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A Systematic Scoping Review: What is the Risk from Child-Dog Interactions to Dog Quality of Life?

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Running Title: Dog Quality-of-Life in Child-Interactions

Abstract

There is growing interest in the value of assistance dogs, therapy dogs, and untrained pet dogs, for supporting children with specific needs. Research in this area focuses almost exclusively on the effect of dogs on child well-being and quality of life. The lack of research reporting the role of dog quality of life in this dynamic limits the development of best practice guidelines. Little attention has been paid to the risk from structured and unstructured exposures to children for dog quality of life to best protect the well-being of both parties and maximize the quality of interactions to enhance therapeutic effects.

This systematic scoping review searched five databases to address the question 'what is the risk from child-dog interactions to the quality of life of assistance, therapy and pet dogs?' The review identified that there is limited specific scientific investment in understanding the relationship between child-dog interactions and dog quality of life. Of the five relevant articles that were identified specifically addressing this issue, two looked at aspects relating to quality of life of dogs living in family homes, (1=pet dogs, 1=trained assistance dogs). The remaining three papers reported factors relevant to quality of life of trained dogs working in structured therapy sessions. Specific child-dog interactions may be important risk factors to consider in relation to dog quality of life, specifically interactions involving unprovoked child attention (e.g., rough contact), interactions and environmental predictability (e.g., meltdowns and recreation time) and child initiated games (e.g., 'dress up'). Identifying and monitoring the intensity and frequency of these interactions may be important for protecting dog quality of life in the therapeutic and home environment.

Keywords: assistance dogs; pet dogs; therapy dogs; quality of life; child-dog interactions, well-being.

Introduction

There is growing scientific and societal interest in the importance of assistance dogs, therapy dogs (Sachs-Ericsson et al., 2002; Berry et al., 2013; Burgoyne et al., 2014; Audrestch et al., 2015) and pet dogs (Carlisle, 2015;Wright et al., 2015; Hall et al., 2016; Purewal et al., 2017; Ward et al., 2017; Silva et al., 2018) for promoting child quality of life, particularly those with specific needs, such as autism spectrum disorder (O'Haire, 2013). The training received and types of roles these dogs are expected to fulfil are varied. Whereas assistance dogs working in animal assisted interventions, also referred to as service dogs in some literatures (not to be confused with military or police working dogs), are typically trained to perform certain tasks with their handler in the home environment (e.g., assisting with crossing the road, providing deep pressure therapy during meltdowns or times of anxiety) on a daily basis, therapy dogs work closely with an adult handler, who has been trained to deliver specific therapies, usually within structured relatively short-sessions in a clinical/therapeutic setting. The specific training received by assistance and therapy dogs will be partly determined by the specific organisation, the standards of practice outlined by Animal Assisted Intervention International (2019) offer little distinction in training practices between the two. In contrast, pet dogs typically receive no formal training, but may offer informal emotional support within the day to day home environment.

The complex nature of the environment in which these dogs work or live, inevitably means their sensory systems are taxed with novel and potentially emotionally arousing stimuli, which may place them in frequent or chronic states of stress (Mills et al., 2012), which can have long term effects for the animal's quality of life. In order to form a comprehensive regulatory framework in which to practice animal assisted interventions (AAI) with dogs, it is essential that we identify the specific risk factors (i.e., triggers) in interacting with children which may have an immediate effect on dog well-being and general quality of life. Not only will this inform appropriate care practice from the dog's perspective, but it will also reduce risk of harm to the child which is associated with interacting with a stressed dog (i.e., dog bites), and improve the quality of therapy through the promotion of a mutually beneficial and positive environment.

Whilst research has identified a number of risk factors in dog management which can increase dog stress, such as spatial restrictions, social isolation, changes in routine (Beerda et

al., 1999a,b), loud noises and unexpected events (Beerda et al., 1998a; Blackwell et al., 2013), there appears to have been little attention paid to the risk factors associated with child interactions. Additionally, methods to measure dog stress in controlled laboratory type environments often focus on assessment of immediate behavioral or physiological responses; whereas for dogs performing long-term therapeutic duties it may be more appropriate to consider broader and enduring effects on quality of life. In terms of immediate behavioral responses, it is widely suggested that a range of dog behaviors such as shaking, cowering, scratching, yawning, vocalisations, biting, as well as more subtle behaviors such as lying down, pawing, moving close to handlers/owners, blinking and lip-licking may indicate stress in the dog (Hargrave, 2015; Beerda et al., 2000). However, the ability to identify these behaviors may be problematic particularly for untrained owners/handlers, and the behavioral signs associated with low level stress are often missed (Kerswell et al., 2009; Mariti et al., 2012). Physiological responses associated with stress in dogs include changes to urinary epinephrine to creatinine ratios, urinary cortisol to creatinine ratios (Beerda et al., 2000), salivary cortisol and heart rate (Beerda et al., 1998a). However, the ways in which stress are evidenced can be highly variable between dogs (Beerda et al., 1997) and physiological measures may be a better proxy of arousal rather than emotional valence (Beerda et al., 1998a; Hewison et al., 2014; Barnett and Hemsworth, 1990), as such a triangulation of measures may be the most reliable form of assessment (Mills et al., 2014).

QoL is a multi-dimensional concept which encapsulates satisfaction across a number of domains (e.g., psychological, physical and social) given the circumstance, and so it may be a preferable point of reference than the dog's physical well-being when examining the effect of risk factors on dogs working in a long-term role. Nonetheless, assessing QoL in companion animals is subject to two fundamental barriers. Firstly, QoL is notoriously challenging to define, particularly in the animal population (McMillan, 2000, Taylor and Mills, 2007), because the widely used definition provided by the World Health Organisation (WHO) to conceptualise human QoL refers to cultures and values (WHO Group, 1995, Belshaw et al., 2015) which is not directly applicable to dogs. Secondly, there is a current lack of validated instruments to assess dog quality of life. Although a range of disease specific instruments have been developed (e.g.,, Favrot et al., 2010; Freeman et al., 2005; Noli et al., 2011a,b; Iliopoulou et al., 2013), relatively little attention has been paid to dog general quality of life (Belshaw et al., 2015). This is an issue when assessing the welfare effect of factors such as

human interactions (including therapy sessions) in otherwise healthy individuals in their daily environment.

