Assistance Dogs and Human Health and Wellbeing

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Abstract

Assistance dogs are guide dogs, hearing dogs and service dogs, all of which are specifically trained to perform tasks to mitigate the effects of an individual's disability. Service dogs include, but are not limited to; mobility, alert, response, autism, psychiatric and foetal-alcohol spectrum disorder dogs. The level of effectiveness of assistance dog use on human health and wellbeing is an area within human-animal interaction research that has limited understandings. A review of the literature aims to synthesise relevant knowledge in the area.

Overview

For a number of people living with disabilities and health problems, animal-assisted interventions have been utilised. One particular intervention is the use of assistance dogs. These are dogs individually task-trained to provide assistance to people living with disability. Assistance dogs comprise guide dogs, hearing dogs and service dogs. As the number of assistance dogs continue to rise globally, their effectiveness as a tool for mitigating individuals' disability is an important consideration. This review of the literature outlines the existing types of assistance dogs and under what conditions such animals are used, including their history and evidence for improvement of human physical, psychological and social health. Suggestions for future research are made.

Disability

As outlined by Assistance Dogs International (ADI, 2020) the term "disability" is defined as an impairment that substantially limits one or more major life activities, including people with history of such an impairment, and people perceived by others as having such an impairment. The World Health Organization (WHO) International Classification of Functioning, Disability and Health (2001) provides a three-dimensional model of disability. Firstly, the model involves impairment in a person's body structure or function or mental functioning, such as loss of a limb or memory loss. Secondly, the model refers to activity limitation, such as difficulty seeing, walking, or problem solving. And thirdly, it refers to restriction in participation of regular activities, such as working or engaging in recreational activities. Activities include domestic tasks, self-care, community-based activities and accessing health care services. Parallel to these dimensions are the contextual factors with which they interact. Contextual factors include personal factors such as personality, culture and identity, as well as environmental factors such as place of residence. For example, a person with multiple sclerosis may have difficulties walking. They may then use a

wheelchair, which may have repercussions on activity participation due to inaccessibility (e.g. stairs to a restaurant with no wheelchair ramp). The person may also have contextual factors at play. For example, they may have an introverted personality, not wanting to seek-out social situations, or they may live rurally and therefore have less accessibility to healthcare services. Disability is therefore not simply a health problem, but rather a multifaceted condition involving structure, activity, participation and contextual factors, which all interplay (WHO, 2011).

Health and Wellbeing

The notion of health for this review is guided by the World Health Organization's (WHO, 1948) definition expressing that "health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." WHO's definition closely aligns with the biopsychosocial model of health, considering physiological, psychological and social factors in health, tying them to wellbeing. Wellbeing refers to a positive state of living, linking health to a means of living well (Centers for Disease Control and Prevention, 2018).

Assistance Dogs

Assistance dogs are a particular type of domesticated dog which fall alongside, but separate to working, therapy and emotional support dogs (American Kennel Club, 2020). Assistance dogs adopt a health-oriented position relative to other types of dogs, hence their categorisation as animal-assisted interventions. Specifically, animal support is given by accredited organisations that train dogs and dog-handlers for healthcare services, such as mobility service dogs assisting movement for a paraplegic client (Animal Assisted Intervention International, 2020). According to Assistance Dogs International (ADI, 2020) an assistance dog is a guide, hearing, or service dog specifically trained to do three or more tasks to mitigate the effects of an individual's disability.

There are differing types of assistance dogs, dependent on disability type and individual needs. Some types of assistance dog, such as the guide dog, are used for people living with vision impairment and have been utilised by humans for decades, with their documented systematic introduction dating back to the early 1900's (Ostermeier, 2010). Other types of assistance dog, such as the psychiatric service dog, have more diverse services to accommodate differing conditions and were only formally developed relatively recently. For example, the Americans with Disabilities Act (1990) formally defined the idea that service dogs could be used to aid health conditions outside of blindness and deafness only 30 years ago.

Moreover, assistance dogs are not restricted by breed, though desirable characteristics typically include a calm temperament, ease in trainability and good health. Assistance dogs range in size, with medium-sized dogs typically used as guide dogs (e.g. Golden Retrievers and Labradors), small dogs typically used as hearing dogs (e.g. Terrier mixes), and larger breeds using their strength and stamina to provide mobility services (e.g. German Shepherds) (ADI, 2020). On average, it takes two years and over A$50,000 to raise, train and place a guide dog (Guide Dogs Australia, 2020). Similar reports from Australian Lions Hearing Dogs (2020) and Assistance Dogs Australia (2018) approximate upwards of $30,000 and $40,000 in costs for hearing dogs and service dogs respectively. This raises questions about the cost-benefit ratio of training such aids, as well as considerations for the experiences of guide dog puppy raisers (Chur-Hansen, Werner, McGuiness & Hazel, 2015) and dogs themselves (Ng, Albright, Fine, & Peralta, 2015). In 2018 The International Guide Dog Federation (IGDF, 2020) reported that 3,299 guide dog teams (fully trained guide dog successfully matched with client) were produced by the 99 IGDF member organisations operating across 32 countries across 12 months. The exact number of assistance dogs (guide dogs, hearing and service dogs collectively) at present globally, is unknown.

In addition to regular health needs, individuals living with disability have specific needs related to their disability. Due to bodily function or structure barriers, as well as psychological and social barriers limiting access to health services, some individuals with disability may experience greater health impediments (WHO, 2011). The utilisation of assistance dogs is posited to reduce the need for certain services to individuals, as the dogs can be trained to meet individual requirements, theoretically reducing dependency on other healthcare services (ADI, 2020). For example, families with children on the autism spectrum have reported decreased child meltdowns, anxiety and stress, and researchers have identified reductions in salivary cortisol secretions, on the introduction of an autism service dog to a family (Burrows, Adams and Spiers, 2008; Viau et al., 2010). In addition to these effects are reported improvements in areas such as sleep, attention and language use for the child (Berry, Borgi, Francia, Alleva, & Cirulli, 2013).

In keeping with both ADI's definition of disability and WHO's model of disability, in this review studies involving the effects of assistance dogs on the mitigation of disability will be examined across physical, psychological and social areas of health. As classifications and jurisdictions of assistance dogs vary widely across countries, assistance dog terminology will firstly be reviewed. Assistance dog-types will then be discussed in order of their introduction as a disability-related service, with particular relevance to their history and documented contributions to human health and wellbeing.

Terminology in the Area

The terms 'assistance dog' and 'service dog' are often used interchangeably dependent on the country in which the dog resides. Assistance Dogs International (ADI), an organisation which attempts to create cross-country uniformity, guides contemporary terminology. Unlike working dogs (e.g. herding, police, cadaver or search-and-rescue dogs) which are trained to perform tasks, assistance dogs perform tasks directly related to their

owner's disability. Further, therapy dogs and emotional support dogs, whilst both are trained, are not considered assistance dogs under legislative public access laws (ADI, 2020). This is because roles and rigour of training differ. Therapy dogs are trained to provide comfort and affection, and emotional support dogs are trained to provide emotional or therapeutic support. Unlike assistance dogs, therapy and emotional support dog training is not required by law, and training organisations are not held to the same high accreditation standards as assistance dog organisations. As such, therapy and emotional support dogs do not have the same public access rights as an assistance dog and its owner. Whilst assistance dogs may be secondarily regarded as companion dogs or pets, the reverse is not considered so, and the presence of a dog for protection, personal defence, or comfort does not qualify that dog as an assistance dog. A large body of research in the area of companion animals provides evidence of the benefits of the dog-human relationship (Barker & Wolen, 2008; Keat, Subramaniam, Ghazali, & Amit, 2016). In their 2002 review Sachs-Ericsson, Hansen and Fitzgerald theorise this is also likely to apply to individuals who have obtained an assistance dog, though further updated research to determine this is needed.

A further clarification is the distinction of assistance dogs from other animals within animal-assisted activities and therapy. Animal-assisted activities (AAA) are activities which provide opportunities for motivational, educational, therapeutic and/or recreational benefits to enhance human quality of life (Arkow, 2015). Within this falls animal-assisted therapy (AAT), also known as pet-therapy, which is a more structured and goal-directed treatment process in which the animal is integrally incorporated (Arkow, 2015). Both AAA and AAT do not commonly use assistance dogs. They are characterised by relatively short-term human-animal interactions, compared to the length that assistance dogs interact with their owners, which is typically years. The human-animal interaction between a participant or client and a dog within AAA or AAT are usually visitations, where the client or participant is introduced

to the dog by a trained handler (Animal Assisted Intervention International; AAII, 2020). The human-animal interaction between an assistance dog and their handler can be hours a day and last for many years, meaning the interaction is long-term (Assistance Dogs Australia, 2018). Whilst assistance dogs may be used in AAA or AAT for the general public, this is not usual, as they are trained to perform tasks specific to their owner. Assistance dogs fall under the categorisation of animal-assisted intervention (AAI). AAI is an umbrella term which incorporates both AAA and AAT, however, assistance dog AAIs are more readily recognisable as the intervention is delivered by an accredited organisation with the use of specially trained animal-handlers (AAII, 2020). AAIs with assistance dogs are goal-oriented, but unlike AAAs and AATs, there is a strong focus on documentation and evaluation of the intervention process (AAII, 2020). Contrary to positive public perception (Schoenfeld-Tacher, Hellyer, Cheung, & Kogan, 2017) human health and wellbeing research specific to assistance dogs in the context of guide, hearing and service dogs is minimal.

Guide Dogs

Guide dogs aid people with blindness or vision impairment by assisting them with navigation (ADI, 2020). Guide dogs generally do this by obeying instructions from their owners about which direction to move; they find a suitable path, locate doors, steps, pedestrian crossings and avoid common obstacles such as other people (Health Direct, 2018). In 1916, the world's first modern-day guide dog school opened in Germany to improve the mobility of returning veterans who were blinded in battle (Ostermeier, 2010). It was not until almost a decade later, in 1927, that the guide dog movement began to spread to other parts of the world (Ostermeier, 2010). Regarding large-scale research in the area, dog behaviour and training methods were examined in the 1920's and 1930's by Von Uexkull and Sarris, who found their value worthwhile, and who introduced advanced methods of training (Magnus, 2014).

Formalised literature on guide dogs began in the United Kingdom in the 1940's, with *Forward*, a magazine for supporters, clients and the general public being one of the first publications. Since its first edition, the magazine still publishes up-lifting stories about owners and their guide dogs, as well as their volunteers and trainers. As other guide dog organisations began to grow across the world, they followed suit, offering anecdotal stories which persist on their websites today (International Guide Dog Federation, 2020, https://www.igdf.org.uk/about-us/facts-and-figures/history-of-guide-dogs/; Blindenhundeschule, 2020, http://www.blindenhundeschule.ch/en.html; Guide Dogs UK, 2020, https://www.guidedogs.org.uk; Guide Dogs of America, 2020, https://www.guidedogsofamerica.org; Guide Dogs Australia, 2020, http://guidedogsaustralia.com). Many guide dog organisations (e.g. Guide Dogs NSW, 2019) present annual reports sharing key highlights, stories, strategic planning, partner recognition, financial statements, leadership, governance, company service information and contact details. These reports revolve mostly around the company and training or health implications of the dogs, with little information attributed to scientific evidence or research regarding their effectiveness.

Previous studies of guide dog ownership have demonstrated the usefulness of guide dogs across a range of settings. Upon the identification of people with visual disabilities facing challenges of physical exercise, Yamamoto, Yamamoto and Hart (2015) surveyed guide dog owners to assess their facilitation of walking. They found that guide dog owners walked significantly more when compared to their companion dog owner counterparts. That is, they facilitated walking more frequently and for longer durations, indicating in terms of quantity of physical activity, that guide dogs increased human mobility. A limitation of this study was that questionnaire responses relied upon respondents estimating time spent walking, introducing subjectivity and human error.

Although guide dogs have traditionally been thought to benefit those with visual impairments in practical or functional ways, it has long been postulated that they also offer psychological and social benefits, though as pointed out by McIver, Hall & Mills (2020) many previous studies exploring this have been cross-sectional (e.g. Glenk, Pribylova, Stetina, Demirel and Weissenbacher, 2019). McIver, Hall and Mills' (2020) recent longitudinal study measuring independence and quality of life (QOL), however, illustrated that acquisition of a guide dog showed a significant increase in perceptions of these measures compared with those who remained on the waiting list.

Specific research related to the social benefits of guide dog ownership is at its preliminary stages and more research is needed (Whitmarsh, 2005). In all, guide dog research demonstrates promising outcomes for physical and psychological aspects of human health and wellbeing, with social outcome measures identified as a particular gap in the literature. The utilisation of more rigorous study designs and replication is needed to consolidate research findings.

Hearing Dogs

Hearing dog organisations to assist hearing impaired individuals were formally developed in the United States of America in the 1970's. Specifically, hearing dogs alert individuals who are deaf or hard of hearing to particular sounds like telephones, doorbells or alarm clocks, usually by nudging their owners to attention (ADI, 2020). Hearing dogs were officially recognised in 1976 when the "Hearing Ear Program", later known as Hearing Dog Incorporated, began in Colorado in the United States (International Hearing Dog, Inc., 2020). Rather than breeding puppies specifically, a new model was established whereby dogs were selected from animal shelters and humane societies to be trained for hearing impairment assistance (Tedeschi, Pearson, Bayly, & Fine, 2015).

In much the same way early guide dog literature appears to heavily rely upon testimonials and experiential accounts of owners, so does a large proportion of the literature related to hearing dogs (International Hearing Dog, Inc., 2020; Australian Lions Hearing Dogs, 2020). In addition to various magazines, hearing dog organisations have produced annual reports in much the same way as guide dog organisations (e.g. Australian Lions Hearing Dog Annual Report, 2018).

Studies looking into the effectiveness of hearing dogs on human health and wellbeing again include physical, psychological and social contexts. A longitudinal study aiming to study these effects found that recipients reported significant reductions in measures of hearing-related issues such as reaction to environmental sounds; significant reductions in measures of depression, tension and anxiety; and significant developments in social participation (Guest, Collis, McNicholas, 2006). Prior to this, the most recent studies related to hearing dogs were performed in the nineties (Hart, Zasloff, & Benfatto, 1995; Hart, Zasloff, & Benfatto, 1996). Issues within hearing dog research are analogous to that of guide dogs, with a particular shortage of evidence-based studies related to hearing dogs and human health and wellbeing in general. Overall, although preliminary findings show promising outcomes, hearing dog studies need replication to produce reliable results.

Service Dogs

The introduction of service dogs, which are dogs that work for individuals with disabilities other than blindness or deafness (ADI, 2020), also began in the late 1970's. Canine Companions for Independence (CCI, 2020) pioneered the idea of specialised service dogs that could be individually trained to assist with specific tasks for a person with a disability. They were the first of many organisations to train dogs in multiple assistance roles including, but not limited to, pulling a wheelchair, bracing, retrieving, alerting to a medical crisis and providing assistance in a medical crisis (ADI, 2020). Service dog organisations

took to both puppy-breeding and shelter selection models, and service animals roles have since expanded to support the ever-increasing demand. It is therefore important to note that whilst service dogs have traditionally helped individuals living with physical disabilities, as the conceptualisations of disability and health have evolved, so too has the conceptualisation of service dogs.

Much like guide and hearing dogs, service dog literature is dominated by testimonials (e.g. Canine Partners for Life, 2020; Freedom Service dogs, 2020), and annual reports (e.g. Assistance Dogs Australia, 2019). More evidence-based studies have evolved over the past decade. Giving insight into their potential benefits is a recent study completed by Lundqvist, Levin, Roback and Alwin (2018) which indicated (from their sample of 30 physical service dogs, 20 diabetes alert dogs, 2 epilepsy alert dogs and 3 hearing dogs) that service (and hearing) dogs are a potentially important aid in strain alleviation, independence promotion and the buffering of social isolation. That is, they may assist in the lessening of painful movements, increase the likelihood of autonomous living, and promote more social interactions within the individual's community. In sum, service dogs show promising preliminary effects across physical, psychological and social areas of human health and wellbeing. Each type of assistance dog subcategory will be discussed in greater detail to explore potential individual benefits toward human health and wellbeing.

Mobility Service Dogs

Individuals living with impaired mobility have functional challenges due to a range of factors. Factors contributing to mobility impairment may be largely hereditary such as spina-bifida, caused by external events such as an acquired brain or spinal injury causing paralysis, or by a genetic combination of the two such as Parkinson's disease. Individuals with mobility impairment may find daily tasks difficult, painful or impossible. This is particularly evident when related to environmental inaccessibility, as is the case with manual wheelchair users

(Velho, Holloway, Symonds, & Balmer, 2016). Mobility impairments may lead an individual to a more sedentary lifestyle, in turn leading to a higher susceptibility to health problems (Kloosterman, Snoek, van Der Woude, Buurke, & Rietman, 2013). This can include the development of secondary musculoskeletal impairments, cardiorespiratory deterioration, as well as pain and fatigue (Brown, Dimarco, Hoit & Garshick, 2006; Xiang, Chany, & Smith, 2006).

Mobility service dogs may help further injury prevention and energy conservation for people with mobility impairments by performing tasks such as opening doors, activating medical devices or detecting/alerting crises, retrieving dropped items and providing counterbalance for transitional movements (ADI, 2020). Anecdotal evidence for this is presented by multiple organisations (e.g. 4 Paws for Ability, 2019; Anything is Pawsable, 2020).

