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Animal-assisted therapy in adults: A systematic review

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ABSTRACT

Animal-assisted therapies have become widespread with programs targeting a variety of pathologies and populations. Despite its popularity, it is unclear if this therapy is useful. The aim of this systematic review is to establish the efficacy of Animal assisted therapies in the management of dementia, depression and other conditions in adult population. A search was conducted in MEDLINE, EMBASE, CINAHL, LILACS, ScienceDirect, and Taylor and Francis, OpenGrey, GreyLiteratureReport, ProQuest, and DIALNET. No language or study type filters were applied. Conditions studied included depression, dementia, multiple sclerosis, PTSD, stroke, spinal cord injury, and schizophrenia. Only articles published after the year 2000 using therapies with significant animal involvement were included. 23 articles and dissertations met inclusion criteria. Overall quality was low. The degree of animal interaction significantly influenced outcomes. Results are generally favorable, but more thorough and standardized research should be done to strengthen the existing evidence.

1. Introduction

The interaction between humans and animals has a storied past. Whether by cohabitation or coevolution (as is the case with dogs), the human-animal bond is at least as old as history itself. Some of the earliest medical texts describe the positive outcomes of these interactions, with Hippocrates prescribing horseback riding for insomnia, and Galen prescribing the same activity to prevent disease [1]. It is no wonder then, that there has been a recent outpouring of studies seeking to describe the positive effects of this interaction [2].

The physiological substrate for this interaction has undergone extensive study. Effects on heart rate, blood pressure, salivary cortisol, and even prolonged survival after heart attack have been reported [3–5]. Studies have examined both the effects of pet ownership and of more structured interventions in specific therapeutic settings, with broadly positive results for both.

Some of these results have been studied purely on the grounds of pet ownership or interaction with an animal at home [6,7], while others have employed specific techniques in healthcare settings [8]. This heterogenous group of activities is known as Animal Assisted Interventions. The nomenclature of interventions that can be performed with an animal is unclear. Different groups, including Animal Assisted Interventions International [9], the American Veterinary Medical Association [10], and specialized texts [11] give slightly different definitions.

This review will focus on the use of animal-assisted therapy (AAT), with a working definition of a structured intervention in which a specifically trained animal is used within the context of the professional practice of a therapist to enhance the results of that practice (6). This type of therapy has been tested in many adult and pediatric populations, with varying degrees of success depending on its intended effect.

The elderly have been the focus of a considerable number of studies. Additionally, pathologies with neurological and psychiatric involvement have received research attention. However, previous reviews have identified few controlled, parallel, trials.

In the absence of definitive studies, careful analysis of the evidence is required in order to justify the considerable investments associated with AAT programs. This review aims to evaluate evidence of AAT for specific indications in the adult population.

2. Methods

No protocol registration was performed for this study. Searches were conducted on Pubmed, EMBASE, ScienceDirect, CINAHL, PsycNET, Cochrane, LILACS, and Taylor & Francis databases using different combinations of search terms “Animal assisted therapy”, “pet therapy”, “dementia”, “stroke”, “multiple sclerosis”, “PTSD”, “spinal cord lesion” and “depression”. Terms pertaining to specific conditions were defined based on the researchers' previous knowledge. MeSH terms, EMTREE terms, or DeCS descriptors were used in exploded form were available. The search strategy was expanded by searching grey literature in OpenGrey, The Grey Literature Report, ProQuest

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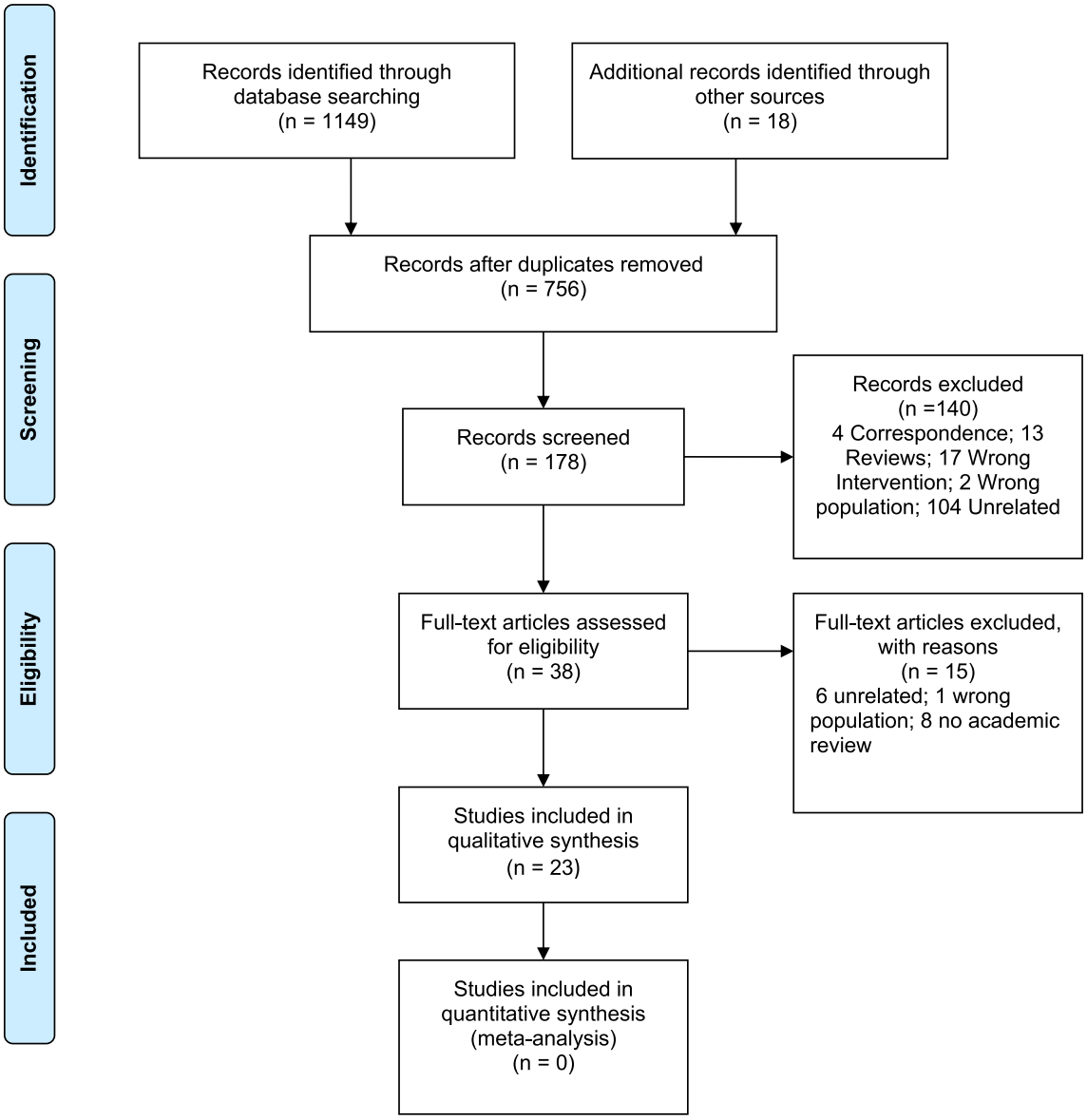

