Benefits of assistance dogs or pets for people on the autism spectrum: A systematic review and meta-analysis

Version 1.0
November 2023
ndis.gov.au

Contents

Disclaimer

The NDIA accepts no responsibility for the accuracy or completeness of any material contained in this report. Further, the National Disability Insurance Agency (NDIA) disclaims all liability to any person in respect of anything, and of the consequences of anything, done or not done by any such person in reliance, whether wholly or partly, upon any information presented in this report.

Views and recommendations of third parties in this report do not necessarily reflect the views of the NDIA or indicate a commitment to a particular course of action. However, this report may inform the implementation of policies in the National Disability Insurance Scheme (NDIS).

Acknowledgements

The NDIA acknowledge the Traditional Owners and Custodians throughout Australia and their continuing connection to the many lands, seas, and communities. The NDIA pay respect to Elders past and present and extends that respect to any Aboriginal and Torres Strait Islander people who may be reading this Report.

Suggested citation

National Disability Insurance Agency 2023. Benefits of assistance dogs or pets for people on the autism spectrum: A systematic review and meta-analysis. Prepared by Dr Melissa Mulraney and A/Prof Amit Lampit.

Enquiries about this publication should be addressed to:
National Disability Insurance Agency. Email: research@ndis.gov.au

Abbreviations

AD	Assistance Dog
C	Credible
DD	Developmental Delay
JBI	Joanna Briggs Institute
NDIA	National Disability Insurance Agency
NDIS	National Disability Insurance Scheme
NS	Not Supported
PRISMA	Preferred Reporting Items for Systematic reviews and Meta-Analyses
RCT	Randomised Controlled Trial
SD	Standard Deviation
U	Unequivocal
USA	United States of America

Glossary

Term	Definition
Adaptive functioning	Adaptive functioning refers to an individual's ability to effectively and appropriately navigate and interact with their environment. It encompasses a range of skills, behaviours, and capacities that allow a person to meet the demands of everyday life and to adapt to the challenges and expectations of their social, cultural, and personal context.
Animal-assisted interventions /supports	Animal-assisted interventions and supports are broad terms that capture any type of intervention or support that includes an animal. This may include assistance dogs (defined below) or any of the following: • Visitation animals are those that belong to a volunteer who trains the animal to visit a facility to increase the wellbeing of the participants. • Therapy animals are similar to visitation animals in the type of training but are used by allied health professionals to support structured, goal-directed interventions. • Companion animals receive no specific training, and the term is interchangeable with pets.
Assistance dogs	Assistance dogs are dogs that have been trained to assist a person with a disability to alleviate the effect of the disability and meet standards of hygiene and behaviour that are appropriate for an animal in a public place.

Term	Definition
	The minimum standard for an assistance dog is that the dog must be trained to perform at least three tasks or behaviours which mitigate the effects of a person's disability when required. These tasks will depend on the person's specific disability and may occur with or without command. They must also be trained to a high level of obedience.
Autism	Autism (also referred to as "autism spectrum disorder") is the collective term for a group of neurodevelopmental conditions affecting the brain's growth and development. Autism is a life-long condition which can impact, to varying degrees, all areas of a person's life, including social communication and social interaction. The behavioural features of autism are often present before a person is three years of age but in others they may not be recognised until their school years or later in life. The developmental challenges, signs and/or symptoms can vary widely in nature and degree between individuals, and in the same individual over time – that is why the term "spectrum" is used. We know that people prefer different terms to describe autism. We have used people on the autism spectrum (person-first language) to be consistent with how we refer to other target populations.
Autism characteristics	Autism characteristics include those used to diagnose autism such as difficulties with social communication (e.g., engagement in play, initiation in social interaction, joint attention), restricted, repetitive, and/or sensory behaviours, as well as challenging behaviours (e.g., noncompliance, aggressive and disruptive behaviour).

Term	Definition
Meta-analysis	A meta-analysis uses statistics to combine the results from these studies to find out how much of an effect the intervention has on selected outcomes (which we call the effect size) and what factors can predict the size of the reported effects.
Parent	For clarity of writing, throughout this report we use the term ‘parent’ to refer to any individual who has parenting responsibilities for a child.
Systematic review	A systematic review summarises the evidence from research studies focused on the same topic.

Executive Summary

This report is the first of two reports that have investigated the impacts of assistance dogs for people on the autism spectrum using systematic review methods. A systematic review is a method for collecting evidence from studies on a particular topic. The second report (Mulraney et al., 2023) summarises the qualitative findings from a systematic review about the lived experiences and perspectives of people with autism with assistance dogs, and their families. This report summarises quantitative evidence from the systematic review to examine the magnitude of possible benefits associated with assistance dogs using statistical methods.

Out of 2016 articles screened, twelve eligible studies were identified which showed there may be some benefits of assistance dogs for people with autism, however, the confidence in the evidence is very low due to limited number of studies, small number of participants in most studies, and poor methodological quality. The key findings were that:

- The benefits of assistance dogs on individual and family outcomes may not exceed those of companion (pet) dogs.
- Small to moderate effects of assistance dogs were reported on measures of autism (difficulty with social communication, repetitive, and/or sensory behaviours), adaptive functioning, and family outcomes (such as parental stress).
- The highest level of evidence is from a single randomised controlled trial conducted in the field, which found that parents of children with autism who had an assistance dog for nine months had significantly decreased parenting stress compared to a waitlist control group.

Our qualitative synthesis found that parents reported a broad range of perceived benefits of assistance dogs both for children with autism, and their families. However, most benefits described by parents are similar to those that have been described by parents of children with autism who have a pet dog (Byström & Persson, 2015; Harwood et al., 2019; Lane, 2020).

The current findings, combined with our synthesis of qualitative data, indicate there is currently limited evidence to suggest that assistance dogs confer unique benefits in autism. It is likely that some individuals will respond well to animal-assisted supports, but the current evidence does not suggest that assistance dogs would be more effective than pets. Given the lack of certainty about benefit, it is recommended assistance dogs are to be considered only after more cost-effective and evidence-based supports have been tried and found ineffective for an individual with autism.

1. Background and NDIS Context

As of March 2023, the total number of active NDIS participants with a primary diagnosis of autism was 199,367, which represents 35% of all participants in the scheme. During Q2 22/23, 19.3% of participants *entering* the NDIS had autism, making it the second largest disability group by entrants, after developmental delay. A major focus of the NDIS is to provide cost effective intervention to improve participant outcomes. This is also with the aim of reducing the intensity of specialist supports required later in life and to maximise functional outcomes throughout life.

Recently, there has been an increasing number of requests by participants with autism for assistance dogs. Between July 2021 and March 2022, there were 348 NDIS requests for assistance dogs. 151 of those requests (43%) were for participants with vision impairment, followed by autism (22%), and psychosocial disability including schizophrenia (7%).

The NDIS use the internationally recognised definition of assistance animals recommended by La Trobe University (Howell et al., 2019). An assistance animal is a dog or other animal which is trained to perform at least three tasks or behaviours which mitigate the effects of a person's disability when required. These tasks will depend on the person's specific disability and may occur with or without command. They must also be trained to a high level of obedience. Examples of assistance animals include dog guides, medical alert animals, hearing assistance animals, mobility assistance animals, psychiatric assistance animals, and assistance animals for developmental disorders (Howell et al., 2016).

This systematic review and meta-analysis complements a qualitative review; *Benefits of assistance dogs for people on the autism spectrum: A systematic review and meta-aggregation* (Mulraney et al., 2023). This report found that parents reported a broad range of benefits of assistance dogs to their child on the autism spectrum, and to the family. However, most benefits described by parents are similar to those that have been described by parents of children with autism who have a pet dog (Byström & Persson, 2015; Harwood et al., 2019; Lane, 2020). Many parents described being unprepared for the practicalities associated with owning an assistance dog and described several challenges related to this, including

appropriately caring for the dog's wellbeing. Finally, there was a lack of awareness in the community about autism and the role of assistance dogs. This meant that families were often denied access to public places with the dog and were often required to engage in community education.

2. What did we do?

The following section provides an overview of the systematic review and meta-analysis approach. A full description of the study methods is available in **Appendix A**.

2.1 Objectives

The objectives of this prospectively registered systematic review and meta-analysis (PROSPERO CRD42022363398) were to synthesise the available evidence on the effects associated with assistance dogs in people with autism. Our specific research questions were:

i. What is the current state of evidence for assistance dogs in autism?
    a. What outcomes have been investigated?
    b. What are the study designs, methods, and characteristics of participants?
    c. What is the quality of evidence?
ii. What is the evidence for the benefits or harms of assistance dogs for people with autism across outcomes?
iii. How do the benefits or harms vary across outcomes and settings?
iv. What is the evidence for cost-effectiveness for assistance dogs (e.g., training and maintenance) for people with autism?
v. What animal welfare or behavioural requirements and considerations are investigated in the assistance dogs for autism literature?

2.2 How did we do it?

Findings included in this report were identified through a systematic review and meta-analysis. A systematic review is a process to locate and summarise the results of all studies that ask a particular research question, usually by using different methods with a common underlying question (e.g., are assistance dogs associated with better outcomes in people with autism?). A meta-analysis is a statistical procedure that combines results from the studies identified in a systematic review to find a common estimate of effect between studies, as well as how effects might vary across settings and other factors (e.g., age, intervention type). Detailed study methodology is provided in **Appendix A**.

We searched four databases to identify studies that examined the efficacy or association of having an assistance dog or pet dog on any outcomes in people with autism at any age. We also included studies reporting qualitative data about participant experiences with assistance dogs and pet dogs, which we reported separately (Mulraney et al., 2023).

We included studies with a comparison group (i.e., people with autism who did not have an assistance dog or pet dog) and single-arm pre-post studies with at least two timepoints of data collection (i.e., studies without a comparison group). Studies including only visitation or therapy dogs were excluded.

We defined outcomes broadly and included any studies that reported changes in autism characteristics; cognitive and language outcomes; functional outcomes; adverse effects (both for child/family and the dogs); costs and cost-effectiveness.

Risk of bias and study quality was assessed using the Revised Cochrane Risk of Bias tool (RoB 2) (Sterne et al., 2019) for randomised trials; the Risk Of Bias In Non-randomised Studies - of Interventions (ROBINS-I) (Sterne et al., 2016) for other study designs comparing two groups; and the National Heart, Lung, and Blood Institute Quality Assessment Tool for Before-After (Pre-Post) Studies With No Control Group (QAT). When studies were reported in more than one manuscript, all manuscripts were combined into a single study.

Outcomes were pooled across studies and analysed using meta-analysis. Differences between groups or time points were converted to standardised mean difference, calculated as Hedges' *g* with 95% confidence interval (CI). Hedges' *g* is the estimate of weighted mean effect size across studies. A positive *g* denotes a benefit associated with dogs regardless of the original direction of the scale. The confidence interval denotes the precision of the effect size estimate. When the CI does not include zero (e.g., 0.2 to 0.6), the effect estimate is considered statistically significant. Conversely, when the confidence interval includes zero (e.g., -0.2 to 0.4), the estimate is not statistically significant, which means that there is not enough information to determine whether the observed effect is due to chance finding.

In addition to estimating pooled (weighted average) effect sizes and their precision, we assessed heterogeneity across studies. Heterogeneity is the extent to which individual effect sizes are dispersed around the mean effect size. Heterogeneity is quantified using the tau-squared statistic (denoted as τ^2), which is simply the variance of 'true' effects across different settings. The larger the τ^2, the less confident we are that in the ability of the mean effect size to predict treatment outcome.

Outcomes were first examined from longitudinal studies (randomised controlled trials (RCTs) and cohort studies) with comparison groups, and again using a single arm approach that compared changes in outcomes from before and after the intervention. Outcomes were also examined from cross-sectional studies with comparison groups, pooling outcomes from cross-sectional studies and the follow-up time points from cohort studies (i.e., after the dog had been placed with families). When only one study was available for analysis, its results were converted to Hedges' *g* and presented without performing a meta-analysis.

3. What did we find?

The following section highlights the key findings from the review. A detailed description of results from the meta-analysis is available in **Appendix B**.

3.1 Summary of study participants and outcomes

Twelve primary studies, comprising 1011 participants with autism (649 received an intervention and 362 controls) were included in the meta-analyses. Of the included studies, eight reported on assistance dogs (N= 505 participants; 275 received an assistance dog and 230 controls) and six (representing 4 studies) reported on pet dogs (N= 506; 374 with a pet dog and 132 without pets).

The characteristics of included studies, including the type of training received by assistance dogs, are shown in **Table 1.** Most studies (n=10) included only children, with one pet study including only adults (Atherton et al., 2022) and one assistance dog study including both children and adults (Leung et al., 2022). Included studies were from Australia (Leung et al., 2022), Canada (Dollion et al., 2022; Fecteau et al., 2017; Moses Bélanger et al., 2022; Viau et al., 2010), France (Grandgeorge et al., 2012), Ireland (Burgoyne et al., 2014), UK (Atherton et al., 2022; Hall, Wright, Hames, et al., 2016; Wright, Hall, Hames, Hardiman, Mills, & Mills, 2015; Wright, Hall, Hames, Hardiman, Mills, Team, et al., 2015), and USA (Carlisle, 2012; Hoffman, 2012; Tseng, 2022; Wild, 2012).

Eight studies reported autism characteristics outcomes, three studies reported adaptive functioning, five studies reported child mental health, two studies reported child safety, and five studies reported on family outcomes (parenting stress, parenting, family quality of life).

3.2 Characteristics of studies

All studies included dogs living in the home, but the level of training the dog and families received prior to placement, as well as length of time that the dog had been in the home varied across studies. There was one RCT (Fecteau et al., 2017) and one cohort (i.e., prospective, and longitudinal but not randomised) study (Wild, 2012) comparing assistance dogs to a waitlist control. Four studies compared outcomes between those with assistance dogs and either a waitlist (Burgoyne et al., 2014; Dollion et al., 2022; Leung et al., 2022) or no treatment (Hoffman, 2012) control. Two studies were single-arm and compared outcomes before and after (pre-post) having an assistance dog placed with the family (Tseng, 2022; Viau et al., 2010). Four studies compared outcomes between those with and without pets (Atherton et al., 2022; Carlisle, 2012; Grandgeorge et al., 2012; Hall, Wright, Hames, et al., 2016; Wright, Hall, Hames, Hardiman, Mills, & Mills, 2015; Wright, Hall, Hames, Hardiman, Mills, Team, et al., 2015), with two of these (Grandgeorge et al., 2012; Hall, Wright, Hames, et al., 2016; Wright, Hall, Hames, Hardiman, Mills, & Mills, 2015; Wright, Hall, Hames, Hardiman, Mills, Team, et al., 2015) including follow-up assessments. A detailed description of the interventions including, where available, details about the type and duration of training received by dogs and families is shown in **Table B2**.

Table 1: Characteristics of included assistance dog studies

Notes: ABAS= Adaptive Behavior Assessment System; AFEQ= Autism Family Experience Questionnaire; APSI= Autism Parenting Stress Index; ASQ= Autism Spectrum Quotient; ATEC= Autism Treatment Evaluation Checklist; CBCL= Child Behavior Checklist; CSQ= Caregiver Strain Questionnaire; PSS= Perceived Stress Scale; SDQ = study designed questions; SRS= Social Responsiveness Scale; SSIS= Social Skills Improvement System; STAI= State-Trait Anxiety Index; RCT= Randomised controlled trial.

Risk of bias assessed by the RoB-2 can be rated as low risk of bias, some concerns, or high risk of bias. Risk of bias assessed by the ROBINS-I can be rated as low, moderate, serious, or critical risk of bias. Study quality assessed by the QAT can be rated as good, fair, or poor.

Study name	Study Design	Sex (% male); Age (mean (range))	Outcome	Intervention description	Comparison group description	Type of training received by dog	Risk of Bias/ Quality
Fecteau 2017 (Fecteau et al., 2017; Moses Bélanger et al., 2022); Canada	RCT	80%; 6.7 (5-10) years	Family outcomes (QEAP-IV, PSI); autism characteristics, mental health, adaptive functioning (QEAP-IV)	N = 49; Assistance dog placed with family for 9 months	N = 49; Waitlist	Mira Foundation training	High
Wild 2012 (Wild, 2012); USA	Cohort	80%; 6.75 (4-16) years	Autism characteristics (SRS); adaptive functioning (ABAS-2); family outcomes (SDQ); child safety (SDQ)	N = 10; Assistance dog place with family for 12 months	N = 10; Waitlist	Not reported	Serious
Burgoyne 2014; Ireland	Cross-sectional	89.6%; Age categories only reported (0-6 n = 90, 7-9 years n = 74)	Family outcomes (PPCS, CSQ); child safety (SDQ)	N = 80; Assistance dog placed with family for unspecified length of time	N = 84; Waitlist	Not reported	Serious
Dollion 2022; Canada	Cross-sectional	76.7%; 12.8 (8-19) years	Autism characteristics (Facial emotion recognition)	N = 15; Assistance dog placed with family for at least 2.5 years (mean delay between dog placement and time of experimentation, 51.9 (SD 13.4) months)	N = 15; Waitlist	Mira Foundation training	Serious

Study name	Study Design	Sex (% male); Age (mean (range))	Outcome	Intervention description	Comparison group description	Type of training received by dog	Risk of Bias/ Quality
Hoffman 2012; USA	Cross-sectional	96.7%; 12.17 (8-18) years	Autism characteristics (SRS, SSIS)	N = 62; Assistance dog placed with family for unspecified length of time	N = 60; No treatment, matched to intervention group on age, sex, IQ, and comorbidities	Not reported	Serious
Leung 2022; Australia	Cross-sectional	72.2%; Age categories only reported (5-10 n=7; 10-16 n=6; 16-20 n=2; >20 n=3)	Autism characteristics (ATEC, SRS-2); adaptive functioning (ABAS-3); family outcomes (AFEQ);	N = 6; Assistance dog placed with family for varying length of time (<6 month (50%), 6-12 months (16.7%), >12 months (33.3%))	N = 12; Waitlist	Not reported	Serious
Tseng 2022; USA	Single group pre-post	83.8%; 9.1 (5-12) years	Autism characteristics (ASQ, SRS-2); family outcomes (AFEQ, APSI, PSS); mental health (CBCL, STAI)	N = 11; Assistance dog placed with family for 8-12 weeks	No control group	Can Do Canines training	Poor
Viau 2010; Canada	Single group pre-post	88.1%; 7.1 (3-14) years	Autism characteristics (SDQ);	N = 42; Assistance dog placed with family for 4 weeks and then removed for 2 weeks	No control group	Mira Foundation training	Poor

Table 2: Characteristics of included pet dog studies

Notes: Notes: ADI-R= Autism Diagnostic Interview-Revised; ASQ= Autism Spectrum Quotient; Brief FAM-III= Brief Version of the Family Assessment Measure-III General Scale; LSAS= Liebowitz Social Anxiety Scale; SWLS= Satisfaction with Life Scale; SCAS-P= Spence Child Anxiety Scale-Parent report; SSIS= Social Skills Improvement System.

Risk of bias assessed by the RoB-2 can be rated as low risk of bias, some concerns, or high risk of bias. Risk of bias assessed by the ROBINS-I can be rated as low, moderate, serious, or critical risk of bias. Study quality assessed by the QAT can be rated as good, fair, or poor.