In spite of these challenges, evidence from working dog literature highlights the importance of considering quality of life in assistance, therapy and pet dogs who have regular contact with children. Both the nature and quality of interactions between adult owner/handler and dog have been found to affect not only performance but also well-being in pet dogs, military dogs and search dogs (Lefebvre et al., 2007; Horváth et al., 2008; Arhant et al., 2010; Rooney and Cowan, 2011; Diverio et al., 2017). It is therefore likely that child-dog interactions will also effect on the performance and well-being of assistance, therapy and pet dogs. This may be particularly pertinent given children's unpredictable and active mannerisms (Morrongiello et al., 2007), lack of perspective taking skills (Selman, 1980), and reduced awareness of subtle signs of dog aggression (Lakestani et al., 2014; Meints et al., 2014), which may lead to interactions which place greater stress on the dog – and thereby increasing the risk of displays of aggression (Rooney et al., 2009). Indeed, children are at a greater vulnerability for receiving a dog bite than adults (Matthias et al., 2015; Westgarth et al., 2018). Displays of human-directed aggression in dogs can have devastating consequences for the individual, potentially leading to their relinquishment (Salman et al., 2000) and euthanasia (Fatjó et al., 2006; Welsh, 2015) as well contributing to a negative societal attitude towards the species more generally (Arluke et al., 2017). Therefore, not only may some child-dog interactions be unacceptable because of their immediate effect on dog quality-of-life (e.g., in terms of creating physical or emotional discomfort to the dog), but also because of their potential to lead to a breakdown in the relationship.

Aim

Given that the quality of child-dog interactions has important welfare implications we sought to address the question 'what is known about the specific risk from child-dog interactions to assistance, therapy and pet dog quality of life?' Since this is a broad question, and given that there has yet to be a comprehensive review of the literature in this area, a scoping of relevant literatures was conducted (Pham et al., 2014; Peters et al., 2015). A scoping review is often recommended for knowledge synthesis on an exploratory research question, when the literature related to the area has not yet been formally reviewed and may be heterogeneous in nature, in order to assess the probable value and scope of a full systematic review/meta-

analysis (Colquhoun et al., 2014, Peters et al., 2015). For the purpose of this paper we consider the effect on dog quality of life in terms of the psychological (as inferred through behaviors) physical, or social arising from child-dog interactions which might occur within a therapeutic setting. This encompasses the three domains (physical, psychological or social) which are considered fundamental dimensions of QOL by WHO (WHO Group, 1995).

Methods

The study employed a systematic scoping review methodology, adhering to the Preferred Reporting of Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009) (Figure 1).

Participants, interventions and comparators. Participants for this study were taken from the scientific peer-reviewed literature and included assistance dogs, therapy or pet dogs and children (≤ 17 years) who had contact with the dog(s) in question. The interventions/exposure was stipulated as dogs who had contact with children, in a family, assistance or therapy dog role. Given that this is a scoping review, and the authors were uncertain about the quality and quantity of available literature there was no stipulation set on comparators for this review.

Systematic review protocol. The inclusion criteria for selection of articles were: publication in a peer reviewed journal in English; a study of any design focusing specifically on the effect of children (≤17 years) on dog quality of life, including physical, behavioral or social effect (as per our chosen definition of quality of life); assistance dogs, therapy dogs and untrained pet dogs were included. No exclusion was made based on dog or child demographics. Papers were excluded if they did not meet the inclusion criteria, or if they reported a review or meta-analyses of existing data.

Search Strategy. Different combinations (OR / AND) of the search terms relating to the question were used to identify the majority of relevant papers referring to the effect of children on dog quality of life were found (see Table 1). Search terms were decided following expert consultation with established researchers in the field and through evaluation of common terms used in titles and abstracts of papers known to the researchers. At each stage of the review process, a selection of articles were cross-checked by another researcher to ensure agreement on inclusion and exclusion decisions. Full text articles for all papers were

sourced electronically and reviewed by two authors (SSH, LF). Informal searching was also undertaken, including hand searching of article references.

Data sources, study selection and data extraction. A systematic search was conducted using the following databases: PsycINFO, Medline, Allied and Complementary Medicine (AMED), Centre for Agriculture and Biosciences (CAB) Abstracts (using the Ovid search engine), Scopus and PubMed. Searches were conducted in May 2018 and databases were searched from their earliest starting point. Databases were selected based on popular indexing of relevant journal articles. Data extraction was performed by SSH and LF using a data collection form, which included *Characteristics of the Sample*: Dog sample characteristics (number, age, sex, breed, pet/service dog); Child sample characteristics (number, age, sex, developmental status); *Methodological considerations*: Data reliability checks, comparators and measures of effect and *Inputs affecting dog quality of life*; Child-dog interactions; *Outputs associated with dog quality of life:* Psychological/behavioral effect (with focus on behavioral indicators of stress (Beerda et al., 1998b, 2000;Mills et al., 2014), Physical effect (physiological indicators of stress, including signs of being unwell; Mills et al., 2014), and Social effect (social behaviors which may indicate stress or level of willingness to interact). Any discrepancies were discussed in a meeting until consensus was reached.

Data Analysis. Given the early stage of enquiry within this field, it was appropriate to map the evidence in this area more broadly rather than conduct meta-analyses (Pham et al., 2014, Peters et al., 2015). Data is reported in tabulated and descriptive form with evaluation of the robustness (i.e. evidence of reliability and validity) of outcome measures, in addition to a synthesis of the literature, in order to provide clinically relevant information associated with child-dog interactions and their effect.

Results

A flow diagram summarising the outcome of the retrieval process at each stage of the review is provided in Figure 1.

Study selection and characteristics. The combined searches resulted in a total of 204 articles (after removal of duplicates) plus 1 relevant paper from hand searching, (n = 205), after full-text review, 5 articles were identified as relevant and included in the review (Figure 1). As anticipated, the searches showed there was little investment in research in this area. Of

the limited number of papers that met the inclusion criteria, one contained very little descriptive study information (Marinelli et al., 2009). The corresponding author was contacted to provide further information but did not reply, however, given that this is a scoping review, the paper still merited inclusion. Of the five papers included, two utilised a qualitative design, and there were no Randomised Control Trial (RCT) papers, therefore meta-analyses or comparison of effect sizes were not appropriate to consider.

Synthesised findings. Details of our data extraction and assessment of the effect of child-dog interactions on dog quality of life are reported in Table 2a, 2b and 2c and elaborated below.

Characteristics of the sample

Dog characteristics. Only one of the five papers considered the quality of life of pet dogs around children (Hall et al., 2017). The remaining four papers discussed trained dogs which were referred to by the terms; therapy dog (Palestrini et al., 2017; McCullough et al., 2018) animal assisted intervention dog (Marinelli et al., 2009) and service dog (Burrows et al., 2008). All papers reported the number of dogs involved. In general sample sizes were small, varying from a single case study (Palestrini et al., 2017) to 36 dogs (Hall et al., 2017). The youngest dogs included in the studies were 6 months old (Marinelli et al., 2009) and the oldest were 13 years (McCullough et al., 2018), one study did not report dog age (Burrows et al., 2008). All studies reported either dog breeds (Burrows et al., 2008; Marinelli et al., 2009; Palestrini et al., 2017, McCullough et al., 2018), or dog size (Hall et al., 2017). Breeds varied widely, but large breed dogs (e.g., Labradors and retrievers; Burrows et al., 2008, Marinelli et al., 2009; Palestrini et al., 2017; McCullough et al., 2018), were more commonly included than small breed dogs (e.g., dachshund; McCullough et al., 2018). All studies reported dog sex, but two failed to report neuter status (Burrows et al., 2008; McCullough et al., 2018).