Fig. 1. PRISMA flow-diagram.

Dissertations & Theses Global, and Google Scholar. The search syntax used for Pubmed was: ((((animal assisted therapy[MeSH Terms]) OR pet therapy[MeSH Terms]))).

2.1. Inclusion and exclusion criteria

No date, study type, or language filters were used. However, case reports, case series, book chapters, and qualitative studies were excluded, as well as studies without live animals or those published before the year 2000. Studies focusing on mixed samples for which the effect on any particular population could not be ascertained were also excluded. The interventions considered were required to have significant subject interaction with both therapist and animal. Articles in English, Spanish, French, German, or Hungarian were considered for review. A total of 1149 references were retrieved, and 18 additional references were identified by hand searching previous reviews on the topic and the archives of journals frequently featuring AAT studies. After duplicate elimination, 756 references remained, of which 178 were determined to be relevant to the search's objectives. Of these, 23 studies were selected for qualitative synthesis (Fig. 1).

2.2. Data extraction and analysis

Quality was graded by two independent researchers using the Critical Appraisal Tools provided by the Joanna Briggs Institute of the University of Adelaide [12] and the National Heart, Lung, and Blood Institute [13], with any disagreements resolved by a third. Quality assessment tools from different sources were used to better represent the study designs considered. Likewise, data extraction was performed independently. Extracted data pertain to the PICOS characteristics of each study, along with animal used, and measurement scales used. Given the heterogeneity of outcomes, measurements and design, meta-analysis was deemed inappropriate.

3. Results

Of the 23 studies that met our inclusion criteria, 9 were randomized parallel clinical trials [14–22], 5 were non-randomized parallel clinical trials [23–27], 7 were quasi-experimental pre-post studies [8,28–33], one used a wait-list control design [34], and one was a retrospective cohort study [35]. On quality assessment, studies were graded according to the instrument which better represented its design.

Table 1
Quality assessment.
Two different assessments tools were used to evaluate the quality of the articles that were chosen. The Critical Appraisal Tools provided by the Joanna Briggs Institute of the University of Adelaide and the National Heart, Lung, and Blood Institute Quality Assessment Checklists.

Randomized Clinical Trials. Joanna Briggs Institute Quality Assessment

Study	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12	Item 13
Panzer-Koplow, 2000	Y	U	Y	NA	NA	N	U	Y	Y	Y	Y	Y	Y
Barak et al., 2001	U	U	Y	NA	NA	Y	Y	Y	Y	Y	Y	N	Y
Banks and Banks, 2002	Y	N	U	NA	NA	U	Y	N	Y	Y	Y	Y	U
Le Roux and Kemp, 2009	U	U	Y	NA	NA	N	Y	N	N	Y	Y	N	Y
Beinotti et al., 2013	Y	Y	Y	NA	NA	N	U	Y	N	Y	U	Y	Y
Bono et al., 2015	Y	N	N	NA	NA	N	U	Y	N	Y	Y	N	Y
Friedmann et al., 2015	Y	U	Y	NA	NA	N	Y	N	Y	Y	Y	Y	N
Olsen et al., 2016	Y	N	N	NA	NA	N	Y	Y	Y	Y	Y	Y	U
Vermöhlen et al., 2017	Y	Y	Y	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y

Non-randomized Clinical Trials. Joanna Briggs Institute Quality Assessment

Study	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9
Silkwood-Sherer and Warmbier, 2007	Y	Y	Y	Y	N	N	Y	Y	Y
Beinotti et al., 2010	Y	Y	Y	Y	N	Y	Y	Y	Y
Muñoz-Lasa et al., 2011	Y	N	U	Y	N	Y	N	Y	Y
Nordgren and Engstrom, 2014	Y	Y	Y	Y	Y	Y	Y	Y	N
Menna et al., 2016	Y	Y	Y	Y	N	Y	Y	Y	Y

NIH Study Quality Assessment Tools Pre-Post Studies with no control group

Study	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item12
Lechner et al., 2003	Y	Y	Y	N	Y	N	CD	N	Y	Y	N	NA
Richeson, 2003	Y	Y	N	N	N	Y	Y	N	Y	Y	Y	NA
Hammer et al., 2005	Y	Y	Y	N	N	Y	CD	N	Y	N	Y	NA
Lechner et al., 2007	Y	Y	Y	N	N	Y	CD	Y	Y	Y	Y	NA
Pedersen et al., 2011	Y	Y	N	N	N	N	N	NA	N	N	N	NA
Earles et al., 2015	Y	Y	Y	N	N	Y	CD	NA	Y	Y	N	NA
Kloep, 2016	Y	Y	N	N	N	Y	Y	NA	Y	Y	N	NA

Cohort Studies. Joanna Briggs Institute Quality Assessment

Study	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11
Püllen et al., 2013	Y	Y	Y	Y	N	U	U	Y	Y	NA	Y

Regarding randomized clinical trials, items 4 and 5 of the Joanna Briggs Institute were not applicable to AAT.

Most studies use a variety of self-reported surveys or scales to measure outcomes, which precludes the possibility of blinding outcome evaluation. Measures to control sources of bias such as randomization, allocation concealment, and rater blinding, are seldom reported in the published literature. Performance bias is an additional concern with patients that are institutionalized, since personnel could significantly alter the living conditions of each subject. Prior trial registration or protocol publication was also rare, making it difficult to determine completeness in reporting. Hence, quality was generally found to be low. Only one study met all of the quality criteria [20] (Table 1).