Study name	Study Design	Sex (% male); Age (mean (range))	Outcome	Intervention description	Comparison group description	Risk of Bias/Quality
Atherton 2022; UK	Cross-sectional	54%; 28.64 (18-63) years	Mental health (LSAS, SWLS, UCLA Loneliness Scale)	N = 265; Pet dog	N = 61; No treatment	Serious
Carlisle 2012; USA	Cross-sectional	92.3%; 12.8 (8-18) years	ASD characteristics (SSIS)	N = 47; Pet dog	N = 23; No treatment	Serious
Grandgeorge 2012; France	Cohort	Study 1: 75%; 10.83 (6-15) years Study 2: 50%; 11.08 (6-16) years	Autism characteristics (ADI-R)	Study 1: N = 12; acquired a pet (dogs, cats and one hamster) approximately 79 months before follow up.	Study 1: N = 12 Study 2: N = 8 Never owned a pet	Serious

Study name	Study Design	Sex (% male); Age (mean (range))	Outcome	Intervention description	Comparison group description	Risk of Bias/Quality
				Study 2: N = 8; owned a pet (dogs, cats and one rabbit) since birth		
Wright 2015; UK	Cohort	Study 1: 78.6%; 8.67 (2-16) years Study 2: 80.6%; 8.9 (2-16) years Study 3: 75%; 11.5 (3-16) years	Family outcomes (Brief FAM-III, PSI); mental health (SCAS-P)	Study 1: N = 42; Pet dog with family for 3-10 weeks Study 2: N = 38; Pet dog with family for 25-40 weeks Study 3: N = 22; Pet dog with family for 2.5 years	No pets Study 1: N = 28 Study 2: N = 24 Study 3: N = 14	Serious

3.3 Overview of results

The results are presented below first by summarising the findings across all outcomes, and then by providing a more in-depth discussion of the findings in each outcome domain.

Overall, results indicate that that assistance dogs may be associated with modest benefits in autism across all outcome domains. However, effect estimates are imprecise due to there being only a small number of studies, and there are weak indications for benefit over and above pet ownership. Further, results must be interpreted in the context of the serious risk of bias in studies.

Figure 1 presents results from longitudinal, between-group designs (i.e., two or more groups being tested over time), which are arguably the most reliable as they represent the change in outcomes over time and above a control group which included people who did not receive a dog.

Figure 1. Summary of results from longitudinal between-groups studies

Note: An accessible version of the data displayed in this figure is presented in Table 3 below.

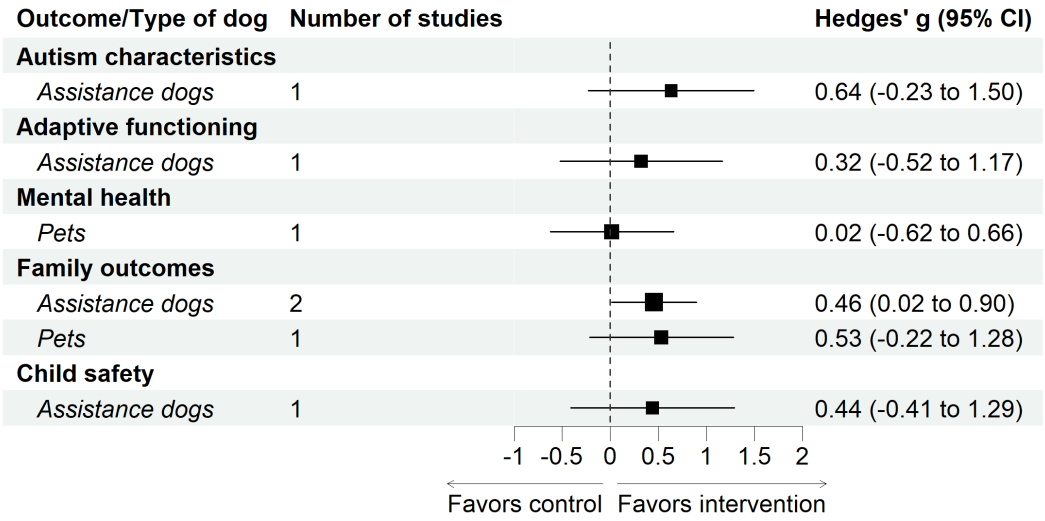


Table 3. Table version of summary of results from longitudinal between-groups studies

Note: This table presents the information displayed in Figure 1 in an accessible format.

Outcome	Type of dog	Number of studies	Hedges' g (95% CI)
Autism characteristics	Assistance	1	0.64 (-0.23 to 1.50)
Adaptive functioning	Assistance	1	0.32 (-0.52 to 1.17)
Mental health	Assistance	1	0.02 (-0.62 to 0.66)
Family outcomes	Assistance	2	0.46 (0.02 to 0.90)
Family outcomes	Pet	1	0.53 (-0.22 to 1.28)
Child safety	Assistance	1	0.44 (-0.41 to 1.29)

Figure 2 provides cross-sectional estimates, meaning that outcomes are compared between groups but only at a single time point (months or years after receiving a dog), and no information is available regarding the period before receiving the dog. Both types of study designs comparing groups indicate benefits associated with having a dog. Effect sizes for autism characteristics, adaptive functioning, and family outcomes are generally comparable between the two design types, as well as between assistance dogs and pets. Child safety outcomes were reported only for assistance dogs and are of moderate effect size.

Figure 2. Summary of results from cross-sectional between-groups studies

Note: An accessible version of the data displayed in this figure is presented in Table 4 below.

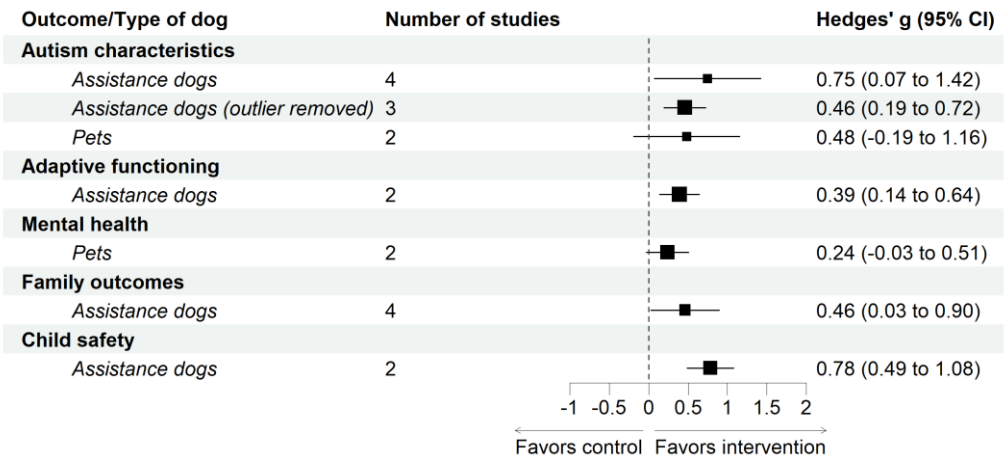


Table 4. Table version of summary of results from cross-sectional between-groups studies

Note: This table presents the information displayed in Figure 2 in an accessible format.

Outcome	Type of dog	Number of studies	Hedges' g (95% CI)
Autism characteristics	Assistance	4	0.75 (0.07 to 1.42)
Autism characteristics (after outlier was removed)	Assistance	3	0.46 (0.19 to 0.72)
Autism characteristics	Pet	2	0.48 (-0.19 to 1.16)
Adaptive functioning	Assistance	2	0.39 (0.14 to 0.64)
Mental health	Pet	2	0.24 (-0.03 to 0.51)
Family outcomes	Assistance	4	0.46 (0.03 to 0.90)
Child safety	Assistance	2	0.78 (0.49 to 1.08)

Figure 3 summarises the effect estimates for pre-post (within-group) designs. It is important to note that these effect sizes cannot be directly compared to those in Figures 1 and 2 as the latter estimates the benefits over a control group whereas the effect sizes in Figure 3 are simply changes over time without a comparison condition.

Once again, these direct effects are of moderate size. No pre-post data were available for pets.

Figure 3. Summary of results from single-arm pre-post studies

Note: An accessible version of the data displayed in this figure is presented in Table 5 below.

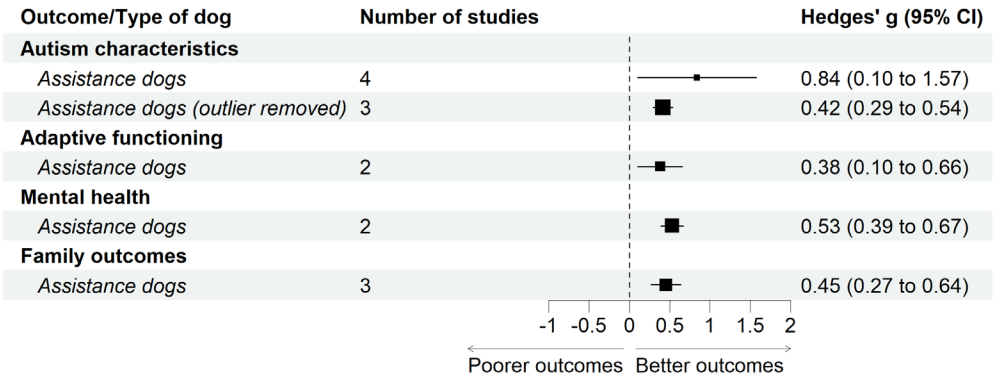


Table 5. Table version of summary of results from single-arm pre-post studies

Note: This table presents the information displayed in Figure 3 in an accessible format.

Outcome	Type of dog	Number of studies	Hedges' g (95% CI)
Autism characteristics	Assistance	4	0.84 (0.10 to 1.57)
Autism characteristics (after outlier was removed)	Assistance	3	0.42 (0.29 to 0.54)
Adaptive functioning	Assistance	2	0.38 (0.10 to 0.66)
Mental health	Assistance	2	0.53 (0.39 to 0.67)
Family outcomes	Assistance	3	0.45 (0.27 to 0.64)

3.4 Autism characteristics

Seven studies investigated the association between assistance dogs and autism characteristics (1 cohort, 3 single-arm pre-post, and 3 cross-sectional studies). The results of between-groups analyses indicate that assistance dogs may be associated with lower autism characteristics compared with children within the control group. The between-groups analysis showed a large effect size (g = 0.75), with substantial

heterogeneity (τ^2=0.40). However, one study (Hoffman, 2012) was identified as an outlier (**Figure B1**). The difference between this outlier and the other three studies could be related to recruitment methods: Hoffman (2012) recruited intervention participants from assistance dog organisations, while the control group included people with autism who did not have an assistance dog (referred to as 'no treatment') and were recruited from autism organisations. Conversely, the other three studies that examined between-group differences recruited all participants from the same sources and used a waitlist control (i.e., participant waiting to receive an assistance dog). Excluding the outlier from the analysis resulted in a substantially reduced pooled effect size (g = 0.46, **Figure B2**), and eliminated observed heterogeneity (i.e., $\tau^2 \approx 0.0$).

Similarly, the single-arm analysis of assistance dogs showed autism characteristics reduced from pre to post intervention (g = 0.84, **Figure B5**). However, the results from single-arm analyses should be interpreted with caution, as without a control group we cannot know whether the change is due to the dog or other factors (e.g., other treatments, natural history). An outlier (Viau et al., 2010) was also identified in the single-arm analysis. Viau et al. (2010) used study designed questions to measure autism characteristics, whereas all other pre-post studies used validated measures. Excluding Viau et al. from the analysis resulted in a much smaller pooled effect size (g = 0.42, **Figure B6**).

Two studies (1 cohort, 1 cross-sectional) investigated the association between pet dogs and autism characteristics. The pooled effect size suggested a comparable positive association to that of assistance dogs, but was not statistically significant (g = 0.48, **Figure B4**).

3.5 Adaptive functioning

Three studies (1 cohort, 1 cross-sectional, 1 single-arm pre-post) investigated the association between an assistance dog and adaptive functioning. The results of between-groups analyses indicate that assistance dogs are associated with higher adaptive functioning scores compared to controls (g = 0.39, **Figure B8**). The single-arm analysis suggested an improvement in adaptive functioning over time (g = 0.38, **Figure B9**).

No studies examined reported adaptive functioning outcomes of pet dog ownership.

3.6 Mental health

No studies compared mental health outcomes between those with an assistance dog and a control group. Two single-arm pre-post studies found that assistance dogs may be associated with improved child mental health (g = 0.53, **Figure B10**). However, without a control group it is unclear whether these improvements are due to the dog or other factors and should be interpreted with caution.

Two studies (1 cohort, 1 cross-sectional) investigated the association between pet dogs and child mental health. Although the pooled effect was not statistically significant, the results indicated that those with pet dogs may have slightly better mental health compared to those without pet dogs (g = 0.24, **Figure B11**).

3.7 Child safety

Two studies (1 cohort, 1 cross-sectional) investigated the association between an assistance dog and child safety. The results of between groups analyses indicate that assistance dogs are associated with benefits in child safety compared to controls (g = 0.78, **Figure B12**).

No studies examined child safety in relation to pet dog ownership.

3.8 Family outcomes

Five studies (1 RCT, 1 cohort, 1 single-arm, and 2 cross-sectional studies) investigated the associations between assistance dogs and family outcomes (parenting, parenting stress, family quality of life). All comparisons found that assistance dogs may be associated with moderate benefits across these outcomes. In particular, the results of the RCT (Fecteau et al., 2017) indicated a medium effect size (g = 0.59, **Figure B13**) of assistance dogs in reducing parenting stress.

No studies examined family outcomes in relation to pet dog ownership.

3.9 Quality of the available evidence

Risk of bias was serious/high in all studies comparing intervention to a control group (i.e., RCT, cohort, and cross-sectional studies) and the quality of the pre-post studies was assessed as poor.

4. Discussion

To the best of our knowledge, this is the first systematic review and meta-analysis of the potential benefits of assistance dogs or pet dogs for people with autism. Overall, despite limited quantitative research, there was some evidence that assistance dogs may be associated with benefits across several key outcomes, but these benefits do not appear to be larger than those associated with pet dogs. Further, the findings need to be interpreted with caution as outcomes are potentially overstated (i.e., prone to bias) due to very few studies available for analysis (especially for comparisons with pets), heterogeneity across studies and methodological limitations. In particular, only two assistance dog studies reported longitudinal results (i.e., change in outcomes over time), and only one was a RCT. Moreover, all studies were found to have a serious risk of bias, and only two included adult participants.

The data from this quantitative review is consistent with the findings from our qualitative synthesis (Mulraney et al., 2023), which found that parents reported a broad range of perceived benefits of an assistance dog to their child as well as to the family. However, the perceived benefits of assistance dogs described by parents

were largely similar to the benefits of pet dogs reported by parents of children with autism (Byström & Persson, 2015; Harwood et al., 2019; Lane, 2020). This report extends on these qualitative findings by including, where possible, direct comparisons of the effect size of assistance dogs with pet dogs.

Although only two studies investigated the outcome of child safety, both studies found parents with an assistance dog perceived their children were safer compared to the reports of parents of children on a waitlist. However, these results need to be interpreted with caution as the studies neither compared those putative benefits to other approaches to prevent child 'absconding,' nor suggested that dogs can replace parental responsibilities for supervising children. Further, the NDIS will not fund an assistance animal if it is used as a mechanical restraint in the manner described in these studies (i.e., the child was tethered to the dog).

Autism characteristics were the most common outcome reported across studies, and it appears that assistance dogs are associated with reduced autism characteristics. However, when the analyses were repeated excluding outliers (i.e., extremely positive, and unrealistic results, which are related to investigation method rather than to the dogs), these effect sizes were comparable to those of pets. The benefits on family outcomes were similar to those of pets as well. Finally, there was some evidence for benefits on adaptive functioning outcomes, but it is not possible to compare these to pets as no pet study reported this outcome.

4.1 NDIS perspective

While our results provide preliminary indications that assistance dogs may be associated with some benefits for people with autism, it is critical to interpret them in context; namely the overall quality of the evidence and the efficacy of assistance dogs compared to other common supports for people with autism (Whitehouse et al., 2020). Further, it is important to consider that the poor quality of the reporting across studies means that, although the dogs appear to be assistance animals, in many instances it is not clear whether the dogs would meet the NDIS definition of an assistance animal.

Quality of the available evidence. Currently, the evidence base for assistance dogs in autism is narrow and of generally low research standards. Specifically, only one of the eight included studies was a randomised clinical trial (which had serious methodological flaws), four compared groups at a single time point only, and two did not include a comparison group. Moreover, studies that reported large effect sizes were different in fundamental ways from the rest of the studies (e.g., by using uncommon outcome measures or comparison groups that could inflate the real change). Therefore, it is very likely that inclusion of future studies will reveal different results from those reported in this review, meaning that our confidence in the results is low at this stage.

Efficacy vs other ASD supports. The effect size estimates from the current evidence base for assistance dogs are similar, if not inferior, not only to pet dogs but also to other supports available for autism. For example, the effect size estimates for assistance dogs in this review are substantially lower than those reported for canine-assisted therapy in a recent systematic review (Hardy & Weston, 2020) and a large RCT (Ben-Itzchak & Zachor, 2021). Similarly, these effect sizes are comparable to those estimated by recent meta-analyses of common clinical interventions in autism such as our recent analysis of behaviourally-based interventions in autism (Ghezzi & Lampit, 2023) and the comprehensive Project AIM review (Sandbank et al., 2020).

Therefore, there is currently little quantitative evidence to suggest that assistance dogs confer unique benefits in autism, at least at the population level. It is likely that some individuals will respond well to animal-assisted supports, but the current

evidence does not support the notion that assistance dogs under current definitions would be more effective than animal-assisted therapy, visitation animals or pets. Given the lack of certainty about benefit it may be prudent to consider assistance dogs only after more cost-effective and evidence-based supports have been tried and found ineffective for an individual.

4.2 Limitations of this report

This report summarised and statistically synthesised the evidence for five outcomes across the literature. The small number of studies meant that there was not enough data in any single analysis to calculate effect sizes with sufficient precision. This also meant that there was no scope to investigate heterogeneity across studies, and particularly any effect moderators. It is therefore not possible at this stage to examine whether the type of comparison group, clinical factors, or follow-up time (just to name a few factors) are associated with effect size.

There were several outcomes of interest specified in the protocol that have not been investigated to date in the quantitative literature. For example, no studies reported on cognitive, language, education or social functioning outcomes, and there was no information reported in relation to cost effectiveness. Other outcomes of interest such as adverse effects and outcomes related to the behaviour and wellbeing of the assistance dog were not reported in the quantitative studies but are explored in the qualitative research and are included in the qualitative report (Mulraney et al., 2023). Most studies provided little information about the training received by both the dog and families including whether there were follow ups to assess dog wellbeing and/or additional training needs post dog placement. In several studies, the length of time the dogs had been with the family prior to assessment was not reported. Thus, it is difficult to learn from the published evidence how long a dog needs to be with a person with autism before the benefits are realised. However, some studies did show benefits within 4 weeks of dog placement.

Studies varied in how comprehensively they described the intervention and any other interventions the participants may have been receiving. This makes it difficult to know what level of training (for both dogs and handlers) is needed to achieve

outcomes or whether the effects are due to the dog or to other interventions that may have differed between the intervention and control groups.

Although the review was intended to investigate benefits and harms in autism and developmental delay (DD), no studies in DD were identified. Thus, the findings relate only to autism and may not generalise to DD. Similarly, there was very limited data on the benefits of assistance dogs in adults with autism.