A systematic review evaluating service dogs for people with mobility-related physical disabilities found that all studies which met the review criteria found a positive relationship between service dog ownership and either functional benefits, psychological benefits and/or social participation (Winkle, Crowe, & Hendrix, 2012). All 12 studies, however, had methodological design concerns. Each included study was rated as weak due to small participant sizes, poor intervention descriptiveness and outcome measures, leaving the area with encouraging yet unreliable results.

Alert and Response Dogs

Alert and response dogs cover a wide range of service dogs specific to different medical conditions, most commonly epilepsy and diabetes (ADI, 2020). Epilepsy is a neurological disorder characterised by recurrent seizures. Seizures are episodes of sensory disturbance which involve involuntary convulsions and loss of consciousness associated with abnormal electrical activity in the brain (WHO, 2019). Epilepsy is often associated with

fatigue and can cause permanent brain damage, increasing the risk of co-morbidities (Stafstrom & Carmant, 2015). Diabetes is a chronic disease related to impaired insulin production and can similarly increase the risk of co-morbidities (WHO, 2019).

Alert dogs refer to service dogs that are trained to alert a person to the onset of a condition such as abnormal insulin levels or a seizure (ADI, 2020). Response dogs refer to service dogs that are trained to provide safety to a person experiencing or who has just experienced a medical episode such as a seizure (ADI, 2020). Many organisations purport that trained detection and response is highly beneficial (e.g. Dogs 4 Diabetics, 2020; Paws with a Cause, 2013).

For diabetes-alert dogs, two recent studies both using continuous glucose monitoring systems, revealed largely positive participant experiences but low reliability in detection and high false-positive rates. Los, Ramsey, Guttmann-Bauman and Ahmann (2017) concluded that dog alerting is unlikely to be helpful in differentiating abnormal levels of glucose and Gonder-Frederick, Grabman and Shepard (2017) found that only 3 out of 14 individual dogs performed statistically higher than chance, indicating that dog performance was highly variable. Similarly, a review of seizure alert dogs to verify innate seizure-alerting abilities found results to be inconclusive (Dalziel, Uthman, McGorray, & Reep, 2003). Prior to this, two surveys investigated seizure-alerting and response behaviours looking at psychological measures rather than physical measures (Kirton, Wirrell, Zhang, & Hamiwka, 2004; Kirton, Winter, Wirrell, & Snead, 2008). Both reported positive differences in quality of life scores between families with and without dogs, yet the question was raised as to whether reported benefits were related to seizure assistance abilities or simply animal companionship. Social benefits of alert dogs are relatively understudied and are identified as a gap in the literature. There is a significant gap between positive experiences reported and objective research findings in the reliability of alert and response dogs trained to be receptive to different

medical conditions. Paradoxically, dog users are generally satisfied with their dogs though objective tests of dog alerting performance show low reliability, demonstrating that they may have psychological benefits, but these are not explicitly linked to their training as a service dog.

Autism Service Dogs

Autism spectrum disorder (ASD) is a developmental condition that involves persistent difficulties in social interaction, speech and nonverbal communication characterised by restricted or repetitive patterns of thought and behaviour (American Psychiatric Association, 2018). Growing evidence suggests morbidity and mortality rates for those with ASD are significantly higher than the general population, and that symptom severity varies widely across people (Croen et al., 2015; Hirvikoski et al., 2016; Bishop-Fitzpatrick & Kind, 2017).

Autism service dogs reflect this variety in the individualised tasks that they are trained to perform. Tasks commonly performed by autism service dogs include; keeping a child from fleeing, alerting guardians to dangerous behaviours, involvement in search and rescue activities, facilitation in sensory integration and calming, and social support (Burrows & Adams, 2008; Pavlides, 2008). Many tasks performed by autism service dogs take a socially-based approach, and though these dogs are used to increase independence of the individual (i.e. increased impulse-control and ability to function in public), their involvement in also providing their owners with emotional and physical support makes them difficult to distinguish from therapy dogs and search-and-rescue dogs (Collins et al., 2006).

A lack of distinguishable literature in the autism service dog area reflects incongruity with the public perception of their potential positive outcomes. Outlined by Pavlides (2008), testimonials of therapists, animal trainers and families of individuals with autism remain the largest portion of the autism service dog evidence-base (e.g. Smart Pups, 2017; RSB Autism Assistance Dogs, 2020).

An early study addressing the social impact of assistance dogs on children with disabilities found that children in wheelchairs received more social acknowledgements when a service dog was present compared to when a service dog was not present, suggesting that service dogs may normalise social interactions and act as a social buffer (Mader, Hart, & Bergin, 1989). Since this time, although ASD and therapy dog research has received more attention than that of ASD and service dog research, a critical review of the evidence on both dog-types for children with ASD concluded that further research with better designs and larger samples is needed to strengthen intervention-to-clinic translation (Berry, Borgi, Francia, Alleva and Cirulli, 2013). Within this review only two studies met the specified assistance dog inclusion criteria. Burrows, Adams and Spiers (2008) conducted a semi-structured interview investigating experiences of gaining a service dog. Whilst they found that service dogs may provide benefits to children with ASD and their families functionally, psychologically and socially, the subjectivity of questions introduced bias. Viau et al. (2010) performed a longitudinal repeated-measures design looking at the physiological impact of service dogs on cortisol levels of ASD children. They found that cortisol diminished in the presence of the service dog, which lends support to potential behavioural benefits.

Psychiatric Service Dogs

Psychiatric (or mental) disorders or illnesses, comprise of a range of problems with differing symptoms. Symptoms are usually characterised by a combination of abnormal thoughts, emotions, behaviour and relationships with others (WHO, 2017). Examples of psychiatric illnesses include depression, anxiety, schizophrenia and post-traumatic stress disorder (PTSD). Long term outcomes of untreated mental illness vary. They may be related to chronic physical health problems (e.g. increased risk of myocardial infarction), acute physical symptoms (e.g. headaches or muscle tension related to anxiety), or social outcomes

(e.g. job stability issues or homelessness) (The Australian Government Department of Health, 2009).

The vast array of problems experienced by people living with mental disorder means that psychiatric dogs, like all service dogs, are individually trained to perform tasks specific to their owner's disability. Trained behaviours to mitigate a psychiatric disability can include, but are not limited to; providing environmental assessment for paranoia, acting as a brace to guide the handler through stressful situations such as accessing public transport, alerting behaviours for interrupting self-harm or reminding the handler to take medication (Froling, 2009).

According to Lloyd, Johnston and Lewis (2019) literature searches specific to psychiatric service dog use for people living with mental health disorders revealed that there is little known about the individuals who own these service dog-types, the types of dogs used or the functions they provide. As psychiatric service dogs are an emerging complementary treatment area, it appears literature on effectiveness is only in the beginning stages. Studies investigating the role psychiatric service dogs play in the lives of military members and veterans with PTSD has recently gained popularity in the service dog area. Anecdotal accounts of their value are documented (e.g. Mind Dog, 2017; Little Angels Service Dogs, 2020) and empirical research on their effectiveness is in its infancy, as stated by O'Haire and Rodriguez (2018) in their preliminary efficacy study. They found that the addition of trained service dogs to usual care may offer meaningful improvements in PTSD symptomology, though it does not appear to be significantly associated with a loss of diagnosis, and ongoing research is needed. Shortly after this study, a scoping review was performed on available studies of psychiatric service dogs for PTSD (Van Houtert, Endenburg, Wijnker, Rodenburg, & Vermetten, 2018). Reviewers similarly recommended methods be expanded to include the

development of standardised and objective measures besides self-reported welfare of assisted humans.

Foetal-alcohol Spectrum Disorder Dogs

Foetal-alcohol spectrum disorders (FASDs) are a group of conditions affecting physicality as well as behaviour and learning which occur in a person whose mother drank alcohol during pregnancy (Australian Medical Association, 2016). Organisations such as Nina Service Dogs train dogs in behaviour disruption and scent training, much like autism service dogs. Testimonials are presented for the concept of foetal-alcohol spectrum disorder dogs within these organisations (Greene, 2012), however, to date zero evidence-based research studies on FASD dogs exist in the literature.

Future research

Research has explored the effectiveness of assistance dogs on human health and wellbeing, though there is heterogeneity in study designs, outcome measures and the theoretical frameworks implemented. Consequently, the effectiveness of assistance dogs on human health and wellbeing is inconclusive. Further in-depth systematic research is fundamental in understanding the effectiveness of assistance dogs as a justifiable intervention for people with a disability. Specifically, a systematic review of the literature is an essential step towards identifying gaps in available evidence. Unlike literature reviews, systematic reviews involve internationally recognised, rigorous and transparent steps to identify and examine all the available evidence. A clearer understanding of published findings will guide researchers to undertake primary research focusing on understudied areas, thereby ultimately informing future healthcare practices.

As highlighted, findings regarding the effectiveness of assistance dogs vary within the body of relevant studies. Findings indicate that the effectiveness of assistance dogs appears to vary both between assistance dog-type and within assistance dog-type. That is, guide and

hearing dogs show promising findings, response and alert dogs show unfavourable results, and for all other service dogs it is unclear. Within an assistance dog-type (e.g. within response and alert dogs) there are observed inconsistencies between reported outcomes. That is, while there are positive results in self-reported outcomes, objective measurement outcomes are neutral (i.e. the halo effect, Burrows and Adams, 2008). A systematic review may illuminate inconsistencies such as these, allowing them to be explored further from an evidence-based standpoint. Accordingly, future primary research could then improve the robustness of the evidence-base, guiding our knowledge and understanding of assistance dogs.

To date, several literature reviews investigating assistance dogs as an intervention for people with a disability have been conducted. Sachs-Ericsson, Hansen and Fitzgerald (2002) have conducted a review of the benefits of service and hearing dogs, though this investigation is both dated and limited in that it does not consider guide dogs. Furthermore, Winkle, Crowe and Hendrix (2012) more recently reviewed the effectiveness of service dogs, though this only considered people with a physical disability. Reviews specific to certain types of assistance dogs have also been conducted. For example, Dalziel, Uthman, Mcgorray and Reep's (2003) review focuses on seizure-alert dogs and Van Houtert, Endenburg, Wijnker, Rodenburg and Vermetten's (2018) review focuses on service dogs for veterans with PTSD. However, there does not appear to be any recent collation of the best available evidence pertaining to all assistance dog-types and to their impact on human health and wellbeing as a whole. Exploration of current human health and wellbeing outcomes in the context of a contemporary understanding of disability is warranted.

Research in the area of assistance dogs is important in the context of health. Approximately 15% of the global population lives with a form of disability, with 2-4% experiencing significant functioning deficits (WHO, 2011). Advancements in assistive

technologies may help to ameliorate some of these deficits in function. Alternatively, if assistance dogs do not benefit people, filtering resources into evidence-based interventions, or conducting further research into advancing technologies, may more effectively assist health-care systems and individuals. At present, although studies are beginning to use more rigorous designs, there remains limited exploration utilising randomised controlled trials, longitudinal or observational designs. Furthermore, the systematic synthesis of existing literature has not been conducted. A synthesis of available research excluding case report and case series reduces the potential impact of biases, thereby maximising the attainment of an accurate and generalisable estimation of the effects of assistance dogs. A systematic review may assist allied health (e.g. physiotherapists, psychological and occupational therapists or disability social workers) to make decisions on chosen physiological, psychological and social interventions involving assistance dogs. Such findings can be used to promote and implement a holistic approach to healthcare.

Overall, a systematic review of the best available evidence may highlight gaps in the literature, giving rise to specific primary research target-areas. A synthesis of information would provide a better understanding of the effectiveness of assistance dogs across different settings, and as a whole. This process would provide greater clarity around consistency of the effectiveness of assistance dogs, which can be used to inform future healthcare practice.

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Assistance Dogs and Human Health and Wellbeing:

A Systematic Review

Abstract

Research in the area of assistance dogs is largely inconclusive. A systematic review of the best available evidence to determine the effects assistance dogs may have on individuals' disability is needed to guide knowledge and understanding of the area. Following Joanna Briggs Institute methodology a synthesis of experimental and observational analytic studies on guide, hearing and service dogs aimed to determine their current level of effectiveness in assisting human health and wellbeing. Based on apriori inclusion criteria a total of 20 studies were included in the review; one randomised controlled trial, 12 quasi-experimental studies, 5 cross-sectional studies and two mixed methods design. Studies varied greatly in population, intervention, outcome measures and conclusions drawn. The overall quality of included studies was poor. The most frequently investigated disability-type was physical (guide, hearing, mobility, alert and response dogs), followed by psychological (psychiatric dogs), then social (autism service dogs). Outcomes varied, with some potentially positive effects of assistance dogs evident, but with significant methodological issues present throughout. Heterogenic findings limit recommendations for future practice, however, multiple future research recommendation are made.

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Keywords: Assistance dogs, disability, health, wellbeing; systematic review

Introduction

Assistance dogs are a type of animal-assisted intervention utilised by people living with disability. Assistance dogs are health-oriented working dogs task-trained to provide assistance in an individualised manner to people, dependent on their disability-type. Guide dogs are used to assist people living with visual impairment, hearing dogs for those with auditory impairment, and service dogs for people with a range of disabilities. This range includes mobility service dogs, alert and response dogs, autism service dogs, psychiatric service dogs and foetal-alcohol spectrum disorder dogs.

As defined by The World Health Organization (WHO) International Classification of Functioning, Disability and Health (2001), disability is contextualised by three-dimensions. The dimensions are: 1) Impairment in a person's body structure or function or mental functioning, such as loss of a limb or memory loss, 2) Activity limitation, such as difficulty seeing, walking, or problem solving, and 3) Restriction in participation of regular activities, such as working or engaging in recreational activities. Contextual factors, including personal factors of personality, culture and identity, and environmental factors including transport, climate and residence, coincide and interact with these dimensions. Disability is therefore not simply a physical health problem, but rather a multifaceted condition involving structure, activity, participation and contextual factors, which all interplay (WHO, 2011). Similarly, guided by WHO (1948), health is contextualised as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

Interchangeability of terminology dependent on the country in which the dog resides alters the vocabulary used for assistance dogs. Assistance Dogs International (ADI, 2020), an organisation which creates cross-country uniformity, guides contemporary terminology. Therapy dogs, which are trained to provide comfort and affection; emotional support dogs, which are trained to provide emotional or therapeutic support; and pet dogs, commonly

associated with companionship, are not assistance dogs. They do not have the same formalised accreditation or training processes and therefore do not have the same public access rights as assistance dogs.

The value of assistance dogs is highly contended, with great variation in the literature regarding their effectiveness. Though previous reported findings are encouraging (Sachs-Ericsson, Hansen & Fitzgerald, 2002), a positive bias in self-reported outcomes has been observed (Burrows & Adams, 2008), along with multiple methodological concerns (Stern & Chur-Hansen, 2013). Historically, anecdotal accounts of the value of assistance dogs have been documented (e.g. Guide Dogs Australia, 2020). More recently, multiple primary research studies have been conducted with varying research designs (e.g. Guest, Collis, McNicholas, 2006; Davis, 2017). Further, reviews within assistance dog (e.g. Berry, Borgi, Francia, Alleva, & Cirulli, 2013) or human disability (Winkle, Crowe, & Hendrix, 2012) have been undertaken.

There is however, no recent all-encompassing systematic review to synthesise these findings. Particular assistance dog-types demonstrate promising results, whilst others indicate unfavourable results or observed inconsistencies. A systematic review would provide greater clarity regarding their actual level of effectiveness.

Objective

The existing literature on assistance dogs and their level of effectiveness toward human health and wellbeing is unclear. Research interest has increased steadily over time, with reviews taking place particularly in the physical disability and post-traumatic stress disorder (PTSD) (i.e. mobility service dog and psychiatric service dog) areas (Winkle, Crowe, & Hendrix, 2012; Van Houtert, Endenburg, Wijnker, Rodenburg, & Vermetten, 2018). Thorough reviews of high-quality evidence, however, are sparse. Thus, this systematic review aimed to add to the existing literature by synthesising best available existing evidence

regarding the effectiveness of assistance dogs on human health and wellbeing, whilst simultaneously identifying patterns and gaps in the literature. Furthermore, suggestions for future research and practice will be made based on findings.

Methods

This systematic review was guided by Joanna Briggs Institute (JBI) methodology for systematic reviews of effectiveness (2020). The review was submitted for registration with PROSPERO in February 2020 and is awaiting approval. The review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidance (Moher, Liberati, Tetzlaff, & Altman, 2009).

Eligibility Criteria

Studies were eligible for inclusion in the systematic review if they met the following criteria: (i) participants of any age or gender who had a disability; (ii) intervention involved an assistance dog (guide, hearing or service dog); (iii) assessment of human health and wellbeing outcomes; (iv) had an experimental or observational analytic study design; and (v) were published in English. For those studies that included a comparator group, this could consist of either a waitlist control, or of repeated measures either with and without the assistance dog, or of effects with the assistance dog over time.

Ideally studies state that participants were diagnosed with a disability, however, due to a limited amount of studies in the area, in instances where disabling conditions and assistance dogs were not supported with evidence (i.e. a diagnosis of a disabling condition verified by a medical practitioner, or the accreditation from a certified dog-training association), studies were still included. That is, if authors stated the participants had a disability, and if the dogs were referred to as assistance dogs, studies were included. For exclusion, there had to be clear absence of disability (i.e. no diagnosis or disabling condition) or contradiction of dog training or accreditation (i.e. the organisation was listed, but was not

an accredited organisation). This was to ensure high sensitivity in the incorporation of relevant studies. Similarly, health and wellbeing outcomes were intentionally kept broad in order to capture the multi-dimensional aspects of health and wellbeing (e.g. biological/ physical outcomes such as heart-rate, psychological outcomes such as quality of life, and social outcomes such as community participation). Mixed methods studies were included if the quantitative components could be clearly extracted. Editorials, commentaries, case studies, conference abstracts, qualitative studies and reviews were excluded.

