

Systematic Review in Occupational Health Psychology

Animal-assisted interventions and post-traumatic stress disorder of military workers and veterans: A systematic review

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Abstract

Introduction: Animal-Assisted Interventions (AAIs) have been increasingly used in the workplace to mitigate the effect of work-related stress and improve psychological well-being among employees. Military workers returning home from combat and veterans face a high burden of post-traumatic stress disorders (PTSD). This systematic review aimed to investigate the potential benefits of AAIs on military workers and veterans affected by PTSD.

Methods: A systematic review was conducted across Scopus, PubMed Central/Medline, Web of Science, and Google Scholar in December 2021 and June 2022 using predefined search criteria. All types of studies published in the English language were included except editorials, commentaries, and narrative reviews. Studies published from January 2001 to December 2021 were included. We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 reporting guidelines for this systematic review. The assessment of study quality was carried out with a 16-item Quality Assessment Tool for Studies with Diverse Designs (QATSDD)

Results: Overall, 25 studies were finally included in this systematic review. Most of the AAIs were canine-assisted programs (n=12) and therapeutic horseback riding or equine-assisted psychotherapy (n=11). There was only one intervention study utilizing a pinnipeds-based program (n=1), while one study was based on several types of animals (n=1).

Out of 25 studies focusing on the effects of AAIs on PTSD in the military (n=3) and veterans (n=21), the majority of them (n=18) observed significantly lower PTSD symptomatology following AAIs. Three studies observed no statistically significant difference in PTSD symptomatology.

Discussion: Our findings indicated that implementing AAI programs among military workers and veterans may improve their psychological well-being and reduce the severity of PTSD symptoms. Policymakers and occupational health services should consider adopting AAIs during military service and after military discharge to support the mental health of military workers.

Take-home message: This systematic review provides evidence to support the implementation of AAIs as adjunctive therapy to alleviate PTSD symptoms among military workers and veterans.

Keywords: Animal-assisted Interventions; Military veterans; Pets; Occupational health; Workplace.

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INTRODUCTION

Psychosocial hazards (PHs) in the workplace have been identified as one of the key emerging risks in occupational safety and health [1-7]. PHs are defined as "those aspects of work design and the organization and management of work, and their social and environmental context, which may have the potential to cause psychological or physical harm" [8]. Working conditions that may affect the relationship between workers and their working environments encompass a broad spectrum of organizational and environmental factors, ranging from working time (e.g. hours of work, rest periods, and work schedules) to physical and mental (e.g. cognitive and emotional) demands, as well

as remuneration and other organizational issues [9–11]. Moreover, occupational PHs range from work-related stress (WRS) and emotional demands to workplace violence and critical events or incidents [1–7]. Some consequences of occupational stressors include anxiety, depression, and burnout syndrome (BOS) [9–11]. The European Agency for Safety and Health at Work (EU-OSHA) has defined WRS as a “tension experienced when the demands of the work environment exceed the workers’ ability to cope with or control them” [12]. BOS has been recently labeled by the World Health Organization (WHO) as an occupational phenomenon resulting from chronic workplace stress that has not been successfully managed, and is characterized by emotional exhaustion, cynicism, and reduced professional efficacy [13,14].

According to the Diagnostic and Statistical Manual of Mental Disorders - Fifth Edition (DSM-5), trauma-and-stressor-related disorders, adjustment disorders, and post-traumatic stress disorders (PTSD) may be diagnosed as a consequence of exposure to occupational stressors [15]. According to DSM-5 TR, adjustment disorders with mixed disturbances or emotions (anxiety and/or depression) and conduct, as well as post-traumatic stress disorders may result from occupational stressors of different severity and nature [16,17]. Adjustment disorders and especially, PTSD have been associated with critical events and workplace violence, including physical, psychological (bullying, harassment), and sexual violence experienced in the workplace environment. PTSD and BOS are two relevant psychological disorders related to high suicidality and turnover intention rates among healthcare and frontline workers, especially in the context of the current COVID-19 pandemic [18–21].

PTSD was first coded in the *Diagnostic and Statistical Manual of Mental Disorders (DSM)* 3 in 1980, driven in part by sociopolitical aftereffects of the Vietnam War [22]. It is a complex and evolving biological, psychological, and social entity, often described by war and disaster survivors as the result of direct or secondhand exposure to assaults, terror attacks, violence, and accidents. PTSD symptoms can interfere with interpersonal and occupational function and manifest in psychological, emotional, physical, behavioral, and cognitive impairment. Military workers are exposed to an array of potentially and suddenly traumatizing experiences during wartime. Furthermore, they may also experience non-military-related traumatizing experiences, such as interpersonal violence, and physical or sexual abuse [18,19,22].

For this reason, in European Union, OSH laws (Framework Directive 89/391/EEC) require public and private employers of all occupational sectors, including military sectors, to carry out a mandatory and documented risk assessment process for evaluating the likelihood and severity of consequences of all types of occupational PHs. This evaluation was aimed to carry out appropriate preventive measures against all potential PHs [23,24] and is a necessary requisite in the workplace. Undeniably, rehabilitation is complex, and medical and cognitive behavioral therapies are not always effective against psychological disorders [25]. Depression, BOS, and PTSD have been characterized in highly stressful jobs, such as military workers (both veterans and active duty service members), who face challenging demands due to exposure to death and occupational traumas among others. PTSD is particularly prevalent in militaries involved in war scenarios, and this diagnosis in U.S. military workers varies widely from 10% to more than 30% [18,26–28]. In a cross-sectional study, Stern et al. [29] observed that military veterans living with a dog increased their feeling of calmness and decreased loneliness, depression, and worries about their own and the family’s safety.

Accumulating research evidence indicates how the presence of animals can play a positive role in helping people improve their quality of life, and with the implementation of AAIs symptoms related to mental health problems in both youth and adults can be reduced [30–32]. The inclusion of animals in psychological treatment is neither new nor peculiar. The first report dates back to the late 18th century when animals were brought into psychiatric institutions to promote and enhance the socialization of patients [33]. Several studies indicate that animals can act as safe caregivers or primary social supports, providing a sense of purpose that is recognized as a protective factor in existing suicide and mental health research [34,35].

In particular, the use of AAI for the treatment of trauma is increasing. One previous systematic review [36] observed that AAIs provide improvements in several areas among people suffering from symptoms of trauma they have experienced: Acting as social facilitators to connect people and reduce feelings of isolation and loneliness; reducing symptoms of hyperarousal, anger, anxious thoughts, emotional numbing, and depression while improving positive emotions; enabling people to stay in the present; reducing fear of public spaces; and promoting the production of oxytocin [37,38] and the reduction of stress-related biological parameters, such as cortisol, heart rate, and blood pressure [38]. Many of the problems listed are still relevant to military veterans today, which is why the use of AAI has begun [39].

Members of the military have a long tradition of working with animals. They are a source of pride in the form of mascots, have specific tasks that help soldiers, can relieve stress, and increase humility during difficult times, and are now associated with an easier transition to civilian life after service [39,40]. The use of companion animals for military veterans is a relatively new area of research but builds directly on the growing evidence base showing that animals-particularly in the assistance role can positively influence the management of symptoms associated with PTSD and improve overall well-being [41–43].

Military and veterans who work with animals specifically trained to manage PTSD through specific supportive behaviors (e.g. waking someone from a night terror, acting as a sentinel in public, helping to self-regulate anger or grief) report that this complementary treatment leads to greater composure, more positive affect, and reduced feelings of nervous system overexcitement and states of hypervigilance [44]. Chalmers and Dell [45] described AAI for veterans with PTSD as an important source of individual support and complementary treatment to improve veterans' overall well-being. Treatment of PTSD through the implementation of AAI is still in the early stages of empirical research, but existing studies show promising results [39,46–50]. Gillett and Weldrick [46] identify three specific areas of benefit: biomedical, psychological, and social. Examples of direct effects include improved physiological markers, such as decreased anxiety and blood pressure, and increases in oxytocin (the "feel good" hormone) [51]. Indirect effects result from everyday social interactions that can positively impact overall health, for instance, walking the dog to exercise and reducing social isolation or loneliness [52]. O-Haire et al. [36] observed that satisfaction with the quality of life of military veterans returning from a deployment can be improved even though an increased self-efficacy in coping with stressful life events, reduced fear of public spaces, decreased anger, and increased levels of well-being.

Most PTSD treatment is fraught with the stigma associated with a military member seeking treatment for internalized fears or emotional pain. The use of AAI offers a potential treatment

pathway with relatively little stigma and an option being viewed as acceptable by veterans themselves [39]. In addition, the demonstrated reduction in PTSD symptoms, reduction in depression, and increase in overall quality of life are necessary elements of suicide prevention. Given the strong correlation between suicidality and the affective states associated with PTSD [53], animals keep their veterans company and become surrogate caregivers within their family unit. This secure attachment is similar to that between humans and is one of the most important factors in suicide prevention.

A 2016 systematic review on the effects of AAI on trauma supported short-term, subjective benefits of AAI for trauma, including reduced depression, PTSD symptoms, and anxiety. However, effect sizes ranged from small to large, and intervention procedures and research designs varied greatly, evidencing the preliminary nature of research in this area [36]. Therefore, the aim of the current review was to systematically investigate the benefit of pet ownership and animal-assisted support programs among active-duty military workers and veterans affected by PTSD or post-traumatic stress symptoms.