4. Measurements used in AAT research

A total of 52 different scales were used across all studies to measure outcomes. Only two scales, the Demographic Pet History Questionnaire [15] and the Pet Attitude Scale [36], are specifically related to interaction with animals. Other measurements correspond to specific conditions. However, a large number of scales were used to measure similar features. In studies with a focus on depression, 3 different scales were used to measure depression severity, out of which one was used twice Beck Depression Inventory (BDI) [37]. Studies on dementia used 5 different scales to measure cognitive status, and only one was used more than once Mini-Mental Status Examination (MMSE) [38]. In the case of Post-Traumatic Stress Disorder (PTSD) research, the PTSD Checklist [39] was used twice to measure symptom severity, with three other scales used for this purpose as well. Motor outcomes in different settings, including Multiple Sclerosis (MS), spinal cord injury and stroke were commonly measured using the Berg Balance Scale (BBS) [40], the Tinetti Performance-Oriented Mobility Assessment (POMA) [41], and the Ashworth Scale [42]. A single study on patients with schizophrenia was retrieved, in which the Social-Adaptive Functioning Evaluation [43] was used to measure outcomes (Table 2).

5. Therapy characteristics

The variety of therapies used show great heterogeneity in overall duration, direct interaction with the animal, and the goals assigned to each session. Consequently, determining the implications of the results found is challenging for any single condition.

Dogs and horses were the most commonly used animals, accounting for 22 (13 dogs, 9 horses) of the studies [8,14–27,29–34,44]. One study allowed for either cats or dogs to be used and another combined various farm animals [22,28]. Therapy duration varied between 72 and 3 total hours. Dog-Assisted Therapies (DATs) lasted a mean of 14 h, with individual sessions lasting a median of 30 min. Equine-Assisted Therapies (EATs) lasted a mean of 7 h, with individual sessions lasting a median of 30 min (Table 1). A study on farm activities tested an intervention which lasted 72 h [28]. The duration for some of the therapies could not be calculated [8,27,34], due either to the nature of the therapy (e.g. intensive therapy retreat), or to the authors not reporting specific

Table 2
Study Characteristics PICOS
characteristics, animal used, measurement scales used, and general results are presented.

Author	Year	Title	Animal	Design	Population	Therapy intensity	Outcomes measured	Overall results
Depression								
Panzer-Koplow	2000	Effects of animal assisted therapy on depression and morale among nursing home residents	Dog	Randomized Parallel Clinical trial	35 residents from 6 different units in a long-term care facility DAT: 16 patients Control: 19 patients	15 min intervention once per week for 10 weeks	MMSE Beck Depression Inventory The Geriatric Depression scale Philadelphia Geriatric Center Morale Scale The Pet attitude Scale	No significant differences found between control and AAT groups, for any of the outcomes measured. In fact, there was a non-significant difference which suggested superiority of control.
Banks MR, Banks WA	2002	The Effects of Animal-Assisted Therapy on Loneliness in an Elderly Population in Long-Term Care Facilities	Dog	Randomized Parallel Clinical trial	Subjects from 3 long-term care facilities, predominantly female (80%) and older than 75 years (70.9%), no prior diagnosis DAT1: (n = 15) DAT2: (n = 15) Control: (n = 15)	AAT1: weekly 30min sessions for 6wks AAT2: sessions per wk for 6wks. Control: No interaction 18 h	Mini-Mental State Examination (MMSE) Demographic Pet History Questionnaire (DPHQ) UCLA Loneliness Scale v3	Reductions in loneliness scores were observed for both experimental groups, but not for the Control group. There was no difference in change from baseline between experimental groups.
Le Roux M.C.; Kemp R.	2009	Effect of a companion dog on depression and anxiety levels of elderly residents in a long-term care facility	Dog	Randomized Parallel Clinical trial	Elderly residents (> 65 years) of a long-term care facility. DAT: (n = 8) Control: (n = 8)	AAT: 30min interaction weekly for 6wks Control: No intervention 15 h	Beck Depression Inventory (BDI) Beck Anxiety Inventory (BAI)	Without changes for control group. Significant changes for AAT group. Risk of performance bias is significant due to the subjects being inpatients and frequently in contact with personnel that had knowledge of group allocation.
I Pedersen, T Nordaunet, EW Martinsen, B Berget, BO Braastad.	2011	Farm Animal-Assisted Intervention: Relationship between Work and Contact with Farm Animals and Change in Depression, Anxiety, and Self-Efficacy Among Persons with Clinical Depression	Various farm animals	Single-group, pre-post design	19 subjects	1.5–3 h sessions, twice a week for 12 weeks. Subjects were free to engage in a variety of farm activities, with or without animals	Beck Depression Inventory, Beck Anxiety Inventory, Spielberger Trait Anxiety Inventory-State Subscale, Generalized Self-efficacy Scale.	Work task intensity negatively correlated with levels of depression, though only two of the tasks were significantly correlated (Milking and technical preparations, and Moving Animals). Some behaviors showed correlation in the opposite direction (Mucking, Grooming, Inactivity, and Pure Animal Contact), though none were significant.
Dementia								
Richeson NE	2003	Effects of animal-assisted therapy on agitated behaviors and social interactions of older adults with dementia	Dog	Single-group, pre-post design	15 subjects	One-hour 5 days per week for three weeks	Mini-Mental State Examination (MMSE) Cohen-Mansfield Agitation Inventory (CMAI)	Significant decrease in agitation symptoms at post-intervention and follow-up also increase social interaction.
Mossello et al.	2011	Animal-assisted activity and emotional status of patients with Alzheimer's disease in day care	Dog	Single-group, pre-post design; wait-list control	10 subjects	5 total intervention weeks; two weeks of TAU, remaining weeks in DAT Measurements taken Pre control intervention; Pre-AAT; Post-AAT		

(*continued on next page*)

Table 2 (*continued*)