Information Sources and Search Strategy

Seven electronic databases (CINAHL, Embase, Medline, ProQuest Dissertations and Theses, PsycINFO, Scopus, and Web of Science) were searched on February 1st, 2020. The search aimed to identify published and unpublished studies. An initial limited search of Medline and Scopus was undertaken to identify articles on the topic. The text words contained in the titles and abstracts of relevant articles were used to develop a full search strategy. The search strategy, including all identified keywords and index terms, was adapted for each included information sources, for which there were no date restrictions (see Table A, supplementary material). Three research librarians were consulted throughout the process to ensure accuracy of search terms. A manual search of reference lists of included studies was undertaken to identify any missed relevant studies.

Study Screening and Selection

Following the search, all identified citations were collated and uploaded into EndNote (Clarivate Analytics, PA, USA) and duplicates removed. Titles and abstracts were screened by one reviewer (IB) for assessment against the inclusion criteria for the review. A random 10% subset of the initial search (i.e. 53 records) were co-screened by two second authors (ACH) and (CS), as were any additional uncertainties, for discussion and consensus.

Potentially relevant studies were retrieved in full and all full-text papers were screened by all authors, with any discrepancies resolved through discussion.

Assessment of Quality

Authors met to discuss the tools and determined how each criterion would be met to ensure a consistent approach. JBI critical appraisal tools (2017) were used to assess the reported methodological quality of the 20 included studies. Assessment was carried out by the first author (IB), with the two secondary authors (ACH) and (CS) independently co-assessing the same 20 studies (i.e. 10 studies each). Any discrepancies were resolved by discussion. The extent to which each study considered the potential for bias across study design, conduct and analysis was assessed by responding “yes”, “no”, unclear” or “not applicable” to between eight and thirteen questions, dependent on the checklist used for each corresponding study design (see Tables 2, 3 and 4). All studies regardless of methodological quality were included in the review.

Data Extraction

Adhering to the JBI guidelines for systematic reviews of effectiveness, a data extraction excel spreadsheet was developed and piloted. Piloting the data extraction spreadsheet with a second reviewer (CS) prior to use and assessing the standardisation of data extraction prior to commencement, ensured consistency and minimised the potential for errors. The data spreadsheet summarised key relevant information such as (i) study details (e.g. title, author/s, publication date, location); (ii) demographic features (e.g. number of participants, age, gender, disability-type); (iii) intervention details (e.g. study design, treatment modalities, duration, data collection frequency, follow-up, comparator); (iv) main clinical characteristics (e.g. outcomes of interest, data analyses, results); (v) other (e.g. ethics approval, informed consent, and animal welfare considerations). For simplification of data analysis processes, in instances of studies investigating both between subjects and within

subjects, results reflect extraction from the higher-level evidence of between subjects only. In the instance of data collection at multiple differing time points, only baseline data and the last data collection time point, in addition to any follow-up time points, were extracted for analysis (i.e. pre, post and follow-up). Lastly, when composite scores were reported as well as sub measure scores, only composite scores were extracted. Numerical values were extracted and interpreted as reported by authors in the original publications. Data collection was commenced by the first author (IB). Queries were discussed with a second reviewer (CS) and any disagreements were resolved through further discussion with a third reviewer (ACH).

Data Synthesis

Where possible, studies were to be pooled with statistical meta-analysis with effect sizes expressed as either odds ratios (for dichotomous data) or weighted (or standardized) final post-intervention mean differences (for continuous data) with their 95% confidence intervals. Due to the heterogeneity of studies (i.e. populations, interventions and outcomes) meta-analysis was not possible. Results are presented narratively and supported by tabular presentation. The narrative presentation of results is organised first by assistance dog-type, and then further categorised by outcome measure. Outcome measures are categorised into biological and physical, psychological, social, or composite outcomes. Composite outcomes are outcomes with measures which fit into more than one category. As it is organised by outcome, some studies appear multiple times within the one table.

To feasibly assess the importance of heterogenic findings in this review, a number of criteria were applied. A result was considered clinically significant if the effect size was (i) moderate to large (i.e. Cohen's $d \geq 0.5 – 0.8$; partial eta squared $\eta_p^2 \geq 0.09 – 0.25$) (Cohen, 1988) and (ii) statistically significant (i.e. $p \leq .05$). In the absence of effect sizes, p values were used to contextually determine the clinical and statistical significance for each outcome measure within each study.

Results

Study Inclusion

The initial search yielded a total of 825 records; 784 records identified through database searching and 41 records identified through manual searching. After the removal of duplicates, 531 records remained. Reviewal of these records against the inclusion and exclusion criteria at both a title/abstract level, then a full-text screening level, resulted in 20 independent studies being included in the systematic review. Studies were excluded mainly due to incorrect study design. See Figure 1 for full details and reasons for excluded studies.

Study Characteristics

Twenty studies with publication dates spanning across a 33-year period (from 1987 to 2020) were included in the review (see Table 1). Of the studies that reported their location, most were of western-origin. The United States of America was the primary source of the studies ($N_{studies}$ = 5), followed by Canada, ($N_{studies}$ = 2), the United Kingdom ($N_{studies}$ = 1), and Sweden ($N_{studies}$ = 1). Sample sizes ranged from 9 to 141 participants and the total sample size was 1016 participants.

All studies were undertaken in the home or community setting. Studies were predominantly quasi-experimental ($N_{studies}$ = 12). Cross-sectional (analytic) designs were the second most popular study design ($N_{studies}$ = 5). Two studies were mixed methods and employed cross-sectional (analytic) and quasi-experimental study designs, and one study was a randomised controlled trial.

Half of the total number of studies included a waitlist control group in their study design. A further six studies, all quasi-experimental, did not use a waitlist control group and instead participants acted as their own controls. The remainder of studies were cross-sectional and did not use a comparator. One fifth of the studies were theses ($N_{studies}$ = 4) whilst the remainder of studies were peer-reviewed journal articles. Across the twenty studies, seventy-

one unique outcome measures were employed, which were mostly self-report. The most repeatedly used measures were the PTSD checklist (PCL; Weathers, Litz, Herman, Huska, & Keane, 1993) which was employed four times and the Craig Handicap Assessment and Reporting technique (CHART; Whiteneck, Charlifue, Gerhart, Overhosler, & Richardson, 1992) which was employed three times. A total of nine measurements were used twice.

Study duration and frequency of data collection varied widely. Some studies collected data at one time point within a 20 minute time frame, and others collected data across multiple different time points, over as long as two years. Twenty percent of studies collected data at follow-up and the longest follow-up period was two years ($N_{studies}$ = 4). Most (80%) reported on informed consent ($N_{studies}$ = 16), and a minority (25%) of studies touched on animal welfare ($N_{studies}$ = 5). Animal welfare concerns mostly pertained to suitability tests to determine dog appropriateness ($N_{studies}$ = 2), and waivers or protocol ensuring satisfactory care of the animal was being taken ($N_{studies}$ = 3).

Participant Characteristics

The age of the participants ranged from 3 to 87 years. Of the studies which reported it, the mean age (standard deviation) of the adult participants was 42.4 years (SD = 6.54) ($N_{studies}$ = 15). The mean age of all reported participants was 37 years (SD = 12.5) ($N_{studies}$ = 17), however, this was inclusive of two child-specific studies. The mean age of child participants was 6.9 years (SD= 0.18) ($N_{studies}$ = 2). Slightly more than half of the total pooled participants (N = 1016) were male (54%). The most frequently investigated disability-types were physical ($N_{studies}$ = 13), followed by psychological ($N_{studies}$ = 5), then social ($N_{studies}$ = 2). Physical disabilities were most commonly labelled as wheelchair or spinal cord injuries ($N_{studies}$ = 5). One study each investigated participants living with; chronic physical disorders, gait disorders, deafness or hard of hearing, blindness or visual impairment diabetes or epilepsy. Two studies investigated various physical disabilities; (i) mobility and hearing

impairments, and (ii) diabetes, neurological disorders, musculoskeletal disorders, deafness or hard of hearing, as well as epilepsy. For the second of these two studies it is important to note that only neurological and musculoskeletal (combined into one mobility impairment group) and diabetes groups employed a suitable number participants for analysis (i.e. 30 and 20 people, respectively). As the other two groups employed 2 or 3 participants each, they are not separately analysed and discussed in this review. All five psychological disability-related studies explored participants living with post-traumatic-stress disorder. Lastly, for social disabilities, each of the two studies investigated people on the autism spectrum.

Quality Assessment of Included Studies

The reported methodological quality of the twenty studies was examined using three JBI critical appraisal checklists; the checklist for randomised controlled trials ($N_{studies}$ = 1), the checklist for quasi-experimental study designs ($N_{studies}$ = 14), and the checklist for cross-sectional study designs ($N_{studies}$ = 5) (see Tables 2, 3 and 4).

Results for the randomised controlled trial (Allen & Blascovich, 1996) fulfilled eight of the thirteen criteria. It is important to note that in this area, blindness to treatment delivery or assignment is particularly problematic. The majority of quasi-experimental studies (Champagne, Gagnon, & Vincent, 2016; Guest, Collis, & McNicholas, 2006; Kopicki, 2016; Lundqvist, Levin, Roback, & Alwin, 2018; McIver, Hall, & Mills, 2020; O'Haire, & Rodriguez, 2018; Rintala, Matamoros, & Seitz, 2008; Rooney, Morant, & Guest, 2013; Strong, Brown, Huyton, & Coyle, 2002; Viau et al., 2010; Vincent, Gagnon, & Dumont, 2019; Whitworth, Scotland-Coogan, & Wharton, 2019; Wild, 2012; Yarborough et al., 2017) gave a clear indication of cause and effect, reliably measured participant outcomes in the same way, and used appropriate statistical analyses. Where quasi-experimental results were divisive or more unclear, was in reporting instances of multiple pre-post measurement or follow-up, and reporting whether participants were similar. This is particularly important

when considering whether higher-priority individuals may have been allocated to the experimental group. Use of a control group was also divided, with half of the quasi-experiments using a waitlist control and half using a repeated-measures design. For those that used a repeated-measures design (Champagne, Gagnon, & Vincent, 2016; Lundqvist, Levin, Roback, & Alwin, 2018; Rooney, Morant, & Guest, 2013; Strong, Brown, Huyton, & Coyle, 2002; Vincent, Gagnon, & Dumont, 2019), Question 6: "Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analysed?" was rated as non-applicable.

The strong point of cross-sectional studies (Craft, 2007; Davis, 2017; Hart, Hart, & Bergin, 1987; Rodriguez, Bryce, Granger, & O'Haire, 2018; Vincent et al., 2015) was use of valid and reliable outcome measures, with four of five measuring outcomes validly and reliably. A distinct weaknesses of cross-sectional studies was lack of identification and strategies to address confounding factors, with only one of five studies identifying and addressing possible confounders. Although included studies were considered methodologically weak overall, all were included in the review.

Synthesis of Results

Guide dogs

A singular guide dog study was included in the review (McIver, Hall, & Mills, 2020). It contained individuals who were legally blind or dependent on a mobility aid. Quality of life was measured using an adapted Flanagan Quality of life scale (Flanagan, 1982), with an additional measure of independence for the 16th item. Over six months the study found no differences in overall quality of life across three groups; established guide dog owners who had been in partnership with their dogs for a minimum of three years, those who received a guide dog anytime throughout the study, and those who did not receive a guide dog. For the adapted independence item, however, a small positive effect was seen in the established guide dog partnership group compared to the control group while a large effect was seen in

those who received a guide dog throughout the study compared with controls. Comparison of the two intervention groups saw a significant medium to large effect in favour of those who received a dog throughout the study (Table 5).

Hearing dogs

Two studies involving individuals who were deaf or had a hearing impairment and were given a hearing dog were included in the review (Guest, Collis, & McNicholas, 2006; Rintala, Matamoros, & Seitz, 2008). For biological/physical outcomes, no differences were observed regarding functional motor independence over six months. Two psychological outcomes were measured; mood (Guest, Collis, & McNicholas, 2006) and life satisfaction (Rintala, Matamoros, & Seitz, 2008). There was a significant improvement in mood at three months after receiving the hearing dog however this did not remain significant at 14 months follow-up; there was no difference in life satisfaction at six months follow-up. Composite measures pertained to multiple different areas of health, such as mental and physical health. Results were mixed with Guest, Collis, & McNicholas (2006) finding significant improvement after three months and no significant maintenance at 14 months follow-up, and Rintala, Matamoros and Seitz (2008) finding no significant improvement after six months (Table 6).

Mobility service dogs

Nine studies focussed on mobility service dogs (Allen & Blascovich, 1996; Champagne, Gagnon, & Vincent, 2016; Craft, 2007; Davis, 2017; Hart, Hart, & Bergin, 1987; Lundqvist, Levin, Roback, & Alwin, 2018; Rintala, Matamoros, & Seitz, 2008; Vincent, Gagnon, & Dumont, 2019; Vincent et al., 2015). Participants often required the use of a wheelchair and had commonly sustained a spinal cord injury, however, a minority had other physical or neurological disabilities. Subsequently biological/physical outcomes were most commonly investigated, with varying respiratory, cardiovascular, and mobility

measures being utilised, as well as measures of energy and pain. Results from individual studies showed the presence of a mobility service dog significantly improved the following outcomes; oxygen consumption, ventilation, tidal volume, respiratory quotient, heart rate, distance and speed travelled, threshold, ability to travel up a slope for wheelchair users, fatigue, and wheelchair related function. In three different studies measuring pain, the mobility service dog group did not perform significantly better than the control in one study (Craft, 2007) but it did in the other two (Vincent, Gagnon, & Dumont, 2019; Vincent et al., 2015). It is noted, however, that the two latter studies may be using the same participant group. The following biological/physical outcomes showed no difference between mobility service dog and control groups; respiratory rate, vitality, grip-strength, mobility, energy, and functional motor independence.

For psychologically-based outcomes, results were mixed. From single studies, internal locus of control, self-esteem, psychological wellbeing and quality of life showed improvement in hearing dog groups, while depression, intrusiveness, life satisfaction, and psychological adjustment did not. Social outcomes reported by Allen and Blascovich (1996) and by Hart, Hart and Bergin (1987), were mostly positive (i.e. social engagement generally increased with the presence of the hearing dog).

Results were also mixed for composite measures; the first of two handicap measures had three of five sub measures showing no difference, yet the sub measures of occupation and self-sufficiency favoured the hearing dog group over the control (Davis, 2017). The second handicap measure showed no group differences (Rintala Matamoros, & Seitz, 2008). Similarly, all three health-related quality of life measures in one study by Lundqvist, Levin, Roback and Alwin (2018) showed no group differences, nor did mental or physical components of a health survey in a study by Rintala, Matamoros and Seitz (2008).

Occupational performance, however, improved following the intervention in one study (Vincent, Gagnon, & Dumont, 2019) (Table 7).

Psychiatric service dogs

Five studies containing participants with either a formal or informal diagnosis of post-traumatic stress disorder (PTSD) examined the use of psychiatric service dogs (Kopicki, 2016; O'Haire & Rodriguez, 2018; Rodriguez, Bryce, Granger, & O'Haire, 2018; Whitworth, Scotland-Coogan, & Wharton 2019; Yarborough et al., 2017). For biological/physical outcomes, the Pittsburgh Sleep Quality Index (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) was used to measure sleep across two different studies (Rodriguez, Bryce, Granger, & O'Haire, 2018; Kopicki, 2016). Both showed no significant impact upon veterans' sleep. A third study by Yarborough et al. (2017) measured number of hours slept across the psychiatric service dog group and the control and also found no significant difference between groups. Cortisol concentration in a cross-sectional study by Rodriguez, Bryce, Granger, & O'Haire, (2018) demonstrated that psychiatric service dog owners had a significantly higher cortisol awakening response comparative to controls, indicating a positive influence on physiological indicators of wellbeing specific to military veterans with PTSD.

Psychological outcome measures were the most frequently reported, with a common theme of PTSD-related functioning and symptomology. Of the four studies which measured PTSD symptom severity using the PTSD-Checklist (PCL; Weathers, Litz, Herman, Huska, & Keane, 1993), results were mixed; O'Haire and Rodriguez (2018), Rodriguez, Bryce, Granger and O'Haire (2018) and Yarborough et al. (2017) demonstrated that the presence of a psychiatric service dog significantly improved PTSD symptom severity, whilst Kopicki (2017) showed no difference. Other PTSD-related findings correspondingly demonstrated heterogeneity; in a study by Whitworth, Scotland-Coogan and Wharton (2019) psychiatric

service dogs appeared to have a positive effect on trauma symptomology for three of four sub scales, and in a study by Yarborough et al. (2017), for psychiatric symptomology, three of five sub scales were positively affected. Other psychological outcomes included depression, quality of life, happiness, and resilience. Depression was consistently lower for psychiatric service dog groups across two measures in one study (O'Haire & Rodriguez, 2018), and one sub measure in another (Yarborough et al., 2017). Quality of life, measured using three different scales in one study (O'Haire & Rodriguez, 2018) and once in another (Yarborough et al., 2017), consistently and significantly showed higher levels in the service dog group compared to controls, as did happiness in one study (Yarborough et al., 2017). Resilience did not significantly differ across groups (Yarborough et al., 2017).

Social outcomes were also mixed. For one study (O'Haire & Rodriguez, 2018), an overall measure of social and work functioning demonstrated better performance for the psychiatric service dog group on all three sub measures compared to controls. The sub measures were; ability to participate in social activities, social isolation and companionship, and a measure of activity level. A second measure of activity, however, found no significant group differences (Yarborough et al., 2017).

