftermath (Cassels et al., 2017; Piper, 2014), the possibility of animals providing a level of support cannot go unrecognized. Adolescents may experience concern regarding stigma associated with mental health, and this may negatively impact their professional help-seeking behaviors (Lawrence et al., 2015). Therefore, inclusion of animals in the aftermath of a crisis event for adolescents may significantly increase engagement in a therapeutic process. For example, animal-assisted therapy has been found to produce significantly higher retention and attendance rates for adolescents than standard psychological treatments (Jones et al., 2019). Considering trauma-focused mental health treatment is often associated with high rates of drop-out (Berke et al., 2019), animal-assisted interventions, such as animal-assisted crisis response, may considerably help individuals in the aftermath of a traumatic event.

This idea can be applied to an even more specific population: adolescents who have experienced a traumatic event. Following the event, there may be many overwhelming emotions that surface for the adolescent. These emotions can be challenging to talk about in traditional settings, especially for a child or teenager. In effort to provide a safe place where adolescents can talk about their experiences, animal-assisted interventions may be incorporated to decrease an individual’s level of physiological stress. For example, researchers found that children who had an animal present during a forensic interview regarding child sexual abuse had lower levels of stress (e.g., lower heart rate) during the interview (Krause-Parello et al., 2018). This is an important finding as it demonstrates that the presence of an animal in the interview room facilitated the reduction in the child’s physiological stress response, which in turn increased the child’s level of comfort, permitting them to communicate more openly about their traumatic experiences. Moreover, incorporating animal-assisted interventions with trauma survivors can elicit improvements that are natural to the human-animal bond.

**Animal-Assisted Crisis Response**

Survivors of trauma and crisis events frequently report experiencing a heightened state of alertness, difficulty relaxing, social isolation, a lack of safety and security, numbness, intrusive thoughts, and flashbacks. In addition, individuals who have experienced these responses to trauma often feel ostracized, stigmatized, and alone (O’Haire et al., 2019). In the immediate aftermath of a crisis, the incorporation of animals into crisis response can help facilitate recovery in several ways, including a more rapid
development of rapport by creating a bridge between the survivor and helper, providing a
safe and calming presence, reducing the need for verbal communication, encouraging
physical movement, and facilitating present minded thinking by providing a reality-
oriented focus for survivors (Greenbaum, 2006). Research has found that interacting with
an animal can reduce and mitigate the physiological stress response (Beetz et al., 2012),
restore a sense of calmness and security (Taylor et al., 2013; Yount et al., 2012), reduce
self-reported fear and anxiety (Barker et al., 2015; Barker et al., 2003; Lass-Hennemann et
al., 2014), and thus modulate overall arousal in individuals exposed to trauma.

As mentioned previously, individuals exposed to a traumatic event often experience
an array of reactions that are both psychological and physiological. Further complicating a
survivor's experience, research has found that repeated exposure to trauma can have a
significant and cumulative impact on an individual’s mental health and increase their risk
for PTSD, suicide, and substance abuse (Glenn, 2017). A study that examined the effects
of cumulative traumatic stress on emergency personnel involved in responding to the 9/11
terrorist attack in New York City produced findings that have implications for the field of
AACR (Alvarez & Hunt, 2005). Due to the nature of their job, first responders are a unique
population who are chronically exposed to both direct and vicarious trauma. Among the
emergency personnel participants was a group of canine search-and-rescue (SAR) teams
who had never assisted in a man-made disaster of this caliber, with so few survivors, and
with such a large death toll (Alvarez & Hunt, 2005). Interestingly, results from this study
indicated that, although deployed SAR handlers endorsed elevated rates of psychological
distress and symptoms of PTSD, the levels of PTSD symptom severity, as endorsed on
self-report measures, were lower than the rates reported in previous studies of non-canine
handler first responders (Alvarez & Hunt, 2005). Researchers have speculated that search-
and-rescue animal handlers might be more resilient than other first responders due to the
protective effect animals can have on moderating traumatic stress, the development of
PTSD, and depression (Allen et al., 2002; Arambasic et al., 2000).