Author	Year	Title	Animal	Design	Population	Therapy intensity	Outcomes measured	Overall results
							Severe Impairment Battery (SIB); Cornell Scale for Depression in Dementia (CSDD); Neuropsychiatric Inventory (NPI); Cohen-Mansfield Agitation Inventory (CMAI)	None of the outcomes were statistically significant; Scores on the SIB showed no significant reduction across time; scores in the NPI did not show statistically significant differences.
Pullen et al.	2013	Tiergestützte Therapie im Demenzbereich eines Akutkrankenhauses	Dog	Retrospective cohort study	105 geriatric patients (mean age of 84) with varying degrees of cognitive impairment (median of 18 points)	30 min sessions every 2 weeks. Therapy included a variety of manual exercises which included feeding the animal treats using wooden pliers.	Self-developed questionnaire which measured the patient's mood, Semi structured Interviews	Mood improvements were qualitatively noted for 58% of patients. Interviews with staff showed acceptance of therapy, and a perceived improvement in the patients' mood.
Nordgren & Engström	2014	Effects of dog-assisted intervention on behavioral and psychological symptoms of dementia	Dog	Non-randomized Parallel Clinical trial	DAT: (n = 20)	DAT: Individualized protocols with 45–60min sessions delivered once or twice per week up to a total of 10 sessions. After intervention, follow-up measurements at 3 and 6 months.	Cohen's-Mansfield Agitation Inventory (CMAI)	9 participants in the DAT group were excluded (7died and 2 moved out). 5 subjects in control group were excluded (3 died and 2 moved out).
					Control: (n = 13)	Control. participants in other nursing homes had the same amenities and activities available to them, except for DAT.	Multi-Dimensional Dementia Assessment Scale (MDDAS)	Significant differences in the MDDAS between groups were found at baseline. Minor changes were found across measurements at post-intervention.
Bono et al.	2015	Effects of animal assisted therapy (AAT) carried out with dogs on the evolution of mild cognitive impairment	Dog	Randomized Parallel Clinical trial	DAT = 12	AAT: 2 sessions per month, 1 h in duration for 8 months.	Barthel Index	After eight months of follow-up, the DAT group showed a significant positive improvement in the measures used to compare the groups.
					Control = 12	Control: This group was followed up twice per month across 8 months.	Alzheimer Disease Assessment Scale (ADAS) CSDD	
Friedmann E.; Galik E.; Thomas S.A.; Hall P.S.; Chung S.Y.; McCune S.	2015	Evaluation of a pet-assisted living intervention for improving functional status in assisted living residents with mild to moderate cognitive impairment: A pilot study	Dog	Randomized Parallel Clinical trial	DAT: (n = 22) 2 residents died and one move out.	The intervention consisted of a 60–90min session twice per week for 12 weeks, with a follow up of 3 months	Apathy Evaluation Scale (AES) Cornell Scale for Depression in Dementia (CSDD)	Lower agitation in DAT group, no change in control.
					Control (n = 18)		Cohen-Mansfield Agitation in Dementia (CMAD)	Apathy improved slightly in the DAT group. Control group showed a non-significant tendency towards worsening symptoms.
							Barthel Index	Greater decrease in symptoms in depression symptoms for DAT group.
Menna et al.	2016	Evaluation of the efficacy of animal-assisted therapy based on the reality orientation therapy protocol in Alzheimer's disease patients: a pilot study	Dog	Non-randomized Parallel Clinical trial	DAT (n = 20)	DAT and ROT: One session weekly of 45 min for 6 months.	Geriatric Depression Scale (GDS)	Statistically significant positive effect in DAT and ROT groups. Improvement greater in DAT group over others.
					Control (n = 10) Reality Orientation Therapy (ROT) (n = 20)		Mini-Mental State Examination (MMSE)	
Olsen et al.	2016	Effect of animal-assisted activity on balance and quality of life in home-dwelling persons with dementia	Dog	Randomized Parallel Clinical trial	DAT = 41	DAT: 3 to 7 participants took 30min sessions twice per week for 12 weeks	Berg Balance Scale (BBS)	Significant differences between pre and post intervention were observed in the BBS for the DAT group, but not for control group. Effect observed at post-intervention was not observed at 3-month follow-up.
					Control group = 38	Control: 30–45 min of standard motion exercises Measurements at To (pre-test) T1 (intervention finished) T2 (3 months after)	Quality of Life in Late-stage Dementia (QUALID)	

(*continued on next page*)

Table 2 (*continued*)

Author	Year	Title	Animal	Design	Population	Therapy intensity	Outcomes measured	Overall results
PTSD								
Earles, Vernon, & Yetz	2015	Equine-Assisted Therapy for Anxiety and Posttraumatic Stress Symptoms	Horse	Single-group, pre-post design	16 subjects	Therapy was delivered in 2-h weekly sessions for six weeks	PTSD Checklist - Specific. Life Events Checklist for trauma history. Trauma Emotion Questionnaire. Generalized Anxiety Disorder Scale. Patient Health Questionnaire. Alcohol Use Disorders Identification Test. Somatic Symptom Severity Scale of the Patient Health Questionnaire.	Significant decreases were observed in emotional distress, symptoms of anxiety, symptoms of depression, and alcohol use.
Kloep	2016	The Effect of Psychiatric Service Dogs for PTSD Symptom Amelioration in Military Veterans	Dog	Single-group, pre-post design	12 subjects	Psychiatric Service Dog intervention as part of a wider, 3-week, intensive treatment program (This Able Veteran). The program also included, resiliency and life-skills training, assigned readings, and group sessions.	PTSD Checklist. Post-Deployment Social Support Scale. Quick Inventory of Depressive Symptomatology. Posttraumatic Cognitions Inventory. Burckhardt Quality of Life Scale. Dimensions of Anger Reactions. Attention Bias Task performance.	Significant differences were observed for changes from baseline for the Posttraumatic Cognitions Inventory, with a large effect size (Cohen's d = 5.04).
Multiple sclerosis								
Hammer et al.	2005	Evaluation of therapeutic riding (Sweden) = hippotherapy (United States). A single-subject experimental design study replicated in eleven patients with multiple sclerosis	Horse	Single-group, Pre-Post design	13 patients	Ten weekly therapeutic riding sessions, each lasting 30 min.	Berg balance scale (BBS). The 10 m walking test The modified Ashworth scale (MAS) The Index of Muscle Function (IMF) Birgitta Lindmark motor assessment (BLMA). Patient-Specific Functional Scale (PSFS). The short form 36 (SF-36) health survey	In HRQOL, 28 positive and 16 negative changes, with slightly more positive changes in the Mental Health Component questionnaire. Observation of negative changes is compatible with natural history of MS. Mixed results in other tests.
Silkwood-Sherer & Warmbier	2007	Effects of Hippotherapy on Postural Stability, in Persons with Multiple Sclerosis: A Pilot Study	Horse	Nonrandomized Parallel Clinical trial	EAT: 9 patients Control group: 6 patients	14 weeks of EAT one session each week. Each session lasted 40 min.	Berg Balance Scale (BBS) Tinetti Performance Oriented Mobility Assessment (POMA) The Clinical Test for Sensory Interaction on Balance (CTSIB)	Significant differences were observed between the pre and post-EAT periods, and the magnitude of the effect was comparable to that of other physical therapy interventions that were more time-consuming.
Muñoz-Lasa et al.	2011	Effect of therapeutic horseback riding on balance and gait of people with multiple sclerosis	Horse	Nonrandomized Parallel Clinical trial	27 patients 12: EAT 15: TAU	Two series of ten weekly sessions	Extended disability Status Scale (EDSS) Barthel index Tinetti Performance Oriented Mobility Assessment (POMA) Only EAT: Gait analysis	Significant improvement in POMA scores, stride time and ground reaction forces for the EAT group. No statistically significant changes were reported in the control group.