Lastly, composite measures of health-related quality of life, behaviour, disability level, and general health, which each incorporate bio-psycho-social measures within, were varied. Though referred once as measuring health-related quality of life and once as measuring general health, the Veterans RAND 12-item Health survey (Iqbal et al., 2007) was used across two studies (O'Haire & Rodriguez, 2018; Yarborough et al., 2017). It showed psychiatric service dogs performed significantly better than the control for the mental health component, with a medium (O'Haire & Rodriguez, 2018) and a large (Yarborough et al., 2017) effect size, but no difference was observed between groups for the physical health component (Table 8).

Alert and response service dogs

Three alert and response service dog studies were included in the systematic review (Lundqvist, Levin, Roback, & Alwin, 2018; Rooney, Morant, & Guest, 2013; Strong, Brown, Huyton, & Coyle, 2002). Studies used different alert and response dog-types and measured different human health and wellbeing outcomes. They mostly investigated biological/physical outcomes. Rooney, Morant and Guest (2013) found that diabetes medical detection dogs performed higher than chance with regards to alerting their owners to blood glucose levels that were out of their normal range, over a time period that ranged from 5 to 581 months. Strong, Brown, Huyton and Coyle (2002) found that seizure frequency significantly reduced following the six month introduction of seizure alert dogs, and that this reduction was significantly maintained at nine months. Lundqvist, Levin, Roback and Alwin (2018) found no significant difference in health-related quality of life at three months for diabetes alert dog owners and controls (Table 9).

Autism service dogs

Two studies focused on autism service dogs (Viau et al., 2010; Wild, 2012). Outcome measures, all performed on children living with autism spectrum disorder (ASD), were mostly socially-oriented. However, Viau et al. (2010) did investigate stress responses by measuring cortisol awakening response from salivary samples; there was no difference at one month follow-up compared to baseline. Further, it did not significantly increase, as hypothesised, when the dog was removed at 2 months.

Social measures had mixed findings. Viau et al. (2010) focussed on patterns of child behaviour and used parent questionnaires to track problem behaviours across two months. Reported problem behaviour since the one month acquisition of the service dog significantly diminished, however, problem behaviour did not significantly increase at dog removal. Wild (2012) again focussed on child behaviour, but found no significant difference across (service

dog vs. no service dog) groups at six months. Wild (2012) also measured social reciprocity which indicated, better social responsiveness was experienced at six months by the service dog group compared to the control (Table 10).

Discussion

Main Findings

This systematic review shows that the current evidence of assistance dog use for human health and wellbeing is mixed. Findings suggest that guide dogs may have a positive influence on visually impaired individuals' independence, and hearing dogs may have a positive influence on hearing impaired individuals' mood. Mobility service dogs could encourage social engagement for people living with a physical disability, and psychiatric service dogs may lower levels of depression, increase mental health-related quality of life and lower levels of post-traumatic stress disorder severity for people living with the disorder. Alert and response dogs may have a beneficial effect toward the detection of particular medical conditions, and autism service dogs may assist children with ASD in improving their social reciprocity. These trends represent positive outcomes, however, they cannot be considered reliable. Results are largely based on single studies and no meta-analysis was possible. Animal welfare issues are highlighted throughout the discussion, demonstrating the lack of consideration for dog wellbeing in the included studies.

Measurements such as sleep within the PTSD population or health-related quality of life within the physical-disability population, were consistently unaffected by service dog interventions across groups in multiple studies. Trends such as these indicate that, for example, psychiatric service dogs are unlikely to impact upon sleep for veterans, and mobility service dogs are unlikely to impact upon health-related quality of life for those with a physical disability. Furthermore, some studies demonstrated contradictory findings;

measures of ASD child behaviour in two studies had contrasting conclusions regarding the effects of autism service dogs, for example.

In addition to contrary findings, the included studies together have numerous methodological weaknesses which must be taken into account. Participant characteristics were often inconsistent between whole study samples and between intervention and control groups within studies (e.g. in age, gender, and level of detail given to disability). Convenience sampling was regularly used without acknowledgement of the potential for selection bias, thus giving rise to the possibility that those with higher disability severity were selected for the intervention group (e.g. Yarborough et al., 2017). This has the potential to skew results. Likewise, participant attrition was often not explored, possibly affecting the validity of results and contributing to Type I error. As noted by Stern and Chur-Hansen (2013) publication bias in the area of animal-assisted interventions is also likely, and dog organisations may want the animals that they have provided to be effective, consequently encouraging and sharing positive findings.

Study design varied markedly which made it difficult to compare effects across studies. Small sample sizes in some studies raised concern about the reliability of results as although they may have demonstrated positive findings, they were likely underpowered (e.g. Rooney, Morant, & Guest, 2013). Whilst particular studies had multiple post-measurement and follow-up times spreading over many months (e.g. Allen & Blascovich, 1996), others' only spanned over one month or less (Kopicki, 2016) or were unspecified (e.g. O'Haire & Rodriguez, 2018), and those that were cross-sectional did not employ post-measurement or follow-up at all (e.g. Craft, 2007). It is recognised that blinding to intervention type is near impossible, however, case-control studies were not utilised and may be a viable option as researchers could still utilise a quasi-experimental design, but match participants (in the intervention and control groups) on different variables (e.g. disability severity, age, gender)

to increase comparability between groups. With the longest follow-up time of included studies recorded at 24 months post assistance dog receival, studies could aim to longitudinally track effects over time. This would enable exploration of development over the life-span or significant life transition stages (e.g. as a child with ASD enters adulthood, or how it is managed if and when the assistance dog dies).

Characteristics of the interventions differed. As dog-types varied between studies (i.e. guide dogs, hearing dogs and service dogs), so too did the organisations from which dogs were commissioned (e.g. the MIRA Foundation, Texas Hearing and Service Dogs, and K9s for Warriors). As such, it is likely that training, which was often explored in little to no detail, also varied. There is a movement toward standardisation of dog-training procedures as seen by Assistance Dogs International accreditation, however, the extent to which training is consistent remains unverified. Matching and measuring the motivation and personality-types of both dogs and humans, though suggested by Winkle, Crowe and Hendrix (2012) many years ago, was not utilised by many of the included studies. Similarly, although basic Farm Animal Welfare Council (2009) “freedoms” of thirst, hunger, discomfort, injury, fear and distress are generally met, the freedom to express ‘normal’ behaviour for assistance animals (e.g. for a dog, interacting with other dogs) has been put forward as an ethical consideration (Serpell, Coppinger, Fine & Peralta, 2010) and is yet to be addressed.

Outcome measurements reported in studies were so diverse that seventy-one were employed once and only eleven were employed on more than one occasion. As highlighted by Winkle, Crowe and Hendrix, (2012) interdisciplinarity of outcome measures can be advantageous in their applicability to multiple areas of practice, but challenging in synthesis of agreed-upon terminology. To demonstrate; different measurement tools were used to measure the same concept (e.g. ‘depression’ as measured by the Center for Epidemiologic Studies Depression Scale [Radloff, 1977] or the Patient Health Questionnaire [Kroenke &

Spitzer, 2003]) and different concepts were measured using the same tool (e.g. the Veteran's RAND 12 Item Health Survey [Iqbal et al., 2007] being used to measure both 'general health' and 'health related quality of life'). Uniformity in outcome measures is needed to compare results presented across studies.

Further consideration for score interpretation is also needed; seldom were initial (i.e. occurring at short-term follow-up assessments) positive effects considered as possibly driven by the novelty of having the assistance dog, or by investment into the assistance dog (emotionally, financially or otherwise). Similarly, as many measures, particularly in the psychological and social areas were self-reported, this could leave results susceptible to the effects of participant expectations. Additionally, further investigation into potentially long-term adverse effects for client subgroups is warranted (e.g. assistance dog effectiveness may vary for an individual living alone versus an individual living with a partner or social supports). Practitioners also tend to deem an assistance animal performing poorly being due to an inadequate training procedure, rather than considering the possibility that the animal does not want to work as an assistance dog (Brodie, Biley & Shewring, 2002).

Included studies had an abundance of reporting issues. Statistical data were not reported (e.g. O'Haire & Rodriguez, 2018; Yarborough et al., 2017) or were only provided using visual representations (e.g. Guest, Collis, & McNicholas, 2006), and statements about findings were made without numerical evidence to support claims. Overall, statistical significance was generally overemphasised, clinical significance underemphasised, and effect size measures rarely reported.

The potential influence of conflicts-of-interest and publication bias on the available literature should also be considered. Many of the assistance dogs were provided by non-for-profit charity organisations where funding for clinical trials may be limited. With limited funding, the chance of methodological weaknesses and biases may increase as resources are

less available. To justify the continuation of these organisations, biases may have a heavier influence than anticipated, particularly when considering the disproportionately positive public perception of assistance dogs (Schoenfeld, Hellyer, Cheung & Kogan, 2017).

Animal welfare considerations were not commonly discussed in the included studies, with only 25% of included studies touching on the subject. Assistance dogs have complex commands and cannot avoid unwanted social intrusions. They may experience stress-related fatigue from working for extended periods of time with little opportunities for rest, and the use of poorly designed equipment (e.g. traditional wheelchair harnesses) or facilities (e.g. conventional kennels) (Serpell, Coppinger, Fine & Peralta, 2010). Assistance dogs face abrupt lifestyle changes from their foster home, as well as end of working-life difficulties (Neilson, Hart, Cliff, & Ruehl, 2001; Serpell, Coppinger, Fine, & Peralta, 2010). These elements of assistance dog life can all have negative effects on dogs' physical and mental health and wellbeing, which should be taken into consideration and researched in parallel to human health and wellbeing considerations (Broom, 2011; Coppinger, Coppinger & Skillings, 1998).

The effectiveness of assistance dogs shows positive, negative and contradictory findings. There are also multiple methodological weaknesses of the studies from which findings are drawn. Overall, there is significant heterogeneity in all facets of assistance dog research, and homogeneity in sourcing of the dogs from charity-run organisations with a lack of ethical considerations by researchers. This demonstrates the need for great development in the assistance dog research area.

Strengths and limitations

This is the first quantitative systematic review, to the author's knowledge, that has investigated the impact of all types of assistance dogs on human health and wellbeing holistically (i.e. considering biological, psychological and social outcomes together).

Quantitative methods allowed for greater objectivity among results, simultaneously minimising personal bias. The use of numerous search terms paired with broad inclusion criteria was intentional, and this high sensitivity was used to capture all potentially relevant studies, as was the searching of grey literature. Moreover, manual searching of references further maximised the scope of included studies. The search encompassed studies from varying continents. It is important to note that although many studies came from a Western background, this is proportionate to the history and origin of assistance dogs. The use of multiple authors to assess eligibility criteria, study selection and screening, and the quality of included studies was a strength of the review as it increased quality assurance.

Limitations of the review should also be considered. One researcher extracted and synthesised the data, thereby increasing the possibility of errors and the large amount of included studies makes it difficult to disentangle complexities in the literature. As a quarter of studies were cross-sectional and three quarters quasi-experimental, conclusions regarding cause-and-effect cannot be confidently drawn. Additionally, the search was limited to English and did not include qualitative data, preventing potentially useful information from being included, though this was beyond the scope of the current review.

Great variation in terminology means that there is the potential for studies to be in the literature that were not identified by the search. That is, terms such as ‘assistance dog’ and ‘service dog’ are often used interchangeably with further sublabels such as ‘mobility’ or ‘physical’ service dog. If incorrect labels such as ‘therapy’ dog were used when referring to an assistance dog, the studies will not have been found by the search. As assistance dog accreditation was taken at face value, there is the potential that studies included in the review involved dogs not actually accredited, and that other studies where dogs were accredited but were not labelled properly, may have been excluded.

Comparison with Existing Literature

The mixed and unreliable findings of the current systematic review are congruent with existing literature. A review on the use of assistance dogs for individuals with physical disabilities demonstrated some positive benefits with the simultaneous recognition of methodological limitations precluding clear conclusions (Sachs-Ericsson, Hansen, & Fitzgerald, 2002). Similarly, a review evaluating service dogs for people with mobility-related physical disabilities concluded that although the use of dogs increased individuals' sense of independence, rigorous evidence of usefulness was sparse (Winkle, Crowe & Hendrix, 2012). Both reviews mention research design and ethical concerns along with lack of instrument standardisation. In line with the absence of guide dog studies in either of the aforementioned reviews, a single guide dog study met criteria to be included in the present systematic review (McIver, Hall & Mills, 2020), illustrating that similar gaps in the literature have extended across many years. Beyond assistance dogs specifically, it becomes clear that the same issues permeate anthrozoology, with reviews in other areas (e.g. therapy animals) advocating for similar developments (e.g. Kamioka, 2014). This also spreads across species (e.g. horses) (Stern & Chur-Hansen, 2019).

Conclusions and Implications

Research recommendations based on the current systematic review involve both methodological considerations and ethical considerations. Methodological recommendations are consistent with those raised in previously conducted reviews in related areas (Sachs-Ericsson, Hansen & Fitzgerald, 2002; Winkle, Crowe & Hendrix, 2012), including the use of more longitudinal, observational and randomised controlled trial designs, and/or designs with matched comparison groups. Additional recommendations, which are similar to the recommendations made by Stern and Chur-Hansen (2013) for animal-assisted interventions, include the use of larger sample sizes, along with valid and objective measurements, and

again importantly standardisation of outcome measures across studies to deduce meaningful and comparable effects. An emphasis on clinical significance and effect size in the context of the intervention rather than simply statistical significance, as well as complete reporting of results and exploration of attrition is needed. Future research, in addition to repetition in all dog-type areas, may choose to prioritise investigation of identified literature gaps first. It may also choose to isolate and examine specific assistance dog-types in greater depth.

Future studies should strive to go beyond current ethical standards. Assistance dogs, both within studies and in their working life, should be given opportunities meeting their social needs as well as adequate rest. Whilst human health and wellbeing outcomes are the main consideration in the current review; greater efforts regarding maximising the dogs' welfare may in turn also generate positive human health effects. When dogs' "freedoms" are met they may interact or perform more desirably, and this is currently unexplored in the available literature.

Findings are preliminary and inconclusive, therefore future practice implications are limited. What is clear, is that allied health professionals (e.g. physiotherapists, occupational therapists and psychologists) should take this inconclusive evidence into consideration when planning assistance dog-related interventions, as they may benefit individuals in some small physiological, social and psychological ways, but they equally, may not. Practitioners can therefore use this information to more accurately discuss potential harms or benefits of having an assistance dog for clients with specific circumstances or conditions, however ultimately, assistance dogs have no strong evidence backing. A holistic approach to healthcare is encouraged and health psychologists, as supporters of the biopsychosocial model, are well-positioned to use a scientific-backing balanced with a holistic openness to liaise with both researchers and community-run organisations. This may produce both

methodologically sound and conceptually well-understood high-quality research, transferrable to real-world circumstances.

In summary, the available assistance dog studies greatly vary in sample characteristics, study designs and interventions employed, outcome measurements utilised, and the level of reporting shared. As a result, findings relating to the effectiveness of assistance dogs on human health and wellbeing also greatly vary. Based on the evidence of this systematic review, assistance dog effectiveness is inconclusive and practice recommendations cannot be confidently made. In line with research recommendations in previous reviews (Sachs-Ericsson, Hansen, Fitzgerald, 2002; Winkle, Crowe & Hendrix, 2012), further primary research to investigate assistance dogs in a standardised manner with longitudinal follow-up assessments and consistent terminology and measures is necessary to gain further understanding of their impact. This, paired with an emphasis on animal welfare, may maximise reciprocity and thereby the potential for more reliable and valid outcomes.