Purpose of the Study

Given the increasing popularity of animal-assisted interventions overall (Fine et al.,
2019) and AACR specifically (Lackey & Haberstock, 2019), this study was conducted to
examine how the bonds that develop through AACR sustain over time. We also wanted to
explore the context in which these bonds influence stress response in survivors of a
traumatic event who directly engaged in AACR. This interest resulted in two research
questions and hypotheses:

1. What is the effect of therapy animals on bonding and stress in survivors of
the shooting at Marjory Stoneman Douglas High?
   Hypothesis: Survivors of the shooting at Marjory Stoneman Douglas High will
experience high levels of self-reported bonding and decreased levels of stress after
interaction with therapy animals.

2. What are the differences in bonding and stress levels in survivors of the
shooting at Marjory Stoneman Douglas High based on type of therapy animal
exposure?
Hypothesis: Survivors of the shooting at Marjory Stoneman Douglas High will experience similar levels of bonding and stress reduction regardless of type of therapy animal exposure with greater bonding and reduced stress upon direct therapy animal interaction compared to only discussion and/or visual stimuli.

Methods

Participants

Eleven survivors of the shooting at Marjory Stoneman Douglas High (MSDH) participated in the quasi-experimental study. All participants were above the age of 18 ($M = 18.73$). Six participants identified as female and four identified as male. Participants were in varying grade levels with 27.3% ($n = 3$) reporting as seniors in high school, 45% ($n = 5$) reporting as freshmen in college, and 27.3% ($n = 3$) reporting as sophomores in college. Most participants identified as White/Caucasian (45.5%; $n = 5$) with the remaining identifying as Hispanic/Latino (18.2%; $n = 2$), Black/African-American (9.1%; $n = 1$), Asian (9.1%; $n = 1$), and bi-racial (18.2%; $n = 2$). Most participants lived with a dog (72.7%; $n = 8$), and over half had interacted with a therapy dog in the past year (54.6%; $n = 6$).

Measures

Perceived Stress Scale

The Perceived Stress Scale (PSS; Cohen et al., 1983) is a 10-item Likert scale measure used to assess an individual’s perception of their baseline stress levels. Participants indicate how often they have felt or thought a certain way over the past month on a scale of 0-4 (0 = Never to 4 = Very Often). Four items on the scale require reverse-scoring. Higher scores on the PSS indicate higher levels of perceived stress. The PSS has been used often in both research and clinical settings (Answer et al., 2020; Chew et al., 2020; Crutcher et al., 2018). In addition, the PSS has also been used to assess changes in young adults’ perceived stress levels upon exposure to a therapy animal (Fiocco & Hunse, 2017). It was found to have acceptable reliability in the current study ($\alpha = .77$).

Impact of Events Scale- Revised

Prior to completing the Impact of Events Scale- Revised (IES-R; Weiss & Marmar, 1997), participants were asked to reflect upon the tragedy at their high school when answering the items to assess for immediate symptoms of trauma. The IES-R is a 22-item Likert scale instrument (1 = Not at all to 5 = Extremely) that assess participants’ subjective trauma response (i.e., intrusion, avoidance, hyperarousal) to the event. It has been found to appropriately differentiate between traumatized and non-traumatized populations (McCabe, 2019). The IES-R demonstrated appropriate internal consistency in other studies (Craparo et al., 2013; Norhayati & Aniza, 2014; Uver, 2020). It was also highly reliable in this study ($\alpha = .95$).

Center for the Study of Animal Wellness Pet Bonding

The Center for the Study of Animal Wellness Pet Bonding Scale (CSAWPBS; Johnson & Meadows, 2003) was used to assess for participants’ perceptions of their bond with the therapy animal following the exposure. It is a 28-item instrument that measures participants’ attachment to the animal and their feelings of reciprocal acceptance. Items are answered using a 5-point Likert scale (1 = more often true to 5 = more often false). One item must be reverse scored. Lower scores indicate greater degree of bonding as perceived
by the human participant. During scale development, the CSAWPBS was found to be internally consistent ($\alpha = .89$); the present study found identical reliability ($\alpha = .89$).