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Table 2 (*continued*)

Author	Year	Title	Animal	Design	Population	Therapy intensity	Outcomes measured	Overall results
Vermöhlen et al.	2017	Hippotherapy for patients with multiple sclerosis: A multicenter randomized controlled trial (MS-HIPPO)	Horse	Randomized Parallel Clinical trial	EAT: 32 Control group: 38	Intervention group received a weekly 30 min session of EAT for 12 weeks plus TAU Control group received TAU weekly for 12 weeks	BBS Fatigue Severity Scale (FSS)	The results show a significant change in the BBS after 12 weeks of 6.4 points.
Stroke								
Beinotti, Correia, Christofoletti & Borges.	2010	Use of hippotherapy in gait training for hemiparetic post-stroke	Horse	Nonrandomized Parallel Clinical trial	EAT (n = 10) Control (n = 10)	Control: performed conventional treatment three times a week for a period of 16 weeks, for a total of 48 sessions. EAT: performed conventional therapy twice a week and EAT,once a week for 16 weeks, for a total of 48 sessions	Functional Ambulation Category Scale (FAC) Fugl-Meyer Scale (only the lower limbs and balance sub items) Berg Balance Scale Functional assessment of gait (cadence)	Results showed an improvement in the intervention group of motor impairment in lower limbs and balance.
Beinotti, Christofoletti, Correia & Borges G.	2013	Effects of horseback riding therapy on quality of life in patients post stroke	Horse	Randomized Parallel Clinical trial	EAT + TAU (n = 10) TAU (n = 10)	EAT: 2 regular therapy sessions per wk for 16 wks + 1 EAT session per wk Control: 3 regular therapy sessions per wk for 16 wks.	Functional Ambulation Category. Fugl Meyer Scale. Berg Balance Scale Functional assessment of gait.	Results showed a positive outcome in the quality of life greater in the EAT + TAU than TAU alone.
Spinal cord injury								
Lechner et al.	2003	The short-term effect of hippotherapy on spasticity in patients with spinal cord injury	Horse	Single group, Pre-Post design	32 patients	EAT: 11, 25–30min sessions. Control: Subjects sat without saddle on the horse and the horse was led by a skilled equestrian	Ashworth Scale	Results showed that after EAT muscle tones in the lower extremities decrease significantly. There was no difference between paraplegic or tetraplegic patients.
Lechner, Kakebeeke, Hegemann & Baumberger	2007	The effect of hippotherapy on spasticity and on mental well-being of persons with spinal cord injury.	Horse	Single group, Pre-Post design	12 subjects pre and post	Twice-weekly session for four weeks.	Ashworth Scale Self-rating using a VAS	Short-term effectiveness on spasticity and well-being was verified. No long-term effects were observed for any of the three interventions.
Schizophrenia								
Barak et al.	2001	Animal-assisted therapy for elderly Schizophrenic patients	Dog or cat	Randomized Parallel Clinical trial	AAT: 10 Control: 10	Weekly sessions, 3 h in duration for a year	Social adaptive functioning evaluation	Significant improvement compared to baseline scores for both groups. Improvements were significantly greater for the AAT group compared with the control group.

durations for each session. Only one study compared two therapy intensities. Banks & Banks compared the effectiveness of a Dog-Assisted Therapy (DAT) lasting a total of 9 h with the same intervention delivered over 3 h, observing no significant differences on outcomes related to depression [15].

Descriptions of each intervention varied widely, with some describing each session, and some referencing a proprietary manual. Interventions using dogs were clearly different from Equine-Assisted Therapy (EAT).

Biosafety was a common concern to all DATs; previous certification of animal temperament, and absence of zoonotic infections was required for all dogs entering a healthcare facility. Most protocols were already in place due to the use of service dogs by some individuals. Another common feature was the need for the same dog to interact with the same patient in all sessions, particularly in patients with dementia and depression.

The degree of therapist and dog training, and interaction with the subjects was variable. Panzer-Koplow described the need for extensive training of both animal and therapist [16]. In addition to certification from Delta Society International, an advocacy group for AAT, therapists received training in standard communication and interaction techniques relevant to specific populations (e.g. disabled individuals, frail older adults), and guidelines for engaging patients in each session. Similarly, Banks and Banks provided scripts for each interaction [15].

Püllen et al. described a specific exercise during DAT which involved feeding the animal a treat using a pair of tongs [44]. This was meant to improve perception, concentration, and provide sensory stimulation. Training included activities of daily living, motor skills, planning, and social and communication skills [18,19,24,44]. Memory was emphasized in similar subjects in the DAT used by Bono et al. in which the patient was required to perform breed identification through illustrations, memorization of the animal's name and of specific commands, and reading the animal's body language [17].

More free-form group therapies are described by Richeson et al. in which communication and establishment of rapport was the main goal [29]. Similarly, the DAT used by Barak et al. on patients with schizophrenia sought to improve social functioning, and had a focus on these same interactions [22].

In patients with dementia, Nordgren et al. performed highly elaborate interventions [23]. Therapists required 240 h of training, and the need for AAT to be prescribed made tailored therapy design mandatory.

