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A Systematic Review of Equine-Assisted Interventions in Military Veterans Diagnosed with PTSD

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Military veterans transitioning from active duty to civilian life often face challenges during the reintegration process. Reintegration can become more difficult when a veteran is coping with posttraumatic stress disorder (PTSD) and its sequelae. Interventions are urgently needed to support veterans during times of transition. Animal-assisted interventions (AAI) show promise in reducing stress, depression, and improving wellbeing in marginalized populations. Equine-assisted interventions (EAI), in particular, are gaining momentum as a treatment option for veterans with PTSD. To synthesize current evidence on the use of EAI as a treatment option in military veterans formally diagnosed with PTSD, a comprehensive, electronic review of the literature was performed. Inclusion criteria were original quantitative or qualitative research, written in English, use of human participants, published through July 2019. The total number of studies included was nine. Main findings were that the efficacy of EAI on PTSD symptoms were equally mixed with both significant and non-significant findings. Data largely trended in the hypothesized direction for improving mental health states, resiliency, social function, quality of life, biological and behavioral measures, however, overall findings did not reach statistical significance. The investigation of EAI as an adjunct treatment for PTSD in military veterans may be effective, however, we cannot make a clear determination based on current evidence. Although findings largely trended in the hypothesized direction, most were not significant (except for PTSD symptoms) and warrant additional research to understand the effectiveness of EAI as an adjunct treatment in military veterans with PTSD.

Keywords: Posttraumatic Stress Disorder; Military; Veterans; Animal-assisted interventions; Equine-assisted interventions

Introduction

Military veterans returning to civilian life often face reintegration challenges, especially for those diagnosed with posttraumatic stress disorder (PTSD). PTSD is a mental health condition that is a result of witnessing or experiencing a traumatic event. Due to their military service, members of the Armed Forces often witness or experience trauma. Percentages of veterans afflicted with PTSD vary but are significant. The US Department of Veterans Affairs (2019) estimates that PTSD affects 12% of Gulf War (Desert Storm) veterans and between 11–20% of veterans who served in Operations Iraqi Freedom (OIF) and Enduring Freedom (OEF); and up to 30% of Vietnam veterans have had PTSD in their lifetime.

PTSD symptoms are challenging to treat and symptom severity varies. Untreated PTSD can lead to veteran's

inability to regulate emotions, hypervigilance, poor sleep hygiene, anxiety, depression, social disconnectedness, among others (Mayo Clinic, 2019). There are known evidence-based options to treat PTSD [e.g., Prolonged Exposure (PE), Cognitive Processing Therapy (CPT), and Eye Movement Desensitization and Reprocessing (EMDR) and antidepressant medications; Mayo Clinic, 2019)]. Although treatment options are available, many veterans remain untreated due to lack of effectiveness. Due to the consequences of PTSD symptoms in veterans and lack of effective treatments, there is an immediate need to investigate other approaches to PTSD management.

Animal-assisted interventions (AAI) are showing promise in positively influencing human health outcomes in marginalized populations (Krause-Parello, & Gulick, 2015; Krause-Parello, & Kolassa, 2016; Friedmann &

Krause-Parello, 2018). There are various species used in AAI such as dogs, cats, horses, pigs, among others. Equine-assisted interventions (EAI) involving horses encompass a range of interventions including Therapeutic Horseback Riding (THR), Equine-Assisted Learning (EAL), hippotherapy, Equine-Assisted Psychotherapy (EAP), and other Equine-Assisted activities (EAA). THR and EAL typically utilize certified therapeutic riding instructors and volunteers while clients ride a horse or do groundwork whereas medical and counseling professionals are involved in hippotherapy (occupational/physical/speech therapists) and EAP (mental health professionals) to achieve specific therapeutic targets (Burton et al., 2019; Nevins et al., 2013). Although new evidence supports EAls as a treatment option for lessening PTSD symptoms in veterans, gaps in the literature remain.

Purpose

The purpose of this systematic review is to synthesize current evidence on the use of EAI as a treatment option in military veterans formally diagnosed with PTSD.

Methods

In this section we provide a detailed account of the search strategy and search results.

Search strategy

A study protocol was used to define the search strategy, including search terms, population, AAI, inclusion/exclusion criteria, and outcomes (PTSD-related outcomes). Electronic databases were searched from their inception through July 2019 to maximize the number of relevant research articles obtained including: *PubMed*, *Embase*, *PsycINFO*, Cumulative Index to Nursing and Allied Health Literature (*CINAHL*), Educational Resources Information Center (*ERIC*), and Published International Literature on Traumatic Stress (*PILOTS*), the latter which is a PTSD research database maintained by the Department of Veteran Affairs. Criteria for inclusion were original quantitative or qualitative research published in a peer-reviewed journal, written in English, use of human participants, published through July 2019, and those with the chosen identifiers. Theses/dissertations were also included to reduce the potential effects of publication bias.