METHODS

Criteria for study inclusion and search strategy

A systematic review was conducted in December 2021 and June 2022 to provide insight into the beneficial effects of pets' presence in an occupational military context. The study protocol for this review was registered at PROSPERO on 13 December 2021 under the following registration number: CRD 298027. We conducted a comprehensive search of the literature in the databases of Scopus, PubMed/Medline, and WOS. The search strategy was based on the combination of the following search terms: "veterans OR military", "pets OR companion animals", "dogs", "canine", "equine", "animal-assisted therapy", "animal-assisted intervention", "animal-assisted activity", AND "delayed stress syndrome", OR "post-traumatic stress", OR "Post-traumatic Stress Disorder" OR "PTSD". References of the identified papers (citation searching) were also assessed for retrieving additional studies.

Study selection

This study was conducted according to the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) 2020 guidelines [54]. As we aimed to identify prevalence data, the search strategy was focused to identify articles with quantitative approaches, excluding qualitative or mixed method research, case reports, narrative or systematic reviews, meta-analyses, study protocols of RCT, letters to the editors, and commentaries. We included all studies that investigated the effect of the presence of animals in the military context: at work, during the military operation, in health recovery centers, where veterans with PTSD were treated for rehabilitation. We included all studies involving the interaction between military workers/soldiers or veterans with PTSD and any type of human-animal interaction (HAI) (i.e., dogs, cats, pinnipeds, horses), for the preventive purpose of reducing occupational stress or alleviating PTSD symptoms and facilitating recovery. All papers that have exclusively studied the impact of HAI on military workers' psychological health, including work-related stress, distress, and burnout, were excluded for the purposes of this review. Also, we considered studies investigating whether owning pets or pets' attachment outside the workplace could help military workers manage PTSD symptoms, regardless of the presence of animals at work as eligible. Studies that adopted physiological markers i.e. salivary cortisol, alpha-

amylase to monitor stress reaction among soldiers, or change in pharmacological treatment as indirect signs of mental health recovery were also included.

Only articles written in English from January 2001 to December 2021 were included. We excluded studies carried out on non-occupational cohorts or those describing AAIs for disabled or chronically ill people. Similarly, we excluded studies that investigated the effect of the intervention with animals on outcomes other than PTSD and those addressing whether human-animal interaction at work may facilitate the execution of challenging tasks outside the workplace. Also, we excluded all articles concerning AAIs or AATs in other categories of workers (healthcare, social, office workers, etc.), and studies examining the presence of animals in the workplace without therapeutic purposes. Finally, studies examining the knowledge or attitudes of workers towards AAIs were excluded.

Two authors (FC and IC) independently screened all records identified as a result of search to identify eligible titles and abstracts. We conducted the full-texts screening to determine their inclusion in this review. In case of disagreements, a third reviewer (DAM) was consulted to build consensus and taking final decisions. Figure 1 shows a flow diagram of the literature search strategy and the review process.

Data collection process

Retrieved data were exported to Microsoft Excel (Microsoft Corporation, 2018). Data were extracted in a standardized form and included elements, such as source (first author and year of publication), study location and design, study population and instrument, type of intervention/exposure, and main findings on PTSD and other psychological effects including depression, quality of life and others, as the secondary outcome (Table 1). The results of the studies were analyzed qualitatively (narrative synthesis) and where possible, also quantitatively for meta-analysis. The findings obtained were discussed by all the authors. An exploratory meta-analysis was performed for intervention studies of veterans experiencing PTSD or PTSD-related symptoms receiving an AAI intervention compared to either AAI waitlist or standard psychotherapeutic care. Most studies included in this systematic review performed within-subjects, longitudinal designs and could not be synthesized through meta-analytic procedures due to the large heterogeneity (and inflated error) between study designs and endpoints. Since limited studies ($n = 4$) were included in the meta-analysis, an explanation of the methods and results of the meta-analysis is detailed in the supplementary materials.

Study quality assessment

The assessment of study quality was carried out with a 16-item Quality Assessment Tool for Studies with Diverse Designs (QATSDD) [55]. This tool has good reliability and validity for use in the quality assessment of diverse studies in a wide variety of health fields including psychology, allied health, medicine, public health, nursing, health services, and social sciences. The QATSDD contains 16 reporting criteria scored on a scale from 0 to 3 (Not at all/Very slightly/Moderately/Complete) [55].

RESULTS

Description of the studies included

The literature search yielded 3,148 published references. After review of the title, abstract and full text, a total of 25 studies met the inclusion criteria and were reviewed (Figure 1). Almost all the included studies were published between 2017 and 2022, except for one published in 2014 [56]. In an

analysis by country, we found that majority of the studies included were carried out in the USA (n=22), except for three studies being conducted in Denmark [60], Australia [72], and Israel [75]. All publications used a quantitative approach, as illustrated in Table 1. The majority of the studies utilized longitudinal designs (n=23) to analyze the effects of AAI (service animals training programs) among military veterans affected by PTSD (n=24) and military dog handlers (n=1). Only two studies [66, 68] were cross-sectional in nature. The quality assessment of this review showed high-quality scores for the majority of the articles being included in this review.

Most of the AAIs were canine-assisted programs (n=12) [48,57,58,60-62,65-68,70,76,78]) and therapeutic horseback riding or equine-assisted psychotherapy (n=11) [56,59,64,71-75,77-79]). Only one study was based on a pinnipeds-based program [69]. One was based on several types of animals [63].

Most of the studies (n= 17) used the Posttraumatic Stress Disorder Checklist (PCL) in its various versions, three used self-reported measures of PTSD and the CAPS tool, two studies the CAPS and SCID-5 in combination, and one study the revised Trauma Symptom Inventory 2 (TSI-2), and one study used the SPRINT Scale or the Mississippi Scale for Combat-related PTSD. Most of the studies (n=18) observed significantly lower PTSD symptomatology after AAI. Three studies observed no statistically significant differences in PTSD symptomology. Four studies investigated the effects of AAI on other positive and negative psychological outcomes like increased perceived stress [57,58], isolation and self-judgment and increased self-compassion [58], resilience [59], and subjective well-being [60].

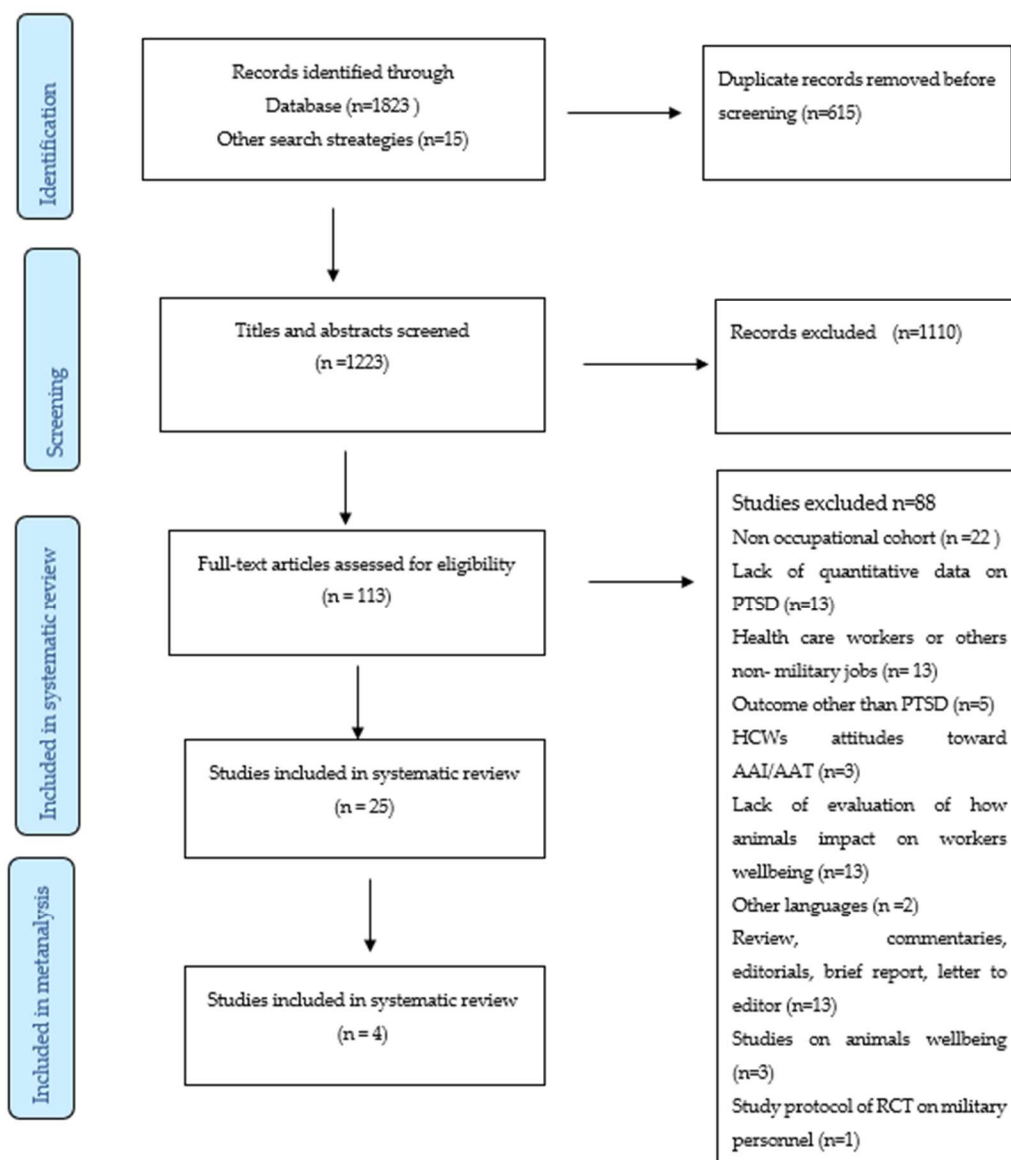


Figure 1. Flowchart detailing selection and screening of the studies included in this review.