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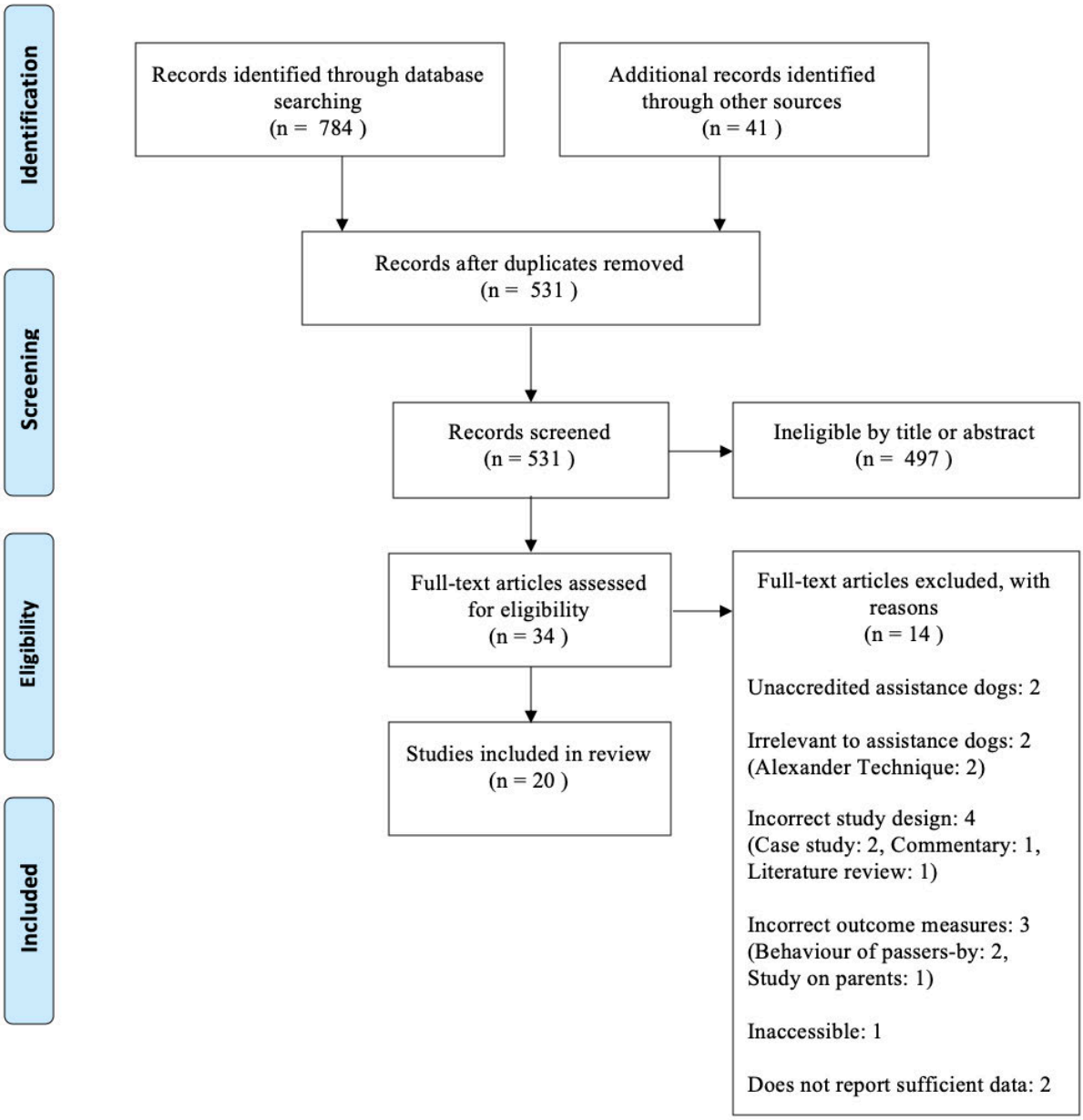

Figure 1. PRISMA Flow Chart of the study selection process. Adapted from "*P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement" by Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009), PLoS Med 6(6): e1000097.

Table 1. Included studies

Lead author (Year) Study design	Participant characteristics	Intervention characteristics	Informed consent reported (Y/N)	Dog title: training and/or organisation reported by researchers (Animal welfare considerations)
Allen (1996) RCT	N = 48 (24 male) M_{age} = 25 (1.5) Severe and chronic ambulatory disability requiring use of wheelchairs Country = USA	Exp Received mobility service dog (n = 24) Ctrl Did not receive mobility service dog (n 24) Frequency = 5 time points (6 & 12 months = Nr) Pre = baseline Post = 18 months Follow-up = 24 months	N	Service dogs: made available through trainers dedicated to providing dogs to people with disabilities, initially raised in family environments, general assistance training and individualised training, total training time ranging from 6 to 12 months
Champagne (2016) Quasi-experiment	N = 13 (10 male) M_{age} = 40 (10.3) Sustained spinal injury and use wheelchair Country = Canada	Repeated measures = mobility service dog Frequency = 2 time points (within the same day)	Y	Mobility assistance dogs: only participants who had been paired with dog for at least 6 months were recruited, all provided by the MIRA Foundation, 2 year comprehensive screening and preparation program followed by 4-month task-specific training course
Craft (2007) Cross-section	N = 86 (15 male) M_{age} = 44.1 (Nr) Chronic physical disability Country = Nr	Exp Received mobility service dog (n = 76) Ctrl Did not receive mobility service dog (n = 10) Frequency = 1 time point	Y	Service dogs: nil detail
Davis (2017) Cross-section	N = 140 (56 male) M_{age} = 41.2 (14.7) Gait disorders Country = Nr	Exp Received mobility service dog (n = 91) Ctrl Did not receive mobility service dog (n = 49) Frequency = 1 time point	Y	Assistance dogs: nil detail
Guest (2006) Quasi-experiment	N = 51 (11 male) M_{age} = 51 (Nr) Deaf or hard-of-hearing Country = Nr	Repeated measures = hearing dog Frequency = 5 time points (at the end of the waiting period & at the end of the 5-day residential week = Nr) Pre = baseline Post = 3 months Follow-up = 14 months	N	Hearing dogs: the dogs were trained for a number of chosen sounds, all dogs came from the organization Hearing Dogs for Deaf People

Hart (1987) Cross-section	N = 28 (Nr male) M_{age} = Nr (Nr) Variety of disabilities all requiring the use of a wheelchair Country = USA	Exp Received mobility service dog (n = 28) Ctrl Did not receive mobility service dog (n = 9) Frequency = 1 time point	Y	Service dogs: from Canine Companions for Independence
Kopicki (2016) Quasi-experiment	N = 18 (14 male) M_{age} = 39 (12.46) Veterans diagnosed with PTSD Country = Nr	Exp Received psychiatric service dog (n = 12) Ctrl Did not receive psychiatric service dog (n = 6) Frequency = 2 time points Pre = baseline Post = 1 month	Y	Service dogs: from organisations accredited by Assistance Dogs International
Lundqvist (2018) Quasi-experiment	N = 55 (8 male) M_{age} = 43.8 (Nr) Diagnosis of diabetes, a neurological disorder, musculoskeletal disorder, deaf or hard of hearing, epilepsy or other Country = Sweden	Repeated measures = mobility service dog (n= 30), diabetes-alert service dog (n= 20), seizure alert dog (n= 2), hearing dog (n= 3) Frequency = 2 time points Pre = baseline Post = 3 months	Y	Service and hearing dogs: companion dogs to begin with, trained to become certified by the Swedish Association of Service Dogs, major and minor tests (Initially the dog was examined by a veterinarian and underwent suitability testing)
McIver (2020) Quasi-experiment	N = 46 (21 male) M_{age} = Nr (Nr) Reliant on a mobility air or legally blind Country = Nr	Exp Established guide dog owners (n = 14) Exp Received guide dog (n = 15) Ctrl Did not receive a guide dog (n = 17) Frequency = 2 time points Pre = baseline Post = 6 months minimum	Y	Guide dogs: nil detail
O'Haire (2018) Cross-section & Quasi-experiment	N = 141 (110 male) M_{age} = 37.1 (8.3) Veterans diagnosed with PTSD Country = Nr	Exp Received psychiatric service dog (n = 75) Ctrl Did not receive psychiatric service dog (n = 66) Frequency = 1 time point & Exp Received psychiatric service dog (n = 75)	Y	PTSD service dogs: from K9s For Warriors, participants paired for between 1 month to 4 years (M = 1.64, SD = 1.07 years). The (predominantly Labrador Retrievers, Golden Retrievers, and Mixes) were primarily rescued from animal shelters and were selected based on a suite of characteristics ranging from physical size to temperamental demeanour (No interactions occurred between the research team and the dogs during the course of the study; therefore a waiver

		Ctrl Did not receive psychiatric service dog (n = 66) Frequency = 5 time points (during waitlist period & immediately prior to service dog acquisition = Nr) Pre = baseline Post = 3 weeks Follow-up = once psychiatric service dog is in home (unspecified)		was obtained from the Institutional Animal Care and Use Committee)
Rintala (2008) Quasi-experiment	N = 43 (10 male) M_{age} = 47.2 (12.5) Mobility or hearing impairment Country = USA	Exp Received service dog (n = 18) Ctrl Did not receive service dog (n = 15) Exp Received hearing dog (n = 6) Ctrl Did not receive hearing dog (n = 4) Frequency = 2 time points Pre = baseline Post = 6 months	Y	Assistance dogs/ service and hearing dogs: from either Texas Hearing and Service Dogs (THSD) or National Education for Assistance Dog Service (NEADS)
Rodriguez (2018) Cross-section	N = 73 (59 male) M_{age} = 37.08 (7.81) Veterans with community diagnosis of PTSD, or meeting the clinical cut-off of 50 on the PCL Country = Nr	Exp Received psychiatric service dog (n = 45) Ctrl Did not receive psychiatric service dog (n = 28) Frequency = 1 time point for survey assessments & 2 timepoints for saliva samples (baseline & 1 day later, averaged)	Y	Service dogs: three-week team training program, participants taught by K9s For Warriors personnel how to interact with, care for, and maintain ongoing training with their service dog with a group of 6–10 recipients, dogs were primarily acquired from animal shelters and selected and screened for physical and temperamental characteristics (e.g. 24 inches at the shoulder, no past or current aggression), all service dogs were trained for a minimum of 120 hours over at least 6 months for basic obedience and a variety of commands specifically trained to mitigate veterans' PTSD symptoms (No interactions occurred between researchers and ser- vice dogs during the study, therefore a waiver was obtained from the Institutional Animal Care and Use Committee)
Rooney (2013) Cross-section & Quasi-experiment	N =11 & 9 (Nr male) M_{age} = 37.2 (18.1) Diagnosis of diabetes Country = Nr	Received medical detection service dog (n = 11) Frequency = 1 time point & Repeated measures = medical detection service dog (n = 9) Frequency = 2 time points Pre = baseline Post = ranged from 5 - 581 months	Y	Medical Detection Dogs: fully trained and certified, or advanced trainee dogs

Strong (2002) Quasi-experiment	N = 10 (4 male) M_{age} = 33.8 (6.1) Diagnosis of epilepsy Country = UK	Repeated measures = seizure alert service dog Frequency = 4 time points (training weeks 13-24 = Nr) Pre = baseline, weeks 1-12 averaged Post = weeks 25-36 averaged Follow-up = weeks 37-48 averaged	Y	Support dogs: seizure alert dog programme, trained seizure alert dogs
Viau (2010) Quasi-experiment	N = 42 (37 male) M_{age} = 7.1 (3.1) Diagnosis of autism spectrum disorder, Asperger syndrome or PDDNOS Country = Nr	Repeated measures = autism service dog Frequency = 3 time points Pre = baseline (2 weeks prior to the dog) Post = 6 weeks (end of 4 weeks with the dog) Removal = 2 months (end of 2 weeks after the dog was removed)	N	Service dogs: dogs from the MIRA Foundation where they received proper training (3 months) and behavioural evaluation then three day training session with participants on how to interact (The regular MIRA Foundation protocol was followed, under the supervision of a team of veterinarians, to ensure satisfactory animal welfare and proper allocation of dogs)
Vincent (2019) Quasi-experiment	N = 17 (9 male) M_{age} = 41.9 (15.3) Sustained spinal injury and use wheelchair Country = Canada	Repeated measures = mobility service dog Frequency = 4 time points (3 & 6 months = Nr) Pre = baseline Post = 9 months	Y	Mobility service dogs: trained by a well-established provincial service dog school, underwent a comprehensive 2 year screening and preparation program, followed by a four month task-specific training program, dogs provided by the MIRA Foundation, partnered participants and dogs then pairs underwent 18 days intensive training together
Vincent (2015) Cross-section	N = 66 (45 male) M_{age} = 41.2 (14.7) Sustained spinal injury and use wheelchair Country = Nr	Repeated measures = mobility service dog Frequency = 2 time points (within the same day)	N	Service dogs: from a well-recognised training school in Quebec, trained by the MIRA Foundation to meet the needs of persons with sensorimotor impairments
Whitworth (2019) Quasi-experiment	N = 30 (26 male) M_{age} = 50.93 (16) Veterans diagnosed with PTSD Country = Nr	Exp Received psychiatric service dog (n = 15) Ctrl Did not receive psychiatric service dog (n = 15) Frequency = 2 time points Pre = baseline Post = 14 weeks	Y	Service dogs: A Certified Master Dog Trainer led these sessions providing individual and group guidance to the veteran as they trained a canine to become their service dog; some veterans come into the program with their own companion dog that they trained to become a service dog while others were provided an untrained canine that they trained, dogs provided by the program were either rescued from an animal shelter or surrendered (The program staff evaluate all participating dogs in order to assure they have suitable temperaments to be a service dog, and that they will be able to

				respond to their veteran's needs once trained in the expected fashion)
Wild (2012) Quasi-experiment	N = 20 (16 male) M_{age} = 6.75 (2.61) Diagnosis of autism spectrum disorder Country = USA	Exp Received autism service dog (n = 10) Ctrl Did not receive autism service dog (n = 10) Frequency = 2 time points Pre = baseline Post = 6 months	Y	Autism service dogs: trained for children with autism, paired with families for a training week
Yarborough (2017) Quasi-experiment	N = 78 (54 male) M_{age} = 42.4 (12) Self-reported PTSD and a clinician's letter supporting veterans' need for a service dog Country = USA	Exp Received psychiatric service dog (n = 70) Ctrl Did not receive psychiatric service dog (n = 54) Frequency = 2 time points Pre = baseline Post = 30 days minimum	Y	Service dogs: researchers collaborated with the following five not-for-profit organizations that train dogs for veterans with PTSD: Paws Assisting Veterans (PAVE), in Oregon; Joys of Living Assistance Dogs (JLAD), Oregon; Bergin University of Canine Studies (Bergin), California; paws4people (p4p), North Carolina; and Canine Assistants (CA), Georgia; dogs supplied by the participating organizations were bred to be service dogs and received extensive training prior to placement and training timing varied across sites

Table 2. Critical appraisal results of eligible Randomised Controlled Trial studies

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13
Allen (1996)	U	U	Y	N	U	U	Y	Y	Y	Y	Y	Y	Y
Total %	**0**	**0**	**100**	**0**	**0**	**0**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Y = Yes, N = No, U = Unclear; JBI critical appraisal checklist for randomised controlled trials: Q1 = Was true randomisation used for assignment of participants to treatment groups?; Q2 = Was allocation to treatment groups concealed?; Q3 = Were treatment groups similar at baseline?; Q4 = Were participants blind to treatment assignment?; Q5 = Were those delivering treatment blind to treatment assignment?; Q6 = Were outcome assessors blind to treatment assignment?; Q7 = Were treatment groups treated identically other than the intervention of interest?; Q8 = Was follow-up complete, and if not, were strategies to address incomplete follow-up utilised?; Q9 = Were participants analyzed in the groups to which they were randomized?; Q10 = Were outcomes measured in the same way for treatment groups?; Q11 = Were outcomes measured in a reliable way?; Q12 = Was appropriate statistical analysis used?; Q13 = Was the trial design appropriate, and any deviations from the standard RCT design (individual randomisation, parallel groups) accounted for in the conduct and analysis of the trial?

Table 3. Critical appraisal results of eligible Quasi-Experimental studies

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
Champagne (2016)	Y	Y	Y	N	N	N/A	Y	U	Y
Guest (2006)	Y	U	U	N	Y	N	Y	Y	Y
Kopicki (2016)	U	U	U	Y	N	N	Y	Y	Y
Lundqvist (2018)	Y	N	U	N	N	N/A	Y	Y	Y
McIver (2020)	Y	U	U	Y	N	N	Y	Y	Y
O'Haire (2018)	Y	Y	U	Y	Y	N	Y	Y	Y
Rintala (2008)	Y	Y	N	Y	N	Y	Y	Y	Y
Rooney (2013)	N	N	U	N	N	N/A	U	N	U
Strong (2002)	Y	Y	U	N	Y	N/A	Y	N	U
Viau (2010)	Y	Y	U	N	N	Y	Y	Y	Y
Vincent (2019)	Y	Y	U	N	N	N/A	Y	Y	Y
Whitworth (2019)	Y	Y	U	Y	N	N	Y	Y	Y
Wild (2012)	Y	Y	N	Y	N	Y	Y	Y	N
Yarborough (2017)	Y	N	U	Y	N	N	U	Y	Y
Total %	**86**	**57**	**7**	**50**	**21**	**38**	**86**	**79**	**79**

Y = Yes, N = No, U = Unclear, N/A = Not Applicable; JBI critical appraisal checklist for quasi-experimental studies: Q1 = Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)?; Q2 = Were the participants included in any comparisons similar?; Q3 = Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?; Q4 = Was there a control group?; Q5 = Were there multiple measurements of the outcome both pre and post the intervention/exposure?; Q6 = Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analysed?; Q7 = Were the outcomes of participants included in any comparisons measured in the same way?; Q8 = Were outcomes measured in a reliable way?; Q9 = Was appropriate statistical analysis used?

Table 4. Critical appraisal results of eligible Cross-Sectional studies

Study	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**
Craft (2007)	Y	Y	N	Y	N	N	Y	U
Davis (2017)	Y	N	N	N	N	N	Y	Y
Hart (1987)	U	N	U	U	N	N	N	N
Rodriguez (2018)	Y	Y	Y	Y	Y	Y	Y	Y
Vincent (2015)	N	N	Y	Y	N	N	Y	U
Total %	**60**	**40**	**40**	**60**	**20**	**20**	**80**	**40**

Y = Yes, N = No, U = Unclear N/A = Not Applicable; JBI critical appraisal checklist for cross-sectional studies: Q1 = Were the criteria for inclusion in the sample clearly defined?; Q2 = Were the study subjects and the setting described in detail?; Q3 = Was the exposure measured in a valid and reliable way?; Q4 = Were objective, standard criteria used for measurement of the condition?; Q5 = Were confounding factors identified?; Q6 = Were strategies to deal with confounding factors stated?; Q7 = Were the outcomes measured in a valid and reliable way?; Q8 = Was appropriate statistical analysis used?