Search terms for all databases included at least one identifier for military veterans, at least one identifier for PTSD, and at least one identifier for AAI in the article title, abstract, and/or key words. The final search algorithm used was “hippotherapy” OR “horse riding” OR “therapeutic horseback riding” OR “horseback riding” OR “therapeutic riding” OR “equine therapy” OR “pet therapy” OR “animal-assisted therapy”[MeSH Terms] OR “equine-assisted” OR “horse therapy” OR “equine movement” OR “equine facilitated therapy” OR “equine-assisted therapy”[MeSH Terms] OR “equine psychotherapy” OR “equine facilitated therapy” AND “Veterans [MeSH Term] OR Military Personnel”[MeSH Term] AND “Stress Disorders, Post-Traumatic”[MeSH] OR “PTSD.”

Search results

Figure 1 (next page) is a flow diagram of the search and articles eliminated and retrieved. The total number of studies included in this systematic review is nine ($n = 5$ quantitative; $n = 3$ mixed methods; $n = 1$ qualitative).

In this section we report specific characteristics of the studies we included in this review, including research design, type of EAI used, study purpose, sample/size, setting, description of interventions, and measures used (i.e., psychosocial, biological, and behavioral) to evaluate responses to the intervention.

Research design

Of the nine studies, one was a randomized controlled trial (Johnson et al., 2018), one used a two-group, sequentially-assigned design with repeated measures (Burton et al., 2019), three were single group, repeated-measures (Craven, 2013; Malinowski et al., 2018; Wharton et al., 2019), three were single group, repeated-measures with mixed methods (Gómez, 2016; Lanning et al., 2017; Nevins et al., 2013), and authors of one study used a qualitative research approach (LaFleur, 2015). Three of these studies were doctoral dissertations (Craven, 2013; Gómez, 2016; LaFleur, 2015).

Type of EAI

Different EAI approaches were used in the studies. Two authors used EAP (Burton et al., 2019; Craven, 2013), three used THR (Johnson et al., 2018; LaFleur, 2015; Lanning et al., 2017), one used equine-assisted therapy (EAT; Gómez, 2016), one used equine-assisted activities therapy (EAAT; Malinowski et al., 2018), one used equine-facilitated cognitive processing therapy (EF-CPT; Wharton et al., 2019), and one used both EAT and natural horsemanship (Nevins et al., 2013).

Study purpose

A common purpose in the quantitative and mixed methods designs was to examine or explore the efficacy/impact of EAI on PTSD symptoms and/or associated psychosocial/biological variables in military veterans (Burton et al., 2019; Craven, 2013; Gómez, 2016; Johnson et al., 2018; Lanning et al., 2017; Malinowski et al., 2018; Nevins et al., 2013; Wharton et al., 2019). In the qualitative study, authors sought to describe the experience of using THR as part of the PTSD treatment in veterans (LaFleur, 2015).

Sample size and setting

Sample sizes ranged from one participant (Nevins et al., 2013) to 51 participants (Lanning et al., 2017), with all participants identified as American military veterans diagnosed with PTSD. Specific military branch was only identified in three studies (Craven 2013; Johnson et al., 2018; Nevins et al., 2013). The majority of settings varied and included training arenas/centers for horses (Burton et al., 2019; Gómez, 2016; Johnson et al., 2018; LaFleur, 2015; Lanning et al., 2017; Malinowski et al., 2018; Nevins et al., 2013), a farm (Wharton et al., 2019), and a ranch (Craven, 2013).