In patients with PTSD, Earles et al. reported great detail [30]. Therapy was delivered in 2-h weekly sessions for six weeks. Each session had a different focus and participants were taught to develop noncritical self-awareness, improved concentration and listening skills. After an introductory session, in Session 2, they learned how to have nonverbal interactions with the horses, exploring the effects of actions and body language, and learned about boundaries in relationships. In Session 3, participants learned to halter the horses and worked on dealing with challenges and stressful situations. In Session 4, they learned how to lead and back up a horse, creating safe spaces and setting boundaries in relationships. In Session 5, participants learned how to stay focused when faced with distraction or temptation. Finally, in Session 6, they reviewed previously learned skills and worked on inner stability [31].

In general, studies with a focus on motor outcomes made use of EATs. All studies on motor outcomes described EATs in which the patient was accompanied by at least two therapists, one of which had specific equestrian training. All sessions reported started with warm-up phases in which stretching exercises on the ground and astride the animal were performed. Afterwards, the exercises executed by the subjects included trunk rotation touching different parts of the horse, leaning forwards and backwards to enhance range of motion and adductor muscle strength, adapting to changes in velocity, and standing on stirrups [20,21,25–27,31–33]. A number of specific programs were mentioned which provide certification, including the American Hippotherapy Association, Deutsches Kuratorium für Therapeutisches Reiten, and the North American Riding for the Handicapped Association.

Adverse events were rare, with only one study reporting an adverse event directly related to therapy. In the study published by Vermöhlen et al. one patient fell from the horse during an EAT session, although no major injury resulted from it [20]. Other studies reported attrition due to intercurrent illnesses [17,19,20,22]. Mortality occurred in the studies on dementia, although none of the events could be attributed to therapy [18,19,23,29].

6. AAT in specific conditions

6.1. Depression

Depression in late life is more common than in the general population, with a prevalence of up to 16% of institutionalized older adults [45], leading to impaired function, increased use of medical services and mortality [46,47].

Le Roux et al., in a study using DAT with 16 participants, compared two groups, one using AAT and another with no activity [14]. Each group had eight subjects. The intervention consisted in a 30-min weekly session for six weeks. They used two scales, the BDI, and the Beck Anxiety Inventory [37,48]. After intervention, significant changes were found in the DAT group, but not in the control group. Changes on the BDI were significant only for the DAT group (BDI: $t = -2.26$, $p = 0.02$; BAI: $t = 1.14$, $p = 0.13$) [14].

Banks & Banks, in a controlled study, compared 45 subjects with depression. They divided the participants into three groups, AAT-1, AAT-2, and control [15]. In AAT-1 the intervention consisted in a weekly session of 30 min per six weeks, whereas in AAT-2 it consisted of three instead of one weekly session. After intervention results showed reductions in loneliness scores on the UCLA Loneliness Scale v3 [49] for both experimental groups, but not for the Control group ($F_{(2,44)}$, $p = .001$). There was no difference in change from baseline between experimental groups [15].

Pedersen et al., tested the effect of a group of farm activities. Outcomes were measured using the BDI. Activities were self-selected, and many were available to choose from, specifically: milking, feeding, fetching feed, cleaning, moving animals, milk-feeding calves, hand-feeding animals, technical preparation before milking, grooming animals, mucking, physical contact with animals, observing animals, inactivity, other activities, dialog with the farmer and talking to animals [28]. The intensity of the intervention consisted of activity twice per week for 12 weeks. Results showed that depressive state varied between the kind of activity that patients received. Milking procedures and Moving animals had a significant correlation ($r = -0.62$, $p = 0.02$ and, $r = -0.58$, $p = 0.03$, respectively). Animal contact showed a marginally significant association with depressive state $r = 0.50$, $p = 0.07$. Activities like, mucking, grooming and inactivity did not show any improvement [28].

Panzer-Koplow carried out a randomized study in 36 elderly adults [16]. No significant differences were found between control and AAT for any of the outcomes. In fact, one of the non-significant results suggested that depression reduction was greater in the control than in the experimental arm.

6.2. Dementia

The age distribution is changing rapidly, with the elderly outnumbering children [50], and an expected exponential rise in the prevalence of dementia. No new pharmacological therapies have been introduced for the management of the disease [51]. Hence, interest in alternative therapies for dementia symptom management has increased. Additionally, these patients constitute a significant challenge to caregivers, both professional and informal [52].

Richeson et al. used a quasi-experimental design, including a follow-up phase [29]. The effects of a DAT on agitation were measured with the Cohen-Mansfield Agitation Scale (CMAS). Results showed a significant decrease in agitation symptoms at post-intervention ($t_{(15)}$ = 5.732, p = 0.001), and an increase from post-intervention to follow-up ($t_{(15)}$ = -3.617, p = .000). Due to the small sample size (n = 15), and the absence of rater blinding, results should be considered preliminary [29].

On the other hand, Mossello et al. report a study in which no statistically significant results were observed. Although none of the outcomes were statistically significant, this was expected due to the small sample size (n = 10) [34]. Scores on the Severe Impairment Battery showed no significant reduction across time (Pre-Control: 21.0(sd = 31.6); Pre-AAT: 18.9(sd = 29.3); Post-AAT: 21.1(sd = 32.7)). Scores in the Neuropsychiatric Inventory did not show statistically significant differences (Pre-Control: 22.2(sd = 10); Pre-AAT: 21.4(sd = 11.5); Post-AAT: 21.3(sd = 10.3)). It is worth noting, that the tendency observed suggested improvement with AAT for both outcomes [34].

Further work by Pullen et al. sought to determine what changes, if any, an established DAT program had on patients' mood [35]. Changes in mood were reported in a self-designed instrument by the treating psychologist, as well as changes in facial expression and gestures, and signs of tension. Significant improvements were observed for all measures, with nurses reporting improvements in both their patients and the working environment in the ward [35].

Nordgren et al. measured the impact that DAT had on quality of life [23]. Although the study included a small number of patients, Quality of Life in Late Stage Dementia (QUALID) scores at post-intervention showed a significant improvement (mean change: 23 to 18 points) [53]. However, these results are not conclusive, due to lack of randomization and groups not being comparable at baseline [23].