Child characteristics. Sample sizes were again relatively small, varying from 11 children (Burrows et al., 2008) to 60 children (McCullough et al., 2018). Two papers reported on children with developmental disorders; autism spectrum disorder and attention deficit hyperactivity disorder (Burrows et al., 2008; Hall et al., 2017). Two papers reported children with specific medical health problems including cancer and those requiring surgical procedures (Palestrini et al., 2017; McCullough et al., 2018). One paper failed to specify the child's specific needs (Marinelli et al., 2009). The youngest children included in the studies

were 3 years old (Palestrini et al., 2017; McCullough et al., 2018) and the oldest were 17 years of age (Palestrini et al., 2017; McCullough et al., 2018). One paper did not report child age (Burrows et al., 2008).

Methodological considerations

Two papers (Burrows et al., 2008; Hall et al., 2017) adopted a primarily qualitative approach utilising parent-owner interviews. Although only one of these papers reported inter-rater reliability of qualitative coding procedures (Hall et al., 2017), the other paper used researcher observations as well as parent based interviews to substantiate findings, providing a degree of convergent validity (Burrows et al., 2008). Two studies (Hall et al., 2017; Marinelli et al., 2009) used a handler/owner checklist of behaviors. One of these studies provided handler training on how to recognise stress behaviors in dogs (Marinelli et al., 2009). Two studies used an arguably more objective researcher-completed behavioral ethogram to record therapy dog behaviors, both of which reported good inter-rater reliability statistics amongst coders (Palestrini et al., 2017; McCullough et al., 2018), although neither paper reported whether coders were blind to the study aim. Only one paper reported the use of a validated scale to assess dog behavior (McCullough et al., 2018), however in this case the Canine Behavioral Assessment and Research Questionnaire (C-BARQ; Hsu and Serpell, 2003) was used to describe the dog's behavioral characteristics, rather than as a direct assessment of the effect of interacting with children on dog behavior. Two papers reported behavioral ethograms and physiological (salivary cortisol: McCullough et al., 2018; heart rate: Palestrini et al., 2017), assessments of dog well-being, thereby proving an arguably more objective and reliable assessment of the effect of child-dog interactions.

It is evident that there is lack of use of appropriate comparators in the available literature. One study compared dog behaviors in the presence of adults and children (Marinelli et al., 2009) and only one study made any sort of comparison (qualitative in this case) of dog behavior in the presence of neuro-typically developing children and children with a neuro-developmental disorder (Hall et al., 2017). In order to draw more robust conclusions on the specific effect of child-dog interactions associated with a therapeutic setting on dog quality of life it is important that comparison is made with a control group (ideally children of a similar age, but without the condition requiring help from the AAI. Pre-post interaction assessments (another important measure of effect from a session) were made in one study (McCullough et al., 2018), but these were not considered in relation to an appropriate comparator group.

Inputs affecting dog quality of life (child-dog interactions)

One paper (sample size: n = 1) reported that child-dog interactions did not significantly correlate with dog stress behaviors (Palestrini et al., 2017). The remaining four papers reported a number of child-dog interactions that were potential sources of stress for both assistance dogs, therapy dogs and pet dogs, as identified through parent/handler (Burrows et al., 2008; Hall et al., 2017) and trained researcher observations (Burrows et al., 2008; McCullough et al., 2018). These inputs can be broadly grouped into three categories of interactions; (i) unprovoked attention from the child, (ii) interactions and environmental predictability, (iii) child games with the dog.

Unprovoked attention. Two papers reported that child meltdowns and tantrums could be particularly stressful for either pet dogs (Hall et al., 2017) or trained assistance dogs (Burrows et al., 2008) as indicated by stress behaviors such as barking, jumping up and shaking in response to the child's behavior. In both papers the dog was identified as being at risk from potentially aggressive behaviors from the child, because they were the closest target, or because the parent had encouraged the dog to interrupt displays of aggression to calm the child. In some cases it was noted that the dog spontaneously (with no prior training) interrupted a meltdown by seeking close physical proximity with the child (Hall et al., 2017). Although such behaviors may be interpreted as the dog coping well and showing affinity with the child, this may also reflect the dog's efforts to calm a stressful situation and thus defuse perceived conflict (Custance and Mayer, 2012). Not all negative attention directed to the dog was the result of heightened arousal from the child (as associated with meltdowns/tantrums). Indeed, the child was reported to jump, prod and poke the dog in a rough manner during daily interactions (Burrows et al., 2008; Hall et al., 2017). The quality (i.e. gentleness) and quantity (i.e. duration) of general 'petting' behaviors (Burrows et al., 2008), including cuddling, kissing, grooming and bathing (Hall et al., 2017) the dog were also identified as key issues to consider in child-dog interactions, albeit that neither were directly measured in any of the papers. For instance, parents noted that the dog enjoyed gentle, short durations of patting, but did not enjoy being held in a tight embrace (Hall et al., 2017).

Interactions and environmental predictability. Two papers identified that environmental instability, including lack of a predictable routine erratic and loud noises (Burrows et al., 2008; Hall et al., 2017), particularly from child visitors (Hall et al., 2017) and lack of peaceful time without child interruptions (Burrows et al., 2008; Hall et al., 2017) were a

source of stress for dogs. Additionally, the importance of regular recreation activities (e.g., waking and off-duty time) was noted to help relieve dog frustration and maintain a healthy weight (Burrows et al., 2008). In some cases children facilitated opportunities for the dog to engage in high-energy activities, however, activities such as walking may also be a source of stress for the dog if attention is not paid to how the child handles the dog on the lead (Hall et al., 2017).

Child games. Two papers reported that child toys and games could have a negative effect on dog well-being as indicated by an increase in stress behaviors (therapy dogs- specific behaviors not defined: McCullough et al., 2018) and those associated with avoidance (e.g., pet dogs-hiding and running away: Hall et al., 2017). It is interesting to note that when relying purely on parent reports, it was believed that the dog enjoyed it when the child played 'dress-up' with them (Hall et al., 2017), however, in another study, trained handlers observed more stress behaviors when children put a bandana on the dog (McCullough et al., 2018). Games which involved loud noises and erratic unpredictable movements, such as those involving wheeled toys or the child bouncing around, were also believed to be disliked by dogs, causing them to seek safety elsewhere (Hall et al., 2017).

Outputs associated with dog quality of life in child-dog interactions.