Table 1. Studies on the effects of AAIs in military/veterans (*n* =25).

Authors and year	Country	Study design	Study population	Type of AAI	Measures of PTSD	Score	Main findings
Arnon et al, 2020 [71]	USA	Longitudinal (Before-after study)	8 Military Veterans with PTSD	EAT (eight weekly 90-min sessions)	PCL-5, CAPS-5	39	Significant improvement in PTSD symptoms severity(CAPS-5) pre to post treat ($t = 9.58, p < 0.001, d = 1.49$) mid-point to post-treat ($t = 2.70, p = 0.035, d = 0.54$) and pre-treat to follow -up ($t = 3.35, p = 0.020, d = 1.60$) and in pre to post-treat (PCL-5) ($t = 3.80, p = 0.009, d = 1.63$)
Beetz et al, 2019 [57]	USA	Longitudinal (NRCT)	60 Military dog handlers (29 AAI group vs 31 “no dog” group)	DTP (1 week for 4 weeks)	Self-reported questions about trauma confrontation during trauma therapy	39	No significant difference in PTSD symptoms severity, perceived stress, or functional problems with emotions and actions due to the PTSD and therapeutic alliance between the two groups. A weekly questionnaire revealed that AAI increases subjective well-being, in particular happiness.
Bergen-Cico et al, 2018 [58]	USA	Longitudinal (NRCT)	45 Military veterans (31 AAI group vs 14 “no dog” group)	DTP (90-minute weekly for 12-18 months)	PCL-M	39	Veterans participating in the Dogs2Vets owner-trainer program experienced significant reductions in symptoms of post-traumatic stress ($p = 0.01$), perceived stress ($p < 0.001$), isolation, and self-judgment ($p = 0.002$) accompanied by significant increases in

Authors and year	Country	Study design	Study population	Type of AAI	Measures of PTSD	Score	Main findings
Burton et al, 2019 [59]	USA	Longitudinal (NRCT)	21 Military veterans with PTSD: 10 subjects received EAP vs 11 subjects treated with standard care	EAP (1 week for 6 week)	PCL-M	39	self-compassion ($p < 0.001$). PTSD symptom severity was significantly reduced within both groups during the 6-week study period ($p < 0.05$); a significant increase in resilience in the EAP group ($p = 0.0268$)
Duncan et al, 2014 [56]	USA	Longitudinal (Before-after study)	31 Military veterans with PTSD	EAL	Self-reported symptoms of PTSD	35	87.1% of veteran participants reported "very positive perceived benefit" regarding relief from their PTSD symptoms.
Farmer, 2021 [63]	USA	Longitudinal (Before-after study)	20 Military veterans (14 with PTSD, 6 without PTSD)	DTP (1 month for three months)	PCL-5	38	A no statistically significant ($p = 0.11$) reduction in PTSD symptoms pre (mean 51.25 ± 13.79) and post (mean 48.65 ± 14.72) AAI was reported.
Fisher et al, 2021 [73]	USA	Longitudinal (NRCT)	63 Military Veterans with PTSD	EAT (eight weekly 90-min sessions)	PCL-5, CAPS-5 (pretreatment, midpoint, post-treatment, and follow-up)	39	Significant improvement in PTSD symptoms severity, assessed by CAPS-5, pre to post treat ($p < 0.0001$, $d = 1.11$) which persist at 3-month follow-up ($p = 0.88$) and assessed by PCL-5 ($p < 0.0001$, $d = 1.05$)
Galsgaard and Eskelund, 2020 [60]	Denmark	Longitudinal (Before-after study)	4 Military veterans with PTSD	DTP (weekly group sessions)	PCL-C	38	AAI led to a substantial reduction in PTSD symptoms measured in 2 cases. In two cases, similar levels of PTSD symptoms were

Authors and year	Cou ntry	Study design	Study population	Type of AAI	Measures of PTSD	Score	Main findings
Johnson et al, 2018 [64]	USA	Longitudinal (RCT)	29 military veterans with PTSD: AAI group (n=15) vs "no dog" group (n=14)	THR	PCL-M	39	measured before and after the intervention. AAI group reported lower PTSD symptoms after 3 weeks of AAI ($P \leq 0.01$) as well as a clinically significant decrease after 6 weeks ($P \leq 0.01$) than the "no dog" group.
Kloep et al, 2017 [78]	USA	Longitudinal (before-after study)	12 Military veterans with PTSD (1 st cohort n=7 2 nd cohort n=5)	AAT (dogs)	PCL-S	39	Significant improvement in PTSD symptoms severity, pre to post-treat ($p < 0.001$) Results indicated that 100% of the current sample achieved clinically significant change in PTSD symptoms at 6-month follow-up.
Krause-Parrello et al, 2019 [65]	USA	Longitudinal (RCT)	120 military with PTSD: AAI group (n=60) vs "no dog" group (n=60)	DTP	PCL-M	39	AAI group experienced greater decreases in stress, as measured by cortisol than controls ($p < 0.05$). AAI group with higher PTSS had a greater reduction in stress assessed with IgA compared with those in the control group.
Lanning et al, 2017 [77]	USA	Longitudinal (before-after study)	39 Military Veterans with PTSD	THR (8-week)	PCLM, PCL-5	39	Improvement in PTSD symptoms pre-post treatment with PCL-5 ($g = -1.15$ 95%CI: -1.71 to -0.59) and PCL-M ($g = 1.76$, 95%CI: 3.46 to -0.05).
Malinowski et al, 2018 [74]	USA	Longitudinal (NRCT)	7 Military veterans with PTSD	EAAT (five consecutive	PCL-5	39	Significant overall reductions in PTSD symptoms pre to post-

Authors and year	Country	Study design	Study population	Type of AAI	Measures of PTSD	Score	Main findings
				daily sessions)			treatment (p=0.049) and specifically in significant reductions in Cluster E Hyperarousal Symptoms (p=0.037)
Miller et al, 2018 [76]	USA	Longitudinal (before-after study)	31 Military veterans with PTSD	DTP	CAPS-5, SCID (DSM5)	39	Non-significant protection effect given by the presence of canines in reducing nightmares (OR =0.75 95%CI 0.47-1.18 p 0.21)
O'Haire and Rodriguez 2018 [48]	USA	Longitudinal (NRCT)	141 Military veterans with PTSD: usual care plus AAI group (n = 75) vs controls/usual care group (n = 66)	DTP	PCL	39	AAI group reported lower PTSD symptoms during follow up with large effect sizes (after 3 weeks: p < .001, d = -2.11, follow-up: p < .001, d = -1.03), depression (p < 0.001), improvement in quality of life (p < 0.001) and social functioning (p < 0.001) than usual care group.
Rodriguez et al, 2018 [61]	USA	Longitudinal (NRCT)	73 Military veterans with PTSD: AAI group (n=45) vs controls/no dog group (n=28)	DTP	PCL, cortisol salivary measurement	39	AAI group showed a higher cortisol awakening response (AUCi p=0.03; CAR p=0.02) compared to waitlist controls
Rodriguez et al, 2021 [66]	USA	CS	129 Military veterans with PTSD: AAI group (n=67) vs controls/no dog group (n=62)	DTP	PCL-C. Self-reported questions on PTSD medication	39	AAI group reported lower PTSD symptom severity (p < 0.001) and often a change (decreased dose) or discontinuation in psychiatric therapy (p<0.001) since getting

Authors and year	Cou ntry	Study design	Study population	Type of AAI	Measures of PTSD	Score	Main findings
Romaniuk et al, 2018 [72]	Australia	Longitudinal (Before-after study)	25 Military veterans with PTSD	EAT	PCL-5	39	their service dog than the “no dog” group. Significant improvement in PTSD symptoms severity (PCL-5) pre to post treat ($t = 3.92, p < 0.017, d = 0.88$) and post-treat to follow -up ($t = -3.49, p = 0.017, d = -1.16$)
Scotland-Coogan et al, 2020 [68]	USA	CS	71 Military veterans with PTSD	DTP	Self-reported questionnaire PTSD symptoms	39	AAI led to a reduction in self-disturbance, PTSD, externalization, and somatization and improved interpersonal difficulties and suicidal ideation.
Shelef et al, 2019 [75]	Israel	Longitudinal (NRCT)	13 Military with PTSD	EAT (weekly 180-min sessions for 6 months)	SPRINT scale	39	Significant overall reductions in PTSD symptoms pre to post-treatment ($d = -2.85 \pm 4.14, p < 0.05$)
Steele et al, 2018 [79]	USA	Longitudinal (before-after study)	85 Military Veterans with PTSD	EAP	Mississippi Scale for Combat-related PTSD	38	Significant improvement in PTSD symptoms severity, pre to post treat ($p < 0.001, d = -0.70$)
Whitworth et al, 2019 [67]	USA	Longitudinal (NRCT)	45 Military veterans with PTSD: AAI group (n=15) vs controls/no dog group (n=30)	DTP	TSI-2	39	AAI group reported lower self-disturbance ($p < 0.05$), post-traumatic stress symptoms ($p < 0.05$), and externalization ($p < 0.05$), depression ($p < 0.05$) and anger ($p < 0.05$) than “no dog” group.
Woodward et al, 2021 [62]	USA	Longitudinal (Before-after study)	54 Military veterans with PTSD	DTP	SCID-5, CAPS-5, PANAS	39	Veterans reported lower PTSD severity (effect = -0.32, CI (99.3%) = -0.40 to -0.23)