Legend

M - Mean
SD - Standard Deviation
MD - Mean Difference
Nr - Not Reported
%Diff Percentage Difference
Med - Median
IQR - Interquartile Range
Exp - Experimental Group
Ctrl - Control Group

Table 5. Guide dog interventions (N = 1)

Lead author (Year) Study Design	Outcomes: outcome measures reported	Results					Main Findings
		Psychological Outcomes					
McIver (2020) Quasi-experiment Exp Rec* (n= 15) Exp Est* (n= 14) Ctrl (n= 17)	1. Quality of Life: 16-item adaptation of the original 15-item Flanagan Quality of Life Scale (QOL)	1. (QOL)	Exp Rec* M (SD)	Exp Est* M (SD)	Ctrl M (SD)	p value	The guide dog groups did not perform significantly better than the control on overall quality of life over 6 months (i.e. QOL scores did not significantly differ), however, they did perform significantly better for the adapted independence sub measure (i.e. I scores were significantly higher) which had varying effects; small (for established versus control), medium to large (for received versus established), to large (for received versus control).
		Pre	74.33 (2.63)	87.64 (3.46)	77.35 (3.34)		
		Post	78.93 (2.89)	88.42 (2.84)	76.17 (2.89)	.23	
		ηp^2	Rec vs. Est 0.04	Rec vs. Ctrl 0.10	Est vs. Ctrl 0.01		
	(i) 16th item: independence	(i)	Exp Rec* M (SD)	Exp Est* M (SD)	Ctrl M (SD)	p value	
		Pre	4.06 (0.31)	5.42 (0.35)	4.76 (0.31)		
		Post	4.93 (0.31)	5.50 (0.27)	4.35 (0.36)	.04	
		ηp^2	Rec vs. Est 0.10	Rec vs. Ctrl 0.14	Est vs. Ctrl 0.03		

*Exp Rec= those who received a dog throughout the six month study, Exp Est= those who already had an established dog partnership for a minimum of three years

Table 6. Hearing dog interventions (N = 2)

Lead author (Year) Study Design	Outcomes: outcome measures reported	Results					Main Findings
		Biological/ Physical Outcomes					
Rintala (2008) Quasi-experiment Exp (n= 18) Ctrl (n= 15)	1. Degree of assistance needed to perform tasks of daily living: Functional Independence Measure: Motor Subscale (FIM)	1. (FIM)	Exp M (SD) 90.8 (0.4)	Ctrl M (SD) 85.3 (7.6)	t value 7.00	p value > .05	After 6 months, the hearing dog group did not perform significantly better than the control in tasks of daily living (i.e. no significant difference in FIM scores was observed).
		Psychological Outcomes					
Guest (2006) Quasi-experiment (N= 51)	1. Mood: Profile of Mood States (POMS)	1. (POMS)*		M (SD)		p value	Three months after receiving the hearing dog, mood significantly improved (i.e. POMS scores significantly decreased), and though mood stayed improved at 14 months follow-up, this was not significant (i.e. POMS scores were not significantly maintained).
		Pre		15 (Nr)			
		Post		-3 (Nr)		< .005	
		Follow-up		4 (Nr)		> .005	
Rintala (2008) Quasi-experiment Exp (n= 18) Ctrl (n= 15)	1. Life Satisfaction: Satisfaction with Life Scale (SWLS)	1. (SWLS)	Exp M (SD) 24.2 (6.1)	Ctrl M (SD) 19.0 (8.2)	t value 0.36	p value > .05	After 6 months, the hearing dog group did not have significantly better life satisfaction than the control (i.e. no significant difference in SWLS scores was observed).
		Composite Outcomes					
Guest (2006) Quasi-experiment (N= 51)	1. General Health: General Health Questionnaire (GHQ)	1. (GHQ)*	Pre M (SD)	Post M (SD)	Follow-up M (SD)	p value	Three months after receiving the hearing dog, general health significantly improved (i.e. all GHQ sub measure scores significantly decreased). Deafness-related issues also significantly improved (i.e. all HDQ sub measures of overall fearfulness and social isolation, reflected significant reductions) and were maintained at 14 months follow-up.
	(i) Anxiety	(i)	4.8	3.7	Nr	< .0083	
	(ii) Depression	(ii)	4.6	3.9	Nr	< .0083	
	(iii) Social Functioning	(iii)	4.5	2.9	Nr	< .0083	
	(iv) Sleep	(iv)	1.5	1.3	Nr	< .0083	
	2. Deafness-related issues: Hearing Dog Questionnaire (HDQ)	2. (HDQ)*	Pre M (SD)	Post M (SD)	Follow-up M (SD)	p value	
		(i) Q6	1.7	0.4	0.6	< .167	

	(i) Fearfulness (Questions 6, 9, 10)	Q9	0.25	0	0.4	< .167	
		Q10	0.8	0.2	0.3	< .167	
		(ii) Q7	2.4	0.7	1.5	< .167	
	(ii) Social isolation (Questions 7, 8, 11)	Q8	1.8	1.7	1.9	< .167	
		Q11	1.4	0.7	1.9	< .167	
Rintala (2008) Quasi-experiment Exp (n= 18) Ctrl (n= 15)	1. Mental and Physical health; 12-Item Short-Form Health Survey (SF-12)	1. (SF-12)	Exp M (SD)	Ctrl M (SD)	t value	p value	After 6 months, the hearing dog group did not have significantly better mental and physical health than the control (i.e. no significant difference in SF-12 scores was observed). The hearing dog group did, however, improve with regards to handicap (i.e. for 2/3 of the CHART sub measures, mobility and occupation, the hearing dog groups scores were significantly higher than the scores of the control).
	(i) Physical Component	(i)	75.0 (33.5)	46.9 (44.3)	1.15	> .05	
	(ii) Mental Component	(ii)	70.7 (22.0)	61.5 (27.8)	0.55	> .05	
	2. Handicap: Craig Handicap Assessment and Reporting Technique (CHART)	2. (CHART)	Exp M (SD)	Ctrl M (SD)	t value	p value	
	(i) Physical Independence: ability to sustain customary and effective independent existence	(i)	100.0 (0.0)	81.5 (28.4)	6.00	> .05	
	(ii) Mobility: ability to move about effectively in one's surroundings	(ii)	100.0 (0.0)	64.8 (17.3)	0.00	< .01	
	(iii) Occupation: ability to occupy time in manner customary to one's sex, age, and culture	(iii)	77.5 (26.0)	36.5 (22.9)	2.63	< .05	

* Data was approximated using visual representation of means in bar graphs presented, as authors did not report numerical data in the paper

Table 7. Mobility service dog interventions (N = 9)

Lead author (Year) Study Design	Outcomes: outcome measures reported	Results						Main Findings
		Biological/ Physical Outcomes						
Champagne (2016) Quasi-experiment (N = 13)	1. Oxygen consumption: Breath-by- breath COSMED K4b2 portable gas analyzer system VO_2 in mL kg^{-1} min^{-1} (O)	1. (O)	Exp M (SD) 5.10 (1.47)	Ctrl M (SD) 8.22 (1.64)	MD -37.96%	d value 1.57	p value $p \leq .001$	After two averaged trials on the same day, when paired with a mobility service dog participants performed significantly better than the control with regards to oxygen consumption, ventilation, tidal volume, respiratory quotient, and heart rate (i.e. had significantly lower scores on the corresponding measures) and effect size measures were all considered large. The exception to this was respiratory rate, which did not significantly differ dependent on pairing (i.e. RR scores did not significantly change).
	2. Ventilation: L min^{-1} (V)	2. (V)	Exp M (SD) 18.35 (5.74)	Ctrl M (SD) 28.69 (9.34)	MD -36.04%	d value 1.33	p value $p \leq .001$	
	3. Tidal volume: L (TV)	3. (TV)	Exp M (SD) 0.77 (0.19)	Ctrl M (SD) 1.00 (0.26)	MD -23.00%	d value 1.01	p value $\leq .001$	
	4. Respiratory quotient: Respiratory quotient (RQ)	4. (RQ)	Exp M (SD) 0.92 (0.07)	Ctrl M (SD) 1.01 (0.09)	MD -8.91%	d value 1.12	p value $\leq .001$	
	5. Respiratory rate: cycles min^{-1} (RR0	5. (RR)	Exp M (SD) 24.44 (4.27)	Ctrl M (SD) 30.80 (8.71)	MD -20.65%,	d value 0.93	p value .013	
	6. Heart rate: BMP (HR)	6. (HR)	Exp M (SD) 102.75 (16.04)	Ctrl M (SD) 114.57 (17.17)	MD -10.32%	d value 0.71	p value $\leq .001$	
Craft (2007) Cross-section Exp (n= 76) Ctrl (n= 10)	1. Energy: Energy/Fatigue Scale (EFS)	1. (EFS)	Exp M (SD) 1.74 (1.02)	Ctrl M (SD) 1.76 (1.14)	t value -.054	p value .958		The mobility service dog group did not perform significantly better than the control with regards to energy and pain (i.e. EFS and PSS scores did not significantly differ across groups).
	2. Pain: Pain Severity Scale (PSS)	2. (PSS)	Exp M (SD) 71.82 (17.64)	Ctrl M (SD) 63.92 (19.44)	t value -1.16	p value .273		

Rintala (2008) Quasi-experiment Exp (n= 18) Ctrl (n= 15)	1. Degree of assistance needed to perform tasks of daily living: Functional Independence Measure: Motor Subscale (FIM)	1. (EFS)	Exp M (SD) 68.9 (15.7)	Ctrl M (SD) 72.3 (18.4)	t value 0.57	p value > .05	After 6 months, the mobility service dog group did not perform significantly better than the control in tasks of daily living (i.e. no significant difference in FIM scores was observed).
Vincent (2019) Quasi-experiment (N= 17)	1. Shoulder Pain: Wheelchair User's Shoulder Pain Index (WUSPI)	1. (WUSPI)	Pre M (SD) 32.2 (11.4)	Post M (SD) 16.0 (14.5)	p value .007		After acquisition of the mobility service dogs for 9 months, pain, fatigue, and wheelchair related function significantly improved (i.e. significantly higher scores of WUSPI, WUWPI, RPE and WST), whilst vitality, grip-strength and mobility did not (i.e. RAND SF-36, GS and LSA scores did not significantly differ over time).
	2. Wrist Pain: Wheelchair User's Wrist Pain Index (WUWPI)	2. (WUWPI)	Pre M (SD) 22.1 (13.0)	Post M (SD) 10.2 (12.4)	p value .002		
	3. Fatigue: Rate of Perceived Exertion (RPE)	3. (RPE)	Pre M (SD) 5.0 (1.4)	Post M (SD) 3.3 (1.9)	p value .005		
	4. Vitality: RAND 36-Item Short-Form Health Survey (RAND SF- 36)	4. (RAND SF-36)	Pre M (SD)	Post M (SD)	p value		
	(i) Feel full of life	(i)	3.53 (0.87)	3.53 (1.28)	.039		
	(ii) Have a lot of energy	(ii)	2.35 (1.12)	2.71 (1.11	.066		
	(iii) Feel worn out	(iii)	3.94 (1.20)	3.00 (1.23)	.068		
	5. Wheelchair-related functional tasks: Wheelchair Skills Test (WST)	5. (WST)	Pre M (SD)	Post M (SD)	p value		
	(i) Steep slopes	(i)	0.41 (0.51)	1.00 (0.00)	< .001		
	(ii) Soft surfaces	(ii)	0.53 (0.51)	0.94 (0.24)	< .001		
	(iii) Threshold > 15cm	(iii)	0.06 (0.47)	0.29 (0.47)	.053		
	6. Grip strength: Jamar dynamometer for grip-strength/prehension (GS)	6. (GS)	Pre M (SD)	Post M (SD)	p value		
	(i) Left hand, female	(i)	49.5 (25.9)	51.4 (22.8)	.583		
	(ii) Left hand, male	(ii)	58.7 (48.7)	63.7 (51.9)	.340		
		(iii)	54.0 (26.3)	55.7 (28.2)	.825		

	(iii) Right hand, female (iv) Right hand, male	(iv)	57.0 (48.0)	55.8 (47.1)	.168	
	7. Mobility: Life Space Assessment (LSA)	7. (LSA)	Pre M (SD) 52.5 (16.9)	Post M (SD) 52.1 (13.8)	p value .550	
Vincent (2015) Cross-section (N= 66)	1. Travelling on a flat route: distance in metres (TD)	1. (TD)	Exp M (SD) 669	Ctrl M (SD) 206	p value < .001	The presence of mobility service dog significantly improved distance and speed travelled, threshold, and ability to travel up a slope for wheelchair users (i.e. significantly higher TD, TS, S, T and O scores) compared to no assistance dog present. Pain significantly improved over 9 months since the introduction of the service dog (i.e. significantly lower WUSPI scores over time).
	2. Travelling on a flat route: speed in metres/second (TS)	2. (TS)	Exp M (SD) 1.36	Ctrl M (SD) 0.79	p value < .001	
	3. Ability to go up a slope: Y/N at unspecified angle (S)	3. (S)	Exp M (SD) 97%	Ctrl M (SD) 59%	p value < .001	
	4. Threshold: Y/N at unspecified threshold (T)	4. (T)	Exp M (SD) 100%	Ctrl M (SD) 53%	p value < .001	
	5. Picking-up objects from the ground: improvements Y/N with unspecified objects (O)	5. (O)	Exp M (SD) 29%	Ctrl M (SD) Nr	p value Nr	
	6. Pain: Wheelchair Users Shoulder Pain Index (WUSPI)	6. (WUSPI)	Pre M (SD) 5.3	Post M (SD) 2.5	p value .004	
			Psychological Outcomes			
Allen (1996) RCT Exp (n= 24) Ctrl (n= 24)	1. Internal locus of control: Spheres of Control Scale (SCS)	1. (SCS)	Exp M (SD)	Ctrl M (SD)	p value	The mobility service dog group performed significantly better on internal locus of control, self-esteem and psychological wellbeing (i.e. had significantly higher SCS, RSS and ABS scores) compared to the control after 18months. This was maintained at 24 month follow-up.
		Pre	64.4 (4.3)	61.5 (1.2)	< .001	
		Post	187.6 (3.9)	135.2 (3.8)	< .001	
		Follow-up	189.8 (1.8)	178.8 (3.7)	< .001	

	2. Self-esteem: Rosenberg Self- esteem Scale (RSS)	2. (RSS)	Exp Rec M (SD)	Ctrl M (SD)	p value		
		Pre	13.0 (2.1)	14.1 (1.2)	< .001		
		Post	36.2 (0.8)	25.3 (1.2)	< .001		
		Follow-up	36.6 (0.7)	35.3 (0.5)	< .001		
	3. Psychological well-being: Affect Balance Scale (ABS)	3. (ABS)	Exp Rec M (SD)	Ctrl M (SD)	p value		
		Pre	1.6 (0.5)	1.8 (0.4)	< .001		
		Post	8.1 (0.4)	6.3 (0.5)	< .001		
		Follow-up	8.8 (0.4)	8.1 (0.3)	< .001		
Craft (2007) Cross-section Exp (n= 76) Ctrl (n= 10)	1. Depression: Center for Epidemiologic Studies Depression Scale (DS)	1. (DS)	Exp M (SD)	Ctrl M (SD)	t value	p value	The mobility service dog group did not perform significantly better than the control with regards depression and intrusiveness (i.e. DS and AIIRS scores did not significantly differ across groups).
			1.14 (0.76)	1.34 (0.66)	.767	.45	
	2. Intrusiveness: Adapted Illness Intrusiveness Ratings Scale (AIIRS)	2. (AIIRS)	Exp M (SD)	Ctrl M (SD)	t value	p value	
			52.25 (19.91)	45.33 (21.47)	-.921	.379	
Rintala (2008) Quasi-experiment Exp (n= 18) Ctrl (n= 15)	1. Life Satisfaction: Satisfaction with Life Scale (SWLS)	1. (SWLS)	Exp M (SD)	Ctrl M (SD)	t value	p value	After 6 months, the mobility service dog group did not have significantly better life satisfaction than the control (i.e. no significant difference in SWLS scores was observed).
			20.4 (6.5)	19.4 (10.2)	0.32	> .05	
Vincent (2019) Quasi-experiment (N= 17)	1. Quality of life: Reintegration to Normal Living Index (RNLI)	1. (RNLI)	Pre M (SD)	Post M (SD)	p value		
	(i) Item 1: I move around my living quarters as I feel necessary	(i)	0.29 (0.59),	0.0 (0.0)	.035		
	(ii) Item 2: I move around my community as I feel necessary	(ii)	0.88 (0.78)	0.29 (0.59)	< .001		
	(iii) Item 3: I am able to take trips out of town as I feel are necessary	(iii)	0.94 (0.90)	0.53 (0.80)	.004		
	(iv) Item 5: I spend most of my days occupied in work activity that is necessary or important to me	(iv)	0.76 (0.75)	0.18 (0.39)	.029		

PIADS scores did not significantly differ over time).