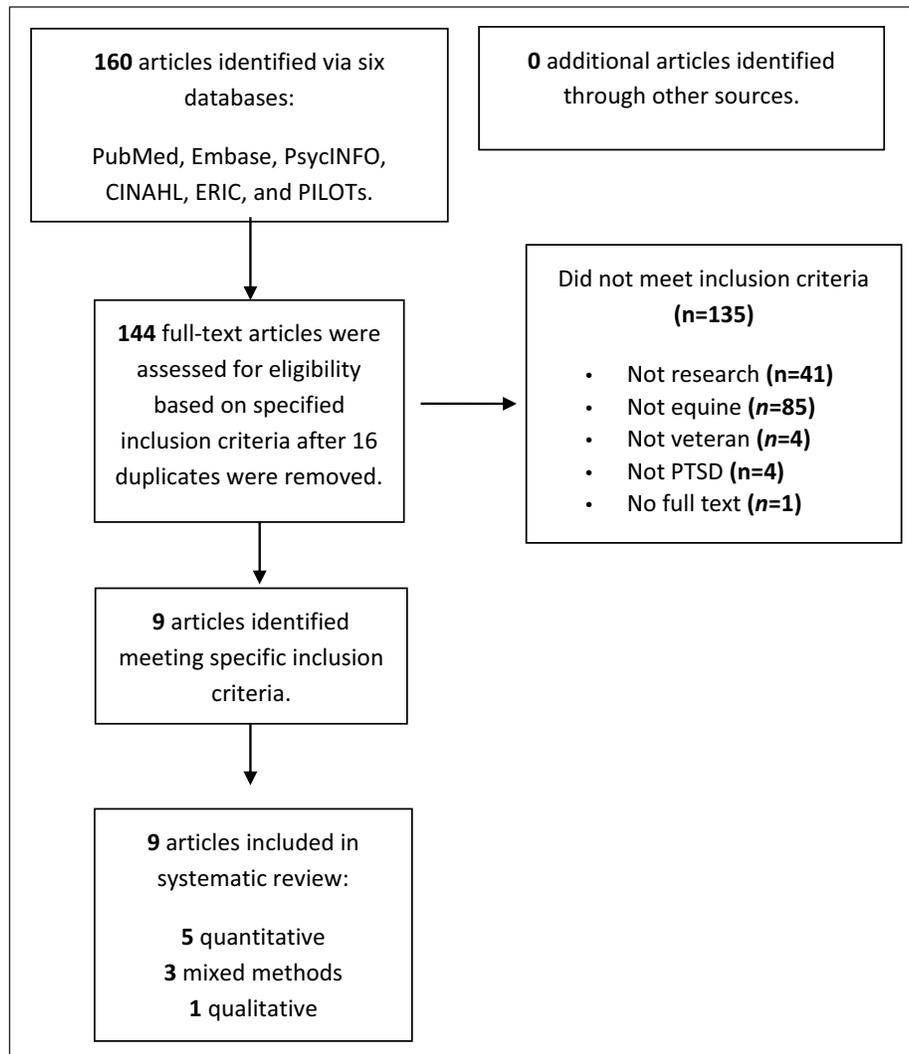


Figure 1: Flow diagram of literature search.

Intervention features

Interventions were used in all studies (see **Table 1**), and time frames ranged from three days (Nevins et al., 2013) to 12 weeks (Wharton et al., 2019). One intervention was held for five days (Malinowski et al., 2018), one was held for four to six weeks (Gómez, 2016), three were held for six weeks (Burton et al., 2019; Craven, 2013; Johnson et al., 2018), and one for eight weeks (Lanning et al., 2017). The time frame in Lafleur's (2015) study varied for each participant, and the exact number of THR sessions was not reported. Interventions in five studies took place in a group format (Burton, et al., 2019; Craven, 2013; Gómez, 2016; LaFleur, 2015; Wharton et al., 2019), two were in an individual format (Johnson et al., 2018; Malinowski et al., 2018), and two interventions included a combination of group and individual activities (Nevins, et al. 2013; Lanning et al., 2017).

PTSD measures

Authors of the eight quantitative studies specifically measured PTSD with different psychometric instruments, including Post-Traumatic Stress Disorder Checklist-Civilian Version

(PCL-C; Craven, 2013; Nevins et al., 2013), Post-Traumatic Disorder Checklist-5th Edition (PCL-5; Gómez, 2016; Lanning et al., 2017; Malinowski et al., 2018), and Post-Traumatic Stress Disorder Checklist-Military Version (PCL-M; Burton et al., 2019; Johnson et al., 2018; Lanning et al., 2017; Wharton et al., 2019). Although definitions of PTSD varied slightly among studies, a common definition was, "the development of a specific set of symptoms (i.e. intrusive symptoms, avoidance of stimuli, cognitive and mood alteration, arousal and reactivity alteration, distress or impairment, substance abuse, depersonalization, derealization) following exposure to a traumatic event" (Gómez, 2016, page 9).

Psychosocial measures

Authors of all studies measured psychosocial variables, which included mental health states, resiliency factors, social functioning, and quality of life.

Mental health states

Affect was measured with the Visual Profile of the Positive and Negative Affect Scale (VPANAS; Craven, 2013), a visual

Table 1: Overview of equine-assisted interventions (EAI) characteristics (n = 9).