Authors and year	Cou ntry	Study design	Study population	Type of AAI	Measures of PTSD	Score	Main findings
Wortman et al, 2018 [69]	USA	Longitudinal (Before-after study)	3 Military veterans with PTSD	PTP	PCL-5	38	Veterans reported lower PTSD symptoms and clinical improvement after AAI.
Yarborough et al, 2017 [70]	USA	Longitudinal (NRCT)	78 Military Veterans with PTSD; Intervention group AAI (n=24) vs waitlist group (n=54)	DTP	PCL-M	38	Longitudinal assessment compared mental health and functioning within individuals in the AAI group indicated significant improvement in VR-12 mental component summary (p=0.008), BASIS depression/functioning Subscale (p=0.013), BASIS emotional lability subscale (p=0.003), PTSD Checklist (p=0.001), activity level (p=0.004), happiness Score (p=0.01) and quality of life score (p=0.001)

Notes: AUCi, Area under the curve with respect to increase; CAPS-5, Clinician-Administered PTSD Scale-5; CAR, Cortisol awakening response in µg/dL; EAL, equine-assisted learning program; EAP, equine-assisted psychotherapy; EAT, equine-assisted therapy; EATT, Equine-Assisted Activities, and Therapies; DTP, dog training program PCL-C, Posttraumatic Symptom Checklist, Civilian version; PCL-M, PTSD Checklist Military Version; PCL-5, Posttraumatic Checklist 5; RCT, randomized clinical trial; SCID-5, Structured Clinical Interview for DSM-5; TSI, 136-item Trauma Symptom Inventory-2; THR, therapeutic horseback riding; PTP, pinnipeds therapy program, NRCT, Non-randomized Clinical trial (Quasi-experimental study); CS, Cross-sectional study. SPRINT, Short Post Traumatic Stress Disorder Rating Interview

Effects of AAI with dogs in military workers and veterans

Most of the studies in our review pointed to the helpful effects of service dogs as a complementary treatment for PTSD in military workers and veterans. However, in our meta-analysis findings, we did observe a non-significant reduction in PTSD symptoms for veterans engaged in AAI programs compared to waitlist controls or standard psychotherapeutic care. The dog-assisted programs were offered in two different forms, including training and playing activities (sessions included walking, different play and grooming activities with dogs and just relaxing together toward the end) [57] and were performed with the aid of both dog-owning participants or dogs specifically trained for these tasks.

O’Haire and Rodriguez [48] demonstrated lower levels of depression and improvement in quality of life and social functioning in the treatment group. Galsgaard and Eskelund [59] observed a reduction in depression and distress symptoms and increased ability to control daily life problems, such as disturbed sleep, social isolation, physical inactivity, lack of emotional regulation and increased quality of life. Rodriguez et al. [61] found that AAI group reported lower anxiety ($p < 0.001$), anger ($p < 0.01$), sleep disturbances ($p < 0.01$), and alcohol abuse ($p < 0.05$) than the “no dog” group. Woodward et al. [62] showed a reduction in negative affect and an increase in positive affect. In two studies, participating in a service dog training program was, therefore, proven to be effective in ameliorating psychiatric symptomatology (self-disturbance, posttraumatic stress, externalization, somatization, lack of emotional regulation), depression, social isolation, and quality of life of veterans suffering from PTSD [60,68]. In another study, in contrast to a group of veterans receiving usual care, the dogs’ group resulted in lower PTSD symptoms after receiving a service dog ($p < 0.001$), as well as in the higher quality of life ($p < 0.001$), less depression ($p < 0.001$) and better social functioning ($p < 0.001$) [48]. Comparing military veterans with PTSD, who completed service dog programs and veterans on a waitlist, Whitworth et al. (2019) [67] observed that the former group experienced a significant decrease in a broad scope of psychological symptoms associated with PTSD posttraumatic symptomatology, in persistent intra/interpersonal difficulties associated with psychological trauma, and in disabilities secondary to their PTSD. Similarly, the study of Krause Parello (2019) [65] supported AAI as a stress-reducing modality in aeromedical evacuation military patients, assessed by physiological biomarkers (cortisol, IgA, alpha amylase), particularly among those who reported higher post-traumatic stress symptoms severity (PTSSS).

In the study by Yarborough et al. [70], a service dog led to a significant improvement in PTSD symptoms severity, psychological well-being, and social functioning. Interestingly, participants indicated specific behavioral tasks performed by the dogs that help them to control PTSD symptoms. These tasks include preventing panic, waking veterans from nightmares, alerting veterans when strangers are in the house, putting space between veterans and strangers, alerting veterans that someone is approaching, and licking or nudging veterans to help them “stay in the present” when they are experiencing distressing memories or flashbacks.

Service dogs reduced hypervigilance by alerting, creating boundaries, and disrupting nightmares, improving sleep quality and duration. Dogs also helped veterans turn their attention away from invasive trauma-related thoughts, improved their emotional connections with others, increased their community participation and physical activity, and reduced suicidal impulses and medication use. Living with a dog had a positive effect on anger, anxiety, sleep disturbance, and alcohol abuse [61]. In the study by Withworth et al. [67], the AAI group reported lower self-disturbance ($p < 0.05$), posttraumatic stress ($p < 0.05$), and externalization ($p < 0.05$), depression ($p < 0.05$) and anger ($p < 0.05$) than veterans from group without treatment. In the study by Rodriguez et al. [66], the AAI group reported lower PTSD symptom severity ($p < 0.001$) and often a change or discontinuation in psychiatric therapy ($p < 0.001$) since getting their service dog than the “no dog” group. Conversely, no significant advantage of the dog-assisted intervention regarding PTSD symptom severity, perceived stress, and functional problems with emotions and actions due to the PTSD was observed in the dogs group in comparison with the control group who received standard

treatment in the studies conducted by Beetz et al. [57] and Farmer [63]. However, it was found in the AAI group an improvement in work and social adjustment [57].

Finally, Woodward et al. [62] observed that engagement with a service dog was associated with significant reductions in negative affect and an increase in positive affect ($p < 0.001$) in a group of 54 military veterans with PTSD.

Effects of AAI with equine and other animals in military workers and veterans

Regarding equine-assisted interventions (EAI), studies obtained mixed results. In contrast to a group of veterans receiving usual care, veterans who have been engaged or involved in therapeutic horseback riding (THR) showed a significant reduction in PTSD score after 3 weeks of THR ($p \leq 0.01$), which was associated with a clinical improvement of PTSD syndrome after 6 weeks of THR ($p \leq 0.01$) [64]. On the contrary, participating in a 6-week EAP program did not produce a statistically significant difference with respect to PTSD symptomatology and perceived stress level, when measured by salivary cortisol level [59]. A single study focused on pinniped HAI program for veterans identified as having PTSD-like symptoms.

Arnon et al. [71] studied the effect of EAT (equine-assisted therapy) on a group of 8 veterans with PTSD diagnosis. They reported that group EAT for veterans with PTSD appeared safe, satisfying, and well-attended; veterans experienced marked clinical improvement in PTSD symptoms severity in the short term although short-term improvements seemed to be transient as they early declined, with worsening symptoms for four of six patients assessed at 3-month follow-up. A subsequent open trial conducted on a relatively large sample of military veterans with clinician-rated and self-report outcome measures of PTSD confirmed the evidence that EAT intervention for PTSD produces clinical benefits by reducing PTSD symptoms severity and in some cases leading to a reduction below the cut-off score for PTSD diagnosis in CAPS-5 questionnaire. This clinical improvement largely persisted for three months following treatment. The pilot study of Duncan et al. [56] on EAT carried out on 31 veterans diagnosed with PTSD utilized a self-report measure developed by the researchers, which included the sub-scales relieving symptoms of PTSD subscale to assess change in PTSD symptoms severity. The study found that 87.1% of veteran participants reported "very positive perceived benefit" regarding relief from their PTSD symptoms. Similarly, Romaniuk et al. [72] observed a "clinically significant change" in terms of PTSD symptoms from pre-EAT intervention to post-EAT intervention in a group of 25 Australian military veterans, although this improvement was not maintained at follow-up. Military veterans engaged in EAAT program for five days reported a significant decrease in all symptoms clusters of PTSD and noteworthy cluster and hyperarousal symptoms were significantly reduced [74].

Shelef et al. [75] also reported a significant decrease in PTSD symptoms in Israeli soldiers with PTSD after six months EAT program; particularly the higher statistically significant improvement was recorded in functioning domains of the SPRINT scale such as the ability to work and perform daily tasks. Lanning et al. [77] recruited 39 combat veterans who completed an 8-week study of THR and reported on improvement in PTSD symptoms, social functioning, and reduced interference of emotions in daily activities. In the study of Steele et al. [79], military veterans with PTSD experienced statistically significant and substantive improvement in PTSD symptomatology after participating in an equine-assisted psychotherapy program.

DISCUSSION

This systematic review aimed to examine the effects of AAI on the psychological well-being of military workers and veterans. The studies included in this work demonstrated the relevant role of AAI, such as rehabilitation programs to support military workers and veterans affected by PTSD symptoms. We found 25 studies [48,56–61,63–79] that examined whether AAIs can help military service workers and veterans cope with psychiatric symptoms, including PTSD symptoms, and improve their social and occupational functioning. The AAIs were also able to help build positive relationships with veterans that help them cope with military-associated trauma reactions. Providing service dog programs for these veterans has been one of the most successful methods of coping with their psychiatric difficulties. In the United States, where most of the studies were conducted, a service dog is defined under the federal Americans with Disabilities Act (ADA) as “any dog that is individually trained to do work or perform tasks for the benefit of an individual with a disability, including a physical, sensory, psychiatric, intellectual or other mental disability” [80]. The work a dog performs must be directly related to the person's disability. There are rehabilitation strategies, including canine-assisted therapies and rehabilitation activities that use dogs as an adjunct to therapy. Examples include guiding the blind, pulling a wheelchair, alerting a person who is hard of hearing, protecting a person experiencing a seizure, and calming a person with PTSD during an anxiety attack or psychiatric episode [81,82].