As per our chosen definition of quality of life, we focus on the psychological (behavioral) effect (behavioral indicators of stress); physical effect (physiological indicators of stress, including symptoms of being unwell); and social effect (social behaviors which may indicate stress or level of willingness to interact) of child-dog interactions.

Psychological (behavioral) Effect. One paper did not mention any specific reference to dog behaviors which may indicate the psychological effect associated with child-dog interactions (Marinelli et al., 2009). The remaining four papers highlighted increased observations of oral behaviors displayed by the dog during child-dog interactions in an assistance dog, therapy dog and pet dog role, including; chewing, lip-licking, grooming, yawning and panting (Burrows et al., 2008; Hall et al., 2017; Palestrini et al., 2017; McCullough et al., 2018), all of which may be indicators of heightened stress levels (Beerda et al., 1998a). Two papers reported that dogs showed behaviors indicative of high stress, including; running away, shaking, urinating and defecating (Burrows et al., 2008; Hall et al., 2017), in addition to safety seeking behaviors (such as hiding, going to their safe place, or

seeking the parent/handler) when interacting with children (Burrows et al., 2008; Hall et al., 2017). These two studies explored the well-being of dogs living full time with children, with one focussing on trained assistance dogs (Burrows et al., 2008) and the other untrained pet dogs (Hall et al., 2017). Behaviors associated with high stress do not appear to be reported from studies involving relatively shorter, more structured therapy-based interactions with children.

Physical Effect. One paper did not provide specific mention of the physical effect associated with child-dog interactions (Marinelli et al., 2009). Two studies took direct measures of physiological functioning and did not find any significant effects of interacting with children on dog heart rate (Palestrini et al., 2017) or cortisol levels (McCullough et al., 2018), potentially indicating a lack of physiological distress. However, both of these studies explored the effect of child-dog interactions during structured animal assisted intervention sessions, whereby interactions with the child were relatively short and controlled. In contrast, dogs living in an assistance or pet role within the family home have more prolonged exposure and interactions are much less controlled. Indeed, the two studies which reported (via parent interviews and observations) on dogs living full time with children identified a range of physical health conditions which may be associated with the presence of chronic stress (Mills et al., 2014), including; ear, eye and skin infections (Burrows et al., 2008; Hall et al., 2017).

Social Effect. Three out of the five papers included in the review referred to the social effect associated with child-dog interactions. Two studies noted that the dog would show distress at separation from the parent when left with the child as indicated by whining, scratching, seeking behavior, and excessive greeting upon reuniting (Burrows et al., 2008, Hall et al., 2017), particularly if the dog was made to sleep in the same room as the child (Burrows et al., 2008), or if the child was creating a stressful situation for the dog (Hall et al., 2017). These studies looked at dogs living full time with children, but similarly a study exploring the effect of children on dogs in a structured AAI setting revealed that the dog chose to interact more with the adult handler than the child, however they showed little evidence of withdrawal behavior from the child (Palestrini et al., 2017). Other evidence also suggested dogs were willing to socialise with the child in both the family home and therapy setting, with reports of the dog being happy to greet the child (Hall et al., 2017).

In Figure 2 we illustrate the links between inputs (child-dog interactions) and outputs (associated effect on the dog).

Discussion

This is the first review to address the nature of the risk to dog quality of life from child-dog interactions in an assistance, support or therapeutic setting and it is apparent that there has been little scientific investment in this potentially important and growing area of interest to date, with only five papers meeting the inclusion criteria, with one of these papers focusing on pet dogs (as opposed to trained dogs). Although the limited number of papers relevant to this review question limits the generalizability and robustness of the conclusions, reference to the Cochrane systematic review database highlights that it is not unusual, or un-useful, for review papers to include such small numbers, or to identify that no relevant studies are identified (Yaffe et al., 2012). Perhaps one of the key findings to emphasise from this review is that further scientific research is warranted in this area and that three of the five papers identified are recent (within the past year), suggesting growth in this interesting area.

Inputs relevant to child-dog interactions which may compromise dog quality of life included those themed around 'unprovoked attention' (e.g., being in the middle of a child meltdown/tantrum, being jumped on and poked), 'interactions and environmental predictability' (e.g., disruptions to routine as a result of the child's needs, need for appropriate recreational activities) and 'child games' (e.g., dress-up, child playing with loud wheeled toys). It is apparent that many of these inputs may be associated with direct physical risk to the dog (e.g., being jumped on, being lashed out at during meltdowns, being roughly handled during dress-up) as well as over loading their sensory system, particularly in terms of auditory stimulation (e.g., loud toys, shouting during meltdowns). Indeed, it well recognised that many domestic dogs show noise sensitivity/fear following traumatic associations with sound which pose longer term risks to their welfare (Sherman and Mills, 2008; Storengen and Lingaas, 2015; Blackwell et al., 2013).

Outputs associated with child-dog interactions included behavioral signs of stress, as evidenced in the dogs in all five studies. Common indicators of both acute and chronic stress (Beerda et al., 2000) that were reported included oral behaviors, such as chewing, lip-licking, yawning and panting, as well as more overt signs of stress, such as cowering, shaking and running away and aggressive behaviors. Behavioral indicators of well-being were more evident across the studies than physical indicators, or behavioral indicators which were

specific to social functioning. This is likely to be because behavioral signs can be easier to identify as they do not require sophisticated equipment and/or complicated collection techniques, or necessarily expert clinical knowledge associated with some physical indices. However, this also raises a point of concern, since it seems both children and adults can have difficulty recognising signs of stress in their dogs, particularly those associated with low level arousal (Meints et al., 2010; Mariti et al., 2012; Lakestani et al., 2014; Meints et al., 2014; Campbell, 2016), thus whilst behavioral indicators may be the most practical to collect, they may not be the most valid or reliable, especially when they come from owners or those less expert with dogs. Nonetheless, the two studies which used physiological measures reported no meaningful changes to heart rate or cortisol levels associated with child-dog interactions (McCullough et al., 2018; Palestrini et al., 2017), which appears to be in contrast with behavioral observations of stress. As such, physiological measures may also not prove reliable as stand-alone measures of dog quality of life, and may be a proxy of immediate arousal rather than general quality of life (Beerda et al., 1998b, Barnett and Hemsworth, 1990). Physical health related proxies of stress (e.g., eye, ear and skin infections) were only reported in two studies where the dog lived full-time with the child (Hall et al., 2017; Burrows et al., 2008). Although such issues have been associated with chronic stress (Mills et al., 2014), based on the nature of these studies it is difficult to purely isolate the role of child interactions in creating any prolonged stress which may lead to these conditions, amongst a combination of a number of other contributing factors (e.g., stress from general management practices, or poor owner maintenance/grooming).