First Author	Year	AAI Terminology	Setting	Format	Interventionist	Sessions		
						Duration (Weeks)	Number	Length (Minutes)
Burton	2019	Equine-assisted psychotherapy	EAP Facility	Group	Certified therapist, Professional horse handler	6	6	60
Craven ^a	2013	Equine-assisted psychotherapy	Ranch	Group	Mental health certified professional, Equine specialist	6	6	60
Gómez ^a	2016	Equine-assisted therapy	ETP Center	Group	Certified therapeutic recreation specialists	4–6	4–6	–
Johnson	2018	Therapeutic horseback riding	PATH Riding Center	Individual	Occupational therapist, PATH-certified instructors, Horse side walkers	6	6	60
LaFleur ^a	2015	Therapeutic horseback riding	PATH Riding Center	Group	Trained equine specialists	–	–	–
Lanning	2017	Therapeutic horseback riding	Therapeutic Riding Center	Individual & group	PATH-certified instructors, trained veteran volunteers, Horse side walkers	8	8	90
Malinowski	2018	Equine-assisted activities therapy	PATH Riding Center	Individual & group	Licensed therapist, Certified equine specialist	5 day	5	60
Nevins	2013	Equine-assisted therapy (natural horsemanship)	Training center	Individual	Certified trainer, Equine specialist	3 day	4	240
Wharton	2019	Equine-facilitated cognitive processing therapy	Farm	Group	Licensed clinical psychologist	12	12	–

Note: Information reported for the EAI condition only; – =not reported; ^a = Doctoral dissertation.

analogue instrument designed to measure both positive and negative affect (Watson, Clark, & Tellegen, 1988). Emotion regulation was defined as “modulation of emotional arousal; awareness, understanding, and acceptance of emotions; and ability to act in desired ways regardless of the emotional state,” (Johnson et al., 2018, page 5) and was measured with the Difficulties in Regulation Scale (DERS; Gratz & Roemer, 2004;). Depression was measured with the Beck Depression Inventory-II (BDI-II; Nevins et al., 2013), a widely used instrument to measure the major components of depressive symptomatology (Beck, Steer, & Brown, 1996). Guilt was measured with the Trauma-Related Guilt Inventory (TRGI; Wharton et al., 2019) which is designed to measure six subscales of guilt: global guilt, distress, guilt cognition, hindsight bias, wrongdoing, and justification (Kubany et al., 1996).

Resiliency

Resiliency was measured with the Response to Stressful Experiences Scale (RSES; Johnson et al., 2011; Nevins et al., 2013) and the Connor-Davidson Resilience Scale (CD-RISC),

defined as “the ability of individuals to adapt positively in the face of trauma,” (Connor & Davidson, 2003; Burton et al., 2019).

Social function

Several authors measured domains related to social function. Craven (2013) did not define the different types of social support, but used different instruments to measure domains of social support and social engagement, including Satisfaction with Participation in Social Roles (SPSR), Satisfaction with Participation in Discretionary Social Activities (SPDSA), Ability to Participate in Social Roles and Activities (APSRA), and the Interpersonal Relations Scale (OQ-45). The World Health Organization Disability Assessment Schedule (WHO-DAS) was used to measure social relationships and social functioning (Lanning et al., 2017) related to difficulties due to health/mental conditions (WHO, 2001). Another author used the Modified Social Support Survey to measure social support and how much support an individual believes he or she has had available over the past month but did not define the variable (MSSS; Nevins et al., 2013). Johnson et

al. (2018) used the Social and Emotional Loneliness Scale for Adults-Short Version to measure emotional, family, and romantic loneliness (SELSA). Wharton et al. (2019) measured the human-animal bond with the Human-Animal Bond Scale (HABS), which measures the bond of participants with equines (Terpin, 2004). Therapeutic alliance between the veteran and therapist was measured with the Working Alliance Inventory-Short Form (WAI-SF) an instrument designed to measure agreement on tasks, agreement on goals, and emotional bonds (Wharton et al., 2019).

Quality of life

Quality of life was measured with a variety of instruments including the Quality of Life Scale-16 (QOLS-16; Gómez, 2016), Quality of Life Assessment (SF-36v2; Lanning et al., 2017), and the Quality of Life Inventory (QOLI; Nevins et al., 2013). The QOLS-16 measures three factors: Relationships and Material Well-Being, Health and Functioning, and Personal, Social and Community Commitment (Burckhardt & Anderson, 2003) whereas the SF-36v2 is more global measuring a profile of functional health and wellbeing (Ware, Kosinski, & Keller, 1994) and the QOLI measures life satisfaction in the areas of health, self-esteem, goals and values, love, etc. (Frisch, Cornell, Villanueva, & Retzlaff, 1992).

Biological measures

Biological measures included blood pressure, heart rate, and respirations (Malinowski et al., 2018), as well as salivary cortisol, a biomarker of stress, measured via enzyme-linked immunosorbent assay (Burton et al., 2019).