Canine-assisted therapies and activities have been practiced in rehabilitation facilities for some time [81,82]. This review shows that service dogs and horses can be useful support for veterans with PTSD. The animals can be individually trained to perform work or tasks that help a person with a mental disability. In addition, pet ownership may be a protective factor against self-harm thoughts in veteran groups [83]. Mental illnesses, especially those following polytraumatic events such as PTSD, are challenging to treat, so they may benefit from complementary therapeutic approaches that include AAIs [84]. There is limited literature on the positive effects of dogs and horses before and during the onset of traumatic events in veterans. However, our study shows that AAI could integrate traditional therapies such as prolonged exposure therapy (PE), cognitive processing therapy (CPT), eye movement desensitization, and reprocessing (EMDR) in combination with psychopharmacological medications in veterans with PTSD [67,85].

The U.S. Army Medical Department also published some very limited data suggesting that AAT may benefit wounded warriors participating in a life skills program and supports the need for further research in the area of AAT as adjunctive therapy for veterans with PTSD and other traumatic injuries, including traumatic brain injury [86,87]. Several hypotheses could explain the benefits of AAI in the psychological rehabilitation of veterans with mental health problems. Owen et al. [88] described canine-assisted therapy as a useful complementary or alternative medical treatment for veterans with PTSD based on a biopsychosocial concept. Yount et al. [89] argued that interactions with dogs may increase oxytocin levels via neurobiological mechanisms that improve mental health in veterans. Another possible mechanism by which dogs may have a positive impact on the mental health of soldiers is by altering the human microbiome. This can be accomplished either through direct interactions between the dog and the caregiver or through indirect effects, such as the dog's contribution to the microbiome of the built environment [90]. Nearly 20 percent of military workers returning from Iraq and Afghanistan—a total of 300,000—report symptoms of post-traumatic stress

disorder or major depression, yet only slightly more than half have sought treatment (cRANDit.) [91]. Current treatment standards (e.g., exposure therapy, cognitive therapy) are limited due to their availability, accessibility, and outcomes (e.g., retention, premature discontinuation, resistance, nonresponse). In addition, inadequate staffing and training of mental health professionals exacerbate pre-existing problems and challenges the quality of care provided to military workers. These problems have led to the need to develop and refine alternative and complementary approaches to provide more options and services to the military population. One such new approach is AAI as a treatment option for veterans and returning military workers. It is important to note that despite the positive research findings, AAI should be considered also from the animals' well-being perspective [92]. For example, some veterans have service-connected or otherwise acquired physical disabilities, health problems such as allergies, or other safety issues such as fear of animals that may prevent them from benefiting from this approach [93]. As with any type of treatment approach, veterans and military workers must be fully informed about the potential risks and benefits of this intervention. They should also be informed that although this form of treatment is becoming better evidenced, it is not yet as established as other treatment modalities. Based on the current results, it appears that veterans benefited from AAI and received an alternative treatment option, especially for those who did not respond well to conventional treatments. The effects of AAI could be further explored to better understand the unique characteristics, applications, and potential benefits of this intervention for this specific population. Mental health professionals can collaborate with organizations that provide AAI as a treatment for returning veterans and military workers struggling with war stress injuries to improve the overall quality of life. Continued development of standardized curricula, therapeutic practices, evaluation measures, and guidelines will lead to a synthesis of the best available evidence that will enable researchers, stakeholders, providers, and consumers to fund, integrate, and recommend AAI for PTSD treatment.

This systematic review has some limitations. Many studies had small sample sizes in both intervention and control groups and short duration of therapy sessions. Another limitation in the quasi-experimental studies was the lack of a randomization schedule. Finally, causality and directionality cannot be determined in the cross-sectional studies. Other limitations included the diversity of interventions included (duration, interactions with animals, etc.), the diversity of samples within studies (e.g., wide age range, differences in trauma, diagnosis/symptom presentation, comorbidity), and the personnel who delivered the interventions.

However, our review has some strengths in that it adds to the body of knowledge about the positive and negative aspects of animal presence in the workplace. This knowledge could be considered by military organizations that intend to implement voluntary workplace health promotion programs during service and after retirement based on pet-friendly policies. In addition, some before-after studies reported that participants were used as their own control subjects to avoid bias due to non-random assignment.

As indicated in our literature review, the psychological burden of PTSD in the U.S. military is high, and social support from civilians and the home environment may play a greater protective role in the long-term severity of PTSD symptoms [92,93]. Although practicing yoga and other spiritual or mindfulness practices in the workplace may improve cognitive functioning (response inhibition) related to PTSD symptoms, as well as other mental health outcomes, sleep hygiene and quality of life

[94–97], and biological stress response in veterans diagnosed with PTSD [98], AAI may be beneficial in military members affected by PTSD. Pets are a spiritual and physical resource [99], and severe psychological trauma can lead to loss of faith and struggles in the spiritual realm, resulting in increased suicide risk [100–104]. Therefore, further research on the psychological effects of AAI associated with mindfulness and spiritual activities in occupational health services could be planned to provide early diagnosis and treatment of PTSD symptoms in both military veterans and active duty service members.

CONCLUSION

In conclusion, this review showed that AAI in the workplace, especially in dogs, may positively impact on mental well-being of military workers and promote the recovery of veterans affected by PTSD. Therefore, service dog programs can be helpful as complementary or alternative treatment options for some veterans. However, AAI programs need to be investigated to better characterize and understand the benefits and limitations of their inclusion in military workers and veteran rehabilitation. Longitudinal studies in the context of mandatory occupational health surveillance programs could be the ideal setting to understand better the effectiveness of these dog service programs on the mental well-being of military workers. Finally, future studies should also investigate the possible negative effects of pet ownership in the workplace and the possible implications for co-workers and employers.

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References

1. Chirico F. The assessment of psychosocial risk: only “work-related stress” or something else? *Med Lav*. 2015;106:65–66.
2. Chirico F. The forgotten realm of the new and emerging psychosocial risk factors. *J Occup Health*. 2017;59(5):433–435. Doi: 10.1539/joh.17-0111-OP.
3. Magnavita N, Chirico F. New and Emerging Risk Factors in Occupational Health. *Int J Env Res Public Health*. 2020;10:8906.
4. Chirico F, Heponiemi T, Pavlova M, Zaffina S, Magnavita N. Psychosocial Risk Prevention in a Global Occupational Health Perspective. A Descriptive Analysis. *Int J Environ Res Public Health*. 2019;16(14):2470. Published 2019 Jul 11. Doi:10.3390/ijerph16142470.
5. Chirico F, Crescenzo P, Sacco A, Riccò M, Ripa S, Nucera G, et al. Prevalence of burnout syndrome among Italian volunteers of the Red Cross: a cross-sectional study. *Ind Health*. 2021;59:117–127.
6. Chirico F, Mazzarella D, Menchinelli C, Giannandrea F, D'Auria F. Indagine sulle cause di discomfort

- psicologico in un call-center. *G Ital Med Lav Erg.* 2004;26(4):192–193 Suppl.
7. Chirico F, Magnavita N. Burnout Syndrome and Meta-Analyses: Need for Evidence-Based Research in Occupational Health. Comments on Prevalence of Burnout in Medical and Surgical Residents: A Meta-Analysis. *Int J Env Res Public Health.* 2020;17:741.
 8. Cox T, Griffiths A, Rial-Gonzalez E. Work-related stress. Office for Official Publications of the European Communities, Luxembourg; 2000.
 9. Furuichi W, Shimura A, Miyama H, Seki T, Ono K, Masuya J, et al. Effects of job stressors, stress response, and sleep disturbance on presenteeism in office workers. *Neuropsychiatr Dis Treat.* 2020;16:1827–1833.
 10. Chirico F, Taino G, Magnavita N, Giorgi I, Ferrari G, Mongiovì MC, et al. Proposal of a method for assessing the risk of burnout in teachers: the VA.RL.B.O strategy. *G Ital Med Lav Erg.* 2019;41(3):221–235.
 11. Chirico F, Capitanelli I, Bollo M, Ferrari G, Maran DA. Association between workplace violence and burnout syndrome among schoolteachers: A systematic review. *J Health Soc Sci.* 2021;6:187–208.
 12. Eu-OSHA. Expert Forecast on Emerging Psychosocial Risks Related to Occupational Safety and Health [cited 2022 August 18]. Available from: <http://osha.europa.eu/en/publications/reports/7807118>.
 13. WHO. Burn-out an "occupational phenomenon": International Classification of Diseases. Available from <https://www.who.int/news/item/28-05-2019-burn-out-an-occupational-phenomenon-international-classification-of-diseases>.
 14. Chirico F. Is burnout a syndrome or an occupational disease? Instructions for occupational physicians. *Epidemiol Prev.* 2017 Sep;41(5-6):294–298. Doi: 10.19191/EP17.5-6.P294.089.
 15. Chirico F. Adjustment Disorder as an Occupational Disease: Our Experience in Italy. *Int J Occup Environ Med.* 2016 Jan;7(1):52–57.
 16. American Psychiatric Association. Desk Reference to the Diagnostic Criteria from DSM-5. 5th ed. Arlington: American Psychiatric Publishing; 2013.
 17. Regier DA, Kuhl EA, Kupfer DJ. The DSM-5: Classification and criteria changes. *World Psychiatry.* 2013 Jun;12(2):92–98. Doi: 10.1002/wps.20050.
 18. Inoue C, Shawler E, Jordan CH, Jackson CA. Veteran and Military Mental Health Issues. 2021 May 24. Treasure Island (FL): StatPearls Publishing; 2022.
 19. Magnavita N, Di Stasio E, Capitanelli I, Lops EA, Chirico F, Garbarino S. Sleep Problems and Workplace Violence: A Systematic Review and Meta-Analysis. *Front Neurosci.* 2019;13:997. Published 2019 Oct 1. Doi:10.3389/fnins.2019.00997.
 20. Magnavita N, Heponiemi T, Chirico F. Workplace Violence Is Associated With Impaired Work Functioning in Nurses: An Italian Cross-Sectional Study. *J Nurs Scholarsh.* 2020;52(3):281–291. Doi:10.1111/jnu.12549.
 21. Chirico F, Nucera G, Szarpak L, Zaffina S. The cooperation between occupational and public health stakeholders has a decisive role in the battle against the COVID-19 pandemic. *Disaster Med Public Health Prep.* 2021;1–4. Doi. 10.1017/dmp.2021.375.
 22. Kucmin T, Kucmin A, Nogalski A, Sojczuk S, Jójczuk M. History of trauma and posttraumatic disorders in literature. *Psychiatr Pol.* 2016;50(1):269–281. Doi: 10.12740/PP/43039.
 23. Chirico F, Magnavita N. The significant role of health surveillance in the occupational heat stress assessment. *Int J Biometerol.* 2019;63(2):193–194. <https://doi.org/10.1007/s00484-018-1651>.