(v) Item 7: I participate in social activities with family, friends, and/or business acquaintances as is necessary or desirable to me	(v)	1.12 (0.93)	0.47 (0.62)	.008
2. Psychological adjustment: Psychosocial Impact of Assistive Devices Scale (PIADS)	2. (PIADS)	Pre M (SD)	Post M (SD)	p value
(i) Adequacy	(i)	2.41 (0.62)	2.47 (0.80)	.687
(ii) Independence	(ii)	2.53 (0.62)	2.53 (0.62)	.956
(iii) Self-esteem	(iii)	1.65 (1.22)	1.29 (1.21)	.423
(iv) Productivity	(iv)	2.24 (0.83)	2.06 (1.09)	.895
(v) Quality of life	(v)	2.41 (0.80)	2.41 (0.80)	.174
(vi) Sense of control	(vi)	1.65 (1.27)	2.18 (1.01)	.069
(vii) Ability to participate	(vii)	2.12 (1.17)	2.24 (0.83)	.598
(viii) Eagerness to try new things	(viii)	1.76 (1.20)	1.53 (1.12)	.843
(ix) Ability to adapt to activities of daily living	(ix)	2.18 (1.01)	1.17 (1.10)	.254
(x) Ability to take advantage of opportunities	(x)	2.06 (0.97)	1.94 (0.90)	.828
		Social Outcomes		
Allen (1996) RCT Exp (n= 24) Ctrl (n= 24)	1. Community Integration: Community Integration Questionnaire (CIQ)	1. (CIQ)	Exp M (SD)	Ctrl M (SD)	p value	The mobility service dog group performed significantly better on community integration, school attendance and part-time employment (i.e. had significantly higher CIQ and DQ scores) compared to the control after 18months. This was maintained at 24 month follow-up.
		Pre	2.3 (0.6)	2.2 (0.5)	
		Post	26.7 (0.7)	15.7 (0.5)	< .001
		Follow-up	27.2 (0.5)	25.3 (0.5)	< .001
	2. Social Demographic information (Demographic Questionnaire (DQ) (i) School attendance	2. (DQ) (i)	Exp M (SD)	Ctrl M (SD)	p value
		Pre	0 (Nr)	0 (Nr)	
		Post	15 (Nr)	10 (Nr)	< .001
		Follow-up	11 (Nr)	7 (Nr)	< .001
	(ii) Part- time employment	(ii)	Exp M (SD)	Ctrl M (SD)	p value

		Pre	0 (Nr)	0 (Nr)	
		Post	21 (Nr)	15 (Nr)	< .001
		Follow-up	23 (Nr)	17 (Nr)	< .001
Hart (1987) Cross-Section Exp (n= 28) Ctrl (n= 9)	1. Approaches: the total number of adults and children approaching them in a friendly way during a typical trip downtown (AP)	1. (AP)	Exp Med (IQR)	Ctrl Med (IQR)	p value
	(i) Adults	(i)	8 (Nr)	1 (Nr)	≤ .01
	(ii) Children	(ii)	5 (Nr)	0 (Nr)	≤ .05
	2. Unaccompanied daytime outings: the number of times per week they would go out alone in the daytime without a person accompanying them (UDO)	2. (UDO)	Exp Med (IQR) Nr	Ctrl Med (IQR) Nr	p value Nr
	3. Unaccompanied night time outings: the number of times per month they would go out alone at night (UNO)	3. (UNO)	Exp Med (IQR) 6 (Nr)	Ctrl Med (IQR) 7 (Nr)	p value > .05
	4. Outings (O)	4. (O)	Exp (%)	Ctrl (%)	
	(i) % of experimental group participants who reported that they took more evening outings when they had the dog compared to when they did not have the dog	(i)	58	Nr	
	(ii) % of experimental group participants who reported no change in evening outings when they had the dog compared to when they did not have the dog	(ii)	32	Nr	
	(iii) % of experimental group participants who reported that they took less evening outings when they had the dog compared to when they did not have the dog	(iii)	11	Nr	

The mobility service dog group performed significantly better regarding approaches (i.e. had a significantly higher number of total approaches) than the control, and did not significantly differ regarding daytime outings (i.e. UDO scores did not significantly differ), whilst night time outings are unknown (UNO scores not reported). Within the service dog group, over half reported more evening outings, under half reported no change in evening outings, and approximately one tenth reported less evening outings when they had the service dog compared to when they retrospectively thought back to when they did not have the service dog.

			Composite Outcomes					
Davis (2017) Cross-section Exp (n= 91) Ctrl (n= 49)	1. Level of Handicap: The Craig Handicap Assessment Technique Short Form (CHART) (i) Physical Independence (ii) Cognitive independence (iii) Mobility (iv) Occupation (v) Social integration (vi) Economic self-sufficiency	1. (CHART) (i) (ii) (iii) (iv) (v) (vi)	Exp M (SD) 93.68 (7.33) 65.02 (30.27) 79.91 (19.04) 56.54 (38.69) 87.41 (18.92) 75.51 (30.06)	Ctrl M (SD) 92.22 (9.02) 66.78 (28.70) 80.14 (27.10) 73.44 (32.89) 85.54 (23.21) 86.53 (25.98)	f value 1.07 0.11 0.01 6.82 0.27 4.69	p value .303 .740 .950 .010 .607 .032		The mobility service dog group did not significantly differ from the control regarding overall level of handicap (i.e. 3/5 CHART sub measures showed no difference in scores across groups, but 2/5 did; occupation and economic self-sufficiency).
Lundqvist (2018) Quasi-experiment (N = 30)	1. Health-related quality of life: The EuroQol five-dimensional (EQ-5D) 2. Health-related quality of life: The EuroQol visual analogue scale (EQ-VAS) 3. Health-related quality of life: The Short-Form 6D (SF-6D)	1. (EQ-5D) 2. (EQ-VAS) 3. (SF-6D)	Pre M (SD) 0.266 (0.323) Pre M (SD) 52.97 (22.301) Pre M (SD) 0.590 (0.093)	Post M (SD) 0.351 (0.282) Post M (SD) 60.93 (17.625) Post M (SD) 0.610 (0.088)	MD 0.086 MD 7.966 MD 0.020	d value 0.243 d value 0.367 d value 0.208	p value .201 p value .058 p value .282	Three months after receiving the mobility service dog, no significant difference in health-related quality of life was evident (i.e. EQ-5D, EQ-VAS and SF-6D scores did not significantly change over time).
Rintala (2008) Quasi-experiment Exp (n= 18) Ctrl (n= 15)	1. Mental and Physical health; 12-Item Short-Form Health Survey (SF-12) (i) Physical Component (ii) Mental Component 2. Handicap: Craig Handicap Assessment and Reporting Technique (CHART) (i) Physical Independence: ability to sustain customary and effective independent existence	1. (SF-12) (i) (ii) 2. (CHART)	Exp M (SD) 25.9 (21.4) 58.6 (25.0) Exp M (SD)	Ctrl M (SD) 29.2 (21.1) 65.2 (23.6) Ctrl M (SD)	t value 0.44 0.78 t value	p value > .05 > .05 p value		After 6 months, the mobility service dog group did not have significantly better mental and physical health or handicap than the control (i.e. no significant difference in SF-12 or CHART scores was observed).

	(ii) Mobility: ability to move about effectively in one's surroundings	(i)	72.3 (39.5)	84.0 (21.4)	1.03	> .05
	(iii) Occupation: ability to occupy time in manner customary to one's sex, age, and culture	(ii)	77.6 (21.0)	86.9 (14.3)	1.46	> .05
		(iii)	44.3 (35.3)	60.4 (38.0)	1.27	> .05
Vincent (2019) Quasi-experiment (N= 17)	1. Occupational performance: Canadian Occupational Performance Measure (COPM)	1. (COPM)	Pre M (SD) 3.8 (2.8)	Post M (SD) 9.2 (1.6)	p value .003	After acquisition of the mobility service dogs for 9 months, occupational performance improved (i.e. COPM scores significantly increased).

Table 8. Psychiatric service dog interventions (N = 5)

Lead author (Year) Study design	Outcomes: outcome measures reported	Results						Main Findings
		Biological/ Physical Outcomes						
Kopicki (2016) Quasi-experiment Exp (n= 12) Ctrl (n= 6)	1. Sleep: The Pittsburgh Sleep Quality Index Global Score (PSQI)	1. (PSQI)	Exp M (SD) 17.60 (1.95)	Ctrl M (SD) 16.83 (2.56)	t value 0.55		p value .60	The psychiatric service dog group, after unspecified amount of time post receiving the dog, did not significantly differ on sleep (i.e. PSQI scores did not significantly differ) compared to the control.
Rodriguez (2018) Cross-section Exp (n= 45) Ctrl (n= 28)	1. Sleep quality: The Pittsburgh Sleep Quality Index (PSQI)	1. (PSQI)	Exp M (SD) 14.76 (3.45)	Ctrl M (SD) 16.26 (3.55)	t value -1.74	d value 0.43	p value .09	The psychiatric service dog group did not significantly differ on sleep (i.e. PSQI scores) compared to the control. The service dog group, however, reported a significantly higher cortisol concentration (i.e. significantly higher CAR score) and change in area under the curve (i.e. significantly higher CAR AUCi scores), compared to the control, with effect size measures not commented on.
	2. Change in cortisol concentration: Cortisol awakening response ug/dl (CAR)	2. (CAR)	Exp M (SD) Nr	Ctrl M (SD) Nr	t value Nr	ß value −0.08	p value < .05	
	3. Change in cortisol concentration with respect to increase: Cortisol awakening response area under the curve ug/dl (CAR AUCi)	3. (CAR AUCi)	Exp M (SD) Nr	Ctrl M (SD) Nr	t value Nr	ß value −1.13	p value < .05	
Yarborough (2017) Quasi-experiment Exp (n= 70) Ctrl (n= 54)	1. Usual hours slept: Average number of hours slept per night (Categorical <6, 7, 8, 9>) (S)	1. (S)	<6 (%)	7 (%)	8 (%)	9> (%)	p value	After 30 days (minimum) the psychiatric service dog group did not significantly differ on sleep compared to the control (i.e. hours slept did not significantly differ across groups).
		Exp	61	30	9	0		
		Ctrl	80	14	2	4	.120	
		Psychological Outcomes						
Kopicki (2016) Quasi-experiment Exp (n= 12) Ctrl (n= 6)	1. Post-traumatic Stress Disorder Symptoms: The PTSD Checklist- Military Version (PCL)	1. (PCL)	Exp M (SD)	Ctrl M (SD)	t value		p value	The psychiatric service dog group, after an unspecified amount of time post receiving the dog, did not significantly differ from the control on overall PTSD symptoms (i.e. PCL scores did not significantly differ) and subscales, except for the hyperarousal subscale, where the service dog group performed
	(i) Re-Experiencing	(i)	9.00 (8.28)	5.00 (0.0)	0.66		.52	
	(ii) Avoidance							

	(iii) Negative Alterations	(ii)	4.75 (2.82)	5.67 (2.89)	-0.48	.64	significantly better (i.e. scored significantly lower) compared to the control.
	(iv) Hyperarousal	(iii)	22.43 (5.72)	24.17 (5.46)	-0.63	.54	
		(iv)	15.71 (5.73)	23.83 (2.17)	-3.33	< .001	
O'Haire (2018) Cross-section & Quasi-experiment Exp (n= 75) Ctrl (n= 66)	1. Post-traumatic Stress Disorder Severity: The PTSD Checklist (PCL)	1. (PCL)	Exp M (SD)	Ctrl M (SD)	t value	d value	p value
		Pre	Nr	Nr			
		Post	Nr	Nr	Nr	-2.11	< .001
		Follow-up	Nr	Nr	Nr	-1.03	< .001
	2. Depression: The Patient Reported Outcomes Measurement Information System (PROMIS)	2. (PROMIS)	Exp M (SD)	Ctrl M (SD)	t value	d value	p value
			22.3 (7.2)	28.9 (7.4)	-5.68	-0.91	< .001
	3. Depression: The Patient Health Questionnaire (PHQ-9)	3. (PHQ-9)	Exp M (SD)	Ctrl M (SD)	t value	d value	p value
			14.0 (5.4)	17.9 (5.3)	-4.62	-0.74	< .001
	4. Quality of Life: The Satisfaction With Life Scale (SWLS)	4. (SWLS)	Exp M (SD)	Ctrl M (SD)	t value	d value	p value
			18.8 (7.9)	15.0 (5.9)	3.00	0.59	.003
	5. Quality of Life: The Bradburn Scale of Psychological Wellbeing (BSPW)	5. (BSPW)	Exp M (SD)	Ctrl M (SD)	t value	d value	p value
			-0.9 (2.5),	-2.7 (2.0)	4.72	0.81	< .001
	6. Quality of Life: The Connor Davidson Resilience Scale (CDRS)	6. (CDRS)	Exp M (SD)	Ctrl M (SD)	t value	d value	p value
			22.8 (8.5)	18.5 (7.5)	3.67	0.54	< .001

Rodriguez (2018) Cross-section Exp (n= 45) Ctrl (n= 28)	1. Post-traumatic Stress Disorder Symptoms: The PTSD Checklist (PCL)	1. (PCL)	Exp M (SD) 57.38 (13.40)	Ctrl M (SD) 69.00 (11.13)	t value -3.80	d value 0.94	p value < .001	The psychiatric service dog group performed significantly better with regards to PTSD symptom severity (i.e. PCL scores were significantly lower) compared to the control, with a large effect size.
Whitworth (2019) Quasi-experiment Exp (n= 15) Ctrl (n= 15)	1. Trauma symptomology: Trauma Symptom Inventory-2 (TSI-2)	1. (TSI-2)	Exp M (SD)	Ctrl M (SD)	t value		p value	The psychiatric service dog group, after 14 weeks, performed significantly better with regards to sleep disturbance, posttraumatic stress and externalisation (i.e. TSI-2 subscale scores were significantly lower), compared to the control. However, the service dog group did not significantly differ on somatisation (i.e. TSI-2 subscale score did not significantly differ), compared to the control.
	(i) Self-disturbance	(i) Pre	53.6 (21)	60.4 (18)				
		Post	30.9 (17)	55.8 (16)	3.40		< .05	
	(ii) Posttraumatic stress	(ii) Pre	86.9 (22)	82.8 (19)				
		Post	52.8 (25)	75.0 (15)	3.42,		< .05	
	(iii) Externalization	(iii) Pre	45.2 (29)	56.8 (23)				
		Post	24.0 (18)	53.2 (19)	2.53		< .05	
	(iv) Somatization	(iv) Pre	18.2 (6)	19.8 (4)				
		Post	13.0 (5)	17.0 (4)	1.29		> .05	
Yarborough (2017) Quasi-experiment Exp (n= 70) Ctrl (n= 54)	1. Psychiatric symptoms and functioning: Behaviour and Symptom Identification Scale (BASIS-24)	1. (BASIS-24)	Exp M (SD)	Ctrl M (SD)	t value	d value	p value	After 30 days (minimum) the psychiatric service dog group performed significantly better with regards to psychiatric symptoms (i.e. 3/5 BASIS-24 sub measure scores were significantly lower), post-traumatic stress disorder symptoms (i.e. PCL scores were significantly lower), general happiness (i.e. GSS scores were significantly higher) and quality of life (i.e. WQOLI scores were significantly higher) compared to the control. Effect sizes were mostly large. After 30 days (minimum) the psychiatric service dog group did not perform significantly different to the control with regards to resilience (i.e.
	(i) Depression/functioning	(i) Pre	1.6 (1.0)	2.6 (.7)				
		Post	Nr	Nr	22.8	-.85	.001	
	(ii) Interpersonal relationships	(ii) Pre	1.8 (1.0)	2.3 (.8)				
		Post	Nr	Nr	5.4	-.54	.023	
	(iii) Emotional liability	(iii) Pre	1.7 (1.2)	2.2 (1.0)				
		Post	Nr	Nr	3.1	.62	.082	
	(iv) Psychosis	(iv) Pre	.8 (1.0)	1.3 (1.0)				
		Post	Nr	Nr	3.5	-.11	.065	
		(v) Pre	.2 (.4),	.5 (.7),				
		Post	Nr	Nr	.83	-.98	.001	

	(v) Substance abuse						DDRI-2 scores did not significantly differ).
	2. Post-traumatic stress disorder symptoms: The PTSD Checklist–civilian version (PCL)	2. (PCL)	Exp M (SD)	Ctrl M (SD)	t value	d value	p value
		Pre	51.8 (18.2)	66.2 (13.1)			
		Post	Nr	Nr	14.5	-.98	.00
	3. Resilience: The Deployment Risk and Resilience Inventory–2 (DRRI-2)	3. (DRRI-2)	Exp M (SD)	Ctrl M (SD)	t value	d value	p value
		Pre	46.4 (16.8)	41.7 (16.3)			
		Post	Nr	Nr	83	.28	.368
	4. General happiness: General Social Survey (GSS)	4. (GSS)	Exp M (SD)	Ctrl M (SD)	t value	d value	p value
		Pre	3.0 (.6)	2.3 (.7)			
		Post	Nr	Nr	18.2	.87	.001
	5. Quality of life: Wisconsin Quality of Life Index (WQOLI)	5. (WQOLI)	Exp M (SD)	Ctrl M (SD)	t value	d value	p value
		Pre	6.6 (2.2)	4.3 (1.7)			
		Post	Nr	Nr	23.5	.87	.001
			Social Outcomes				
O'Haire (2018) Cross-section Exp (n= 75) Ctrl (n= 66)	1. Social and Work Functioning: Three PROMIS scales (PROMIS)	1. (PROMIS)	Exp M (SD)	Ctrl M (SD)	t value	d value	p value
	(i) Ability to Participate in Social Activities	(i)	20.8 (6.9)	16.2 (5.7)	4.83	0.73	< .001
	(ii) Social Isolation	(ii)	26.7 (6.8)	30.6 (6.3)	-3.95	-0.60	< .001
	(iii) Companionship	(iii)	22.1 (6.5)	19.0 (5.4)	2.05	0.52	.043
	2. Social and Work Functioning: The Work Productivity and Activity Impairment Questionnaire Impairment at Work (WPAI)	2. (WPAI)	Exp M (SD)	Ctrl M (SD)	t value	d value	p value
			44.8 (27.4)	64.4 (29.7)	2.03	-0.69	.453

The psychiatric service dog group performed significantly better with regards to ability to participate in social activities (i.e. scored higher), social isolation (i.e. scored lower) and companionship (i.e. scored higher), compared to the control, with medium effect sizes. The service dog group did not significantly differ on impairment at work (i.e. WPAI scores did not significantly differ), compared to the control.