Behavioral measures

Behavioral measures included mindfulness, coping self-efficacy, response to stressful experiences, physical functioning, and vitality. Gómez (2016, page 19) used the Cognitive and Affective Mindfulness Scale-Revised for mindfulness “to measure mindful approaches to thoughts and feelings” (CAMS-R). The Coping Self-Efficacy Scale (CSES) was used to measure coping self-efficacy and was defined as “veterans/perceived ability to successfully respond to unforeseen events” (Johnson et al., 2018, page 5). Vitality was measured with the Vitality Score (Lanning et al., 2017), which is a composite score of four-items on the SF-36v2 that measures energy/fatigue. Response to stressful experiences was measured with the Response to Stressful Experiences Scale, which measures resiliency-focused behaviors and processes, specifically “cognitive flexibility, spirituality, active coping, self-efficacy, meaning-making, and restoration” (RSES; Nevins et al., 2013).

Findings

In this section we discuss important findings from the studies included in this review according to major groups of variables and their relationship with PTSD outcomes (i.e., PTSD symptoms, psychosocial measures, biological measures, and behavioral measures).

PTSD symptoms

In two studies using EAP as the intervention, findings were inconsistent. Craven (2013) reported trends in a reduction for PTSD symptoms (all $p > .08$). Although three out of five participants no longer met DSM-IV diagnostic criteria for PTSD by the six-week follow-up, statistical significance for a reduction in PTSD symptoms was not reached. Burton et al. (2019), however, reported a significant reduction in PTSD symptoms at the six-week follow-up ($p < .0005$).

In three other studies, THR was used as the intervention, and findings were also inconsistent. At three weeks post-intervention, Johnson et al. (2018), who conducted the only randomized controlled trial, reported a significant decrease in PTSD symptoms ($p \leq .01$) and both statistical significance ($p \leq .01$) and clinically significant improvements in PTSD symptoms at six weeks. Lanning et al. (2017) reported a clinically significant reduction in overall PTSD symptoms at eight weeks, but statistical significance was not achieved.

Four authors used variations of EAT, and findings were again inconsistent. Gómez (2016) reported a trend in reduction of PTSD symptoms at their four to six-week follow-up time frame with EAT, but findings did not reach statistical significance (p value not reported, only a reduction in scores reported). Similarly, Nevins et al. (2013) reported consistently decreased scores on their PTSD measure over 12 weeks in their EAT activity with natural horsemanship principles, but p values were not reported. Malinowski et al. (2018), however, reported a statistically significant reduction in overall PTSD symptoms with the use of EAAT ($p = .05$) after only five days, and Wharton et al. (2019) also reported a statistically significant reduction in PTSD symptoms ($p < .01$) after their 12-week intervention with EF-CPT.

Psychosocial measures

Mental health states

Mental health states and domains related to mood were measured by authors in four studies with inconsistent findings. Wharton et al. (2019) was the only author to measure guilt and the only author to report a statistically significant decrease at the post-intervention follow-up ($p < .01$). Craven (2013) measured positive and negative affect from baseline to six-week follow up. Participants reported an increase in positive affect and a decrease in negative affect after each EAP treatment; however, statistical significance was not reached. Nevins et al. (2013) measured depression at baseline, and 12-week follow-up after a natural horsemanship intervention and reported a trend in decreased scores, although statistical significance was not reported. Similarly, Johnson et al. (2018) measured emotion regulation over a six-week time frame of THR, and findings did not reach statistical significance. Qualitative findings reported by one author were improved emotional health (LaFleur, 2015).

Resiliency

Nevins et al. (2013) and Burton et al. (2019) both measured resiliency and reported increased scores post-intervention,

however, only Burton et al. (2019) reached statistical significance ($p < .02$).

Social function

Authors of five studies measured domains of social support, and findings were consistent and non-significant. Lanning et al. (2017) reported clinical significance and upward trends in social function at the eight-week follow-up, but not statistical significance. Craven (2013) also reported an increase in participation of social activities at the six-week follow-up of EAP, however, statistical significance was not reached. Nevins et al. (2013) reported consistently increased scores in social support with their single participant, but statistical significance was not reported. Wharton et al. (2019) reported an increased bond between veteran and horse, as well as an improved therapeutic alliance between veteran and therapist without reaching statistical significance. Johnson et al. (2018) was the only author who reported nonsignificant findings without trends in the hypothesized direction for improving social and emotional loneliness at their follow up. Qualitative findings related to domains of social support were improved relationships (Gómez, 2016), improved ability to provide/receive community support (Lanning et al., 2017), and increased social support (Nevins et al., 2013).