24. Chirico F, Taino G. Se necesita una evaluación adecuada del riesgo de SARS-CoV-2 para la evaluación médico-legal de la infección por COVID-19 [A proper SARS-CoV-2 risk assessment is needed for medico-legal assessment of the COVID-19 infection]. *Spanish J Legal Med.* 2021;47(3):130–131. Doi: <https://doi.org/10.1016/j.reml.2021.01.004>.
25. Höhl W, Moll S, Pfeiffer A. Occupational therapy interventions in the treatment of people with severe mental illness. *Curr Opin Psychiatry.* 2017 Jul;30(4):300–305. Doi: 10.1097/YCO.0000000000000339.
26. Hao Q, Wang D, Xie M, Tang Y, Dou Y, Zhu L, et al. Prevalence and risk factors of mental health problems among healthcare workers during the covid-19 pandemic: a systematic review and meta-analysis. *Front Psychiatry.* 2021;12:567381.
27. Dohrenwend BP, Turner JB, Turse NA, Adams BG, Koenen KC, Marshall R. The psychological risks of Vietnam for U.S. veterans: a revisit with new data and methods. *Science.* 2006 Aug 18;313(5789):979–982. Doi: 10.1126/science.1128944.
28. Fulton JJ, Calhoun PS, Wagner HR, Schry AR, Hair LP, Feeling N, et al. The prevalence of posttraumatic stress disorder in Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) veterans: A meta-analysis *J Anxiety Disord.* 2015;31:98–107.
29. Stern SL, Donahue DA, Allison S, Hatch JP, Lancaster CL, Benson TA, et al. Potential benefits of canine companionship for military veterans with posttraumatic stress disorder (PTSD). *Soc Anim.* 2013;21:14. Doi: 10.1163/15685306-12341286.
30. Linder DE, Siebens HC, Mueller MK, Gibbs DM, Freeman LM. Animal-assisted interventions: A national survey of health and safety policies in hospitals, eldercare facilities, and therapy animal organizations. *Am J Infect Control.* 2017;45(8):883–887. Doi: 10.1016/j.ajic.2017.04.287.
31. Peacock J, Chur-Hansen A, Winefield H. Mental health implications of human attachment to companion animals. *J Clin Psychol.* 2012 Mar;68(3):292–303. Doi: 10.1002/jclp.20866. Epub 2012 Feb 3.
32. Hosey G, Melfi V. Are we ignoring neutral and negative human-animal relationships in zoos? *Zoo Biol.* 2015 Jan-Feb;34(1):1–8. Doi: 10.1002/zoo.21182. Epub 2014 Oct 18.
33. Kruger KA, Serpell JA. Animal-assisted interventions in mental health: Definitions and theoretical foundations. Teoksessa AH Fine (toim.) *Handbook on animal-assisted therapy: Theoretical foundations and guidelines for practice.* Academic Press. New York; 2006, pp.21-38.
34. Douglas VJ, Kwan MY, Gordon KH. Pet Attachment and the Interpersonal Theory of Suicide. *Crisis.* 2021 Aug 31. Doi: 10.1027/0227-5910/a000822.
35. Muela A, Balluerka N, Sansinenea E, Machimbarrena JM, García-Ormaza J, Ibarretxe N, et al. A social-emotional learning program for suicide prevention through animal-assisted intervention. *Animals.* 2021 Nov 25;11(12):3375.
36. O'haire ME, Guérin NA, Kirkham AC. Animal-assisted intervention for trauma: A systematic literature review. *Front Psychol.* 2015:1121.
37. Beetz A, Uvnäs-Moberg K, Julius H, Kotrschal K. Psychosocial and psychophysiological effects of human-animal interactions: the possible role of oxytocin. *Front Psychol.* 2012;3:234.
38. d'Angelo D, d'Ingeo S, Ciani F, Visone M, Sacchettino L, Avallone L, et al. Cortisol levels of shelter dogs in animal assisted interventions in a prison: an exploratory study. *Animals.* 2021;11:345.
39. Taylor MF, Edwards ME, Pooley JA. "Nudging them back to reality": toward a growing public acceptance of the role dogs fulfill in ameliorating contemporary veterans' PTSD symptoms. *Anthrozoös.* 2013 Dec 1;26(4):593–611.

40. Chumley PR. Historical perspectives of the human-animal bond within the Department of Defense. *US Army Med Dep J*. 2012 Apr 1:18–21.
41. Huddy L, Feldman S. Americans respond politically to 9/11: understanding the impact of the terrorist attacks and their aftermath. *Am Psychol*. 2011 Sep;66(6):455.
42. Rossetti J, King C. Use of animal-assisted therapy with psychiatric patients: A literature review. *J Psychosoc Nurs Ment Health Serv*. 2010 Nov 1;48(11):44–48.
43. Berget B, Ihlebæk C. Animal-assisted interventions: effects on human mental health—a theoretical framework. *Psychiatric Disorders-Worldwide Advances*. 2011 Oct 5:121–138.
44. Rodriguez KE, LaFollette MR, Hediger K, Ogata N, O’Haire ME. Defining the PTSD service dog intervention: perceived importance, usage, and symptom specificity of psychiatric service dogs for military veterans. *Front Psychol*. 2020:1638.
45. Chalmers D, Dell CA. Applying one health to the study of animal-assisted interventions. *Ecohealth*. 2015 Dec;12(4):560–562.
46. Gillett J, Weldrick R. Effectiveness of psychiatric service dogs in the treatment of post-traumatic stress disorder among veterans. Hamilton, ON: McMaster University; 2014.
47. Husband A, Ahmed A, Dell CA. An exploratory case study of the impact of psychiatric service dogs on problematic substance use among PTSD-diagnosed veterans. *J Subst Use*. 2020 Mar 3;25(2):113–117.
48. O’Haire ME, Rodriguez KE. Preliminary efficacy of service dogs as a complementary treatment for posttraumatic stress disorder in military members and veterans *J Consult Clin Psychol*. 2018;86:179.
49. Stumbo SP, Yarborough BJH. Preliminary evidence is promising, but challenges remain in providing service dogs to veterans: Commentary on preliminary efficacy of service dogs as a complementary treatment for posttraumatic stress disorder in military members and veterans (O’Haire & Rodriguez, 2018). *J Consult Clin Psychol*. 2019 Jan;87(1):118–121. Doi: 10.1037/ccp0000352.
50. Yount RA, Olmert MD, Lee MR. Service dog training program for treatment of posttraumatic stress in service members. *US Army Med Dep J*. 2012 Apr-Jun:63–69.
51. Nepps P, Stewart CN, Bruckno SR. Animal-assisted activity: Effects of a complementary intervention program on psychological and physiological variables. *J Evid Based Complementary Altern Med*. 2014 Jul;19(3):211–215.
52. Zilcha-Mano S, Mikulincer M, Shaver PR. An attachment perspective on human–pet relationships: Conceptualization and assessment of pet attachment orientations. *J Res Pers*. 2011 Aug 1;45(4):345–357.
53. Smith NB, Mota N, Tsai J, Monteith L, Harpaz-Rotem I, Southwick SM, Pietrzak RH. Nature and determinants of suicidal ideation among U.S. veterans: Results from the national health and resilience in veterans study. *J Affect Disord*. 2016;197:66–73. <https://doi.org/10.1016/j.jad.2016.02.069>.
54. Tricco AC, Lillie E, Zarin W, O’Brien KK, Colquhoun H, Levac D, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med* 2018;169:467–473.
55. Harrison R, Jones B, Gardner P, Lawton R. Quality assessment with diverse studies (QuADS): an appraisal tool for methodological and reporting quality in systematic reviews of mixed-or multi-method studies. *BMC Health Serv Res*. 2021 Dec;21(1):1–20.
56. Duncan R, Critchley S, Marland J. Can Praxis: A model of equine assisted Learning (EAL) for PTSD. *CMJ*. 2014; 14(2):64–69.