Synthesis of the literature suggests that it may be more important to consider the amount of time the dog spends with the child rather than whether or not the dog is trained in an assistance or therapy role or not. The two studies which explored the effect of child-dog interactions in the family home on either trained (Burrows et al., 2008) or untrained (Hall et al., 2017) dogs were the only ones that reported physical health indicators which are potentially related to chronic stress (Mills et al., 2014) and the only studies to report observations of behavior associated with more extreme stress along with a clear effect on social-related behaviors (i.e. separation related distress). In contrast, the studies which focussed on child-dog interactions within a therapy session did not report any physical effect (Palestrini et al., 2017; McCullough et al., 2017) or notice any clear differences in social-related behaviors (Palestrini et al., 2017). It should also be considered here that it may not necessarily be duration of child-dog contact time per se, but the nature of exposure the dog

experiences. When living full time with children it is much more difficult to manage every interaction which occurs, unlike in therapy sessions, which often involve prescribed and adult-moderated activities. A further point to raise is to consider the role of child functioning in this relationship. The studies reporting dog quality of life in the home environment were the only two studies which directly reported on dogs living with children with autism, which is notably associated with difficulties in social interaction, forming and maintaining relationships and adjusting behaviors (Burrows et al., 2008; Hall et al., 2017). Such problems may exacerbate potential well-being risks in child-dog interactions. However, it should be noted that Hall et al. (2017) included neuro-typically developing children in their study as well as children with autism; they concluded the qualitative risk factors to dog quality of life were similar with both groups of children, although quantitative investigations are required to elaborate on the magnitude of the risks involved.

Based on the studies included in this review it appears that child-dog interactions can have implications for dog quality of life, however identifying and measuring these poses practical challenges. Indeed, in general there is a clear lack of validated assessment tools to assess the general quality of life of dogs (Spofford et al., 2013), as well as a lack of knowledge for identifying dog behaviors associated with different affective states (Mills, 2017; Mariti et al., 2012; Lakestani et al., 2014) not to mention the high costs and practical limitations associated with obtaining physical assessments. However, the identification of practical solutions that help to avoid key triggers associated with dog stress responses within child-dog interactions may help to mitigate the negative effects on dog quality of life. For example, Hall et al (2017) detail nine child-dog interactions, identified through interviews with parents of neuro-typically developing children and those with neuro-developmental disorders, which may pose a threat to dog quality of life (meltdowns and tantrums, having child visitors in the home, the child and dog being together in the car, the child bathing/grooming the dog, the child striking out and tail-pulling, the child playing fancy dress with the dog, the child jumping around near the dog, the child playing with loud and wheeled toys, and the child cuddling and kissing the dog). A number of these interactions were also reported in the studies included in this review paper which involved trained therapy dogs (Burrows et al., 2008; McCullough et al., 2017), highlighting the generality of the potential importance of considering these interactions. It is suggested that further research is conducted to assess the potential relationship between these triggers and pet dog quality of life in order to create effective intervention strategies.

The quality of this review and its findings are dependent on the quality of the papers assessed. This review considers only papers published in peer reviewed English literature, and so does not consider the full range of literature that may be available. Nonetheless, by focusing on peer reviewed literature, we are synthesising the most rigorous data available. Our exclusion criteria are unlikely to have introduced a significant bias to our interpretation of the data. The conclusions drawn are limited by the lack of scientific rigour of the available literature and small scale nature of the studies. Whilst naturalistic observations and qualitative investigations provide an important starting point on which to formulate and test hypotheses, the lack of large-scale quantitative approaches employing standardised and objective measures of assessment limit the generalisability of the conclusions. We did not undertake formal quality assessment of the papers due to the fact that all were small-scale or qualitative studies and the aim was to scope the available data rather than establish its quality. It is clear that statistically powered studies are needed to quantify the effects of child-dog interactions on dog quality of life in order to increase confidence in the preliminary conclusions reported here. It is also apparent that there is a lack of appropriate use of a controls. Further research is required which directly compares risk of child-dog and adult-dog interactions for dog quality of life, as it is possible that the stresses associated with child interactions are not unique to this demographic, but also present in adult interactions. Furthermore, whilst these studies predominately focus on the negative aspects of child-dog interactions, it should also be considered that children can bring a range of positive benefits for dog quality of life, providing a source of mutual companionship and creating opportunities for recreational activities (Hall et al., 2017).

In conclusion, the review indicates that the following classes of activity are the most overtly recognisable threats to dog quality of life: *unprovoked child attention* (e.g., accidentally or purposefully rough contact associated with lack of behavioral control or displays of affection), *interaction and environmental unpredictability* (e.g., noise levels associated with meltdowns and tantrums, the importance of recreational activities) and *child games* (e.g., ‘dress-up’, wheeled toys). The effects of these may be realised in terms of altered dog behaviors (e.g., displaying stress-related behaviors), physical consequences (e.g., eye, ear and skin irritations) and social-related behaviors (e.g., separation anxiety from adult-parent). The review has highlighted that there is limited specific scientific literature which investigates the risk of child-dog interactions to dog quality of life. Future research should focus on further identification of triggers which may create tension in the child-dog

462 relationship and how these can be practically avoided. In addition practical research is
463 required into the education of parents and assistance/therapy dog handlers for the
464 identification of behavioral indicators of stress in dogs.

465

466 **Figure Legends**

467 Figure 1. Flow diagram illustrating study selection

468 Figure 2. Links between child-dog interactions and effect to dog well-being

469 **Author Contributions Statement**

470 SH conceived and conducted the review, with primary responsibility for manuscript preparation.
471 LF assisted with data extraction, interpretation and drafting the manuscript. DM contributed to
472 conceptual development, data interpretation and development of the manuscript.

473 **Conflict of Interest Statement**

474 The authors have no conflict of interest to declare.

475 **Funding disclosure**

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477 **Data Availability Statement**

478 All datasets generated for this study are included in the manuscript and the supplementary files.

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480

481 Table 1. Search strategies to identify studies for inclusion

Search terms
pet dog* OR pet canine* OR family dog* OR family canine* OR assistance dog* OR therapy dog* OR service dog* OR guide dog* OR support dog* OR hearing dog*
Child* OR young person* OR youth* OR pre-school* OR kindergarten* OR teenager* OR pediatric* OR paediatric*
Quality of life OR quality-of-life OR QOL or well being OR well-being OR Life satisfaction* OR Physical health OR Psychological health OR stress* OR welfare
Assess* OR measure*

482 *indicates that plurals and related words were searched for, key word sets were combined using 'AND'