**Demographics Form**

Participants also completed a demographics form. Demographics collected included age, gender identity, grade in school, race/ethnicity, religious affiliation, approximate date of last encounter with a therapy animal, and dog guardianship status.

**Physiological Stress Measures**

To monitor for changes in physiological responses to stress, participants’ saliva, heart rate, and blood pressure were obtained. All three measures are commonly used biological indicators of stress (Iqbal et al., 2021; Morris et al., 2016) as well as in human-animal interaction research (Beetz et al., 2012; Ng et al., 2014; Pendry & Vandagriff, 2019). Blood pressure and heart rate were obtained through a wrist monitor. Individual tubes were used to collect saliva at separate time points. Saliva was collected from each participant by unstimulated passive drool for salivary cortisol analysis (participants drooled directly into a 1.5 mL microcentrifuge tube through a small sterile cylinder). Samples were stored in a freezer following participant testing at ~20°C. Cortisol was quantified through the use of a commercially available human enzyme immunoassay (EIA) kit (Salimetrics LLC, USA) which has a 0.91 correlation with serum and a sensitivity < 0.007 ug/dL. Interpolated concentrations are in ug/dL. The samples were read on a BioTek ELx800 plate reader (BioTek Instruments, Inc. Winooski, VT)

**Procedure**

IRB approval was obtained from the authors’ institution prior to participant recruitment by word-of-mouth and through key informants within the Parkland/MSDHS community. To ensure ethical safeguards, all participants were over the age of 18 and provided an information sheet to distribute to their parents describing the context of the study with referrals for mental health resources. In addition, two mental health professions and five mental health masters and doctoral-level trainees were on-site of the study all times. The study was developed in consultation with mental health professionals, a neuroscientist, a survivor of the shooting, parents of students who experienced the event, and Parkland/MSDHS community members. At the time of the study, three years had passed since the event to remove recency of the experience. As a condition of the IRB approval, permission to conduct the study on-location was obtained from Parkland City Hall; due to COVID-19 restrictions and to maintain fidelity to the interventions, the study was conducted outdoors with staggered start times for each participant group. Figures 1, 2, and 3 provide graphics of how the study was conducted within these limitations. All groups completed data collection at pre and post points with interventions based on their randomly assigned group. The first group (Discussion Group; Figure 1) participated in a guided discussion on their experiences with the therapy animals after the shooting at their school. The second group (Photo Group; Figure 2) reviewed photos of the therapy animals from their school. The third group (Therapy Animal Group; Figure 3) participated in a direct interaction with therapy animals that had visited their school. Participants of the first two groups were provided a time that they could return to the site of the study to engage with therapy animals, if interested.
Figure 1
Discussion Group Protocol

| Group 1 (Discussion Group) |
|---------------------------|
| 1) Group 1 participants arrived on site at 9:00 AM. |
| 2) Upon arrival, participants were paired with a research assistant who guided the participant to one of the three data collection sites arranged around the building. |
| 3) Each participant completed pre-intervention self-report measures and data was collected (blood pressure, heart rate, and cortisol via saliva sample) to establish participant baseline. |
| 4) After the intervention, participants completed post-intervention self-report measures and data was collected a second time (blood pressure, heart rate, and cortisol via saliva sample). |
| 5) Once data collection was complete, each participant was directed to the exit which was intentionally located away from the entrance to maintain fidelity to the intervention and compliance with COVID-19 social distancing guidelines. All group 1 participants were cleared from the site by 9:45 AM. |
Figure 2
*Photo Group Protocol*