4.3 Directions for future work

Further primary or synthesis work may be required to directly compare assistance dogs to those of other supports across key outcomes. These may include comparisons of assistance dogs to therapy, visitation, or companion animals, as well as traditional or innovative supports (e.g., robots), or combinations of different supports. Some of this work may be done using more advanced evidence synthesis methods (most notably network meta-analysis), although we note that the number and quality of studies may once again limit the confidence in the results. It may be possible to use participant-level data from primary studies or databases to estimate the benefits and investigate interactions with individual factors more precisely. Additionally, further primary research could investigate whether an assistance dog reduces the need for more complex supports, including in the long term.

References

Atherton, G., Edisbury, E., Piovesan, A., & Cross, L. (2022). 'They ask no questions and pass no criticism': A mixed-methods study exploring pet ownership in autism. *Journal of Autism and Developmental Disorders*, 1-15.

Ben-Itzchak, E., & Zachor, D. A. (2021). Dog training intervention improves adaptive social communication skills in young children with autism spectrum disorder: A controlled crossover study. *Autism, 25*(6), 1682-1693.

Burgoyne, L., Dowling, L., Fitzgerald, A., Connolly, M., Browne, J. P., & Perry, I. J. (2014). Parents' perspectives on the value of assistance dogs for children with autism spectrum disorder: a cross-sectional study. *BMJ open, 4*(6), e004786.

Byström, K. M., & Persson, C. A. L. (2015). The meaning of companion animals for children and adolescents with autism: The parents' perspective. *Anthrozoös, 28*(2), 263-275.

Carlisle, G. K. (2012). *Pet dog ownership in families of children with autism: Children's social skills and attachment to their dogs*. University of Missouri-Columbia.

Dollion, N., Grandgeorge, M., Saint-Amour, D., Loewen, A. H. P., François, N., Fontaine, N. M., Champagne, N., & Plusquellec, P. (2022). Emotion Facial Processing in Children With Autism Spectrum Disorder: A Pilot Study of the Impact of Service Dogs. *Frontiers in Psychology, 13*.

Fecteau, S.-M., Boivin, L., Trudel, M., Corbett, B. A., Harrell Jr, F. E., Viau, R., Champagne, N., & Picard, F. (2017). Parenting stress and salivary cortisol in parents of children with autism spectrum disorder: Longitudinal variations in the context of a service dog's presence in the family. *Biological psychology, 123*, 187-195.

Ghezzi, E., & Lampit, A. (2023). *Behaviourally based interventions in children on the autism spectrum: A systematic review and dose-response meta-analysis*. National Disability Insurance Agency.

Grandgeorge, M., Tordjman, S., Lazartigues, A., Lemonnier, E., Deleau, M., & Hausberger, M. (2012). Does pet arrival trigger prosocial behaviors in individuals with autism?

Hall, S. S., Brown, B. J., & Mills, D. S. (2019). Developing and assessing the validity of a scale to assess pet dog quality of life: Lincoln P-QoL. *Frontiers in veterinary science*, 326.

Hall, S. S., Wright, H. F., Hames, A., Mills, D. S., & Team, P. (2016). The long-term benefits of dog ownership in families with children with autism. *Journal of Veterinary Behavior, 13*, 46-54.

Hall, S. S., Wright, H. F., & Mills, D. S. (2016). What factors are associated with positive effects of dog ownership in families with children with autism spectrum disorder? The development of the Lincoln autism pet dog impact scale. *PLoS One, 11*(2), e0149736.

Hardy, K. K., & Weston, R. N. (2020). Canine-assisted therapy for children with autism spectrum disorder: A systematic review. *Review Journal of Autism and Developmental Disorders, 7*(2), 197-204.

Harwood, C., Kaczmarek, E., & Drake, D. (2019). Parental perceptions of the nature of the relationship children with autism spectrum disorders share with their

canine companion. *Journal of Autism and Developmental Disorders, 49*, 248-259.
Hoffman, M. D. (2012). The impact of canine Companion Service Animal (CSA) use on social behaviors between individuals with autism spectrum disorders who use CSA and those who do not.
Howell, T., Bennett, P., & Shiell, A. (2016). *Reviewing Assistance Animal Effectiveness. Literature review, provider survey, assistance animal owner interviews, health economics analysis and recommendations'. Report to National Disability Insurance Agency.* . https://www.ndis.gov.au/media/859/download?attachment
Lane, J. M. (2020). *Caregiver Perspectives of Pet Dog Ownership for Children with Autism Spectrum Disorder* Grand Canyon University].
Leung, J. Y. L., Mackenzie, L., & Dickson, C. (2022). Outcomes of assistance dog placement in the home for individuals with autism spectrum disorder and their families: A pilot study. *Australian Occupational Therapy Journal, 69*(1), 50-63.
Moses Bélanger, C., Normand, C., Fecteau, S.-M., Trudel, M., & Champagne, N. (2022). Effet différencié du chien d'assistance selon la sévérité de l'autisme chez l'enfant. *Revue de psychoéducation, 51*(1), 231-253.
Mulraney, M., Rincones Pernia, O., Bryant, C., & Lampit, A. (2023). *Benefits of assistance dogs for people on the autism spectrum: A systematic review and meta-aggregation*. National Disability Insurance Agency.
Page, M. J., Moher, D., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hrobjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., McGuinness, L. A., Stewart, L. A., Thomas, J., Tricco, A. C., Welch, V. A., Whiting, P., & McKenzie, J. E. (2021, Mar 29). PRISMA 2020 explanation and elaboration: updated guidance and exemplars for reporting systematic reviews. *BMJ, 372*, n160. https://doi.org/10.1136/bmj.n160
Sandbank, M., Bottema-Beutel, K., Crowley, S., Cassidy, M., Dunham, K., Feldman, J. I., Crank, J., Albarran, S. A., Raj, S., & Mahbub, P. (2020). Project AIM: Autism intervention meta-analysis for studies of young children. *Psychological Bulletin, 146*(1), 1.
Sterne, J. A., Hernan, M. A., Reeves, B. C., Savovic, J., Berkman, N. D., Viswanathan, M., Henry, D., Altman, D. G., Ansari, M. T., Boutron, I., Carpenter, J. R., Chan, A. W., Churchill, R., Deeks, J. J., Hrobjartsson, A., Kirkham, J., Juni, P., Loke, Y. K., Pigott, T. D., Ramsay, C. R., Regidor, D., Rothstein, H. R., Sandhu, L., Santaguida, P. L., Schunemann, H. J., Shea, B., Shrier, I., Tugwell, P., Turner, L., Valentine, J. C., Waddington, H., Waters, E., Wells, G. A., Whiting, P. F., & Higgins, J. P. (2016, Oct 12). ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. *BMJ, 355*, i4919. https://doi.org/10.1136/bmj.i4919
Sterne, J. A. C., Savovic, J., Page, M. J., Elbers, R. G., Blencowe, N. S., Boutron, I., Cates, C. J., Cheng, H. Y., Corbett, M. S., Eldridge, S. M., Emberson, J. R., Hernan, M. A., Hopewell, S., Hrobjartsson, A., Junqueira, D. R., Juni, P., Kirkham, J. J., Lasserson, T., Li, T., McAleenan, A., Reeves, B. C., Shepperd, S., Shrier, I., Stewart, L. A., Tilling, K., White, I. R., Whiting, P. F., & Higgins, J. P. T. (2019, Aug 28). RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ, 366*, l4898. https://doi.org/10.1136/bmj.l4898

Tseng, A. (2022). Brief Report: Above and Beyond Safety: Psychosocial and Biobehavioral Impact of Autism-Assistance Dogs on Autistic Children and their Families. *Journal of Autism and Developmental Disorders*, 1-16.

Viau, R., Arsenault-Lapierre, G., Fecteau, S., Champagne, N., Walker, C.-D., & Lupien, S. (2010). Effect of service dogs on salivary cortisol secretion in autistic children. *Psychoneuroendocrinology, 35*(8), 1187-1193.

Whitehouse, A., Varcin, K., Waddington, H., Sulek, R., Bent, C., Ashburner, J., Eapen, V., Goodall, E., Hudry, K., & Roberts, J. (2020). *Interventions for children on the autism spectrum: a synthesis of research evidence.* . Autism CRC.

Wild, D. L. (2012). *The impact of canine assistance for children with autism and the family unit* Walden University].

Wright, H., Hall, S., Hames, A., Hardiman, J., Mills, R., & Mills, D. (2015). Acquiring a pet dog significantly reduces stress of primary carers for children with Autism Spectrum Disorder: A prospective case control study. *Journal of Autism and Developmental Disorders, 45*(8), 2531-2540.

Wright, H., Hall, S., Hames, A., Hardiman, J., Mills, R., Team, P. P., & Mills, D. (2015). Pet dogs improve family functioning and reduce anxiety in children with autism spectrum disorder. *Anthrozoös, 28*(4), 611-624.

Appendix A. Detailed study methodology

This systematic review adheres to guidelines from the 2020 update of the Preferred Reporting Items for Systematic reviews and Meta-Analyses statement (PRISMA 2020) (Page et al., 2021). The protocol for the systematic review and meta-analysis was registered with PROSPERO on 9th October 2022 (CRD42022363398).

A1. Study objectives

The objectives of the review were to synthesise the available evidence on the effects associated with Assistance Dogs in people with autism. Specifically:

i. What is the current state of evidence for Assistance Dogs in autism?
    a. What outcomes have been investigated?
    b. What are the study designs, methods, and characteristics of participants?
    c. What is the quality of evidence?
ii. What is the evidence for the benefits or harms of Assistance Dogs in people with autism across outcomes?
iii. How do the benefits or harms vary across outcomes and settings?
iv. What is the evidence for cost-effectiveness for Assistance Dogs (e.g., training and maintenance) for people with autism?
v. What animal welfare or behavioural requirements and considerations are investigated in the Assistance Dogs for autism literature?

NB: No studies were found that addressed objectives iv and v.

A2. Electronic search strategy

A single search of MEDLINE, EMBASE, CENTRAL and PsycINFO via OVID was conducted on 30 August 2022 for studies examining the benefits and harms of Assistance Dogs for individuals with ASD. The search strategy is shown in **Table A1**. The search was not limited by time, location, or language. Articles written in a language other than English were translated using Google translate. Additional

articles were identified by scanning the reference lists of existing reviews. One author conducted the initial search. Screening of title and abstracts was conducted by two reviewers and the review of full texts was conducted by three reviewers. Discrepancies were resolved by MM who also contacted corresponding authors for additional information when required.

Table A1: Search Strategy

MEDLINE search strategy
1. Exp child developmental disorders, pervasive/
2. Developmental disabilities/
3. Autis*.mp
4. Asperger*.mp
5. (development* adj3 delay*).mp
6. (ASD or ASDs or ASC).mp
7. 1 or 2 or 3 or 4 or 5 or 6 or 7
8. Exp human-animal interaction/
9. Exp animal-assisted therapy/
10. Pets/
11. Exp animals, domestic/
12. Dogs/
13. (dog$1 or canine).mp
14. ((therap* or Assis* or working or service or companion* or support* or visit* or facilit*) adj3 (animal or pet)).mp
15. 8 or 9 or 10 or 11 or 12 or 13 or 14
16. 7 and 15

A3. Study selection and eligibility criteria

A3.1. Types of studies

All study designs were eligible for inclusion in the review (e.g., randomised controlled trials, observational studies, cross-sectional studies, case-series, and qualitative studies). Eligible studies include peer-reviewed journal articles as well as published reports and policy papers. Unpublished data (e.g., obtained from study authors, reported in pre-prints, unpublished dissertations) were also eligible.

Eligible studies included in the meta-analysis were any that reported sufficient quantitative data to calculate Hedge's g either between an intervention group and a control group or change from pre to post intervention. Data extracted from these studies may have been unpublished (e.g., obtained from study authors).

A3.2. Types of participants

Studies were eligible if they included people of any age diagnosed with autism of any aetiology or Developmental Disorder (DD). Autism/DD comorbid with other conditions (including established or evident intellectual disability) were eligible. Studies combining autism/DD with other conditions (e.g., vision impairment) were eligible for inclusion only if >50% of the sample have a diagnosed autism/DD or if data for participants with autism/DD was available separately from other conditions, however, no studies met these criteria.

A3.3. Types of interventions

Eligible studies included data (qualitative or quantitative) that described the impact, effectiveness, or participant experience with an Assistance Dog or pet dog. Non-assistance Dogs may undergo specific training, but do not provide support that targets a person's specific disability, and do not reside in the participant's home. Studies including only non-assistance dogs were excluded. Examples of non-assistance dogs include visitation dogs and therapy dogs.

A3.4. Types of outcome measures

Eligible qualitative studies report experience or outcomes of assistance dogs in people with autism/DD, their families, or carers.

Eligible quantitative studies would report descriptive or change statistics related to the use of assistance dogs in one of more of the following domains:

- Autism characteristics
    - **ASD characteristics**
        - **Autism symptomology** (global autism symptom measures e.g., Autism Diagnostic Interview, Childhood Autism Rating Scale, Social Communication Questionnaire, Autism Diagnostic Observation Schedule [ADOS] total score)
        - **Emotional regulation** (e.g., self-comforting/self-regulation)
        - ***Restricted repetitive behaviours/sensory*** (e.g., Repetitive Behaviours Scale, ADOS subscale [restrictive and repetitive], overall rigidity, sensitivity [noise, touch, light], sensory subtypes)
        - **Social affect** (foundational social skills, e.g., engagement in play, initiation in social interaction, joint attention, ADOS subscale [social affect])
        - **Socialisation** (application and competence in using social skills, e.g., interaction with peers across settings, play outcomes, theory of mind)
    - **Behavioural characteristics**
        - **Challenging behaviours** (e.g., Aberrant Behaviour Checklist, Child Behaviour Checklist, noncompliance, aggressive and disruptive behaviour)
- Cognitive and language outcomes
    - **Cognition** (verbal and nonverbal cognitive abilities and motor skills e.g., IQ, mental age, developmental quotient)
    - **Language** (receptive and expressive language and verbal communication e.g., Reynell Developmental Language Scales, Preschool Language Scales, utterances/words during observation)
- Functional outcomes

    - **Adaptive behaviour** (everyday functioning e.g., Vineland Adaptive Behaviour Scales, Functional Behaviour Skills Assessment, toileting, helping with chores, answering the phone)
    - **Education outcomes** (e.g., education setting/level of support)
    - **Family outcomes** (e.g., caregiver or family wellbeing, quality of life [child, caregiver, overall family unit], parenting behaviour, parent stress)
    - **Child mental health** (e.g., anxiety/depression, loneliness)
- Adverse effects
    - **Reduced participation in mainstream settings** (e.g., reduced participation in preschool)
    - **Partial/complete attrition**
- Costs for acquiring an Assistance dog and/or maintaining the Assistance dog
- Outcomes related to the behaviour and wellbeing of the Assistance dog
    - Relinquishment rates (people no longer wanting the dog)
    - Behavioural problems
    - Adherence to training
    - Obedience

A4. Data collection and coding

Coding of outcome measures was conducted by MM who double-checked all data for accuracy. Data was coded into an excel spreadsheet for analysis in R. Data from all studies were entered as means and standard deviations (SDs) for single-arm pre-post measures, and for the intervention and control group in RCTs, cohort, and cross-sectional studies. Outcome measures were extracted at baseline (pre-intervention) and all available follow-up points. Reports from the same study were combined into a single unit of analysis. In addition to the primary outcome measures, information on the study design and characteristics were extracted for each eligible article which included: author, publication year, country, study design, sample descriptive information (i.e., age, sex, etc.) intervention description, control description, overall risk of bias rating.

A5. Risk of bias and study quality

Risk of bias and study quality was assessed using the Revised Cochrane Risk of Bias tool (RoB 2)(Sterne et al., 2019) for randomised trials; the Risk Of Bias In Non-randomised Studies – of Interventions (ROBINS-I)(Sterne et al., 2016) for other study designs comparing 2 groups; and the National Heart, Lung, and Blood Institute Quality Assessment Tool for Before-After (Pre-Post) Studies With No Control Group. Studies that did not provide sufficient information to determine its methods were determined as having high risk of bias.

A6. Data analysis

The primary outcome was standardised mean difference (SMD, calculated as Hedges' g) between those who received an Assistance Dog and control groups. Separate analysis of SMD was conducted for single-arm studies among the intervention group. Secondary analyses examined the SMD between those with and those without a pet dog to compare the effectiveness of Assistance Dogs to pet dogs. Precision of the SMD was calculated for each study by the 95% confidence interval (CI). A positive SMD implies better therapeutic effects in the intervention group compared to the control group. In the single-arm analyses, a positive SMD implies an improvement in the outcome from baseline to follow-up.

Effect sizes from individual studies were pooled multivariate restricted maximum likelihood meta-analysis. When studies provided multiple effect sizes, all eligible effect sizes were pooled into the analysis Heterogeneity across studies was quantified using the τ^2 statistic. Small-study effect ('publication bias') was assessed by visually inspecting funnel plots of effect sizes vs standard error. All analyses were conducted using the metafor package for R.

A7. Investigations of heterogeneity

Due to the small number of eligible studies, planned analysis of effect moderators was not conducted.

Appendix B. Detailed results

B1. Study selection

The initial search identified 2016 records, of which 564 were duplicates. A total of 1344 records were screened based on title and abstract. The full text of 202 records were assessed, of which 33 were eligible. Authors from five studies were contacted for additional information, resulting in additional data for one study (Atherton et al., 2022) and identification of a follow-up publication (Moses Bélanger et al., 2022). Two records (Hall et al., 2019; Hall, Wright, & Mills, 2016), reporting on the same study were excluded as the authors did not reply to the request for additional information. Three records (Hall, Wright, Hames, et al., 2016; Wright, Hall, Hames, Hardiman, Mills, & Mills, 2015; Wright, Hall, Hames, Hardiman, Mills, Team, et al., 2015) reported data from the same study and were therefore combined into a single study. The final dataset for the meta-analyses included 12 independent studies comprising one RCT, 3 cohort (2 pets), 6 cross-sectional (2 pets), and two single-arm studies.

As shown in **Tables B1a and B1b**, a total of 34 articles met inclusion criteria for the quantitative and qualitative reviews. For the current quantitative report, 15 articles, representing 12 independent studies, were included in the meta-analyses.

Table B1a: Identification of studies via databases and registries

Articles screened	Articles excluded
2016 records identified from database search	672 duplicates removed
1344 records after duplicates removed	1142 excluded based on title and abstract
202 full text articles assessed for eligibility	169 articles excluded • 75 no eligible outcomes • 47 wrong intervention • 35 reviews • 9 wrong population

Articles screened	Articles excluded
	• 2 identical data already reported • 1 erratum
33 articles met eligibility criteria	

Table B1b: Identification of studies via other methods

Articles screened	Articles excluded
1 record identified through contacting authors	0 articles excluded
1 record assessed for eligibility	0 articles excluded
1 record met eligibility criteria	

B2. Characteristics of studies

Fifteen records representing 12 studies were included in the meta-analysis (N = 1011; 649 received an intervention and 362 controls). Of the included records, nine (representing 8 studies) reported on Assistance Dogs (N = 505; 275 received an Assistance Dog and 230 controls) and six (representing 4 studies) reported on pet dogs (N = 506; 374 with a pet dog and 132 without pets). Participants ranged in age from 2 to 63 years, however most studies (n = 10) included only children, with one pet study including only adults (Atherton et al., 2022) and one Assistance Dog study including both children and adults (Leung et al., 2022). Eligible studies were from Australia (Leung et al., 2022), Canada (Dollion et al., 2022; Fecteau et al., 2017; Moses Bélanger et al., 2022; Viau et al., 2010), France (Grandgeorge et al., 2012), Ireland (Burgoyne et al., 2014), UK (Atherton et al., 2022; Hall, Wright, Hames, et al., 2016; Wright, Hall, Hames, Hardiman, Mills, & Mills, 2015; Wright, Hall, Hames, Hardiman, Mills, Team, et al., 2015), and USA (Carlisle, 2012; Hoffman, 2012; Tseng, 2022; Wild, 2012). Eight studies reported autism characteristics outcomes,

three studies reported adaptive functioning, five studies reported child mental health, two studies reported child safety, and five studies reported family outcomes (parenting stress, parenting, family quality of life).