483 Table 2a. Summary of papers included in the review: study descriptives

First Author (Date)	Dogs					Children			Brief Aim
	N	Status	Age	Breed	Sex	N	Status	Age	
Burrows (2008)	11	Service dog	Not recorded	Labradors = 9 Retrievers = 2	Male = 6; Female = 5	11	ASD[1]	Not recorded	Identify and describe important patterns of behavior in the interactional relationships among assistance dog, child with autism, and family members.
Marinelli (2009)	18	Therapy dog	6 months - 10 years	Labradors = 7, Retrievers = 4, Cocker Spaniel = 2, Brittany Spaniel = 1, Giant Schnauzer = 1, Mongrels = 3	Male = 8 (2 neutered); Female = 10 (8 spayed)	33	Range of specific needs, no specific diagnoses mentioned	< 12 years	Analysis of potential sources of distress for therapy dogs residing in a pet therapy centre
	36	Pet dog	NTD* families = 5.7	Small breed = 29.4% (NTD), 18.8% (NDD);	Male entire = 6% (NTD), 13% (NDD); Male	36	NTD = 18; NDD = 18 = (ASD /	4 -10 years	Identify parent perspectives of the issues which positively and negatively

Hall (2017)			years (average); NDD** families = 4.1 years	Large breed = 41.1% (NTD), 37.5% (NDD); Cross breed = 29.4% (NTD), 43.8% (NDD)	neutered = 35% (NTD), 56% (NDD), Female entire = 29% (NTD), 19% (NDD), Female neutered = 29% (NTD), 13% (NDD)		ADHD[2])		affect quality of life of pet dogs living with neuro-typically developing children and those who have a neuro-developmental disorder
Palestrini (2017)	1	Therapy dog	7 years	Golden Retriever	Female, spayed	20	Undergoing surgical procedures	3-17 years	Measure and compare behavior and heart rate in a therapy dog to examine behavioral and physiological signs of stress in AAT in a paediatric surgery setting
McCullough (2018)	26	Therapy dog	2 - 13 years	Miniature poodles, Newfoundland's, Border Collie cross, Daschund,	Female = 58%	60	Diagnosed with cancer	3-17 years	Measure the physiological and behavioral effects of regular Animal Assisted Interventions (AAI) sessions for registered therapy dogs

		Wheaton Terrier, Golden Retrievers, Labrador Retrievers	in five U.S. paediatric oncology settings

*NTD = Neuro-typically developing; **NDD = Neuro-developmental disorder; [1] ASD = Autism Spectrum Disorder; [2] = ADHD = Attention Deficit Hyperactivity Disorder

487 Table 2b. Summary of papers included in the review: methodological considerations

First Author (Date)	Study Design	Sources of Outcome Measures	Reliability Checks	Comparators	Effect Measures
Burrows (2008)	Qualitative	Interviews with parents and observational data	None mentioned	No comparators	Thematic coding
Marinelli (2009)	Naturalistic observations across a 3 year period	Handlers trained to assess the presence and intensity (5-point scale) of a range of common stress related behaviors	Not mentioned	Elderly clients (>65 years, n=35) and young children (<12 years, n=33).	Mean difference
Palestrini (2017)	Naturalistic observations and physiological assessment at one time point	Behavioral ethogram; Heart rate monitor (Polar Vantage chest strap)	Good Inter-Coder Correlation (ICC) reliability statistics on ethogram coding	No comparators	Mean difference
Hall (2017)	Qualitative	Interviews with parents and dog stress response checklist	Second coding of themes	Neuro-typically developing children (n=18) and children with neuro-developmental disorders (n=18).	Thematic coding (interviews), mean difference (dog stress checklist)

McCullough (2018)	Mixed methods: Naturalistic observations (behavioral) and pre-post design (physiological)	Canine behavioral assessment & research questionnaire (C-BARQ); Salivary cortisol; Behavioral ethogram	Good ICC reliability statistics on ethogram coding	Salivary cortisol was compared between baseline (dog at home) vs their place of work (hospital).	Mean difference

491 Table 2c. Summary of papers included in the review: child-dog interactions and quality of life indicators

First Author (Date)	Environmental Interactions (Child-Dog Interactions)	Psychological/Behavioral Effect	Physical Effect
Burrows (2008)	Unprovoked negative attention from child; Predictability of children's behaviors and general routine; Lack of sleep and peaceful/ recovery time due to child interactions/attention.	Chewing; Excitable behaviors; reluctance to walk or be with child; exhaustion; growling; moving to a safe place; defecating/urinating in the home.	Ear and eye infections; weight gain; physical stress due to lack of time to urinate/defecate.
Marinelli (2009)	Stress related behaviors (no specific references) were more evident when activities involved children under 12 years of age compared to elderly clients (>65 years). Corresponding author contacted for further details 13th March 2018 due to lack of detail, no correspondence was received.	No specific mention	No specific mention
Palestrini (2017)	No correlation was found between stress-related behaviors (lip licking, yawning, grooming, panting, and avoidance) and child interactions.	Large proportion of time panting (28.4%); Self-grooming, lip licking and yawning were observed during the session.	Heart rate remained within a normal range during the sessions (basal metabolic rate: 60-110).
Hall (2017)	Child and dog in car; Child visitors; Noise levels; Meltdowns and tantrums; Rough contact; Cuddling and kissing; Grooming/bathing; High energy activities; Threatening toys and games.	Cowering; Running away; Widening eyes; Barking; Jumping; Shaking; Seeking safety. Similar across NDD and NTD groups.	Problems with digestive system and skin conditions particularly noted in the NDD group. Skin conditions noted in both groups.

	Similar across NDD and NTD groups.		
McCullough (2018)	More stress behaviors displayed by dog when child put bandana on dog. More affiliative behaviors when child: played with dog's toy, talked to the dog, took dog for a walk and practiced dog cues.	Lip licking (oral stress behavior) and tail wagging (affiliative behavior) were the most common behaviors seen during therapy sessions. Stress behaviors (e.g., oral behaviors, shaking, running away, aggression) were associated with affiliative behaviors (e.g., seeking contact with a person). Older dogs showed more stress and affiliative behaviors during sessions than younger dogs.	Cortisol levels were similar on AAT days and rest days. They did not increase over the study duration (33 months). Female dogs and older dogs showed lower cortisol than male dogs and younger dogs, respectively. During the sessions lower cortisol associated with increased affiliative behaviors. Increased cortisol associated with increased stress behaviors.

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493 Table 2c continued.

First Author (Date)	Social Effect	Overall Child Effect
Burrows (2008)	Separation anxiety from parent	Trained assistance dogs living full time with children with autism showed negative behavioral, physical and social effect of child-dog interactions.
Marinelli (2009)	No specific mention	Study concluded that stress related behaviors were more evident in therapy dogs when interacting with children (<12 years) compared to adults. Little evidence reported to support conclusions.
Palestrini (2017)	Spent little time withdrawing from child (0.06%), but interacted with handler more (8.6%) more than child (4.9%).	A single therapy dog working in a structured environment with child patients showed some stress-related behaviors, but little physical or social affect.
Hall (2017)	Separation anxiety from parent noted in both NDD and NTD groups. Often the dog was perceived as being happy to greet the child (NDD and NTD).	Untrained pet dogs living with NTD and NDD children showed evidence of negative behavioral, physical and social effect associated with child-dog interactions. Some positive consequences were also observed such as mutual companionship and the opportunity for shared recreational activities.
McCullough (2018)	No specific mention.	Therapy dogs working with child oncology patients in a structured environment showed some evidence of stress behaviors, but little physical and social effect of child-dog

interactions.