| 6) Group 2 participants arrived on site at 10:00 AM. |
| 7) Upon arrival, participants were paired with a research assistant who guided the participant to one of the three data collection sites arranged around the building. |
| 8) Each participant completed pre-intervention self-report measures and data was collected (blood pressure, heart rate, and cortisol via saliva sample) to establish participant baseline. |
| 9) After the intervention, participants completed post-intervention self-report measures and data was collected a second time (blood pressure, heart rate, and cortisol via saliva sample). |
| 10) Once data collection was complete, each participant was directed to the exit which was intentionally located away from the sites entrance to maintain fidelity to the intervention and compliance with COVID-19 social distancing guidelines. All group 2 participants were cleared from the site by 10:45 AM. |
11) Group 3 participants arrived on site at 11:00 AM.
12) Upon arrival, participants were paired with a research assistant who guided the participant to one of the three data collection sites arranged around the building.
13) Each participant completed pre-intervention self-report measures and data was collected (blood pressure, heart rate, and cortisol via saliva sample) to establish participant baseline.
14) Therapy animal teams arrived on site at 11:15 AM after pre-intervention data was complete.
15) After the intervention, participants completed post-intervention self-report measures and data was collected a second time (blood pressure, heart rate, and cortisol via saliva sample).
16) Once data collection was complete, each participant was directed to the exit which was intentionally located away from the sites entrance to maintain fidelity to the intervention and compliance with COVID-19 social distancing guidelines.
Participants were reminded at multiple points during data collection that they could withdraw at any time as a component of ongoing informed consent. Participants completed a consent form, a demographics form, the Perceived Stress Scale to evaluate baseline stress level, and the Impact of Events-Scale to evaluate the presence of trauma symptoms. Participants then provided measurements of their blood pressure, heart rate, and cortisol through saliva. Saliva samples were wiped with a paper towel to avoid contamination and were immediately placed in a bag of ice to preserve the sample. After this, participants participated in one of the previously described therapy animal-related interventions for approximately 20 minutes. After the intervention, participants completed the Center for the Study of Animal Wellness Pet Bonding Scale. The study concluded with another collection of blood pressure, heart rate, and cortisol through saliva. Again, saliva samples were wiped with a paper towel to avoid contamination and were immediately placed in a bag of ice to preserve the sample. This study took approximately 1 hour per participant group. Licensed mental health practitioners trained in crisis intervention were in attendance in the event participants needed de-escalation. Participants were provided with a Project Information Sheet for Parents that encouraged them to monitor their child following their participation in this study and alert the researchers to any concerns. Contact information was provided in the event parents needed any mental health referrals or had any questions.

For the Therapy Animal Group, the handler of the dog was responsible for monitoring the dog’s fatigue, stress levels, and overall ability to participate. The three dog-handler teams were volunteers recruited from Canine-Assisted Therapy (CAT), a local therapy animal organization from which multiple therapy animal teams were dispatched in response to the need at MSDHS. To register as a therapy dog team with CAT, the organization requires that the dog is at least one year old, under the guardianship of the handler for at least six months, has passed the American Kennel Club Canine Good Citizen Test within the past two years, in good health and current on vaccinations, and non-reactive to strangers and other dogs while enjoying the work. CAT handler dog teams undergo an evaluation and certification process (Canine-Assisted Therapy, 2022) once the prerequisite qualifications are met. Handlers also receive background screening and a series of mentoring sessions prior to independent volunteering. The first team consisted of a handler with an active therapy dog registration with CAT and a female Italian Greyhound/Golden Retriever mixed breed who worked as a therapy dog for approximately four years. The second team consisted of a handler with an active therapy dog registration with CAT and a female Golden Retriever who worked as a therapy dog for approximately six years. The third team consisted of a handler with an active therapy dog registration with CAT and a Shih Tzu/Yorkie mixed breed who worked as a therapy dog for approximately five years. During the study, no teams provided formal PFA as an intervention; rather, participants interacted with the teams in an animal-assist

**Analysis**

Data was analyzed using SPSS. Descriptive statistics were obtained for the PSS, IES-R, and CSWAPB. For cortisol analyses, all samples were run in duplicate, and the average values were analyzed. A paired samples t-test was conducted to examine overall cortisol differences pre and post animal intervention. Correlations were run to establish the strength of the relationship between the pre and post-test. Differences between blood pressure and heart rate levels were also examined through t-test. A regression was
conducted to determine if bonding was a predictor of change in stress levels. An ANOVA was conducted to explore the differences between the groups of intervention conditions.