A detailed description of the interventions is shown in **Table B2**. All studies included dogs living in the home, but the level of training the dog and families received prior to placement, as well as length of time that the dog had been in the home varied across studies. There was one RCT (Fecteau et al., 2017) and one non-randomised cohort study (Wild, 2012) comparing Assistance Dogs to a waitlist control. Four studies compared outcomes between those with Assistance dogs and either a waitlist (Burgoyne et al., 2014; Dollion et al., 2022; Leung et al., 2022) or no treatment (Hoffman, 2012) control. Two studies were single-arm (Tseng, 2022; Viau et al., 2010) and compared outcomes before and after having an Assistance dog placed with the family. Four studies compared outcome between those with and without pets (Atherton et al., 2022; Carlisle, 2012; Grandgeorge et al., 2012; Hall, Wright, Hames, et al., 2016; Wright, Hall, Hames, Hardiman, Mills, & Mills, 2015; Wright, Hall, Hames, Hardiman, Mills, Team, et al., 2015), with two of these including follow-up assessments (Grandgeorge et al., 2012; Hall, Wright, Hames, et al., 2016; Wright, Hall, Hames, Hardiman, Mills, & Mills, 2015; Wright, Hall, Hames, Hardiman, Mills, Team, et al., 2015).

Six validated instruments were used to assess autism characteristics, and two studies used study designed surveys. The validated instruments included:

- Social Responsiveness Scale (SRS) and Social Responsiveness Scale Revised (SRS-2)
- Social Skills Improvement System (SSIS)
- Autism Diagnostic Interview-Revised (ADI-R)
- Autism Treatment Evaluation Checklist (ATEC)
- Autism Spectrum Quotient (ASQ)
- Facial emotion recognition task

Four validated instruments were used to assess family outcomes, and two studies used study designed questions. The validated instruments included:

- Parenting Stress Index (PSI)

- Perceived Stress Scale (PSS)
- Autism Parenting Stress Index (APSI)
- Caregiver Strain Questionnaire (CSQ)
- Autism Family Experience Questionnaire (AFEQ)
- Brief FAM-III-General Scale

A range of validated and study designed instruments captured the other outcomes. Including:

- Adaptive functioning (Adaptive Behavior Assessment System, 2nd and 3rd Editions, study designed questions)
- Mental Health (Child Behavior Checklist (CBCL/YSR), Liebowitz Social Anxiety Scale, Loneliness Scale, Satisfaction with Life Scale, Spence Child Anxiety Scale, State-Trait Anxiety Index, UCLA Loneliness Scale, study designed questions)
- Child Safety (study designed questions)

Table B2: Detailed intervention description

Study	Intervention description
Fecteau 2017	Mira Foundation Training – The service dog training, which teaches obedience commands, lasts three months and is divided into several blocks. The main goal of the training is to teach service dogs to remain calm to ensure safety should their environment become chaotic. Selected dogs are deemed to adapt easily to various environments, to be even-tempered, to use staircases comfortably, to easily manage their insecurities, and to be calm and respectful, to increase the child's autonomy and to facilitate the parents' task. Parents are appointed to issue basic dog obedience commands and to hold the service dog's harness. It is suggested that their child could be attached to the harness, at the parents' discretion. Each dog is also carefully matched with the child's temperament and needs before being placed in a family. Pre-intervention assessment took place approximately 3 weeks prior to dog placement, with follow ups 3 and 9 months later.
Wild 2012	Assessment took place after the Assistance Dog had been with the family for an unspecified length of time. No information provided about the training the dog or families received.
Burgoyne 2014	Assessment took place after the Assistance Dog had been with the family for an unspecified length of time. No information provided about the training the dog or families received other than to say that it was "within the context of a specific national assistance dog intervention in the Republic of Ireland" (p.2).
Dollion 2022	Mira Foundation Training - the children had their service dog for at least 2.5 years (mean delay between dog placement and time of experimentation, 51.9 (SD 13.4) months).
Hoffman 2012	Assessment took place after the Assistance Dog had been with the family for an unspecified length of time. No information provided about the training the dog or families received. No information provided about the control group other than they did not have an Assistance Dog.

Study	Intervention description
Leung 2022	Assessment took place after the Assistance Dog had been with the family (<6 month (50%), 6-12 months (16.7%), >12 months (33.3%)). No information provided about the training the dog or families received other than to say the study was conducted in partnership with Assistance Dogs Australia.
Tseng 2022	Can Do Canines Training - Clients of the assistance dog provider receive Autism-Assistance Dogs (AADs) whose temperaments/talents are carefully matched to families by highly experienced trainers. Trainers are able select for certain characteristics (e.g., hypoallergenic breeds) and tailor final training to meet the needs of individual families. By the time they are ready for final training, potential AADs may have already had more than 18 months of socialization, general training, assessments, and intensive training specific to their assistance dog careers. Once the match is made, one caregiver undergoes training to become the primary dog handler and works with trainers and the AAD without their child present. When they are ready to have the dog move into the home, trainers then work with the triad (handler-dog-child) together to build their partnerships and skills in everyday life. These AAD teams require approximately 8–12 weeks to complete team training and certification. Assessment took place prior to dog placement with a follow-up 8-12 weeks following certification.
Viau 2010	Mira Foundation Training – assessments were conducted 3 weeks prior to dog placement, after 4 four weeks of the dog being in the home, and once more after the dog was removed for a 2-week period.
Atherton 2022	Analyses compared outcomes between people with autism who owned a pet to those who did not own a pet. Pet ownership was 48.3% dogs, 37% cats, 14.7% other animals (e.g., fish, bird, horse, etc.). It was not specified how long participants had owned their pet.

Study	Intervention description
Carlisle 2012	Analyses compared outcomes between people with autism who owned a pet dog to those who did not own a pet. On average participants had owned their dog for 3.89 years (range 0.3-13 years).
Grandgeorge 2012	Two studies compared outcomes between people with autism who did not own a pet and those who had owned a pet: a) their whole life (dogs, cats and one rabbit), and b) approximately 79 months before follow-up (dogs, cats and one hamster).
Wright 2015	Assessed participants prior to acquiring a pet dog and then again 3-10 weeks, 25-40 weeks, and 2.5 years post-dog acquisition. Participants were recruited via Dogs for the Disabled's PAWS (Parents Autism Workshops and Support) network. The PAWS program involves a series of three workshops that educate parents about dog behaviour, welfare, and training, whilst advising on the suitability and integration of pet dogs into families with children with autism. Control groups were those who had never owned a pet dog and did not acquire one prior to each follow-up time point.

B2.1. Summary of included studies

Fecteau and colleagues (Fecteau et al., 2017) conducted an RCT comparing the impact of assistance dogs (n = 49) to a waitlist control group (i.e., families who were on the waiting list to receive an assistance dog)(n = 49) on parent stress in parents of children with autism aged 5-10 years with a DSM-IV diagnosis of autism. Stress was measured via parents' salivary cortisol levels and self-report on the Parenting Stress Index (PSI) approximately 3 weeks prior to randomisation, and parents completed the PSI a second time 9 months later. After the 9-month follow up participants on the waitlist received an assistance dog. There was a significant interaction between group and time ($F(1, 58) = 5.19$, $p = 0.03$) so that those with an assistance dog ($M_1 = 99$, $M_2 = 91.8$) had a significant reduction in parenting stress over time compared to those in the waitlist control group ($M_1 = 107.5$, $M_2 = 110.8$).

A second study was published which also looked at assistance dogs in the same sample of 5–10-year-old children with autism reported in Fecteau et al (Fecteau et al., 2017). However, this study reported data pre-post intervention combining the two groups from the RCT into a single group for analysis (Moses Bélanger et al., 2022). They (Moses Bélanger et al., 2022) report the outcomes from a survey designed by the assistance dog organisation (QEAP-IV) that is administered to parents immediately prior to dog placement and again after three months. The QEAP-IV has a 13 items measuring a range of behaviours the dog may provide assistance with including: (1) sleep, (2) unwanted behaviours (such as stereotypical movements or activities and self-stimulatory behaviours), (3) family climate, (4) social interactions, (5) sensory perceptions, (6) travel, (7) daily activities, (8) outings to different professionals, (9) crisis behaviours, (10) runaway behaviours, (11) somatic discomfort, (12) language, and (13) anxiety. There were statistically significant improvements in all domains for children except runaway behaviours. Also, those with more severe symptoms at baseline had greater improvement than those with mild symptoms.

Wild (Wild, 2012) reports a mixed-methods doctoral dissertation on families of children with autism aged between 4 and 16 years. Ten parents of children who received an assistance dog, and 10 parents of children on the waitlist for an assistance dog completed the Adaptive Behavior Assessment System (ABAS),

Social Responsiveness Scale (SRS), and study designed questions about child safety and parent stress at two time points (prior to receipt of the dog and 12-months later). There was no interaction between group and time on child safety ($F(1,18) = 0.77$, $p = .393$), adaptive behaviours ($F(1, 18) = 3.05$, $p = .098$), or parent stress ($F(1, 18) = 0.00$, $p = .948$) indicating that the change over time on these variables did not differ between groups. However, there was a significant group x time interaction ($F(1, 18) = 6.84$, $p = .017$) on social interaction whereby the control groups scores remained stable over time ($M_1 = 2.72$, $M_2 = 2.71$) whereas the group who received an assistance dog had improved social interaction over time ($M_1 = 2.76$, $M_2 = 2.47$).

Burgoyne and colleagues (Burgoyne et al., 2014) conducted a cross-sectional survey of parents of children with autism aged between 0 to 9 years. The study included families who had an assistance dog (n = 134) for an unspecified length of time and families on the waitlist for an assistance dog (n = 87). The survey included the Caregiver Strain Index and study designed questions about perceived parenting competence and child safety. Compared to parents on the waiting list, parents whose child had an assistance dog reported greater child safety (M = 23.0, M = 32.4, respectively) and increased perceived parenting competence (M = 17.9, M = 19.8, respectively). There was no difference between groups on caregiver strain (objective strain M = 35.9, M = 35.0; subjective internalised strain M = 23.6, M = 22.5; subjective externalised strain M = 7.9, M = 7.7; waitlist control, assistance dog respectively).

Leung and colleagues (Leung et al., 2022) conducted a cross-sectional survey of 18 families (adult participants with autism and parents of children with autism) who had an assistance dog (n = 6) or were on the waitlist for an assistance dog (n = 12). Families had the assistance dog for varying lengths of time (<6 month (50%), 6-12 months (16.7%), >12 months (33.3%)) prior to the assessment. Outcomes included autism characteristics (SRS-2, Autism Treatment Evaluation Checklist (ATEC)), adaptive functioning (ABAS-3), and family quality of life (Autism Family Experience Questionnaire (AFEQ)). There were no statistically significant differences between groups on any of the measures (intervention vs control, respectively: ABAS-3 total M = 29.5, M = 34.5; SRS-2 total M = 111.8, M = 127.1; ATEC total M = 75.3, M = 68.9; AFEQ M = 138.2, M = 139.6).

Dollion and colleagues (Dollion et al., 2022) compared facial emotion recognition in children (8-19 years) who had an assistance dog (n = 15; average length of time with a dog 51.9 (SD = 13.4) months) to those on the waitlist for an assistance dog (n = 15). The two groups did not differ from one another in their accuracy recognising facial emotions ($X^2 = 0.03$, p = 0.870).

Hoffman (Hoffman, 2012) reports a cross-sectional doctoral dissertation comparing autism characteristics between children with autism who have an assistance dog (n = 62) and those who do not have a dog (n = 60). Whereas all other studies with an assistance dog group have a waitlist control group, Hoffman's comparison group is a 'no treatment' group (meaning the children did not have a dog, whether they were receiving any other treatments was not reported) recruited through autism organisations. Participants were parents of children aged 8 to 18 years with autism who completed the Social Skills Improvement System (SSIS) and SRS. Children with an assistance dog had significantly lower autism characteristics on the SRS (F (1, 68) = 516.5, p <.001) and SSIS (F (1, 68) = 154.8, p <.001) than those without a dog.

Tseng and colleagues (Tseng, 2022) reports a single-arm pre-post study of children (5-12 years) with autism (n = 11) who received an assistance dog. Parents completed measures of autism characteristics (Autism Spectrum Quotient (ASQ), SRS-2), mental health (Child Behavior Checklist (CBCL), State-Trait Anxiety Index (STAI)), and family outcomes (AFEQ, Autism Parenting Stress Index (APSI), Perceived Stress Scale (PSS)) prior to dog placement and again 8-12 weeks later. There were significant improvements over time in all outcomes measured (ASQ M_1 = 50.9, M_2 = 45.6; SRS-2 M_1 = 117.0, M_2 = 108.3; CBCL M_1 = 27.7, M_2 = 19.7; STAI State M_1 = 46.4, M_2 = 40.6; STAI Trait M_1 = 49.6, M_2 = 44.5; AFEQ M_1 = 148.3, M_2 = 135.4; APSI M_1 = 21.8, M_2 = 17.4; PSS M_1 = 21.5, M_2 = 17.6).

Vaiu and colleagues (Viau et al., 2010) conducted an experiment to measure the impact of assistance dogs on salivary cortisol in children (3-14 years) with autism. In this single-arm study parents were asked to rate their children's problematic behaviours on an 11-item study designed questionnaire two weeks prior to the assistance dog being introduced into the home, 4-weeks after the dog had been with the family, and again after a 2-week period in which the dog was removed from the home. The number of problematic behaviours reported by parents significantly

decreased after the dog was introduced (F (2, 82) = 106.0, p <.001), and did not change between the two follow up time points.

Atherton and colleagues (Atherton et al., 2022) report a mixed-methods study exploring the impact of owning a pet in adults (18-63 years) with autism. Adults with autism (n = 326) and neurotypical adults (n = 409) completed an online survey at a single point in time measuring their attachment to their pets and their mental health (including the Liebowitz Social Anxiety Scale, Satisfaction with Life Scale, and UCLA Loneliness Scale). Pet ownership was 48.3% dogs, 37% cats, 14.7% other animals (e.g., fish, bird, horse, etc.) and it was not specified how long the participants had owned their pet. Those with autism were equally as attached as neurotypical participants but were less likely to own a pet. A MANOVA found that there was a main effect of diagnostic group and a main effect of pet ownership on mental health outcomes so that those with ASD had poorer mental health and those with a pet had better mental health, however, there was no interaction between diagnostic group and pet ownership.

Carlisle (Carlisle, 2012) reports a doctoral dissertation wherein a cross-sectional mixed-methods study was undertaken exploring the impact of pet dog ownership on social skills of children with autism (8-18 years). Parents of children with a pet dog (n = 47) and without a pet dog (n = 23) completed the SSIS. There were no statistically significant differences between those with and without pets on any of the SSIS subscales. There were small correlations between length of dog ownership and improved social skills and reduced positive problematic behaviours.

Grandgeorge and colleagues (Grandgeorge et al., 2012) conducted a cohort study of pet ownership in children with autism with two cohorts: one cohort had a group of children with autism who had owned a pet since birth (n = 8; pets were dogs, cats, and one rabbit) and a group of children with autism matched on age, sex, language ability, and history of epilepsy (n = 8) who had never owned a pet; and the other cohort had a group of children with autism (n = 12; pets were dogs, cats, and one hamster) who acquired a pet after the first assessment but approximately 79 (SD = 29) months prior to the second assessment and a group of children with autism matched on age, sex, language ability, and history of epilepsy (n = 12) who had never owned a pet. Parents of participants in both cohorts completed the Autism

Diagnostic Interview-Revised when the children were 4-5 years old and again when the children were approximately 10-11 years old. There were no changes in ADI-R total or subscale scores over time in any of the groups, and no differences between the groups with pets and controls.

Wright and colleagues (Wright, Hall, Hames, Hardiman, Mills, Team, et al., 2015) conducted a longitudinal cohort study of the impact of pet ownership on children with autism (2-16 years). Parents of children with autism who were planning to acquire a pet dog (n = 82) completed surveys about their child's mental health (Spence Child Anxiety Scale (SCAS)) and family quality of life (Family Assessment Measure-III General Scale (FAM-III)) at baseline (up to 17 weeks prior to acquiring the dog) and 3-10 weeks and 25-40 post dog acquisition. A control group of parents of a child with autism who did not have a pet dog (n = 28) completed the same measures at matching timepoints. There was a main effect of group so that those with a pet dog had better family quality of life ($F (1, 67) = 9.36$, $p = .003$) but there was no interaction between group and time on the FAM-III ($F (1, 67) = 0.26$, $p = 0.61$). Only a subset of participants (n = 40) completed the SCAS, and so formal tests of group x time interaction were not conducted. However, although anxiety decreased in both groups over time, the decrease in anxiety in the control group appeared to be smaller in magnitude than that of the control group. Wright (Wright, Hall, Hames, Hardiman, Mills, & Mills, 2015) report on the same study, but on the impact of acquiring a pet dog on parenting stress (measured by the PSI). There was a significant effect of group, so that those with a pet dog had reduced parenting stress ($F (1, 59) = 6.57$, $p = .013$), but the group x time interaction was not significant ($F (1, 59) = 2.45$, $p = .123$). Hall (Hall, Wright, Hames, et al., 2016) followed up the cohort 2.5 years after pet dog acquisition. Families who had acquired a pet dog (n = 22) had significantly improved family quality of life ($F (1, 32) = 4.71$, $p = .037$) compared to the control group (n = 15), there was no difference between groups on parenting stress.

B3. Study quality

The RCT was assessed for risk of bias using the RoB-2 (Sterne et al., 2019). Overall, the study was determined to be "at high risk of bias" due to a high risk of

bias the measurement of outcome data and in the missing outcome data domains. The cohort and cross-sectional studies were assessed for risk of bias using the ROBINS-I, with all studies determined to be at serious risk of bias (**Table B3**). The quality of the pre-post studies was assessed using the NHLBI Quality Assessment Tool for Before-After (Pre-Post) Studies with No Control Group, with all studies determined to be of poor quality (**Table B4**).

Table B3a: Summary of Risk of Bias Assessment of RCTs, Cohort, and Cross-sectional Assistance Dogs Studies

Note: The RoB-2 was used to assess risk of bias for Fecteau (the RCT), and so the first 3 domains of the ROBINS-I are not relevant. One domain differs, 'Risk of bias arising from the randomization process' and is reported in this table in the column 'Risk of bias due to classification of intervention.'