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References - Not in the Journal style – please fix

Animal Assisted Intervention International. 2019. Available: https://aai-int.org/wp-content/uploads/2019/02/AAII-Standards-of-Practice.pdf. Accessed 4th March 2019.

Arhant, C., Bubna-Littitz, H., Bartels, A., Futschik, A. & Troxler, J. 2010. Behaviour of smaller and larger dogs: effects of training methods, inconsistency of owner behaviour and level of engagement in activities with the dog. Appl. Anim. Behav. Sci. 123**,** 131-142.

Arluke, A., Cleary, D., Patronek, G. & Bradley, J. 2017. Defaming Rover: Error-Based Latent Rhetoric in the Medical Literature on Dog Bites. J. Appl. Anim. Welf. Sci**.** 1-13.

Audrestch, H.M., Whelan, C.T., Grice, D., Asher, L., England, G.C. & Freeman, S.L. 2015. Recognizing the value of assistance dogs in society. Disab. Health J. 8**,** 469-474.

Barnett, J.L. & Hemsworth, P.H. 1990. The validity of physiological and behavioural measures of animal welfare. Appl. Anim. Behav. Sci. 25**,** 177-187.

Beerda, B., Schilder, M., Van Hooff, J., De Vries, H. & Mol, J. 2000. Behavioural and hormonal indicators of enduring environmental stress in dogs. Anim. Welf. 9**,** 49-62.

Beerda, B., Schilder, M.B., Bernadina, W., Van Hooff, J.A., De Vries, H.W. & Mol, J.A. 1999a. Chronic stress in dogs subjected to social and spatial restriction. II. Hormonal and immunological responses. Physiol. Behav. 66**,** 243-254.

Beerda, B., Schilder, M.B., Van Hooff, J.A. & De Vries, H.W. 1997. Manifestations of chronic and acute stress in dogs. Appl. Anim. Behav. Sci. 52**,** 307-319.

Beerda, B., Schilder, M.B., Van Hooff, J.A., De Vries, H.W. & Mol, J.A. 1998a. Behavioural, saliva cortisol and heart rate responses to different types of stimuli in dogs. Appl. Anim. Behav. Sci. 58**,** 365-381.

Beerda, B., Schilder, M.B., Van Hooff, J.A., De Vries, H.W. & Mol, J. A. 1998b. Behavioural, saliva cortisol and heart rate responses to different types of stimuli in dogs. Appl. Anim. Behav. Sci. 58**,** 365-381.

Beerda, B., Schilder, M.B., Van Hooff, J.A., De Vries, H.W. & Mol, J.A. 1999b. Chronic stress in dogs subjected to social and spatial restriction. I. Behavioral responses. Physiol. Behav. 66**,** 233-42.

Belshaw, Z., Asher, L., Harvey, N. & Dean, R. 2015. Quality of life assessment in domestic dogs: An evidence-based rapid review. Vet J. 206**,** 203-212.

Berry, A., Borgi, M., Francia, N., Alleva, E. & Cirulli, F. 2013. Use of assistance and therapy dogs for children with autism spectrum disorders: A critical review of the current evidence. J. Altern. Complementary Med. 19**,** 73-80.

Blackwell, E. J., Bradshaw, J.W. & Casey, R.A. 2013. Fear responses to noises in domestic dogs: Prevalence, risk factors and co-occurrence with other fear related behaviour. Appl. Anim. Behav. Sci. 145**,** 15-25.

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**,** e004786.

Burrows, K.E., Adams, C.L. & Millman, S.T. 2008. Factors affecting behavior and welfare of service dogs for children with autism spectrum disorder. J Appl. Anim. Welf. Sci. 11**,** 42-62.

Campbell, E.J. 2016. Owners' abilities to recognise and comprehend signs or displays of aggression in their canine companions outwith the home environment. Vet. Nurs. J. 31**,** 329-333.

Carlisle, G.K. 2015. The social skills and attachment to dogs of children with autism spectrum disorder. J Autism Develop. Disord. 45**,** 1137-1145.

Colquhoun, H.L., Levac, D., O'brien, K.K., Straus, S., Tricco, A.C., Perrier, L., Kastner, M. & Moher, D. 2014. Scoping reviews: time for clarity in definition, methods, and reporting. J. Clin. Epidemiol. 67**,** 1291-1294.

Custance, D. & Mayer, J. 2012. Empathic-like responding by domestic dogs (Canis familiaris) to distress in humans: an exploratory study. Anim. Cog. 15**,** 851-859.

Diverio, S., Menchetti, L., Riggio, G., Azzari, C., Iaboni, M., Zasso, R., Di Mari, W. & Santoro, M.M. 2017. Dogs' coping styles and dog-handler relationships influence avalanche search team performance. Appl. Anim. Behav. Sci. 191**,** 67-77.

Fatjó, J., Ruiz-De-La-Torre, J. & Manteca, X. 2006. The epidemiology of behavioural problems in dogs and cats: a survey of veterinary practitioners. Anim. Welf. 15**,** 179-185.

Favrot, C., Linek, M., Mueller, R. & Zini, E. 2010. International task force for canine atopic dermatitis development of a questionnaire to assess the impact of atopic dermatitis on health-related quality of life of affected dogs and their owners. Vet. Dermatol. 21**,** 63-69.

Freeman, L.M., Rush, J.E., Farabaugh, A.E. & Must, A. 2005. Development and evaluation of a questionnaire for assessing health-related quality of life in dogs with cardiac disease. J. Am. Vet. Med. Assoc. 226**,** 1864-1868.

Hall, S.S., Wright, H.F., Hames, A. & Mills, D.S. 2016. The long-term benefits of dog ownership in families with children with autism. J. Vet. Behav*:* Clinic. Appl. Res. 13**,** 46-54.

Hall, S.S., Wright, H.F. & Mills, D.S. 2017. Parent perceptions of the quality of life of pet dogs living with neuro-typically developing and neuro-atypically developing children: An exploratory study. PloS one. 12**,** e0185300.

Hargrave, C. 2015. Anxiety, fear, frustration and stress in cats and dogs—Implications for the welfare of companion animals and practice finances. Comp. Anim. 20**,** 136-141.

Hewison, L.F., Wright, H.F., Zulch, H.E. & Ellis, S.L. 2014. Short term consequences of preventing visitor access to kennels on noise and the behavior and physiology of dogs housed in a rescue shelter. Physiol. Behav. 133**,** 1-7.