Yarborough (2017) Quasi-experiment Exp (n= 70) Ctrl (n= 54)	1. Activity level: Regular engagement in 25 daily activities in the prior month (A)	1. (A)	Exp M (SD)	Ctrl M (SD)	t value	d value	p value	After 30 days (minimum) no significant differences were observed for activity level across the psychiatric service dog group and control (i.e. A scores did not significantly differ).
		Pre	2.4 (.4)	2.2 (.4)				
		Post	Nr	Nr	2.8	.64	.098	
				Composite Outcomes				
O'Haire (2018) Cross-section Exp (n= 75) Ctrl (n= 66)	1. Health related quality of life: The Veteran's RAND 12 Item Health Survey (VR-12) (i) Mental Health (ii) Physical Health	1. (VR-12)	Exp M (SD)	Ctrl M (SD)	t value	d value	p value	The psychiatric service dog group performed significantly better with regards to mental health (i.e. VR-12 mental health subscale scores were significantly higher) compared to the control, and there was a medium effect size. The service dog group did not significantly differ on physical health (i.e. VR-12 physical health subscale scores did not significantly differ), compared to the control.
		(i)	30.9 (10.1)	24.4 (9.7)	3.87	0.66	< .001	
		(ii)	36.8 (10.9)	37.1 (12.3)	-0.12	-0.02	.908	
Rodriguez (2018) Cross-section Exp (n= 45) Ctrl (n= 28)	1. Behaviour: Patient-Reported outcome measurement information system (PROMIS) (i) Alcohol (ii) Anxiety (iii) Anger (iv) Sleep disturbance	1. (PROMIS)	Exp M (SD)	Ctrl M (SD)	t value	d value	p value	The psychiatric service dog group performed significantly better with regards to behaviour (i.e. PROMIS scores were significantly lower) compared to the control, with medium to mostly large effect sizes.
		(i)	39.88 (19.51)	53.14 (8.91),	-2.38	0.87	0.02	
		(ii)	64.50 (6.83)	71.31 (7.28)	-3.98	0.96	< .001	
		(iii)	66.54 (9.81)	73.24 (8.49)	-2.95	0.73	< .01	
		(iv)	60.65 (9.19)	66.31 (7.62)	-2.71	0.67	< .01	
Whitworth (2019) Quasi-experiment Exp (n= 15) Ctrl (n= 15)	1. Disability level: The World Health Organization-Disability Assessment Schedule 2.0 (WHO-DAS 2.0)	1. (WHO-DAS 2.0)	Exp M (SD)	Ctrl M (SD)	t value	p value		The psychiatric service dog group, after 14 weeks, performed significantly better with regards to disability level (i.e. scored significantly lower on the WHO-DAS 2.0) compared to the control.
		Pre	42.4 (17)	54.5 (13)				
		Post	26.8 (13)	50.3 (13)	3.92	< .05		
Yarborough (2017)	1. General Health: The Veterans RAND 12-Item Health Survey (VR-12)	1. (VR-12)	Exp M (SD)	Ctrl M (SD)	t value	d value	p value	After 30 days (min) the psychiatric service dog group performed

Quasi-experiment Exp (n= 70) Ctrl (n= 54)	(i) Mental Health	(i) Pre	42.6 (10.1)	35.8 (8.0)				significantly better with regards to the mental component of the health survey (i.e. mental VR-12 scores were significantly higher compared to the control) with a large effect size. No significant difference was observed for the physical component of the health (i.e. physical VR-12 scores did not significantly differ across groups).
		Post	Nr	Nr	9.6	.76	.003	
	(ii) Physical Health	(i) Pre	40.7 (7.8)	41.5 (61)				
		Post	Nr	Nr	.26	-.37	.615	

Table 9. Alert and response service dog interventions (N = 3)

Lead author (Year) Study Design	Outcomes: outcome measures reported	Results						Main Findings
		Biological/Physical Outcomes						
Rooney (2013) Cross- section & Quasi-experiment 1. (n= 11)	1. Odds ratios for glucose levels outside owner's target range (i.e. usually 5-15nm/l), comparing alert (i.e. when the dog cues the owner) vs. routine (i.e. conducted routinely by the owner) tests: Glycated Hemoglobin test (HbA1c)	1. (HbA1c)	Pooled odds ratio 3.4					Glucose level odds ratios for comparing alert and routine tests was reported, on average, to convey that diabetes medical detection dogs were effectively alerting owners when their blood glucose level was outside of their target area (i.e. HbA1c odds ratio was higher than 1). Glycaemic concentration was significantly better post dog, for most owners (i.e. GC samples within range were significantly higher post dog compares to GC samples within range pre dog), where post ranged from 5-581 months.
2. (n= 9)	2. Glycaemic concentration: Glycaemic concentration nanometer per litre (nm/l) within range (categorised as within-range or outside of range i.e. low/high) (GC)	2. (GC)	Pre M (SD) Nr	Post M (SD) Nr	p value < .001	States that for 7 out of 9 owners, percentage of samples within the target range post dog was significantly greater compared to pre dog		
Strong (2002) Quasi-experiment (N= 10)	1. Seizure frequency: seizure diaries reporting average number of seizures in each 4-week period (SF)	1. (SF)	M (SD)		p value			Overall seizure frequency significantly improved since introduction of seizure alert dogs at 25-36 weeks, and was maintained at the follow-up time of 37-48 weeks (i.e. SF significantly decreased and was significantly maintained).
		Pre	13.8 (Nr)					
		Post	8.8 (Nr)		.0039			
		Follow-up	8.0 (Nr)		.002			
		Composite Outcomes						
Lundqvist (2018) Quasi-experiment (N= 20)	1. Health-related quality of life: The EuroQol five-dimensional (EQ-5D)	1. (EQ-5D)	Pre M (SD)	Post M (SD)	MD	d value	p value	Three months after receiving the diabetes-alert service dog, no significant difference in health-related quality of life was evident (i.e. EQ-5D, EQ-VAS and SF-6D scores did not significantly change over time).
			0.656 (0.277)	0.674 (0.366)	0.017	0.077	.741	
	2. Health-related quality of life: The EuroQol visual analogue scale (EQ-VAS)	2. (EQ-VAS)	Pre M (SD)	Post M (SD)	MD	d value	p value	
			56.00 (20.685)	63.89 (23.120)	7.895	0.434	.075	
	3. Health-related quality of life: The Short-Form 6D (SF-6D)	3. (SF-6D)	Pre M (SD)	Post M (SD)	MD	d value	p value	
			0.699 (0.143)	0.719 (0.143)	0.020	0.188	.424	

Table 10. Autism spectrum disorder (ASD) service dog interventions (N = 2)

Lead author (Year) Study Design	Outcomes: outcome measures reported	Results						Main Findings
		Biological/ Physical Outcomes						
Viau (2010) Quasi-experiment (N= 42)	1. Stress response: Averaged Salivary 'Basal' Cortisol awakening response (CAR)	1. (CAR)	Pre M (SD)	Post M (SD)	Removal M (SD)	F value	p value	Since acquisition of the ASD service dog for 4 weeks, stress response did not significantly improve (i.e. CAR measures did not significantly decrease), nor did stress response significantly deteriorate at the 2 month time point of 2 week dog removal (i.e. CAR measures did not significantly increase).
			Nr	Nr	Nr	< 1	Nr, but stated there was no effect of conditions	
		Social Outcomes						
Viau (2010) Quasi-experiment (N= 42)	1. Child's behavioural assessment: 11-item Questionnaire completed by parents about their child's behaviour (BA)	1. (BA)	Pre M (SD)	Post M (SD)	Removal M (SD)	F value	p value	Since acquisition of the ASD service dog for 4 weeks, measures of child behaviour significantly improved (i.e. BA scores significantly decreased) however, at the 2 month timepoint of 2 week dog removal, measures of child behaviour did not significantly deteriorate at the 2 month follow-up time point of 2 week dog removal (i.e. BA measures did not significantly increase).
			33	25	26	106.0	< .001	
Wild (2012) Quasi-experiment Exp (n= 10) Ctrl (n= 10)	1. Adaptive behaviour: Adaptive Behaviour Assessment System- 2nd edition (ABAS-II)	1. (ABAS-II)	Exp M (SD)	Ctrl M (SD)	F value	p value		The ASD service dog group did not perform significantly better than the control on adaptive behaviour (i.e. ABAS-II scores did not significantly differ) after 6 months. It did, however, perform significantly better than the control after 6 months on social responsiveness (i.e. SRS scores were significantly lower).
		Pre	.96 (.33)	.73 (.62)				
		Post	1.13 (.4)	.74 (.54)	3.05	.098		
	2. Social reciprocity: Social Responsiveness Scale (SRS)	2. (SRS)	Exp M (SD)	Ctrl M (SD)	F value	p value		
		Pre	2.76 (.35)	2.72 (.41)				
		Post	2.47 (.46)	2.71 (.38)	6.84	.017		

Supplementary Material

Table A

Logic Grids for Electronic Database Searches

CINAHL- 55 records retrieved

Assistance dog	Study design
MH "service animals" OR TI "alert dog*" OR AB "alert dog*" OR TI "allergy dog*" OR AB "allergy dog*" OR TI "assistance dog*" OR AB "assistance dog*" OR TI "autism dog*" OR AB "autism dog*" OR TI "diabetic dog*" OR AB "diabetic dog*" OR TI "diabetes dog*" OR AB "diabetes dog*" OR TI "FASD dog*" OR AB "FASD dog*" OR TI "fetal alcohol spectrum disorder dog*" OR AB "fetal alcohol spectrum disorder dog*" OR TI "guide dog*" OR AB "guide dog*" OR TI "hearing dog*" OR AB "hearing dog*" OR TI "medical dog*" OR AB "medical dog*" OR TI "mobility dog*" OR AB "mobility dog*" OR TI "psychiatric dog*" OR AB "psychiatric dog*" OR TI "seeing eye dog*" OR AB "seeing eye dog*" OR TI "seeing-eye dog*" OR AB "seeing-eye dog*" OR TI "seizure dog*" OR AB "seizure dog*" OR TI "service dog*" OR AB "service dog*" OR TI "alert canine*" OR AB "alert canine*" OR TI "allergy canine*" OR AB "allergy canine*" OR TI "assistance canine*" OR AB "assistance canine*" OR TI "autism canine*" OR AB "autism canine*" OR TI "diabetic canine*" OR AB "diabetic canine*" OR TI "diabetes canine*" OR AB "diabetes canine*" OR TI "FASD canine*" OR AB "FASD canine*" OR TI "fetal alcohol spectrum disorder canine*" OR AB "fetal alcohol spectrum disorder canine*" OR TI "guide canine*" OR AB "guide canine*" OR TI "hearing canine*" OR AB "hearing canine*" OR TI "medical canine*" OR AB "medical canine*" OR TI "mobility canine*" OR AB "mobility canine*" OR TI "psychiatric canine*" OR AB "psychiatric canine*" OR TI "seeing eye canine*" OR AB "seeing eye canine*" OR TI "seeing-eye canine*" OR AB "seeing-eye canine*" OR TI "seizure canine*" OR AB "seizure canine*" OR TI "service canine*" OR AB "service canine*"	TI "Intervention*" OR AB "Intervention*" OR TI "RCT*" OR AB "RCT*"OR TI "randomised control trial*" OR AB "randomised control trial*" OR TI "randomized control trial*" OR AB "randomized control trial*" OR TI "experiment*" OR AB "experiment*" OR TI "quasi-experiment*" OR AB "quasi-experiment*" OR TI "observational study*" OR AB "observational study*" OR TI "observational design*" OR AB "observational design*" OR TI "longitudinal*" OR AB "longitudinal*"

Embase- 230 records retrieved

Assistance dog	Study design
"service dog"/exp OR 'alert dog*':ti,ab OR 'allergy dog*':ti,ab OR 'assistance dog*':ti,ab OR 'autism dog*':ti,ab OR 'diabetic dog*':ti,ab OR 'diabetes dog*':ti,ab OR 'FASD dog*':ti,ab OR 'fetal alcohol spectrum disorder dog*':ti,ab OR 'guide dog*':ti,ab OR 'hearing dog*':ti,ab OR 'medical dog*':ti,ab	'Intervention*':ti,ab OR 'RCT*':ti,ab OR 'randomised control trial*':ti,ab OR 'randomized control

OR ‘mobility dog*’:ti,ab OR ‘psychiatric dog*’:ti,ab OR ‘seeing eye dog*’:ti,ab OR ‘seeing-eye dog*’:ti,ab OR ‘seizure dog*’:ti,ab OR ‘service dog*’:ti,ab OR ‘alert canine*’:ti,ab OR ‘allergy canine*’:ti,ab OR ‘assistance canine*’:ti,ab OR ‘autism canine*’:ti,ab OR ‘diabetic canine*’:ti,ab OR ‘diabetes canine*’:ti,ab OR ‘FASD canine*’:ti,ab OR ‘fetal alcohol spectrum disorder canine*’:ti,ab OR ‘guide canine*’:ti,ab OR ‘hearing canine*’:ti,ab OR ‘medical canine*’:ti,ab OR ‘mobility canine*’:ti,ab OR ‘psychiatric canine*’:ti,ab OR ‘seeing eye canine*’:ti,ab OR ‘seeing-eye canine*’:ti,ab OR ‘seizure canine*’:ti,ab OR ‘service canine*’:ti,ab	trial*’:ti,ab OR ‘experiment*’:ti,ab OR ‘quasi-experiment*’:ti,ab OR ‘observational study*’:ti,ab OR ‘observational design*’:ti,ab OR ‘longitudinal*’:ti,ab

Medline- 200 records retrieved and PsychINFO- 59 records retrieved

Assistance dog	Study design
alert dog*.ti,ab. OR allergy dog*.ti,ab. OR assistance dog*.ti,ab. OR autism dog*.ti,ab. OR diabetic dog*.ti,ab. OR diabetes dog*.ti,ab. OR FASD dog*.ti,ab. OR fetal alcohol spectrum disorder dog*.ti,ab. OR guide dog*.ti,ab. OR hearing dog*.ti,ab. OR medical dog*.ti,ab. OR mobility dog*.ti,ab. OR psychiatric dog*.ti,ab. OR seeing eye dog*.ti,ab. OR seeing-eye dog*.ti,ab. OR seizure dog*.ti,ab. OR service dog*.ti,ab. OR alert canine*.ti,ab. OR allergy canine*.ti,ab. OR assistance canine*.ti,ab. OR autism canine*.ti,ab. OR diabetic canine*.ti,ab. OR diabetes canine*.ti,ab. OR FASD canine*.ti,ab. OR fetal alcohol spectrum disorder canine*.ti,ab. OR guide canine*.ti,ab. OR hearing canine*.ti,ab. OR medical canine*.ti,ab. OR mobility canine*.ti,ab. OR psychiatric canine*.ti,ab. OR seeing eye canine*.ti,ab. OR seeing-eye canine*.ti,ab. OR seizure canine*.ti,ab. OR service canine*.ti,ab.	Intervention*.ti,ab. OR RCT*.ti,ab. OR randomised control trial*.ti,ab. OR randomized control trial*.ti,ab. OR experiment*.ti,ab. OR quasi-experiment*.ti,ab. OR observational study*.ti,ab. OR observational design*.ti,ab. OR longitudinal*.ti,ab.

ProQuest Dissertations and Theses- 10 records retrieved and Web of Science- 33 records retrieved

Assistance dog	Study design
(“alert dog” OR “allergy dog” OR “assistance dog” OR “autism dog” OR “diabetic dog” OR “diabetes dog” OR “FASD dog” OR “fetal alcohol spectrum disorder dog” OR “guide dog” OR “hearing dog” OR “medical dog” OR “mobility dog” OR “psychiatric dog” OR “seeing eye dog” OR “seeing-eye dog” OR “seizure dog” OR “service dog” OR “alert canine” OR “allergy canine” OR “assistance canine” OR “autism canine” OR “diabetic canine” OR “diabetes canine” OR “FASD canine” OR “fetal alcohol spectrum disorder canine” OR “guide canine” OR “hearing canine” OR “medical canine” OR “mobility	AND (Intervention OR RCT OR “randomised control trial” OR “randomized control trial” OR experiment OR quasi-experiment OR “observational study” OR “observational design” OR longitudinal)

canine" OR "psychiatric canine" OR "seeing eye canine" OR "seeing-eye canine" OR "seizure canine" OR "service canine") AND ("Intervention" OR "RCT" OR "randomised control trial" OR "randomized control trial" OR "experiment" OR "quasi-experiment" OR "observational study" OR "observational design" OR longitudinal)	

Scopus- 197 records retrieved

Assistance dog	Study design
("alert dog" OR "allergy dog" OR "assistance dog" OR "autism dog" OR "diabetic dog" OR "diabetes dog" OR "FASD dog" OR "fetal alcohol spectrum disorder dog" OR "guide dog" OR "hearing dog" OR "medical dog" OR "mobility dog" OR "psychiatric dog" OR "seeing eye dog" OR "seeing-eye dog" OR "seizure dog" OR "service dog" OR "alert canine" OR "allergy canine" OR "assistance canine" OR "autism canine" OR "diabetic canine" OR "diabetes canine" OR "FASD canine" OR "fetal alcohol spectrum disorder canine" OR "guide canine" OR "hearing canine" OR "medical canine" OR "mobility canine" OR "psychiatric canine" OR "seeing eye canine" OR "seeing-eye canine" OR "seizure canine" OR "service canine")	AND (Intervention OR RCT OR "randomised control trial" OR "randomized control trial" OR experiment OR quasi-experiment OR "observational study" OR "observational design" OR longitudinal)

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