Quality of life

Authors of three studies measured quality of life and coping and reported similar findings. Nevins et al. (2013), Gómez (2016), and Lanning et al. (2017) all measured quality of life and reported trends in the hypothesized direction (improvements) from baseline to follow up, however, statistical significance was not reached.

Biological measures

Authors of two studies collected physiological data, and both reported nonsignificant findings. Respiration, blood pressure, and heart rate were measured by Malinowski et al. (2018) from baseline and every day for five days of EAP. Heart rate was significantly lower ($p = .006$) on one day of the treatment; however, overall non-significant findings were reported for respirations, blood pressure, and heart rate. Burton et al. (2019) collected morning salivary cortisol samples and reported no difference between the control and intervention groups at the six-week follow-up. In addition, the qualitative finding of improved sleep was reported by Nevins et al. (2013).

Behavioral measures

Four authors measured different behavioral domains, and all authors reported trends in the hypothesized direction, but findings were non-significant. Gómez (2016) reported improved mindfulness scores, but not statistical significance. Coping self-efficacy was measured by Johnson et al. (2018); however, findings did not reach statistical significance. Lanning et al.'s (2017) findings for vitality and Nevins et al.'s (2013) findings for responses to stressful experiences

were not statistically significant. Qualitative findings were improved caring and compassion (Gómez, 2016), motivation (LaFleur, 2015), confidence, trust, acceptance of self and others, and gratitude (Lanning et al., 2017).

Discussion

The purpose of this systematic review was to synthesize current evidence on the use of EAI as a treatment option in military veterans formally diagnosed with PTSD. Main findings were that the efficacy of EAI for PTSD symptoms were equally mixed with both significant and non-significant findings. In addition, data largely trended in the hypothesized direction for domains of mental health states, resiliency, social function, quality of life, biological, and behavioral measures, however, overall findings did not reach statistical significance.

PTSD measures

Findings were mixed for the eight quantitative studies that evaluated the efficacy of EAI in reducing PTSD symptoms with four authors reporting nonsignificant findings (Craven, 2013; Lanning et al., 2017; Gómez, 2016; Nevins et al., 2013) and four authors reporting significant findings (Burton et al., 2019; Johnson et al., 2018; Malinowski et al., 2018; Wharton et al., 2019). Of note, all four authors of studies with non-significant findings reported PTSD scores trended in the hypothesized direction. The only researchers who conducted a randomized controlled trial (RCT) reported significant decreases in PTSD symptoms and clinically significant improvements in PTSD symptoms after six weeks of THR (Johnson et al., 2018).

The significant findings in this review are consistent with other published studies involving EAI and military personnel (Romaniuk et al., 2018; Steele et al., 2018). Both of these studies were excluded from our systematic review because it could not be confirmed that all participants were diagnosed with PTSD. Steele et al. (2018) used EAP in their intensive 7-day program and Romaniuk et al. (2018) used EAT in their comprehensive program, and both authors reported a statistically significant reduction in PTSD symptoms. Interestingly, both authors' methodologies differed from the studies included in our systematic review in that EAI was not the only activity for participants. For example, Steele et al. (2018) evaluated participants who were participating in a seven-day "Warrior Camp," that included a variety of activities, such as eye movement desensitization, reprocessing therapy, yoga, narrative writing, as well as EAP. Similarly, Romaniuk et al. (2018) evaluated participants who were enrolled in a five-day comprehensive program that also included Relational Gestalt Therapy, mindfulness, grounding techniques, as well as EAT used in an Individual program and a Couples program.

Some authors have proposed that certain interventions with horses, including THR, enhance outcomes due to the multifactorial conditions including grooming the horse, applying tack, learning horsemanship skills, as well as

interacting with the horse leader or side-walker (Johnson et al., 2018). In our systematic review, we found that Johnson et al. (2018) used THR and reported significant findings, whereas Lanning et al. (2017) also used THR, but their findings did not reach significance. Nevertheless, due to the scarce number of studies, it is not clear whether or not multifactorial interventions influence findings.

Small sample size and high attrition rates may explain non-significant findings for four authors who studied PTSD symptoms in our review; however, sample sizes for all studies in this review should be considered small; the largest sample size was $N = 38$ (Johnson et al., 2018). Of note, even with a small sample size, Johnson et al. (2018) reported significant findings. Another potential explanation for non-significant findings is that veterans in waitlisted groups may have sought other treatment for PTSD symptoms in the interim, thus affecting their overall PTSD score during the data collection for these studies (Kopicki, 2016). While this is a possibility, it does not fully provide a reason for the non-significant findings, since two of the studies with significant findings also used waitlisted veterans as control groups (Johnson et al., 2018; Malinowski et al., 2018).