57. Beetz A, Schöfmann I, Girgensohn R, Braas R, Ernst C. Positive Effects of a Short-Term Dog-Assisted Intervention for Soldiers With Post-traumatic Stress Disorder-A Pilot Study. *Front Vet Sci*. 2019 Jun 7;6:170. Doi: 10.3389/fvets.2019.00170.
58. Bergen-Cico D, Smith Y, Wolford K, Gooley C, Hannon K, Woodruff R, et al. Dog ownership and training reduces post-traumatic stress symptoms and increases self-compassion among veterans: Results of a longitudinal control study. *J Altern Complement Med*. 2018 Dec 1;24(12):1166–1175.
59. Burton LE, Qeadan F, Burge MR. Efficacy of equine-assisted psychotherapy in veterans with posttraumatic stress disorder. *J Integr Med*. 2019;17:14–19.
60. Galsgaard A, Eskelund K. An explorative clinical pilot study into the effect of service dogs on chronic posttraumatic stress disorder. *Traumatology*. 2020;26:361–369.
61. Rodriguez KE, Bryce CI, Granger DA, O'Haire ME. The effect of a service dog on salivary cortisol awakening response in a military population with posttraumatic stress disorder (PTSD). *Psychoneuroendocrinology*. 2018 Dec;98:202–210. Doi: 10.1016/j.psyneuen.2018.04.026.
62. Woodward SH, Jamison AL, Gala S, Lawlor C, Villasenor D, Tamayo G, et al. Tracking positive and negative affect in PTSD inpatients during a service dog intervention. *J Consult Clin Psychol*. 2021 Jun;89(6):551.
63. Farmer SM. Integrating Animal-Assisted Interventions in United States Veterans With Self-Reported Posttraumatic Stress Disorder. *J Nurse Pract*. 2021;17:619–622.
64. Johnson RA, Albright DL, Marzolf JR, Bibbo JL, Yaglom HD, Crowder SM, et al. Effects of therapeutic horseback riding on post-traumatic stress disorder in military veterans. *Mil Med Res*. 2018;5:1-3.
65. Krause-Parello CA, Friedmann E, Wilson C, Hatzfeld JJ, Kolassa J, Hackney A, et al. Relation of post-traumatic stress disorder symptom severity to the efficacy of an animal-assisted intervention for stress reduction after military aeromedical evacuation. *Stress Health*. 2019 Oct;35(4):480–490.
66. Rodriguez KE, Anderson LM, Ott CA, O'Haire ME. The Effect of a PTSD Service Dog on Military Veterans' Medication Regimens: A Cross-Sectional Pilot Study. *Anthrozoös*. 2021;34:393–406.
67. Whitworth JD, Scotland-Coogan D, Wharton T. Service dog training programs for veterans with PTSD: results of a pilot controlled study. *Soc Work Health Care*. 2019;5:412–430.
68. Scotland-Coogan D, Whitworth JD, Wharton T. Outcomes of participation in a service dog training program for veterans with PTSD. *Soc Anim*. 2020;1:1–22.
69. Wortman RA, Vallone T, Karnes M, Walawander C, Daly D, Fox-Garrity B. Pinnipeds and PTSD: An Analysis of a Human-Animal Interaction Case Study Program for a Veteran. *Occup Ther Int*. 2018 Jun 13;2018:2686728. Doi: 10.1155/2018/2686728.
70. Yarborough BJ, Owen-Smith AA, Stumbo SP, Yarborough MT, Perrin NA, Green CA. An observational study of service dogs for veterans with posttraumatic stress disorder. *Psychiatr Serv*. 2017 Jul 1;68(7):730–734.
71. Arnon S, Fisher PW, Pickover A, Lowell A, Turner JB, Hilburn A, et al. Equine-assisted therapy for veterans with PTSD: Manual development and preliminary findings. *Mil Med*. 2020 May;185(5-6):e557–564.
72. Romaniuk M, Evans J, Kidd C. Evaluation of an equine-assisted therapy program for veterans who identify as 'wounded, injured or ill' and their partners. *PLoS One*. 2018;13(9):e0203943. <https://doi.org/10.1371/journal.pone.0203943>.
73. Fisher PW, Lazarov A, Lowell A, Arnon S, Turner JB, Bergman M, et al. Equine-Assisted Therapy for

- Posttraumatic Stress Disorder Among Military Veterans: An Open Trial. *J Clin Psychiatry*. 2021 Aug 31;82(5):36449.
74. Malinowski K, Yee C, Tevlin JM, Birks EK, Durando MM, Pournajafi-Nazarloo H, et al. The Effects of Equine Assisted Therapy on Plasma Cortisol and Oxytocin Concentrations and Heart Rate Variability in Horses and Measures of Symptoms of Post-Traumatic Stress Disorder in Veterans. *J Equine Vet Sci*. 2018 May;64:17–26. Doi: 10.1016/j.jevs.2018.01.011. Epub 2018 Feb 12.
 75. Shelef A, Brafman D, Rosing T, Weizman A, Stryjer R, Barak Y. Equine Assisted Therapy for Patients with Post Traumatic Stress Disorder: A Case Series Study. *Mil Med*. 2019 Oct 1;184(9-10):394–399. Doi: 10.1093/milmed/usz036.
 76. Miller KE, Jamison AL, Gala S, Woodward SH. Two independent predictors of nightmares in posttraumatic stress disorder. *J Clin Sleep Med*. 2018 Nov 15;14(11):1921–1927.
 77. Lanning BA, Wilson AL, Krenek N, Beaujean AA. Using therapeutic riding as an intervention for combat veterans: an international classification of functioning, disability, and health (ICF) approach. *Occup Ther Ment Health*. 2017;33:259–278.
 78. Kloep ML, Hunter RH, Kertz SJ. Examining the effects of a novel training program and use of psychiatric service dogs for military-related PTSD and associated symptoms. *Am J Orthopsychiatry*. 2017;87(4):425.
 79. Steele E, Wood DS, Usadi EJ, Applegarth DM. TRR's Warrior Camp: An intensive treatment program for combat trauma in active military and veterans of all eras. *Mil Med*. 2018 Mar 1;183(suppl_1):403–407.
 80. US Department of Justice. ADA Requirements. Service Animal [cited 2022 August 25]. Available from: https://www.ada.gov/service_animals_2010.htm.
 81. Yarborough BJ, Owen-Smith AA, Stumbo SP, Yarborough MT, Perrin NA, Green CA. An observational study of service dogs for veterans with posttraumatic stress disorder. *Psychiatric Serv*. 2017 Jul 1;68(7):730–744.
 82. Tunçay Elmacı D, Cevizci S. Dog-assisted therapies and activities in rehabilitation of children with cerebral palsy and physical and mental disabilities. *Int J Environ Res Public Health*. 2015 May;12(5):5046–5060.
 83. Thompkins AM, Adkins SJ, Leopard M, Spencer C, Bentley D, Bolden L, et al. Dogs as an adjunct to therapy: Effects of animal-assisted therapy on rehabilitation following spinal cord injury. *Anthrozoös*. 2019 Sep 3;32(5):679–690.
 84. Williamson AK, Riendeau RP, Stolzmann K, Silverman AF, Kim B, Miller CJ, et al. An exploratory analysis of self-reported protective factors against self-harm in an enrolled veteran general mental health population. *Mil Med*. 2019 Nov;184(11-12):e738–744.
 85. Kinney AR, Eakman AM, Lassell R, Wood W. Equine-assisted interventions for veterans with service-related health conditions: a systematic mapping review. *Mil Med Res*. 2019;6:1–5.
 86. Reisman M. PTSD treatment for veterans: What's working, what's new, and what's next. *P T*. 2016 Oct;41(10):623.
 87. Beck CE, Gonzales Jr F, Sells CH, Jones C, Reer T, Wasilewski S, et al. The effects of animal-assisted therapy on wounded warriors in an Occupational Therapy Life Skills program. *US Army Med Dep J*. 2012 Apr-Jun;38–45.