Study	Confounding	Selection of participants into study	Classification of intervention	Deviations from intended intervention	Missing data	Measurement of outcomes	Selection of reported result	Overall
Fecteau 2017			Some concerns	Low	High	High	Low	High
Wild 2012	Serious	Low	Low	Serious	Low	Serious	Moderate	Serious
Burgoyne 2014	Serious	Serious	Low	Serious	Low	Serious	Moderate	Serious
Dollion 2022	Serious	Serious	Low	Serious	Low	Low	Moderate	Serious
Hoffman 2012	Serious	Serious	Low	Serious	Low	Serious	Moderate	Serious
Leung 2022	Serious	Serious	Low	Moderate	Moderate	Serious	Moderate	Serious

Table B2b: Summary of Risk of Bias Assessment of RCTs, Cohort, and Cross-sectional Pet Dogs Studies

Note: The RoB-2 was used to assess risk of bias for Fecteau (the RCT), and so the first 3 domains of the ROBINS-I are not relevant. One domain differs, 'Risk of bias arising from the randomization process' and is reported in this table in the column 'Risk of bias due to classification of intervention.'

Study	Confounding	Selection of participants into study	Classification of intervention*	Deviations from intended intervention	Missing data	Measurement of outcomes	Selection of reported result	Overall
Atherton 2022	Serious	Serious	Low	Serious	Low	Serious	Moderate	Serious
Carlisle 2012	Serious	Serious	Low	Serious	Low	Serious	Moderate	Serious
Grandgeorge 2012	Serious	Serious	Low	Serious	Moderate	Low	Moderate	Serious
Wright 2015	Serious	Low	Low	Serious	Serious	Serious	Moderate	Serious

Table B4: Summary of Quality Assessment of Pre-Post Studies

Note: CD: cannot determine; NA: not applicable.

Quality assessment questions	Tseng 2022	Viau 2010	Moses Belanger 2022
1. Was the study question or objective clearly stated?	Yes	Yes	Yes
2. Were eligibility/selection criteria for the study population prespecified and clearly described?	Yes	Yes	Yes
3. Were the participants in the study representative of those who would be eligible for the test/service/intervention in the general or clinical population of interest?	Yes	Yes	Yes
4. Were all eligible participants that met the prespecified entry criteria enrolled?	Yes	Yes	Yes
5. Was the sample size sufficiently large to provide confidence in the findings?	No	Yes	Yes
6. Was the test/service/intervention clearly described and delivered consistently across the study population?	CD	Yes	CD
7. Were the outcome measures prespecified, clearly defined, valid, reliable, and assessed consistently across all study participants?	Yes	No	No

Quality assessment questions	Tseng 2022	Viau 2010	Moses Belanger 2022
8. Were the people assessing the outcomes blinded to the participants' exposures/interventions?	No	No	No
9. Was the loss to follow-up after baseline 20% or less? Were those lost to follow-up accounted for in the analysis?	Yes	Yes	Yes
10. Did the statistical methods examine changes in outcome measures from before to after the intervention? Were statistical tests done that provided p values for the pre-to-post changes?	Yes	Yes	Yes
11. Were outcome measures of interest taken multiple times before the intervention and multiple times after the intervention (i.e., did they use an interrupted time-series design)?	No	Yes	No
12. If the intervention was conducted at a group level (e.g., a whole hospital, a community, etc.) did the statistical analysis consider the use of individual-level data to determine effects at the group level?	NA	NA	NA
Quality Rating	Poor	Poor	Poor

B4. Findings of the review

B4.1 Overall impact on autism characteristics outcomes

B4.1.1 Between groups analysis

Four studies (one cohort, three cross-sectional) reporting autism characteristics were included in the cross-sectional between-groups analysis of Assistance Dogs. The combined effect size was large (g = 0.75, 95% CI = 0.07 to 1.43, p = 0.031 τ^2 = 0.40; **Figure B1**). An outlier (Hoffman) was identified, this study differed from the others as the control group was a no treatment condition whereas all other studies included a waitlist control. Thus, the analysis was re-run excluding the outlier. The pooled effect size reduced to small, and heterogeneity decreased (g = 0.46, 95% CI = 0.19 to 0.72, p <.001, τ^2 = 0.0; **Figure B2**). The funnel plot indicated evidence of asymmetry with smaller studies reporting larger study effects (**Figure B3**), but formal testing was not conducted due to limited studies.

Two studies (1 cohort, three cross-sectional) reporting autism characteristics were included in the cross-sectional analysis of pet dogs. The combined effect size was medium and non-significant (g = 0.48, 95% CI = -0.19 to 1.16, p = 0.159, τ^2 = 0.22; **Figure B4**).

Figure B1: Forest Plot of Autism Characteristics Outcomes in Cross-sectional Between Groups Analyses of Assistance Dogs

Note: An accessible version of the data displayed in this figure is presented in Table B5 below.

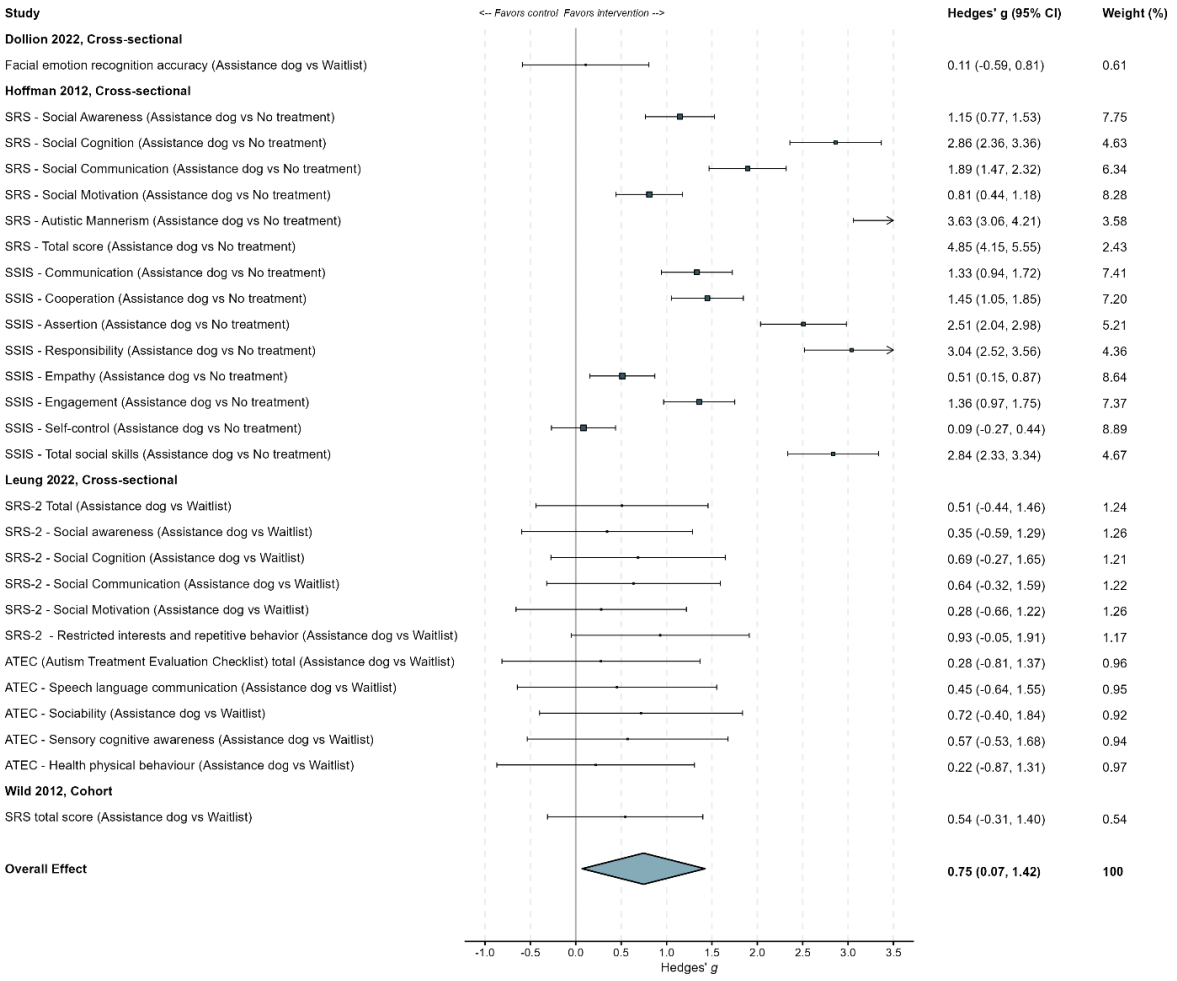


Table B5. Table Version of Forest Plot of Autism Characteristics Outcomes in Cross-sectional Between Groups Analyses of Assistance Dogs

Note: This table presents the information displayed in Figure B1 in an accessible format.

ATEC= Autism Treatment Evaluation Checklist; CI= Confidence Interval; SRS= Social Responsiveness Scale; SSIS= Social Skills Improvement System.

Study	Hedges' g (95% CI)	Weight (%)
Dollion 2022, cross-sectional		
Facial emotion recognition accuracy (assistance dog vs waitlist)	0.11 (-0.59 to 0.81)	0.61
Hoffman 2012, cross-sectional		
SRS – Social awareness (assistance dog vs no treatment)	1.15 (0.77 to 1.53)	7.75
SRS – Social cognition (assistance dog vs no treatment)	2.86 (2.36 to 3.36)	4.63
SRS – Social communication (assistance dog vs no treatment)	1.89 (1.47 to 2.32)	6.34
SRS – Social motivation (assistance dog vs no treatment)	0.81 (0.44 to 1.18)	8.28
SRS – Autistic mannerism (assistance dog vs no treatment)	3.63 (3.06 to 4.21)	3.58
SRS – Total score (assistance dog vs no treatment)	4.85 (4.15 to 5.55)	2.43
SSIS – Communication (assistance dog vs no treatment)	1.33 (0.94 to 1.72)	7.41
SSIS – Cooperation (assistance dog vs no treatment)	1.45 (1.05 to 1.85)	7.20
SSIS – Assertion (assistance dog vs no treatment)	2.51 (2.04 to 2.98)	5.21
SSIS – Responsibility (assistance dog vs no treatment)	3.04 (2.52 to 3.56)	4.36

Study	Hedges' g (95% CI)	Weight (%)
SSIS – Empathy (assistance dog vs no treatment)	0.51 (0.15 to 0.87)	8.64
SSIS – Engagement (assistance dog vs no treatment)	1.36 (0.97 to 1.75)	7.37
SSIS – Self-control (assistance dog vs no treatment)	0.09 (-0.27 to 0.44)	8.89
SSIS – Total social skills (assistance dog vs no treatment)	2.84 (2.33 to 3.34)	4.67
Leung 2022, Cross-sectional		
SRS-2 Total (assistance dog vs waitlist)	0.51 (-0.44 to 1.46)	1.24
SRS-2 – Social awareness (assistance dog vs waitlist)	0.35 (-0.59 to 1.29)	1.26
SRS-2 – Social cognition (assistance dog vs waitlist)	0.69 (-0.27 to 1.65)	1.21
SRS-2 Social communication (assistance dog vs waitlist)	0.64 (-0.32 to 1.59)	1.22
SRS-2 – Social motivation (assistance dog vs waitlist)	0.28 (-0.66 to 1.22)	1.26
SRS-2 – Restricted interests and repetitive behaviour (assistance dog vs waitlist)	0.93 (-0.05 to 1.91)	1.17
ATEC Total (assistance dog vs waitlist)	0.28 (-0.81 to 1.37)	0.96
ATEC Total (assistance dog vs waitlist)	0.45 (-0.64 to 1.55)	0.95
ATEC Total (assistance dog vs waitlist)	0.72 (-0.40 to 1.84)	0.92
ATEC Total (assistance dog vs waitlist)	0.52 (-0.53 to 1.68)	0.94
ATEC Total (assistance dog vs waitlist)	0.22 (-.87 to 1.31)	0.97
Wild 2012, Cohort		
SRS Total (assistance dog vs waitlist)	0.54 (-0.31 to 1.40)	0.54
Overall Effect	0.75 (0.07 to 1.42)	100

Figure B2: Forest Plot of Autism Characteristics Outcomes in Cross-sectional Between Groups Analyses of Assistance Dogs Excluding Outliers

Note: An accessible version of the data displayed in this figure is presented in Table B6 below.

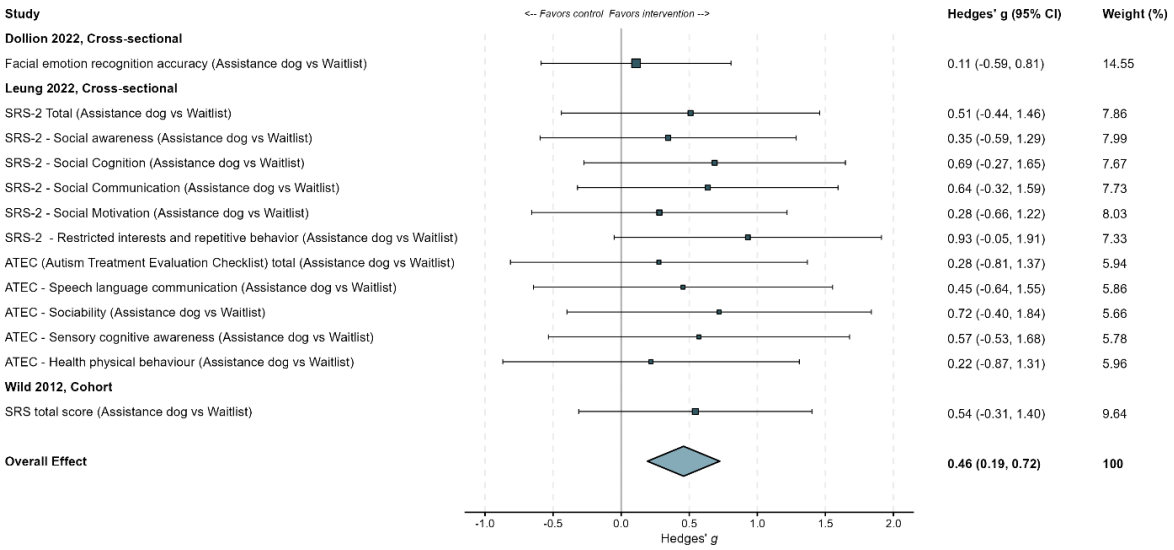


Table B6. Table Version of Forest Plot of Autism Characteristics Outcomes in Cross-sectional Between Groups Analyses of Assistance Dogs Excluding Outliers

Note: This table presents the information displayed in Figure B2 in an accessible format. ATEC= Autism Treatment Evaluation Checklist; CI= Confidence Interval; SRS= Social Responsiveness Scale; SSIS= Social Skills Improvement System.

Study	Hedges' g (95% CI)	Weight (%)
Dollion 2022, cross-sectional		
Facial emotion recognition accuracy (assistance dog vs waitlist)	0.11 (-0.59 to 0.81)	14.55
Leung 2022, Cross-sectional		
SRS-2 Total (assistance dog vs waitlist)	0.51 (-0.44 to 1.46)	7.86
SRS-2 – Social awareness (assistance dog vs waitlist)	0.35 (-0.59 to 1.29)	7.99
SRS-2 – Social cognition (assistance dog vs waitlist)	0.69 (-0.27 to 1.65)	7.67
SRS-2 Social communication (assistance dog vs waitlist)	0.64 (-0.32 to 1.59)	7.73
SRS-2 – Social motivation (assistance dog vs waitlist)	0.28 (-0.66 to 1.22)	8.03
SRS-2 – Restricted interests and repetitive behaviour (assistance dog vs waitlist)	0.93 (-0.05 to 1.91)	7.33
ATEC Total (assistance dog vs waitlist)	0.28 (-0.81 to 1.37)	5.94
ATEC Total (assistance dog vs waitlist)	0.45 (-0.64 to 1.55)	5.86
ATEC Total (assistance dog vs waitlist)	0.72 (-0.40 to 1.84)	5.66
ATEC Total (assistance dog vs waitlist)	0.527 (-0.53 to 1.68)	5.78
ATEC Total (assistance dog vs waitlist)	0.22 (-0.87 to 1.31)	5.96
Wild 2012, Cohort		
SRS Total (assistance dog vs waitlist)	0.54 (-0.31 to 1.40)	9.64
Overall Effect	0.75 (0.07 to 1.42)	100

Figure B3: Funnel Plot of Autism Characteristics Outcomes in Cross-sectional Between Groups Analyses of Assistance Dogs

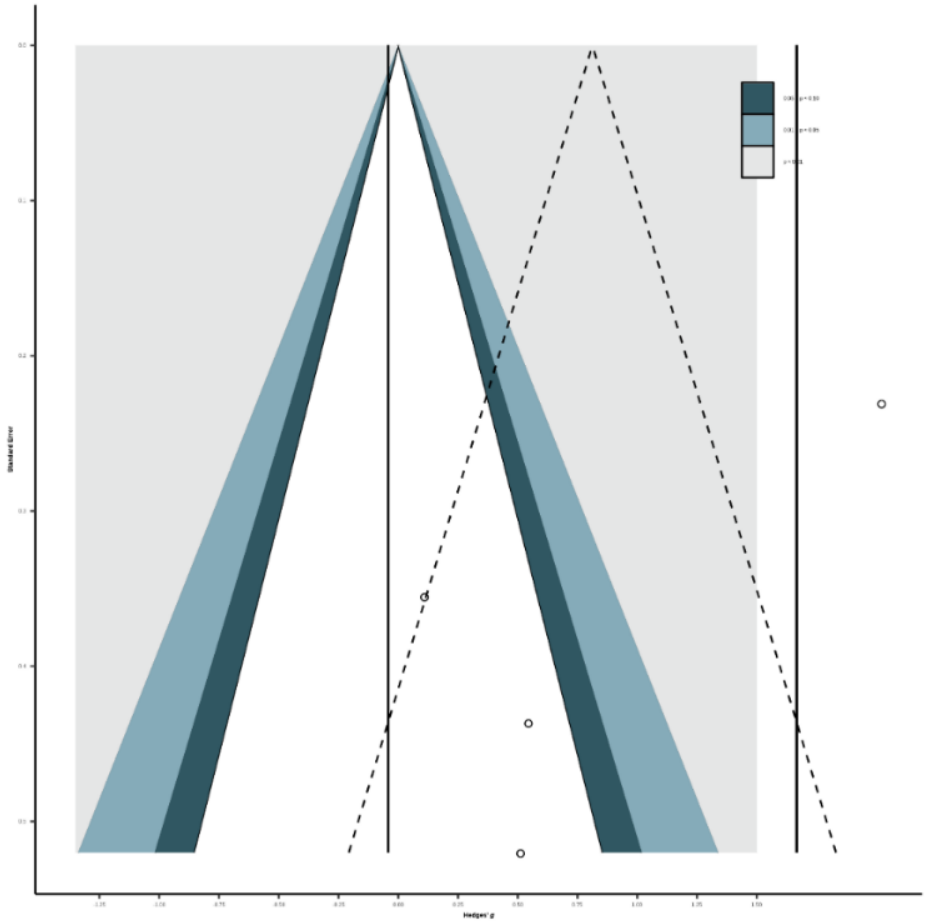


Figure B4: Forest Plot of Autism Characteristics Outcomes in Cross-sectional Between Groups Analyses of Pet Dogs

Note: An accessible version of the data displayed in this figure is presented in Table B7 below.