Psychosocial Measures

Mental health states

Authors of studies that measured mental health states largely reported non-significant findings (positive/negative affect, depression, emotion regulation; Craven, 2013; Nevins et al., 2013; Johnson et al., 2018; respectively). Similar to non-significant findings with PTSD symptoms, all non-significant findings related to mental health states trended in the hypothesized direction. Authors of only one study reported a significant reduction in the mental health domain of guilt (Wharton et al., 2018).

Contrasting findings could be related to differences in effects between short-term interventions (six weeks, six weeks, five days; Craven, 2013; Nevins et al., 2013; Johnson et al., 2018; respectively); versus longer-term interventions (12 weeks; Wharton et al., 2018), the latter which would likely be more consistent in developing a bond that improves mental health states in veterans. However, Romaniuk et al. (2018) reported a statistically significant reduction for anxiety and depression in their five-day “short-term” intervention with EAT/Psychotherapy that incorporated Relational Gestalt Therapy, mindfulness, grounding techniques, and elements of natural horsemanship. In their study measures on depression, but not anxiety, returned to pre-intervention levels three months following the Individual program. Interestingly, in their Couples program, symptoms of depression, stress, and PTSD were significantly reduced after the five-day program and the reduction remained three months later with the authors suggesting that the Couples program may facilitate greater long-term psychological outcomes than the Individual program (Romaniuk et al., 2018).

Our findings differ from O’Haire and colleagues (2015) who found significant reductions in depression and anxiety

in their systematic review primarily among survivors of child abuse but also included veterans with PTSD symptoms. In their systematic review, they include two studies using EAP with teenagers (Kemp et al., 2013; McCullough, 2011) and one study with natural horsemanship in adults (Nevins et al., 2013). Both McCullough (2011) and Kemp et al. (2013) reported significantly improved mental health symptoms associated with PTSD. Nevins et al. (2013), however, is the same article we include in our systematic review, and scores for mental health states were improved but statistical significance not reported. It is unclear if differences between the systematic reviews are attributable to age differences or differing responses between populations who have suffered from trauma.

Resiliency

Findings were mixed with one author reporting non-significant findings (Nevins et al., 2013) and one reporting significant findings (Burton et al., 2019). Again, Nevins et al. (2013) also found that scores trended in the hypothesized direction, improved resiliency. It is plausible that veterans would perceive improved resiliency after a six-week intervention with EAP (Burton et al., 2019) without the same perception after a three-day intervention with EAT (Nevins et al., 2013).

As a comparison, authors who studied veterans with PTSD and AAI with service dogs reported non-significant changes in resiliency in their eight-week intervention (Beck et al., 2012). In other AAI studies with service dogs, it is unclear why veterans with service dogs would perceive improved resiliency after three weeks with a service dog (O’Haire & Rodriguez, 2018) and not after three months with a service dog (Yarborough et al., 2017). These inconsistent findings support the need for additional research.

Social function

Findings in social function related to EAI all indicate that EAP, THR, and EF-CPT were not significantly effective in improving social function, reducing social or emotional loneliness, improving social support, or improving therapeutic alliance (Craven, 2013; Johnson et al., 2018; Nevins et al., 2013; Wharton et al., 2019, respectively). Similar to other findings present in this review, all authors except for Johnson et al. (2018) reported scores trended in the hypothesized direction, despite not reaching statistical significance. These findings differ from Steele et al.’s (2018) statistically significant findings of improved adult attachment in veterans with PTSD post-EAP.

Despite overall non-significant findings, it may be worth noting a difference in two cohorts within one study (Craven, 2013). In the cohort stationed in Houston, TX ($n = 2$), social functioning significantly improved in two of the five participants, although overall findings were deemed non-significant. In another cohort stationed in Tyler, TX ($n = 3$), all findings were non-significant for each participant (Craven, 2013). However, participants from Houston met for the first

time during the study and socialized outside of the study, whereas, the Tyler participants knew each other prior to the study, and did not socialize outside of the study (Craven, 2013). Similarly, Romaniuk et al. (2018) used a Couples program (EAT/Psychotherapy) and also found greater long-term results in reducing psychological outcomes; however, as part of their program they also used other approaches including mindfulness and grounding techniques. Although it is not possible to determine if the absence or presence of socialization outside of the study or purposively included as part of the study influenced study findings, it supports the view that additional studies are needed to control for extraneous variables including social variables and other interventions that may bias findings (Craven, 2013).