88. Owen RP, Finton BJ, Gibbons SW, DeLeon PH. Canine-assisted adjunct therapy in the military: an intriguing alternative modality. *J Nurse Pract*. 2016;12:95–101. Doi: 10.1016/j.nurpra.2015.09.014.
89. Yount R, Ritchie EC, St. Laurent M, Chumley P, Olmert MD. The role of service dog training in the treatment of combat-related PTSD. *Psychiatr Ann*. 2013;43:292–295. Doi: 10.3928/00485713-20130605-11.
90. Hoisington AJ, Billera DM, Bates KL, Stamper CE, Stearns-Yoder KA, Lowry CA, et al. Exploring service dogs for rehabilitation of veterans with PTSD: A microbiome perspective. *Rehabil Psychol*. 2018 Nov;63(4):575.
91. Smith-Osborne A, Selby A. Reflections on a Therapeutic Horseback Riding Experience for a Group of Aging Veterans. *Reflections: Narratives of professional helping*. 2009;15(1):15–19.
92. Winkle M, Johnson A, Mills D. Dog welfare, well-being and behavior: considerations for selection, evaluation and suitability for animal-assisted therapy. *Animals*. 2020 Nov 23;10(11):2188.
93. Acquadro Maran D, Capitanelli I, Cortese CG, Ilesanmi OS, Gianino MM, Chirico F. Animal-Assisted Intervention and HealthCare Workers Psychological Health: A Systematic Review of the Literature. *Animals*. 2022;12:383. <https://doi.org/10.3390/ani12030383>.
94. Minatrea NB, Wesley MC. Reality Therapy Goes to the Dogs. *Int J Real Ther*. 2008 Sep 1;28(1).
95. Zhu X, Suarez-Jimenez B, Zilcha-Mano S, Lazarov A, Arnon S, Lowell AL, et al. Neural changes following equine-assisted therapy for posttraumatic stress disorder: A longitudinal multimodal imaging study. *Hum Brain Mapp*. 2021 Apr 15;42(6):1930-1939. doi: 10.1002/hbm.25360. Epub 2021 Feb 5.
96. Blais RK, Tirone V, Orlowska D, Lofgreen A, Klassen B, Held P, et al. Self-reported PTSD symptoms and social support in U.S. military service members and veterans: a meta-analysis. *Eur J Psychotraumatol*. 2021 Feb 4;12(1):1851078. Doi: 10.1080/20008198.2020.1851078.
97. Chirico F. Spirituality to cope with COVID-19 pandemic, climate change and future global challenges. *J Health Soc Sci*. 2021;6(2):151–158. Doi:10.19204/2021/sprt2.
98. Chirico F, Magnavita N. The Spiritual Dimension of Health for More Spirituality at Workplace. *Indian J Occup Environ Med*. 2019;23(2):99. Doi:10.4103/ijoem.IJOEM_209_18.
99. Chirico F, Sharma M, Zaffina S, Magnavita N. Spirituality and Prayer on Teacher Stress and Burnout in an Italian Cohort: A Pilot, Before-After Controlled Study. *Front Psychol*. 2020;10:2933. Published 2020 Jan 21. Doi:10.3389/fpsyg.2019.02933.
100. Chirico F. Religious Belief and Mental Health in Lay and Consecrated Italian Teachers. *J Relig Health*. 2017 Jun;56(3):839–851. Doi: 10.1007/s10943-016-0242-7.
101. Zaccari B, Callahan ML, Storzbach D, McFarlane N, Hudson R, Loftis JM. Yoga for veterans with PTSD: Cognitive functioning, mental health, and salivary cortisol. *Psychol Trauma*. 2020 Nov;12(8):913–917. Doi: 10.1037/tra0000909. Epub 2020 Aug 10.
102. Deleu S, Ubbink S. Huisdieren; een geestelijke en lichamelijke weldaad [Pets; a spiritual and physical blessing]. *Tijdschr Diergeneeskd*. 1997 Jan 1;122(1):12–15. Dutch.
103. Raines AM, Currier J, McManus ES, Walton JL, Uddo M, Franklin CL. Spiritual struggles and suicide in veterans seeking PTSD treatment. *Psychol Trauma*. 2017 Nov;9(6):746–749. Doi: 10.1037/tra0000239. Epub 2016 Dec 12.

104. Lass-Hennemann J, Schäfer SK, Sopp MR, Michael T. The relationship between dog ownership, psychopathological symptoms and health-benefitting factors in occupations at risk for traumatization. *Int J Environ Res Public Health*. 2020;17:2562.



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Supplementary Materials

Meta-analysis

Methods: The exploratory meta-analysis was performed on intervention studies of veterans experiencing PTSD or PTSD-related symptoms receiving an AAI intervention compared to either AAI waitlist or standard psychotherapeutic care. We included data from four studies on the basis that they had published sample size, mean, and standard deviation of PCL-M (PTSD checklist, military version) scores for both groups at pre-intervention and post-intervention time points. Pre- and post-intervention data were compared at baseline and intervention endpoint only, we did not analyze the longitudinal follow up period. For Johnson et al. (2018), we extracted data from both groups after week 3 of the intervention because after week 3 the controls were invited to participate in the intervention. The studies included are detailed in Supplementary Table 1. Meta-analytic procedures were performed using “metafor” version 3.4-0 (Viechtbauer, 2010) package within R version 4.2.1 (2022/06/23) GUI 1.72 for Mac (Core Team R, 2021). Hedge’s g effect sizes, including variances and 95% confidence intervals were calculated. Hedge’s g was calculated by computing a standardized effect size for pre-intervention and post-intervention for both group using the approach described by Morris (2008). Given the diversity of interventions compared, a restricted maximum likelihood method (REML) was used to fit the meta-analytic model. The value of Hedge's g is < 0 when there is a reduction of PTSD symptoms in the intervention group compared to the AAI waitlist or standard psychotherapeutic care at the end of the intervention. Effect sizes were interpreted using Cohen’s (1988) guidelines of 0.2 = small, 0.5 = medium, and 0.8 = large. Heterogeneity between studies was assessed using the Q and I^2 statistic (Higgins et al. 2003). A significant Q statistic indicates between-study heterogeneity that may be influenced by moderating variable; however, in this analysis, we had a small sample size that could make heterogeneity uninterpretable. Estimated I^2 was interpreted as $< 30\%$ = low heterogeneity, $\geq 31\%$ and $\leq 60\%$ = moderate heterogeneity, and $\geq 61\%$ = high heterogeneity.

Findings: The calculated mean effect size for change in PTSD symptoms was not significant when comparing veterans in AAI interventions to AAI waitlist or standard psychotherapeutic care ($g = -0.76$, $z = -1.56$, 95% CI: -1.71 – 0.19, $p = 0.194$). There was a moderate effect and a non-significant reduction observed in PTSD symptoms with veteran engagement in animal-assisted interventions in the meta-analysis model. Heterogeneity was large and significant ($Q(3) = 35.98$, $p < 0.001$, $I^2 = 89\%$).

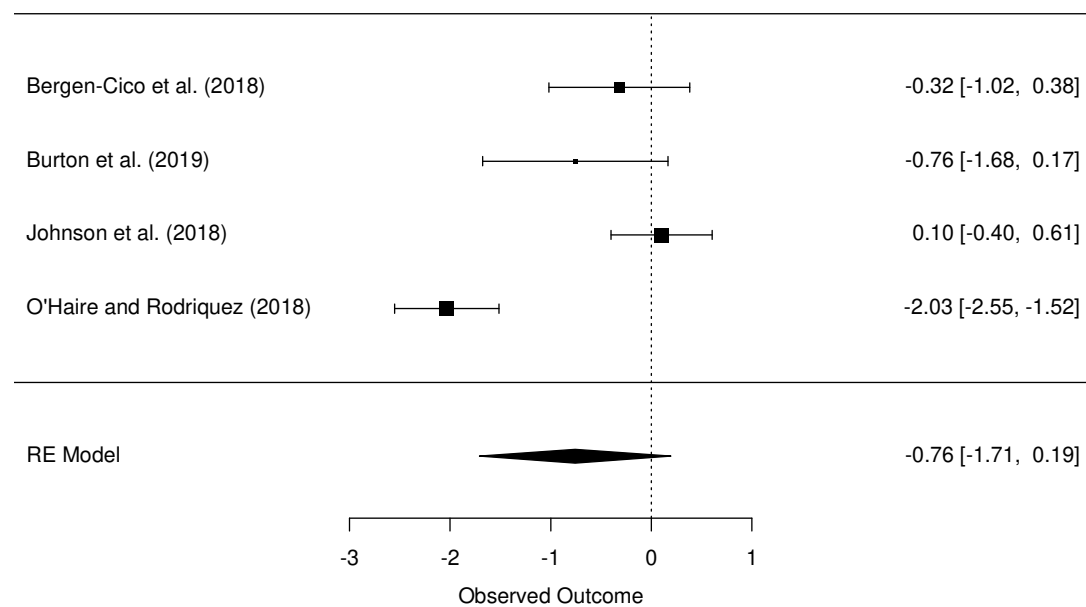
References

1. Cohen J. Statistical power analysis for the behavioural science. New York: Routledge Academic; 1988.
2. Core Team R. R: A language and environment for statistical computing. 2021. Available from: <https://cran.r-project.org/>.

3. Higgins JPT, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ*. 2003;327(7414):557–560.
4. Morris SB. Estimating effect sizes from pretest-posttest-control group designs. *Organ Res Methods*. 2008;11(2):364–386.
5. Viechtbauer W. Conducting meta-analyses in R with the metafor package. *J Stat Softw*. 2010;36(3):1–48.

Supplementary Table 1. A summary of the studies included in the meta-analysis

Study	Design	Animal	AAI	Length	Format	Diagnosis	Sample Size	Mean Age (SD)	Contrast
Bergen-Cico et al. (2018)	NRCT	Canine	CAP	90 min weekly for 12-18 months	Individual	PTSD (DSM-V)	Intervention: n = 31 Control: n = 14	Intervention: 41 (12) Control: 43 (11)	Dogs2Vets vs Waitlist Control
Burton et al. (2019)	NRCT	Equine	EAP	1 hour weekly for 6 weeks	Group	PTSD (DSM-V)	n = 10/group, sex-matched (8M/2F)	Intervention: 48 (15) Control: 46 (13)	EAP vs Standard Care
Johnson et al. (2018)	RCT	Equine	EAP	1 hour weekly for 6 weeks	Group	PTSD (DSM-V)	n = 32 (32M/6F)	Full sample: 54 (13)	EAP vs Waitlist Control
O'Haire and Rodriquez (2018)	NRCT	Canine	CAP	3-week group class	Group	PTSD (DSM-IV)	Intervention: n = 75 (60M/15F) Control: n = 66 (50 M/16F)	Intervention: 37 (9) Control: 37 (8)	CAP vs Waitlist Control
<p>Note. NRCT = non-randomized control trial, RCT = randomized control trial, EAP = equine-assisted program, CAP = canine-assisted program, PTSD = post-traumatic stress disorder, M = male, F = female, SD = standard deviation</p>									



Supplementary Figure 1. A forest plot of the standardized effect size for pre-intervention and post-intervention comparison of AAI intervention veterans vs AAI waitlisted/standard psychotherapeutic care veterans. Effect sizes illustrated are Hedge's *g*.