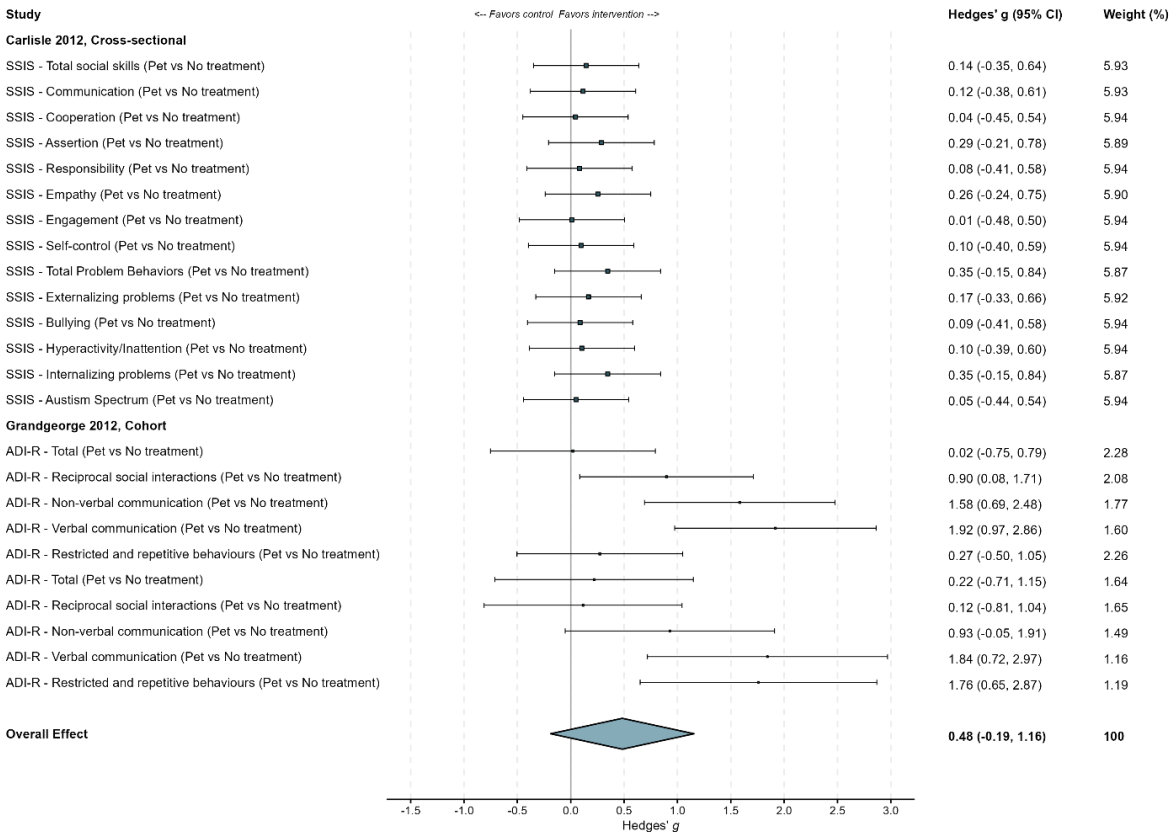


Table B7. Table Version of Forest Plot of Autism Characteristics Outcomes in Cross-sectional Between Groups Analyses of Assistance Dogs Excluding Outliers

Note: This table presents the information displayed in Figure B4 in an accessible format.

ADI-R= Autism Diagnostic Interview-Revised; CI= Confidence Interval; SSIS= Social Skills Improvement System.

Study	Hedges' g (95% CI)	Weight (%)
Carlisle 2012, cross-sectional		
SSIS – Total social skills (pet vs no treatment)	0.14 (-0.35 to 0.64)	5.93
SSIS – Communication (pet vs no treatment)	0.12 (-0.38 to 0.61)	5.93
SSIS – Cooperation (pet vs no treatment)	0.04 (-0.45 to 0.54)	5.94
SSIS – Assertion (pet vs no treatment)	0.29 (-0.21 to 0.78)	5.89
SSIS – Responsibility (pet vs no treatment)	0.08 (-0.41 to 0.58)	5.94
SSIS – Empathy (pet vs no treatment)	0.26 (-0.24 to 0.75)	5.90
SSIS – Engagement (pet vs no treatment)	0.01 (-0.48 to 0.50)	5.94
SSIS – Self-control (pet vs no treatment)	0.10 (-0.40 to 0.59)	5.94
SSIS – Total problem behaviours (pet vs no treatment)	0.35 (-0.15 to 0.84)	5.87
SSIS – Externalizing problems (pet vs no treatment)	0.17 (-0.33 to 0.66)	5.92
SSIS – Bullying (pet vs no treatment)	0.09 (-0.41 to 0.58)	5.94
SSIS – Hyperactivity/Inattention (pet vs no treatment)	0.10 (-0.39 to 0.60)	5.94
SSIS – Internalizing problems (pet vs no treatment)	0.35 (-0.15 to 0.84)	5.87
SSIS – Autism spectrum (pet vs no treatment)	0.05 (-0.44 to 0.54)	5.94
Grandgeorge 2012, cohort		

Study	Hedges' g (95% CI)	Weight (%)
ADI-R – Total (pet vs no treatment)	0.02 (-0.75 to 0.79)	2.28
ADI-R – Reciprocal social interactions (pet vs no treatment)	0.90 (0.08 to 1.71)	2.08
ADI-R – Non-verbal communication (pet vs no treatment)	1.58 (0.69 to 2.48)	1.77
ADI-R – Verbal communication (pet vs no treatment)	1.92 (0.97 to 2.86)	1.60
ADI-R – Restricted and repetitive behaviours (pet vs no treatment)	0.27 (-0.50 to 1.05)	2.26
ADI-R – Total (pet vs no treatment)	0.22 (-0.71 to 1.15)	1.64
ADI-R – Reciprocal social interactions (pet vs no treatment)	0.12 (-0.81 to 1.04)	1.65
ADI-R – Non-verbal communication (pet vs no treatment)	0.93 (-0.05 to 1.91)	1.49
ADI-R – Verbal communication (pet vs no treatment)	1.84 (0.72 to 2.97)	1.16
ADI-R – Restricted and repetitive behaviours (pet vs no treatment)	1.76 (0.65 to 2.87)	1.19
Overall Effect	0.48 (-0.19 to 1.16)	100

B4.1.2 Single-arm pre-post analysis

Four studies (one RCT, one cohort, two single-arm) reporting autism characteristics were included in the single-arm analysis. The combined effect size was large (g = 0.84, 95% CI = 0.10 to 1.58, p= 0.026, τ^2 = 0.51; **Figure B5**). An outlier (Viau) was identified which differed from the other studies as Viau used study designed questions rather than a validated measure of autism characteristics. Thus, analysis was re-run excluding the outlier. The pooled effect size reduced to medium, and heterogeneity decreased (g = 0.42, 95% CI = 0.29 to 0.54, p <.001= 0.033, τ^2 = 0.00; **Figure B6**). The funnel plot indicated evidence of asymmetry with smaller studies reporting larger study effects (**Figure B7**), but formal testing was not conducted due to limited studies.

Figure B5: Forest Plot of Autism Characteristics Outcomes in Single-Arm Analyses of Participants with Assistance Dogs

Note: An accessible version of the data displayed in this figure is presented in Table B8 below.

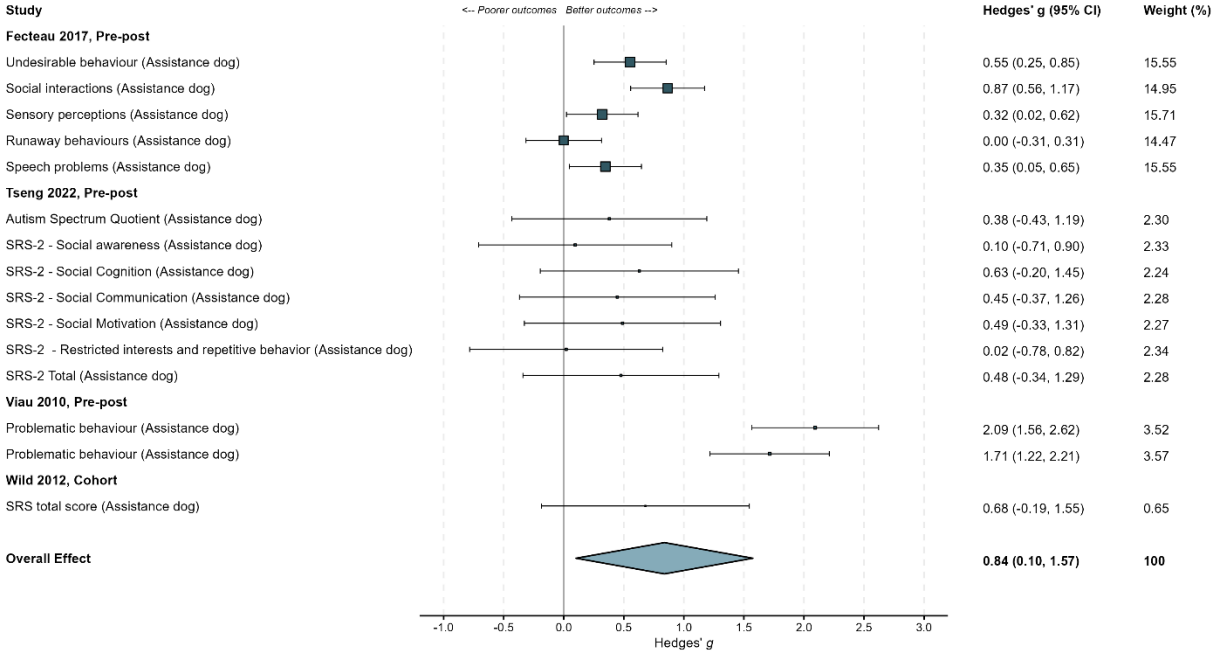


Table B8. Table Version of Forest Plot of Autism Characteristics Outcomes in Single-Arm Analyses of Participants with Assistance Dogs

Note: This table presents the information displayed in Figure B5 in an accessible format.

CI= Confidence Interval; SRS= Social Responsiveness Scale.

Study	Hedges' g (95% CI)	Weight (%)
Fecteau 2017, Pre-post		
Undesirable behaviour (assistance dog)	0.55 (0.25 to 0.85)	15.55
Social interactions (assistance dog)	0.87 (0.56 to 1.17)	14.95
Sensory perceptions (assistance dog)	0.32 (0.02 to 0.62)	15.71
Runaway behaviours (assistance dog)	0.00 (-0.31 to 0.31)	14.47
Speech problems (assistance dog)	0.35 (0.05 to 0.65)	15.55
Tseng 2022, Pre-post		
Autism Spectrum Quotient (assistance dog)	0.38 (-0.43 to 1.19)	2.30
SRS-2 – Social awareness (assistance dog)	0.10 (-0.71 to 0.90)	2.33
SRS-2 – Social cognition (assistance dog)	0.63 (-0.20 to 1.45)	2.24
SRS-2 – Social communication (assistance dog)	0.45 (-0.37 to 1.26)	2.28
SRS-2 – Social motivation (assistance dog)	0.49 (-0.33 to 1.31)	2.27
SRS-2 – Restricted interests and repetitive behaviour (assistance dog)	0.02 (-0.78 to 0.82)	2.34
SRS-2 Total (assistance dog)	0.48 (-0.34 to 1.29)	2.28
Viau 2012, Pre-post		
Problematic behaviour (assistance dog)	2.09 (1.56 to 2.62)	3.52
Problematic behaviour (assistance dog)	1.71 (1.22 to 2.21)	3.57
Wild 2012, Cohort		
SRS Total (assistance dog)	0.68 (-0.19 to 1.55)	0.65
Overall Effect	0.84 (0.10 to 1.57)	100

Figure B6: Forest Plot of Autism Characteristics Outcomes in Single-Arm Analyses of Participants with Assistance Dogs Excluding Outliers

Note: An accessible version of the data displayed in this figure is presented in Table B9 below.

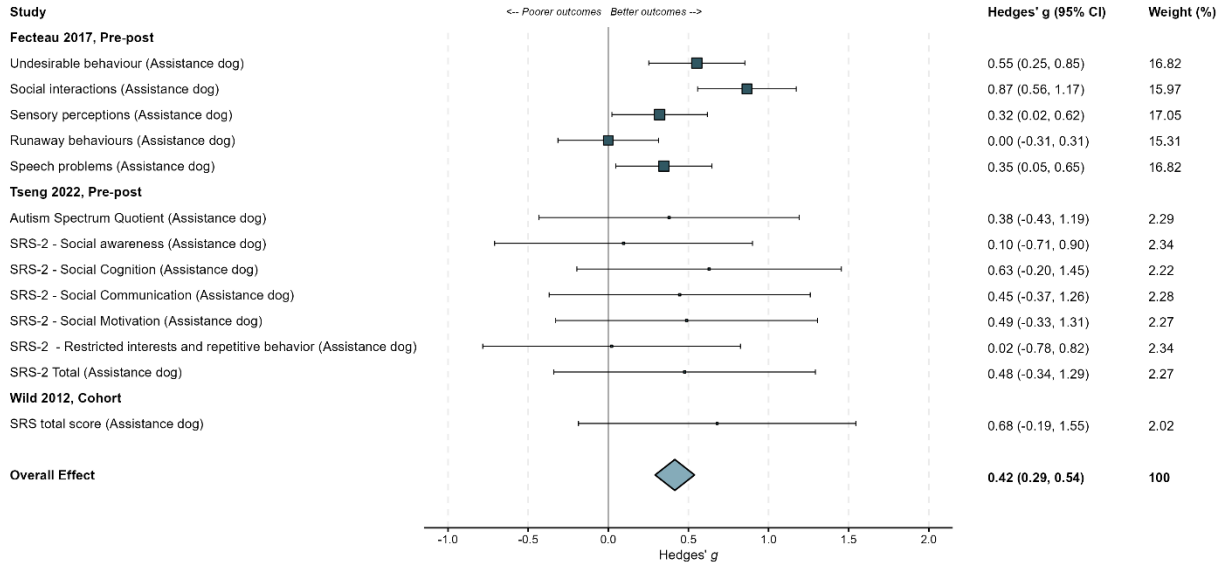


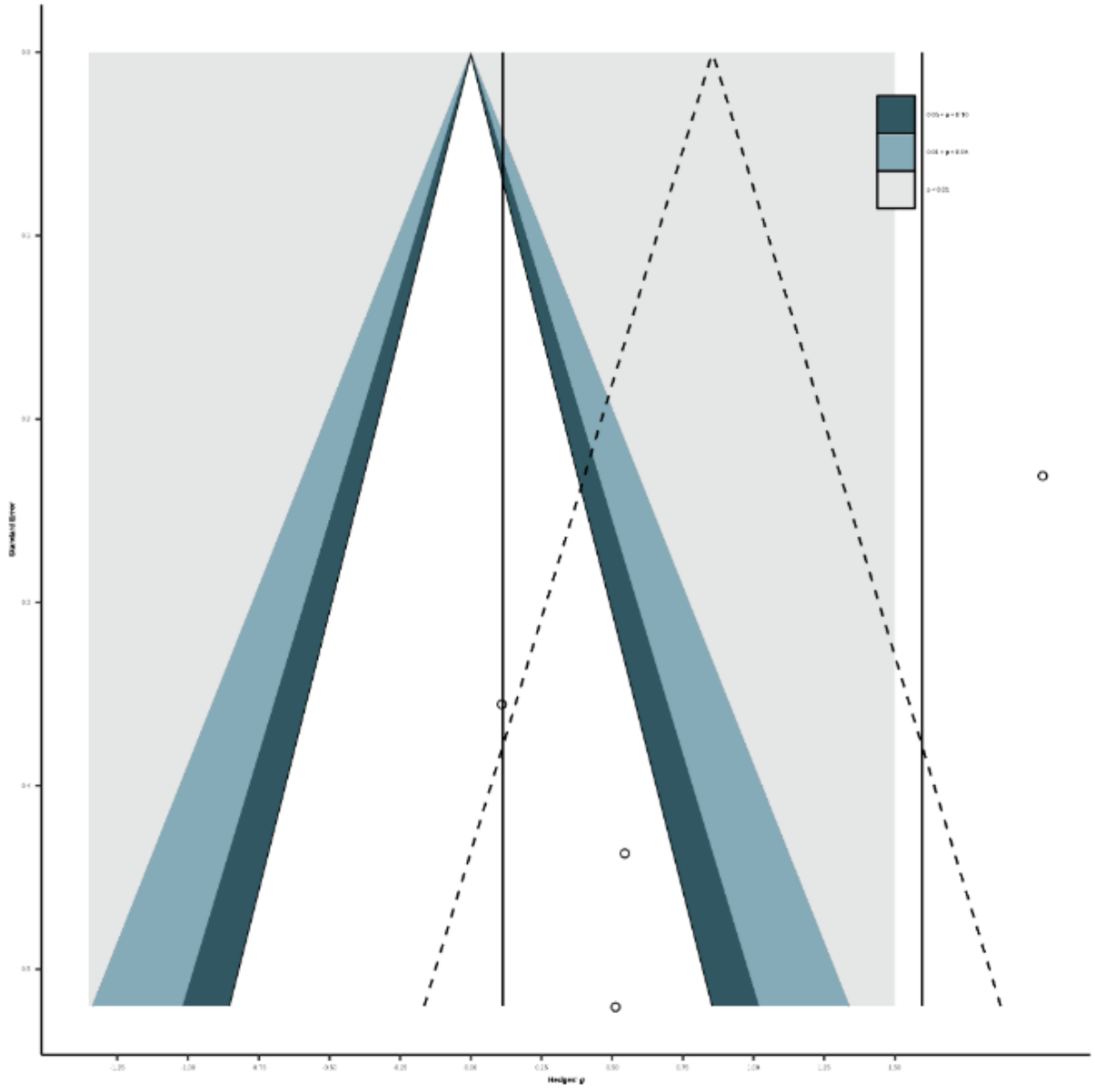
Table B9. Table Version of Forest Plot of Autism Characteristics Outcomes in Single-Arm Analyses of Participants with Assistance Dogs Excluding Outliers

Note: This table presents the information displayed in Figure B6 in an accessible format.

CI= Confidence Interval; SRS= Social Responsiveness Scale.

Study	Hedges' g (95% CI)	Weight (%)
Fecteau 2017, Pre-post		
Undesirable behaviour (assistance dog)	0.55 (0.25 to 0.85)	16.82
Social interactions (assistance dog)	0.87 (0.56 to 1.17)	15.97
Sensory perceptions (assistance dog)	0.32 (0.02 to 0.62)	17.05
Runaway behaviours (assistance dog)	0.00 (-0.31 to 0.31)	15.31
Speech problems (assistance dog)	0.35 (0.05 to 0.65)	16.82
Tseng 2022, Pre-post		
Autism Spectrum Quotient (assistance dog)	0.38 (-0.43 to 1.19)	2.29
SRS-2 – Social awareness (assistance dog)	0.10 (-0.71 to 0.90)	2.34
SRS-2 – Social cognition (assistance dog)	0.63 (-0.20 to 1.45)	2.22
SRS-2 – Social communication (assistance dog)	0.45 (-0.37 to 1.26)	2.28
SRS-2 – Social motivation (assistance dog)	0.49 (-0.33 to 1.31)	2.27
SRS-2 – Restricted interests and repetitive behaviour (assistance dog)	0.02 (-0.78 to 0.82)	2.34
SRS-2 Total (assistance dog)	0.48 (-0.34 to 1.29)	2.27
Wild 2012, Cohort		
SRS Total (assistance dog)	0.68 (-0.19 to 1.55)	2.02
Overall Effect	0.42 (0.29 to 0.54)	100

Figure B7: Funnel Plot of Autism Characteristics Outcomes in Single-Arm Analyses of Participants with Assistance Dogs



B4.2 Overall impact on adaptive functioning

B4.2.1 Between groups analysis

Two studies (one cohort, one cross-sectional) reporting adaptive functioning outcomes were included in the cross-sectional between-groups analysis of Assistance Dogs. The combined effect size was medium (g= 0.39, 95% CI = 0.14 to 0.63, p= 0.003, τ^2 = 0.00; **Figure B8**).