**Results**

To assess the presence of stress and trauma symptoms, descriptive analyses were obtained using the PSS and IES-R. The average PSS score ($M = 21.22; SD = 2.41$) indicated moderate levels of stress at the time of data collection. The average IES-R score ($M = 26.17; SD = 17.35$) indicated the presence of some PTSD symptoms in response to the shooting at their high school, although not at levels probable for a diagnosis of PTSD (Weiss & Marmar, 1997).

**Research Question 1**

To answer the first research question, the paired samples t-test revealed a statistically significant difference in cortisol levels between collection prior to the intervention and after the intervention, $t(10) = 2.72, p < .05$. Figure 4 provides a visual representation of each participants’ cortisol levels pre and post therapy animal intervention; Figure 5 provides a visual representation of the overall change in cortisol levels pre and post therapy animal intervention. To examine further the strength of the relationship between the pre and post results, a Pearson Product correlation was run; all paired samples of systolic blood pressure, diastolic blood pressure, heart rate, and cortisol were strongly correlated ($r = .67, r = .72, r = .85, r = .92$, respectively). An additional correlation was conducted to examine the type of relationship and post-cortisol level. Results revealed a strong negative relationship between the type of intervention and cortisol levels after intervention ($r = -.70$). Due to how the interventions were coded in the data set, this indicated that, the greater degree of exposure to a therapy animal (i.e., discussion, photos, interaction), the stronger relationship to decreased cortisol level. There was no statistically significant difference between blood pressure and heart rate pre and post intervention. The average bonding score was $M = 58.6, SD = 13.6$. When used as a predictor in the regression analysis, there was no predictive relationship between the bonding score and cortisol levels.

**Research Question 2**

To answer the second research question, an ANOVA was conducted to examine the differences between groups. There was a statistically significant difference in post-intervention cortisol levels between groups ($F(2, 8) = 4.45, p < .05$). A Bonferroni post-hoc test revealed differences in post-intervention cortisol levels between the Discussion Group and Therapy Animal Group ($p < .10$). No other differences between groups were uncovered, including between the Photo Group and other intervention groups. There was also no statistically significant difference in the bond across interventions.
Figure 4
Pre/Post Cortisol By Participant During Therapy Animal Intervention

Figure 5
Pre/Post Cortisol Overall During Therapy Animal Intervention
Discussion

The results of this study suggest that the utilization of AACR may be incorporated as a beneficial option in crisis intervention and have long lasting effects on individuals who have experienced this type of intervention. Previous research has shown the positive effects of AACR for both mental and physiological health, specifically in students in the same age group as the participants (Barker et al., 2016; Binfet & Passmore, 2016; Robino et al., 2021). As was expected, those students that had direct interactions with the therapy dogs did experience lower levels of stress as indicated by cortisol levels and a high degree of bonding as measured by the CSAWPBS, and increased levels of bonding as was indicated by cortisol levels.

The cortisol levels at baseline were relatively high at .42 ug/dL. This is consistent with previous work showing that cortisol is chronically elevated following a traumatic experience (Bremner, 2006). For comparison, an acute psychological stress results in average cortisol levels that are .32 ug/dL in a group of young adults (average age = 22). Following the therapeutic intervention, the average cortisol levels dropped to .31 ug/dL. This is also consistent with previous studies which showed that therapeutic intervention following traumatic experiences can significantly reduce cortisol levels in adolescents. For example, therapeutic intervention has been shown to reduce cortisol levels in war-affected adolescents (Dajani et al., 2018) and adolescent refugees with PTSD (Budde et al., 2018).