Bono et al. carried out a parallel randomized clinical trial of AAT in patients with mild cognitive impairment [17]. Equal numbers of patients were assigned to each arm. The intervention consisted of two 1-h sessions per month for 8 months. The control group was followed-up twice per month across 8 months. Measures were taken using the Barthel Index (BI), the Alzheimer Disease Assessment Scale and the Cornell Scale [54–56]. The DAT group showed a significant improvement in all measurements, superior to that of controls. Although this study is a randomized clinical trial, no allocation concealment was reported, and no controls regarding additional therapies received by the subjects were implemented. Additionally, and although not reported by the authors, the reported baseline statistics for the groups suggest that they were not comparable at baseline [17].

Friedmann et al. reported the results of a randomized clinical trial of DAT for agitation, depression, apathy and activities of daily living [18]. Outcomes were measured using the Apathy Evaluation Scale, the Cornell Scale, the CMAS, and the BI. Significant changes were observed in agitation after DAT, but not in the control group. Apathy improved slightly in the DAT group, and worsened in the control group. Depression decreased in both groups, but to a greater extent in the DAT group. This study lacked rater blinding and made no mention of allocation concealment [18].

Menna et al. performed a non-randomized parallel clinical trial to measure the effect of DAT on depression and cognitive impairment [24]. Two control groups were used in this study: an active control with Reality Oriented Therapy (ROT), and a passive control group which received no stimulation. The DAT intervention consisted of an adapted ROT protocol. Outcomes were measured using the Geriatric Depression Scale and the MMSE. Results showed a statistically significant improvement in both groups, with greater improvement in the DAT group. Results of the MMSE showed superiority of DAT over both control arms [24].

Olsen et al. carried out a randomized parallel clinical trial to determine the effects of AAT on balance and quality of life [19]. Balance was measured using the BBS and the QUALID scale. This study found significant changes at post-intervention for the balance outcome, but not for the quality of life outcome. However, the effect was lost after three months [19].

6.3. PTSD

Global mental health surveys have found lifetime prevalences of traumatic experiences as high as 70.4%, out of which 4% are subsequently diagnosed with PTSD [57]. Treatment guidelines for this condition are emphatic in the need for a multidisciplinary approach, including alternative forms of therapy [58].

The use of EAT was explored by Earles et al. on a group of 16 volunteers [30]. Participants were 12 females and 4 males aged 33 to 62 with at least a high school education. It was also required that participants had reported at least one Criterion A traumatic event on the Life Events Checklist and had current PTSD symptoms above a recommended cutoff of 31 on the PTSD Checklist-Specific. Significant decreases were observed in emotional distress, symptoms of anxiety and depression, and alcohol use. However, the study did not make use of a control group, nor did it standardize any additional therapies that the subjects could have been receiving at the time [30].

Kloep, as part of a graduate dissertation, carried out a pre-post DAT study on 12 volunteers with combat-related PTSD [8]. This study was carried out as part of a wider intensive therapy for veterans with PTSD. Outcomes were PTSD symptoms, symptoms of depression, cognitive bias, anger and quality of life. Significant differences were observed in the Posttraumatic Cognitions Inventory, the Quick Inventory of Depressive Symptomatology, the Quality of Life Scale, and the Dimensions of Anger Reactions scale. All effect sizes observed were large and the results were deemed clinically significant. However, all measures are self-reported, precluding the possibility of eliminating that source of bias, and the lack of a control group makes it impossible to determine if the effect corresponds to the intensive therapy program or to DAT. Furthermore, the population may have been self-selected, since the subjects volunteered for the intensive program [8].

6.4. Multiple sclerosis

Four studies focused on the use of EAT in patients with MS [20,25,26,31]. Research focused almost exclusively on motor outcomes, with balance, muscle strength, and gait being the most common.

Hammer et al. measured the impact of an EAT on balance, gait, spasticity, functional strength, coordination, pain, self-rated level of muscle tension, activities of daily living, and health-related quality of life [31]. Diagnoses included relapsing-remitting, primary progressive, and secondary progressive MS. Improvements were observed in balance, with eight subjects experiencing positive outcomes. Changes in all other measures were mixed across subjects and across the tests themselves. For example, in the Health-Related Quality of Life questionnaire, 28 positive and 16 negative changes were registered, with slightly more positive changes in the Mental Health component of the Health-Related Quality of Life questionnaire [31]. The observation of negative changes is compatible with the natural history of MS, for which there are only disease-modifying treatments.

Further research by Slikwood-Sherer & Warmbier, using a controlled design, verified the results observed by Hammer et al. regarding balance [25]. Using both the BBS, and the POMA. Significant improvements were observed for both outcomes, with effect sizes that were greater than those observed for more time-consuming interventions [25].

Positive results on balance were expanded on by Muñoz-Lasa et al. [26]. Using a controlled design with 27 subjects (12 in the EAT arm), positive outcomes on the POMA after EAT were verified, showing significant improvements over baseline. Additionally, significant improvements were observed for stride time and ground reaction forces in

the EAT group. No statistically significant changes were observed in the controls. Results derived from gait analysis were not compared with control subjects, since gait parameters were only measured for the EAT group [26].

Finally, a multi-center, randomized clinical trial was carried out by Vermöhlen et al. [20]. The primary outcome was the BBS score, with secondary outcomes of spasticity, fatigue, and quality of life. Sequence generation, allocation concealment, examiner blinding, and completeness of reporting can be ascertained for this study. The results show a significant change in the BBS after 12 weeks of 6.4 points. Based on the balance literature, this change is both statistically, and clinically significant. Clinically significant changes on quality of life were also observed [20].

6.5. Stroke

Among elders 65 and over in the United States, stroke is the 4th most common cause of death [59,60]. Furthermore, it is one of the most disabling diseases, requiring extensive therapy. Two of the studies found evaluated EATs as potential alternative therapies.

Beinotti et al., using EAT on a population of 20 post-stroke patients who were divided evenly into two groups [27]. The control group received Treatment as Usual (TAU) three times per week for 16 weeks, whereas the EAT group received TAU sessions twice per week plus one weekly EAT session for 16 weeks. Outcomes were measured using the Functional Ambulation Category Scale, the Fugl-Meyer Scale, the BBS, and functional assessment of gait [27].

Results showed that subjects who were part of the EAT group had a significant improvement over the control group in motor impairment ($p = 0.004$) in the Fugl Meyer Scale, and in the lower limb item of the Functional Ambulation Category Scale ($p = 0.01$). However, there was a significant change in motor impairment in the whole population ($p = 0.007$) [27].