Figure B8: Forest Plot of Adaptive Functioning Outcomes in Cross-sectional Between Groups Analyses of Assistance Dogs

Note: An accessible version of the data displayed in this figure is presented in Table B10 below.

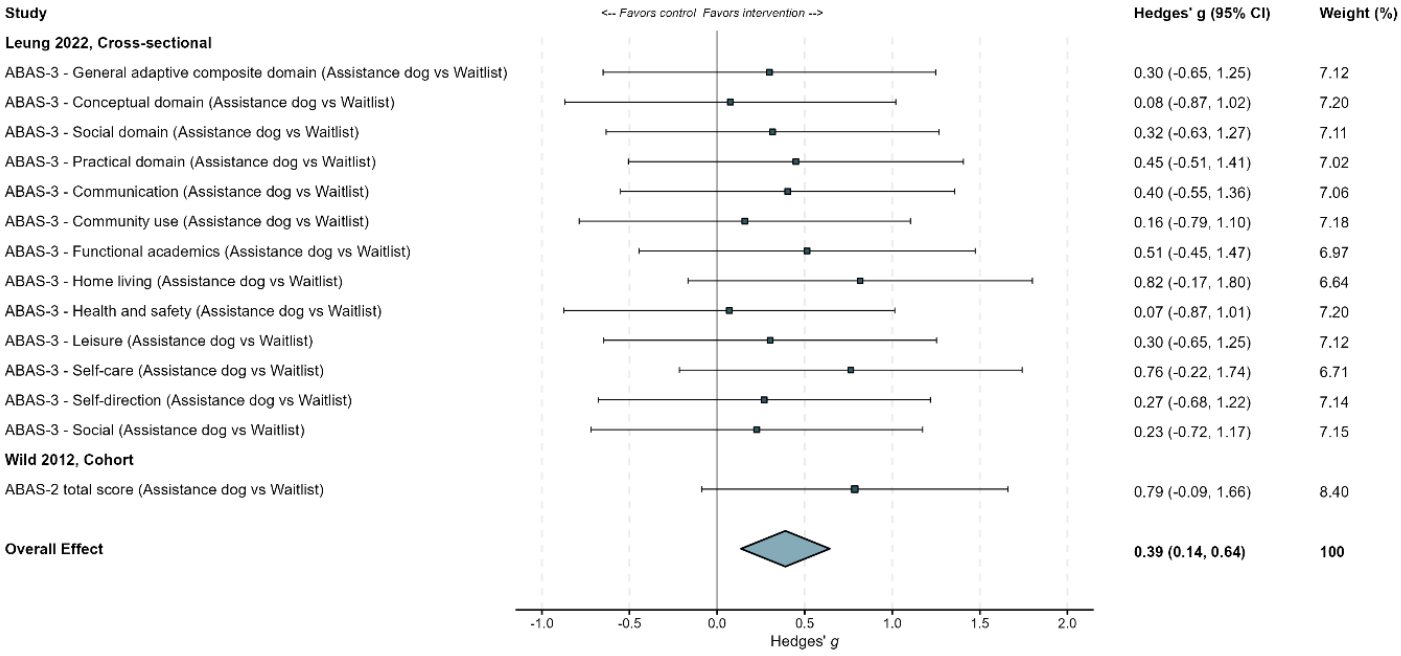


Table B10. Table Version of Forest Plot of Adaptive Functioning Outcomes in Cross-sectional Between Groups Analyses of Assistance Dogs

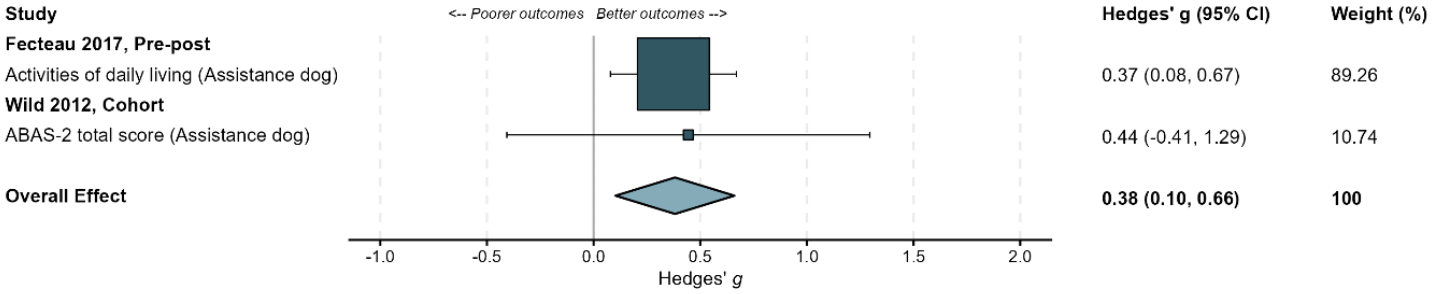
Note: This table presents the information displayed in Figure B8 in an accessible format. ABAS= Adaptive Behavior Assessment System; CI= Confidence Interval.

Study	Hedges' g (95% CI)	Weight (%)
Leung 2022, Cross-sectional		
ABAS-3 – General adaptive composite (assistance dog vs waitlist)	0.30 (-0.65 to 1.25)	7.12
ABAS-3 – Conceptual domain (assistance dog vs waitlist)	0.08 (-0.87 to 1.02)	7.20
ABAS-3 – Social domain (assistance dog vs waitlist)	0.32 (-0.63 to 1.27)	7.11
ABAS-3 – Practical domain (assistance dog vs waitlist)	0.45 (-0.51 to 1.41)	7.02
ABAS-3 – Communication (assistance dog vs waitlist)	0.40 (-0.55 to 1.36)	7.06
ABAS-3 – Community use (assistance dog vs waitlist)	0.16 (-0.79 to 1.10)	7.18
ABAS-3 – Functional academics (assistance dog vs waitlist)	0.51 (-0.45 to 1.47)	6.97
ABAS-3 – Home living (assistance dog vs waitlist)	0.82 (-0.17 to 1.80)	6.64
ABAS-3 – Health and safety (assistance dog vs waitlist)	0.07 (-0.87 to 1.01)	7.20
ABAS-3 – Leisure (assistance dog vs waitlist)	0.30 (-0.65 to 1.25)	7.12
ABAS-3 – Self-care (assistance dog vs waitlist)	0.76 (-0.22 to 1.74)	6.71
ABAS-3 – Self-direction (assistance dog vs waitlist)	0.27 (-0.68 to 1.22)	7.14
ABAS-3 – Social (assistance dog vs waitlist)	0.23 (-0.72 to 1.17)	7.15
Wild 2012, Cohort		
ABAS-2 Total score (assistance dog vs waitlist)	0.79 (-0.09 to 1.66)	8.40
Overall Effect	0.39 (0.14 to 0.64)	100

B4.2.2 Single-arm pre-post analysis

Two studies (one cohort, one pre-post) reported the impact of Assistance Dogs on adaptive functioning and were included in the single-arm analysis. The combined effect size was medium (g = 0.38, 95% CI = 0.10 to 0.66, p = 0.007, τ^2 = 0.00; **Figure B9**).

Figure B9: Forest Plot of Adaptive Functioning Outcomes in Single-Arm Analyses of Assistance Dogs



Note: An accessible version of the data displayed in this figure is presented in Table B11 below.

Table B11. Table Version of Forest Plot of Adaptive Functioning Outcomes in Single-Arm Analyses of Assistance Dogs

Note: This table presents the information displayed in Figure B9 in an accessible format.

ABAS= Adaptive Behavior Assessment System; CI= Confidence Interval.

Study	Hedges' g (95% CI)	Weight (%)
Fecteau 2017, Pre-post		
Activities of daily living (assistance dog)	0.37 (0.08 to 0.67)	89.26
Wild 2012, Cohort		
ABAS-2 Total score (assistance dog)	0.44 (-0.41 to 1.29)	10.74
Overall Effect	0.38 (0.10 to 0.66)	100

B4.3 Overall impact on mental health

No studies compared mental health outcomes between those with an Assistance Dog and a control group.

Two studies (one RCT, one single group pre-post) reporting mental health outcomes were included in the single-arm analysis. The combined effect size was medium (g = 0.53, 95% CI = 0.39 to 0.67, p< 0.001, τ^2 = 0.00; **Figure B10**).

Two studies (one cohort, one cross-sectional) reporting mental health outcomes were included in the cross-sectional between groups analysis of pet dogs. The combined effect size was small and non-significant (g = 0.24, 95% CI = -0.30 to 0.51, p = 0.081, τ^2 = 0.03; **Figure B11**).

Figure B10: Forest Plot of Mental Health Outcomes in Single-Arm Analyses of Assistance Dogs

Note: An accessible version of the data displayed in this figure is presented in Table B12 below.

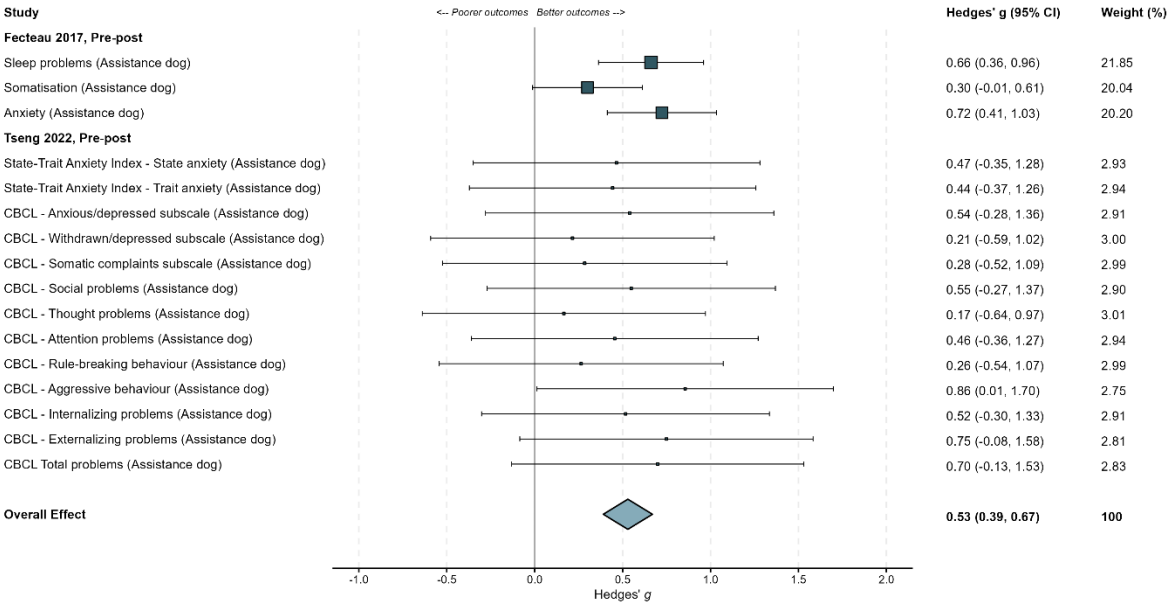


Table B12. Table Version of Forest Plot of Mental Health Outcomes in Single-Arm Analyses of Assistance Dogs

Note: This table presents the information displayed in Figure B10 in an accessible format.

CBCL= Child Behavior Checklist; CI= Confidence Interval.

Study	Hedges' g (95% CI)	Weight (%)
Fecteau 2017, Pre-post		
Sleep problems (assistance dog)	0.66 (0.36 to 0.96)	21.85
Somatisation (assistance dog)	0.30 (-0.01 to 0.61)	20.04
Anxiety (assistance dog)	0.72 (0.41 to 1.03)	20.20
Tseng 2022, Pre-post		
State-trait Anxiety Index – State anxiety (assistance dog)	0.47 (-0.35 to 1.28)	2.93
State-trait Anxiety Index – Trait anxiety (assistance dog)	0.44 (-0.37 to 1.26)	2.94
CBCL – Anxious/depressed subscale (assistance dog)	0.54 (-0.28 to 1.36)	2.91
CBCL – Withdrawn/depressed subscale (assistance dog)	0.21 (-0.59 to 1.02)	3.00
CBCL – Somatic complaints subscale (assistance dog)	0.28 (-0.52 to 1.09)	2.99
CBCL – Social problems (assistance dog)	0.55 (-0.27 to 1.37)	2.90
CBCL – Thought problems (assistance dog)	0.17 (-0.64 to 0.97)	3.01
CBCL – Attention problems (assistance dog)	0.46 (-0.36 to 1.27)	2.94
CBCL – Rule-breaking behaviour (assistance dog)	0.26 (-0.54 to 1.07)	2.99
CBCL – Aggressive behaviour (assistance dog)	0.86 (0.01 to 1.70)	2.75
CBCL – Internalizing problems (assistance dog)	0.52 (-0.30 to 1.33)	2.91
CBCL – Externalizing problems (assistance dog)	0.75 (-0.08 to 1.58)	2.81
CBCL – Total problems (assistance dog)	0.70 (-0.13 to 1.53)	2.83
Overall Effect	0.53 (0.39 to 0.67)	100

Figure B11: Forest Plot of Mental Health Outcomes in Cross-sectional Between Groups Analyses of Pet Dogs

Note: An accessible version of the data displayed in this figure is presented in Table B13 below.

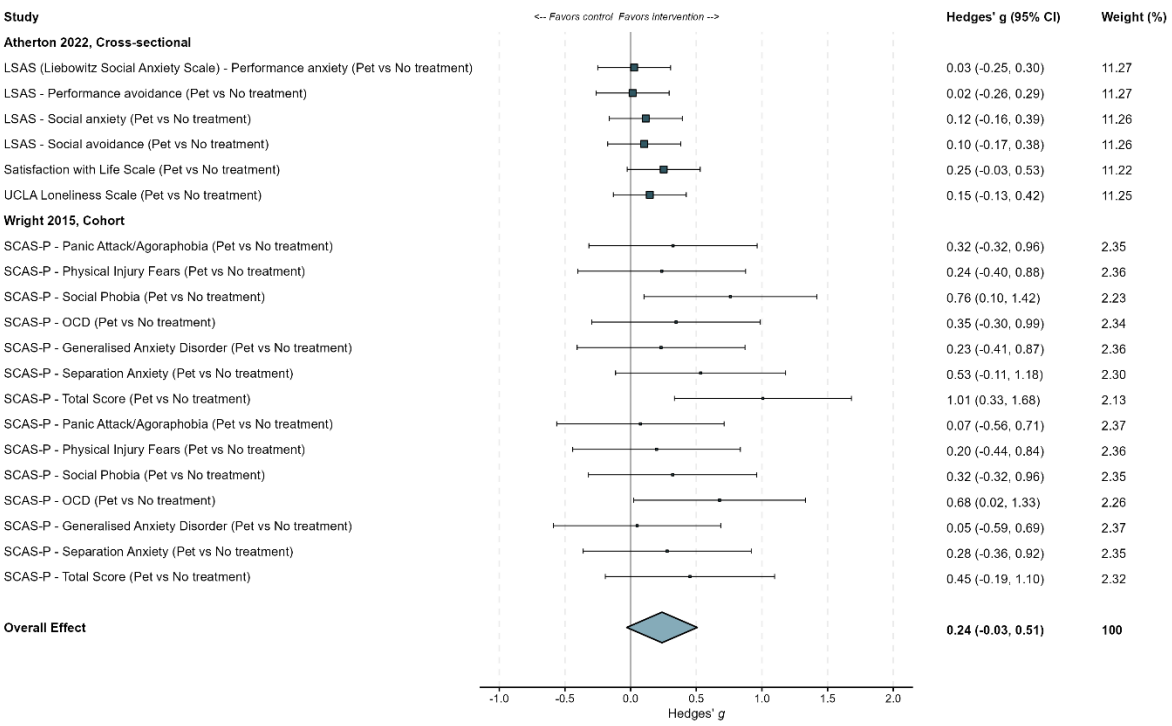


Table B13. Table Version of Forest Plot of Mental Health Outcomes in Cross-sectional Between Groups Analyses of Pet Dogs

Note: This table presents the information displayed in Figure B11 in an accessible format.

CI= Confidence Interval; LSAS= Liebowitz Social Anxiety Scale; OCD= Obsessive-Compulsive Disorder; SCAS-P= Spence Child Anxiety Scale-Parent report; UCLA= University of California Los Angeles.

Study	Hedges' g (95% CI)	Weight (%)
Atherton 2022, Cross-sectional		
LSAS – Performance anxiety (pet vs no treatment)	0.03 (-0.25 to 0.30)	11.27
LSAS – Performance avoidance (pet vs no treatment)	0.02 (-0.26 to 0.29)	11.27
LSAS – Social anxiety (pet vs no treatment)	0.12 (-0.16 to 0.39)	11.26
LSAS – Social performance (pet vs no treatment)	0.10 (-0.17 to 0.38)	11.26
Satisfaction with Life Scale (pet vs no treatment)	0.25 (-0.03 to 0.53)	11.22
UCLA Loneliness Scale (pet vs no treatment)	0.15 (-0.13 to 0.42)	11.25
Wright 2015, Cohort		
SCAS-P – Panic attack/Agoraphobia (pet vs no treatment)	0.32 (-0.32 to 0.96)	2.35
SCAS-P – Physical injury fears (pet vs no treatment)	0.24 (-0.40 to 0.88)	2.36
SCAS-P – Social phobia (pet vs no treatment)	0.76 (0.10 to 1.42)	2.23
SCAS-P – OCD (pet vs no treatment)	0.35 (-0.30 to 0.99)	2.34
SCAS-P – Generalised anxiety disorder (pet vs no treatment)	0.23 (-0.41 to 0.87)	2.36
SCAS-P – Separation anxiety (pet vs no treatment)	0.53 (-0.11 to 0.18)	2.30
SCAS-P – Total score (pet vs no treatment)	1.01 (0.33 to 1.68)	2.13
SCAS-P – Panic attack/Agoraphobia (pet vs no treatment)	0.07 (-0.56 to 0.71)	2.37

Study	Hedges' g (95% CI)	Weight (%)
SCAS-P – Physical injury fears (pet vs no treatment)	0.20 (-0.44 to 0.84)	2.36
SCAS-P – Social phobia (pet vs no treatment)	0.32 (-0.32 to 0.96)	2.35
SCAS-P – OCD (pet vs no treatment)	0.68 (0.02 to 1.33)	2.26
SCAS-P – Generalised anxiety disorder (pet vs no treatment)	0.05 (-0.59 to 0.69)	2.37
SCAS-P – Separation anxiety (pet vs no treatment)	0.28 (-0.36 to 0.92)	2.35
SCAS-P – Total score (pet vs no treatment)	0.45 (-0.19 to 1.10)	2.32
Overall Effect		100

B4.4 Overall impact on child safety

Two studies (one cohort, one cross-sectional) reporting child safety outcomes were included in the cross-sectional between-groups analysis of Assistance Dogs. The combined effect size was large (g = 0.78, 95% CI = 0.49 to 1.08, p< 0.001, τ^2 = 0.00; **Figure B12**).