Most importantly, significant differences were observed between type of exposure and cortisol level. Specifically, those that were exposed to physical interactions with the therapy dogs showed greater reduction in cortisol than did those who were only exposed to photos or discussion of the therapy dogs. As these were students who had previously been exposed to therapy dogs in the aftermath of a traumatic event it suggests that 1) the therapy dogs had an impact on stress and stress management, and 2) the effects were long-lasting. Although there was not a significant reduction in heart rate or blood pressure, it is possible that the conditions of the study (i.e., outdoors in a public space and fast-paced environment) and the low sample size might have contributed to this finding.

This study indicates that the effects of animal-assisted crisis intervention are both long-term and evidenced by both physical and self-reported measures. These bonds appeared most significant when the students were interacting with the therapy dogs, but were also evident when talking about, or looking at their photos. It is important to note that these student survivors were interacting, talking about, or looking at photos of several of the actual dogs that had been present for crisis response in the days, weeks, and months following the mass shooting at MSD.

When the small sample size is considered, it is even more interesting how profound the differences in the interactions were and what they implicate for the inclusion of animal-assisted crisis intervention and animal-assisted therapy in other situations, venues, and with other populations. Certainly, such inclusion as a means of stress reduction during difficult therapeutic interventions or victim/witness testimony in court is implied, as well as in post-crisis situations such as natural or man-made disasters, sexual assault, or other traumatic events.

Also important to note is that moderate stress levels are to be expected when working with young adults, specifically in the context which prompts them to recall a traumatic time in their life. Research has demonstrated that recollecting and discussing
traumatic memories can cause an individual to feel anxious and fearful for the impact of traumatic stress often generates physiological responses of which individuals cannot control, causing the body to flood with stress hormones such as cortisol (Joëls & Barum, 2009). This study promotes the possibility that human-animal interactions might be a useful buffer to stress for young adults. Overall, young adults experience general stress outside of recalling traumatic events due to the nature of this developmental stage (Matud et al., 2020); therefore, this creates therapeutic implications for working with this population even beyond those who have experienced a crisis.

Limitations
This study was challenged by several limitations. First, the sample size was low due to the nature of the population which consisted of students over 18 who had attended Marjory Stoneman Douglas High School at the time of the 2018 mass shooting. The COVID-19 pandemic also proved to be a challenge as the study required face-to-face contact with the therapy animals and their handlers, the collection of saliva, and physical contact with the participants for blood pressure data. Also affected were such logistical concerns such as availability of space, masking, social distancing, and the timeframe of the study.

Future Research
There are several areas where future studies could provide additional information on this subject. As this was a small sample size it would be important to investigate if the same results would be found with a larger and more diverse populations. All of the subjects in this study were survivors of the same tragic event (a mass shooting while in high school) and it would be valuable to see if similar results would be found with other types of tragic or traumatic events. The participants were, on average, 18 years old and majority female. Future studies with a more diverse subject pool would provide broader applicability as to how individuals respond to human-animal interactions in the wake of a traumatic event. In addition, given the findings in cortisol observed here, future work should also consider examining changes in negative feedback regulation of the HPA axis and possible heightened physiological stress responses in adolescents who experience traumatic events.

Conclusion
The purpose of this study was to evaluate stress effects and bonding that develop and are sustained through AACR. Previous studies have shown beneficial and long-lasting effects on individuals of a variety of age groups who experienced this type of intervention. Current findings appear to support these data and suggest that AACR is an effective way to aid students dealing with school-related crisis and trauma. Not only does AACR provide support for these students immediately following these types of events, but then it could provide stress reduction years later. This also supports the idea of human-animal bonding as indicated by cortisol levels measured during direct interactions with the therapy dogs. Despite the small sample size, significant effects on cortisol levels were noted between the different levels of human interactions with the therapy dogs. Consequently, the further and continued incorporation of AACR is indicated and should be further studied related to immediate, short-term, and long-term effects for those dealing with crisis and trauma.
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