In another study by Beinotti et al. they studied the effect of EAT on quality of life [21]. Ten patients were split evenly into EAT and control groups. The EAT intensity consisted in 2 TAU sessions per week for 16 weeks plus one EAT session per week; the control group only received three TAU sessions per week for 16 weeks. Outcomes were measured in the same manner as in the previous study, plus the SF-36 questionnaire [21].

Results showed positive outcomes in quality of life, which were greater in the EAT group. Mean SF-36 increased from 77.0 to 93.6 points for EAT, whereas it decreased from 79.6 to 73.5 points for the control [21].

6.6. Spinal cord injury

Using a pre-post, uncontrolled, design, Lechner et al. measured the short-term effects of a specific EAT program on spasticity in 31 patients with spinal-cord lesions [32]. Determinations of the Ashworth Spasticity scale were made immediately before and after EAT. Results showed a positive effect of EAT on spasticity on the short-term. No follow-up measurements were taken. In addition to not having a concurrent control group or rater blinding, pharmacological therapy was not considered as a confounder.

These issues were addressed in another study by the same group published in 2007 [33]. Twelve volunteers participated in a cross-over trial comparing three interventions: EAT, sitting astride a Bobath Roll and on a modified rocker board. All interventions lasted 25 min and were performed biweekly for 4 weeks. Short-term effectiveness on spasticity and well-being was verified. However, no long-term effects were observed for any of the three interventions [33].

6.7. Schizophrenia

Although AAT has been used in a number of psychiatric conditions, the vast majority of studies have been performed in mixed samples, making it difficult to determine the effect on specific conditions. However, one of the studies found, by Barak et al. reported the results of a randomized clinical trial on a sample of 20 patients with schizophrenia [22]. Assignment was symmetrical and randomized, and patients were allowed to select cats or dogs according to their preference. Significant improvements were observed for the Social Adaptive Functioning Evaluation in both groups. However, the AAT group showed significantly greater differences from baseline. A limitation of this study was the predominantly female sample, which is not consistent with population-wide prevalence [22].

7. Discussion

Limited evidence exists for some of the most commonly reported uses of AAT. There is insufficient scientific support for AAT in the management of depression. Results are inconsistent, even across parallel, randomized, designs. Possible factors that contribute to this variability include the novelty effect, whether the therapy was delivered in group or individual format, and study duration.

The use of AAT in managing agitation in patients with dementia has shown overall positive results. However, the studies conducted have been largely observational, with small samples and equivocal results. Furthermore, at least one study suggests that the effects of AAT are not enduring. As of yet, there is no sufficiently compelling evidence to justify an investment into establishing AAT programs for this purpose.

Preliminary evidence supports the efficacy of AAT in managing behavioral symptoms of dementia in institutionalized patients. However, most studies have used observational designs, or have measured outcomes using unblinded evaluators. There is a clear need for more rigorous research to verify the findings of these studies. Accordingly, at least one randomized, parallel assignment, clinical trial is underway (NCT02829801). The successful implementation of AAT for behavioral symptoms promises to have a significant effect on everyday management of dementia. Since burnout risk is particularly high in dementia caregivers [52], the reduction of behavioral symptoms promises to reduce disease burden to both patients and caregivers.

Some evidence exists that AAT can have an effect on both the spectrum of cognitive decline and healthy aging. At least one study has reported positive effects on the quality of life of unimpaired elderly adults. Since assisted-living facilities often congregate patients with various degrees of decline, AAT could provide benefits to the entire population.

AAT constitutes a new possibility of treatment for people with PTSD. One study in healthy subjects suggested that DATs can be combined with standard cognitive behavioral therapy to reduce anxious arousal, but this association is yet to be tested in actual patients [61]. More studies are needed to strengthen the evidence regarding AAT in PTSD patients, but the tendency suggests a benefit. Further research could be supported by the significant resources that governmental agencies have devoted to this issue [62].

The use of EAT in MS has undergone increasingly rigorous testing, culminating with high-quality evidence of its efficacy in improving balance and quality of life. Although some evidence exists supporting EAT's use to improve spasticity and fatigue, these have only been explored as secondary outcomes. Further research regarding these secondary end-points is required. Likewise, results from studies on spinal-cord injury and stroke require further development.

The studies found raise no concerns regarding the safety of the interventions. Although EAT has clear risks, they appear to be addressed sufficiently in the study protocols, as no participant experienced a serious adverse event derived from therapy.

Although no specific cost-effectiveness studies have been conducted for AATs, some evidence from other settings can be extrapolated. Animal upkeep can be a considerable expense, and lifetime upkeep of a therapy dog has been estimated to be around $10,000 USD [63]. With

regards to horses, the University of Tennessee in 2015 estimated general costs associated with a horse-related business to be around $47,301 USD per year [64]. Additionally, training for specialized personnel is required and can vary depending on the animal. For example, the starting certification offered by PATH International exceeds $4000 USD [65].

This review is limited in its extent by having considered only articles in European languages. High variability in instruments, and a lack of detailed information regarding specific techniques, limit more thorough analysis. There is some overlap with existing reviews for the earliest studies included in this review, which limits novelty. The field of AAT has evolved since these early studies were published, often in response to study results, and new handbooks have been published since [11]. However, these early studies allow for an appreciation of the steadily-increasing quality of AAT research.

It is noticeable that greater effect sizes were observed in studies focusing on motor outcomes after EAT, which is also the most consistent form of AAT. Therapies using other animals have shown less consistency.

Unanswered questions regarding AAT include the effect of more consistent interventions, optimal animal characteristics [11,66], therapy intensity, cost-effectiveness and degree of animal involvement.

8. Conclusions

AAT has many potential applications in patients with particular conditions and their caregivers. In dementia, research shows a reduction in agitation, enhanced quality of life, and a potential reduction in caregiver distress. In depression, although research shows overall positive results, the scientific evidence in favor of AAT is insufficient. There is a paucity of research published in scientific journals regarding AAT for PTSD, but preliminary results suggest a potential benefit. There is strong evidence supporting the use of EAT for motor outcomes and quality of life in patients with MS. In patients with stroke and spinal cord lesions, EAT has shown improvements in motor impairment, although further research is needed to consolidate this indication.

Research shows favorable results toward the use of this therapy. However, more thorough research should be done to strengthen the existing evidence. Therapy intensity and procedures should be standardized for a better interpretation of the benefits.

Conflicts of interest

None of the authors declare any conflict of interest.

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