Figure B12: Forest Plot of Child Safety Outcomes in Cross-sectional Between Groups Analyses of Assistance Dogs

Note: An accessible version of the data displayed in this figure is presented in Table B14 below.

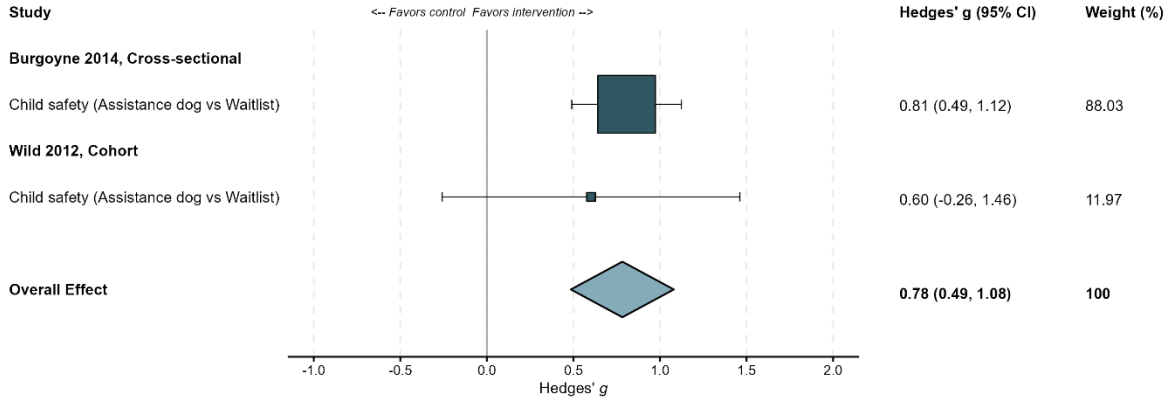


Table B14. Table Version of Forest Plot of Adaptive Functioning Outcomes in Single-Arm Analyses of Assistance Dogs

Note: This table presents the information displayed in Figure B12 in an accessible format.

ABAS= Adaptive Behavior Assessment System; CI= Confidence Interval.

Study	Hedges' g (95% CI)	Weight (%)
Burgoyne 2014, Cross-sectional		
Child safety (assistance dog vs waitlist)	0.81 (0.49 to 1.12)	88.03
Wild 2012, Cohort		
ABAS-2 Total score (assistance dog vs waitlist)	0.60 (-0.26 to 1.46)	11.97
Overall Effect	0.78 (0.49 to 1.08)	100

B4.5 Overall impact on family outcomes

B4.5.1 Between groups analyses

Two studies (one RCT, one cohort) reported on the impact of Assistance Dogs on parenting stress from pre to post intervention. The combined effect size was medium (g = 0.46 95% CI = 0.02 to 0.90, p = 0.042, τ^2 = 0.05; **Figure B13**). The funnel plot indicated evidence of asymmetry with smaller studies reporting larger study effects (**Figure B14**), but formal testing was not conducted due to limited studies.

Four studies (one RCT, one cohort, two cross-sectional) reporting family outcomes (parenting, parenting stress, family quality of life) were included in a cross-sectional between-groups analysis of Assistance Dogs. The combined effect size was medium (g = 0.46, 95% CI = 0.03 to 0.90, p = .038, τ^2 = 0.15; **Figure B15**). The funnel plot indicated evidence of asymmetry with smaller studies reporting larger study effects (**Figure B16**), but formal testing was not conducted due to limited studies.

Figure B13: Forest Plot of Parenting Stress Outcomes in Longitudinal Studies of Assistance Dogs

Note: An accessible version of the data displayed in this figure is presented in Table B15 below.

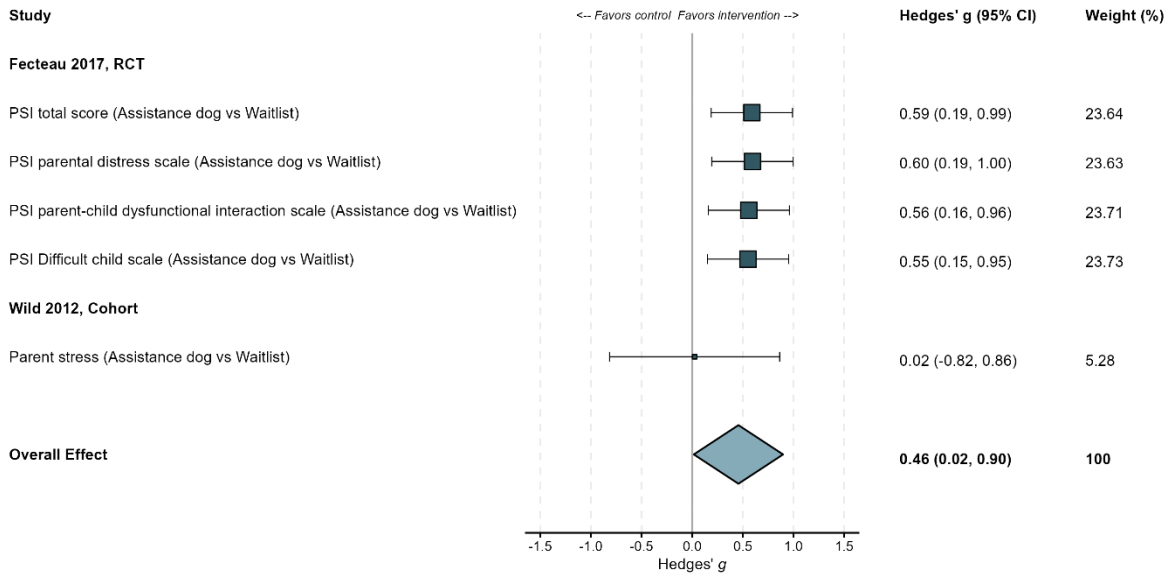


Table B15. Table Version of Forest Plot of Parenting Stress Outcomes in Longitudinal Studies of Assistance Dogs

Note: This table presents the information displayed in Figure B13 in an accessible format.

CI= Confidence Interval; PSI= Parenting Stress Index.

Study	Hedges' g (95% CI)	Weight (%)
Fecteau 2017, RCT		
PSI – Total score (assistance dog vs waitlist)	0.59 (0.19 to 0.99)	23.64
PSI – Parental distress scale (assistance dog vs waitlist)	0.60 (0.19 to 1.00)	23.63
PSI – Parent-child dysfunctional interaction scale (assistance dog vs waitlist)	0.56 (0.16 to 0.96)	23.71
PSI – Difficult child scale (assistance dog vs waitlist)	0.55 (0.15 to 0.95)	23.73
Wild 2012, Cohort		
Parent stress (assistance dog vs waitlist)	0.02 (-0.82 to 0.86)	5.28
Overall Effect	0.46 (0.02 to 0.90)	100

Figure B14: Funnel Plot of Parenting Stress Outcomes in Longitudinal Studies of Assistance Dogs

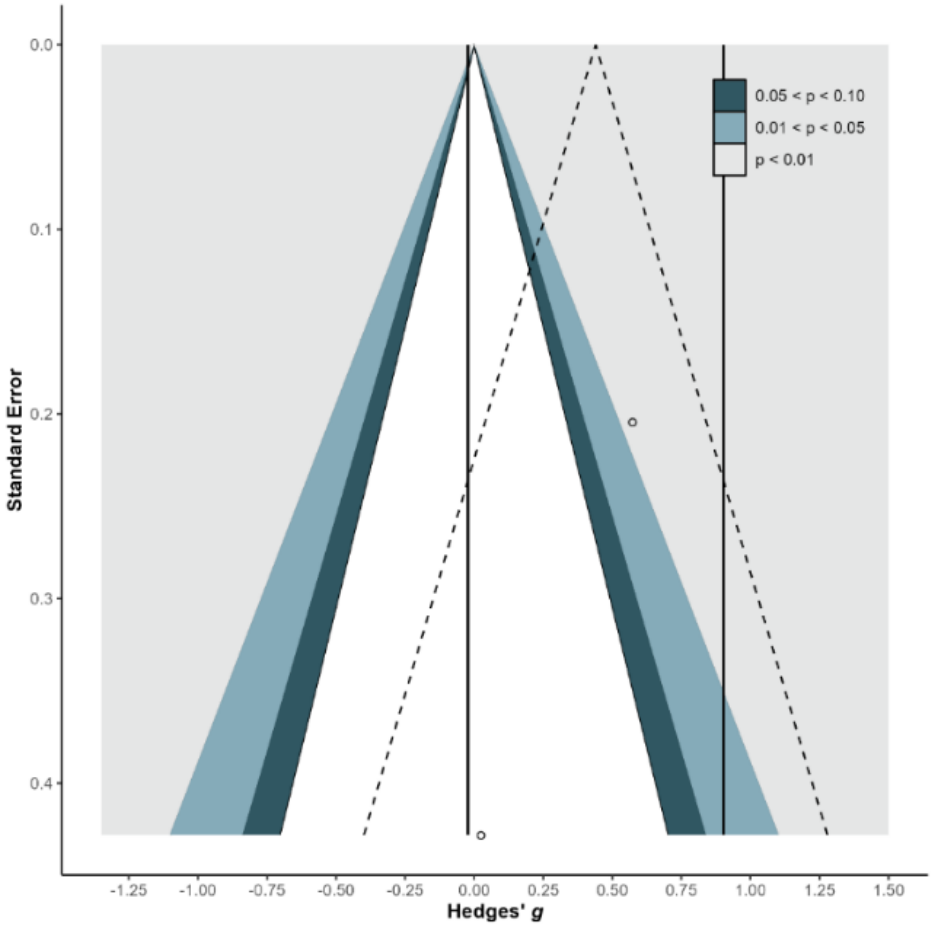


Figure B15: Forest Plot of Family Outcomes in Cross-Sectional Between Groups Studies of Assistance Dogs

Note: An accessible version of the data displayed in this figure is presented in Table B16 below.

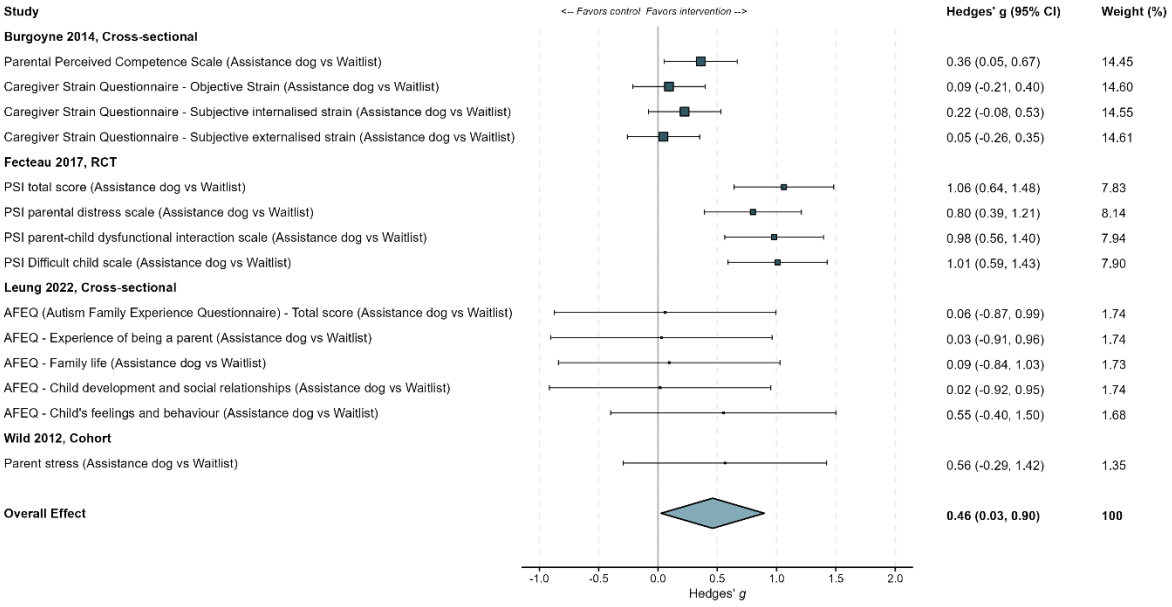


Table B16. Table Version of Forest Plot of Family Outcomes in Cross-Sectional Between Groups Studies of Assistance Dogs

Note: This table presents the information displayed in Figure B15 in an accessible format.

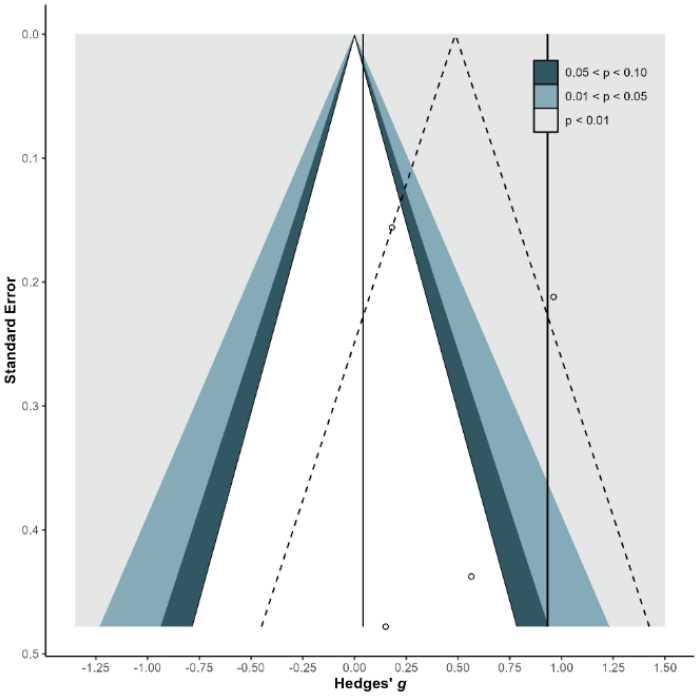
AFEQ= Autism Family Experience Questionnaire; CI= Confidence Interval; PSI= Parenting Stress Index.

Study	Hedges' g (95% CI)	Weight (%)
Burgoyne 2014, Cross-sectional		
Parental Perceived Competence Scale (assistance dog vs waitlist)	0.36 (0.05 to 0.67)	14.45
Caregiver Strain Index – Objective strain (assistance dog vs waitlist)	0.09 (-0.21 to 0.40)	14.60
Caregiver Strain Index – Subjective internalised strain (assistance dog vs waitlist)	0.22 (-0.08 to 0.53)	14.55

Study	Hedges' g (95% CI)	Weight (%)
Caregiver Strain Index – Subjective externalised strain (assistance dog vs waitlist)	0.05 (-0.26 to 0.35)	14.61
Fecteau 2017, RCT		
PSI – Total score (assistance dog vs waitlist)	1.06 (0.64 to 1.48)	7.83
PSI – Parental distress scale (assistance dog vs waitlist)	0.80 (0.39 to 1.21)	8.14
PSI – Parent-child dysfunctional interaction scale (assistance dog vs waitlist)	0.98 (0.56 to 1.40)	7.94
PSI – Difficult child scale (assistance dog vs waitlist)	1.01 (0.59 to 1.43)	7.90
Leung 2022, Cross-sectional		
AFEQ – Total Score (assistance dog vs waitlist)	0.06 (-0.87 to 0.99)	1.74
AFEQ – Experience of being a parent (assistance dog vs waitlist)	0.03 (-0.91 to 0.96)	1.74
AFEQ – Family life (assistance dog vs waitlist)	0.09 (-0.84 to 1.03)	1.73
AFEQ – Child development and social relationships (assistance dog vs waitlist)	0.02 (-0.92 to 0.95)	1.74
AFEQ – Child's feelings and behaviour (assistance dog vs waitlist)	0.55 (-0.40 to 1.50)	1.68
Wild 2012, Cohort		
Parent stress (assistance dog vs waitlist)	0.56 (-0.29 to 1.42)	1.35
Overall Effect	0.46 (0.03 to 0.90)	100

Figure B16: Funnel Plot of Family Outcomes in Cross-Sectional Between Groups Studies of Assistance Dogs

B4.5.2 Single-arm pre-post analysis



Three studies (one RCT, one cohort, one pre-post) reported the impact of Assistance Dogs on parenting stress and were included in the single-arm analysis. The combined effect size was medium (g = 0.45, 95% CI = 0.27 to 0.64, p <.001, τ^2 = 0.00; **Figure B18**). The funnel plot indicated evidence of asymmetry with smaller studies reporting larger study effects **(Figure B19**), but formal testing was not conducted due to limited studies.

Figure B17: Forest Plot of Parenting Stress in Single-Arm Analysis of Participants with Assistance Dogs

Note: An accessible version of the data displayed in this figure is presented in Table B17 below.

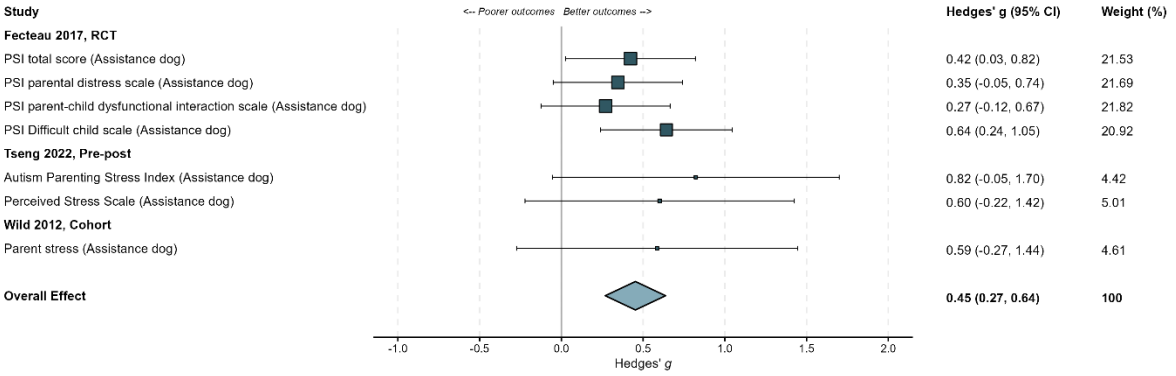


Table B17. Table Version of Forest Plot of Family Outcomes in Cross-Sectional Between Groups Studies of Assistance Dogs

Note: This table presents the information displayed in Figure B17 in an accessible format.

CI= Confidence Interval; PSI= Parenting Stress Index.

Study	Hedges' g (95% CI)	Weight (%)
Fecteau 2017, RCT		
PSI – Total score (assistance dog)	0.42 (0.03 to 0.82)	21.53
PSI – Parental distress scale (assistance dog)	0.35 (-0.05 to 0.74)	21.69
PSI – Parent-child dysfunctional interaction scale (assistance dog)	0.27 (-0.12 to 0.67)	21.82
PSI – Difficult child scale (assistance dog)	0.64 (0.24 to 1.05)	20.92
Tseng 2022, Pre-Post		
Autism Parenting Stress Index (assistance dog)	0.82 (-0.05 to 1.70)	4.42
Perceived Stress Scale (assistance dog)	0.60 (-0.22 to 1.42)	5.01
Wild 2012, Cohort		
Parent stress (assistance dog)	0.59 (-0.27 to 1.44)	4.61
Overall Effect	0.45 (0.27 to 0.64)	100

Figure B18: Funnel Plot of Parenting Stress in Single-Arm Analysis of Participants with Assistance Dogs