Quality of life

For the three authors who measured quality of life outcomes (Gómez, 2016; Nevins et al. 2013; Lanning et al. 2017), their upward trending, but non-significant findings differed from Romaniuk et al.'s (2018) statistically significant improvement in quality of life after veterans completed an Individual and Couples comprehensive EAT/Psychotherapy program. These findings are reminiscent of previously mentioned findings for PTSD symptoms, whereas Romaniuk et al.'s (2018) intervention was multi-factorial and included a variety of activities that may have influenced findings.

Biological measures

Main findings were that physiological measures of respiration, blood pressure, heart rate (Malinowski et al., 2018), and salivary cortisol (Burton et al., 2019) were not significantly different for veterans who participated in EAI. Malinowski et al. (2018), however, reported significantly better heart rate on day one of the intervention when compared to the other days. One potential explanation for this finding is that on day one, participants were primarily grooming and petting the horses, whereas, on the other days, participants were actively leading and walking with the horses. This finding is consistent with other findings in the literature that report heart rate is decreased when petting animals (Coakley & Mahoney, 2009; Vormbrock & Grossberg, 1988).

Salivary cortisol concentrations remained unchanged in both study groups over the course of Burton et al.'s (2019) six-week study. The authors postulate salivary cortisol may not have been the most appropriate biomarker for participants with a diagnosis of PTSD (Burton et al., 2019). Atypical cortisol profiles are common in individuals with PTSD (Yehuda et al., 1996; Clow et al., 2010; Boggero et al., 2017; Morris et al., 2012) and findings in the literature are not consistent regarding expected cortisol concentrations in populations with PTSD. Some authors report higher than normal cortisol concentrations (Gotovac et al., 2003; Song, Zhou, & Wang, 2008), some report lower than normal cortisol concentrations (Pierce & Pritchard, 2016; Wahbeh & Oken, 2013), and yet others report no difference between those with PTSD and control groups (Pinna, Johnson, &

Delahanty, 2014). Clearly, the lack of clear evidence between groups supports the need for further research to investigate the potential interaction effects between individual differences in cortisol concentrations, PTSD symptomology (Burton et al., 2018), and behavioral measures following the use of EAI.

Behavioral measures

For the four authors who measured behavioral domains, main findings were that all data trended in the hypothesized direction; however, none of the findings reached statistical significance (Gómez, 2016, Johnson et al., 2018; Lanning et al., 2017; Nevins et al., 2013). In the studies using qualitative methods, participants reported improvement in various behavioral domains (Gómez, 2016; LaFleur, 2015; Lanning et al., 2017). The quantitative findings differ from Steele et al.'s (2018) study that measured the behavioral domain of dissociative experiences and found a statistically significant decrease for veterans who participated in "Warrior Camp." Again, "Warrior Camp" is a multi-activity experience and differed from the studies in this review that only focused on EAI. It is not clear if this difference in intervention design may have influenced overall findings. These inconsistent findings, however, warrant further research to examine the complex issue of behavioral measures and PTSD and control for extraneous variables.

Implications for Future Research

The results in this systematic review clearly highlight the scarcity of studies published on the use of EAI as a treatment option for veterans with PTSD. Since this review only uncovered one RCT, there is a clear need to conduct RCTs, known as the gold standard trial, to evaluate the effectiveness of the interventions. In addition, it is suggested that more qualitative studies be conducted in the veteran population (e.g., veteran and veterans' family) to explore their perspective on equine therapy. Authors of studies synthesized here used many different psychometric instruments to measure the same or similar concepts. For example, resiliency was measured with the RSES (Nevins et al., 2013) and CD-RISC (Burton et al., 2019). Quality of life was measured with the QOLS-16 (Gómez, 2016), SF-36v2 (Lanning et al., 2017), and QLI (Nevins et al., 2013). If a standardized set of psychometric instruments tools were used to measure similar or same concepts, AAI data sets could be combined, and secondary analyses of existing data could provide human-animal interaction researchers a mechanism to answer high impact questions for the veteran community.

Conclusion

The investigation of EAI as an adjunct treatment for PTSD in military veterans may be effective, however, we cannot make a definitive determination based on the current review of evidence. Although findings for symptoms associated with PTSD largely trended in the hypothesized direction, most were not significant (except for PTSD

symptoms). Quantitative findings (largely non-significant) coupled with the qualitative findings (participants perception of decreased symptoms) indicate that additional research is warranted. Well-designed studies in the future may reveal findings substantive enough to support definitive decisions about the efficacy of EAI as an adjunct treatment for veterans with PTSD.

Competing Interests

The authors have no competing interests to declare.

Author Contributions

L. Boss designed the systematic review and wrote most of the manuscript. S. Branson performed the literature search assisted with writing and editing the manuscript. H. Hagan guided the conception for the review and assisted with writing the manuscript. C. Krause-Parello assisted with writing and editing the manuscript.

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