Horváth, Z., Dóka, A. & Miklósi, Á. 2008. Affiliative and disciplinary behavior of human handlers during play with their dog affects cortisol concentrations in opposite directions. Horm. Behav. 54**,** 107-114.

Hsu, Y. & Serpell, J.A. 2003. Development and validation of a questionnaire for measuring behavior and temperament traits in pet dogs. J. Am. Vet. Med. Assoc. 223**,** 1293-1300.

Iliopoulou, M.A., Kitchell, B.E. & Yuzbasiyan-Gurkan, V. 2013. Development of a survey instrument to assess health-related quality of life in small animal cancer patients treated with chemotherapy. J. Am. Vet. Med. Assoc. 242**,** 1679-1687.

Kerswell, K.J., Bennett, P.J., Butler, K.L. & Hemsworth, P.H. 2009. Self-reported comprehension ratings of dog behavior by puppy owners. Anthrozoös. 22**,** 183-193.

Lakestani, N.N., Donaldson, M.L. & Waran, N. 2014. Interpretation of dog behavior by children and young adults. Anthrozoös. 27**,** 65-80.

Lefebvre, D., Diederich, C., Delcourt, M. & Giffroy, J.-M. 2007. The quality of the relation between handler and military dogs influences efficiency and welfare of dogs. App. Anim. Behav. Sci. 104**,** 49-60.

Marinelli, L., Normando, S., Siliprandi, C., Salvadoretti, M. & Mongillo, P. 2009. Dog assisted interventions in a specialized centre and potential concerns for animal welfare. Vet. Res. Comm. 33**,** 93-95.

Mariti, C., Gazzano, A., Moore, J.L., Baragli, P., Chelli, L. & Sighieri, C. 2012. Perception of dogs' stress by their owners. J. Vet. Behav: Clinic. Appl. Res. 7**,** 213-219.

Matthias, J., Templin, M., Jordan, M. & Stanek, D. 2015. Cause, setting and ownership analysis of dog bites in Bay County, Florida from 2009 to 2010. Zoonoses Pub. Health. 62**,** 38-43.

McCullough, A., Jenkins, M. A., Ruehrdanz, A., Gilmer, M. J., Olson, J., Pawar, A., Holley, L., Sierra-Rivera, S., Linder, D. E., Pichette, D., Grossman, N. J., Hellman, C., Guérin, N. A. & O'Haire, M. E. 2018. Physiological and behavioral effects of animal-assisted interventions on therapy dogs in pediatric oncology settings. Appl. Anim. Behav. Sci. 200**,** 86-95.

McCullough, A., Ruehrdanz, A., Jenkins, M.A., Gilmer, M.J., Olson, J., Pawar, A., Holley, L., Sierra-Rivera, S., Linder, D.E., Pichette, D., Grossman, N.J., Hellman, C., Guerin, N.A. & O'Haire, M.E. 2017. Measuring the Effects of an Animal-Assisted Intervention for Pediatric Oncology Patients and Their Parents: A Multisite Randomized Controlled Trial. J. Pediatric Onc. Nurs**.** 1043454217748586.

McMillan, F. D. 2000. Quality of life in animals. J. Am. Vet. Medic. Assoc. 216**,** 1904-1910.

Meints, K., Brelsford, V., Just, J. & De Keuster, T. 2014. How children and parents interpret dogs' body language. Animals and Humans Together: Integration in Society, International Society for Anthrozoology, Vienna, Austria, p. 207.

Meints, K., Racca, A. & Hickey, N. 2010. How to prevent dog bite injuries? Children misinterpret dogs facial expressions. Inj. Prev. 16**,** A68-A68.

Mills, D., Karagiannis, C. & Zulch, H. 2014. Stress—its effects on health and behavior: a guide for practitioners. Vet. Clinic: Small Anim. Pract. 44**,** 525-541.

Mills, D.S. 2017. Perspectives on assessing the emotional behavior of animals with behavior problems. Curr. Opin. Behav. Sci. 16**,** 66-72.

Mills, D.S., Dube, M.B. & Zulch, H. 2012. Stress and Pheromonatherapy in Small Animal Clinical Behaviour, John Wiley & Sons.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G. & Group, P. 2009. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Medic. 6**,** e1000097.

Morrongiello, B.A., Marlenga, B., Berg, R., Linneman, J. & Pickett, W. 2007. A new approach to understanding pediatric farm injuries. Soc. Sci. Medic. 65**,** 1364-1371.

Noli, C., Colombo, S., Cornegliani, L., Ghibaudo, G., Persico, P., Vercelli, A. & Galzerano, M. 2011a. Quality of life of dogs with skin disease and of their owners. Part 2: administration of a questionnaire in various skin diseases and correlation to efficacy of therapy. Vet. Derm. 22**,** 344-351.

Noli, C., Minafò, G. & Galzerano, M. 2011b. Quality of life of dogs with skin diseases and their owners. Part 1: development and validation of a questionnaire. Vet. Derm. 22**,** 335-343.

O'Haire, M. E. 2013. Animal-assisted intervention for autism spectrum disorder: A systematic literature review. J. Autism Develop. Disord. 43**,** 1606-1622.

Palestrini, C., Calcaterra, V., Cannas, S., Talamonti, Z., Papotti, F., Buttram, D. & Pelizzo, G. 2017. Stress level evaluation in a dog during animal-assisted therapy in pediatric surgery. J. Vet. Behav: Clinic. Appl. Res. 17**,** S221-S222.

Peters, M. D., Godfrey, C. M., Khalil, H., Mcinerney, P., Parker, D. & Soares, C. B. 2015. Guidance for conducting systematic scoping reviews. Int. J. Evid.-based Healthc. 13**,** 141-146.

Pham, M.T., Rajić, A., Greig, J.D., Sargeant, J.M., Papadopoulos, A. & Mcewen, S.A. 2014. A scoping review of scoping reviews: advancing the approach and enhancing the consistency. Res. Synth. Methods. 5**,** 371-385.

Purewal, R., Christley, R., Kordas, K., Joinson, C., Meints, K., Gee, N. & Westgarth, C. 2017. Companion animals and child/adolescent development: a systematic review of the evidence. Int. J. Env. Res. Pub. Health. 14**,** 234.

Rooney, N., Gaines, S. & Hiby, E. 2009. A practitioner's guide to working dog welfare. J. Vet. Behav: Clinic. Appl. Res. 4**,** 127-134.

Rooney, N.J. & Cowan, S. 2011. Training methods and owner–dog interactions: Links with dog behaviour and learning ability. Appl. Anim. Behav. Sci. 132**,** 169-177.

Sachs-Ericsson, N., Hansen, N.K. & Fitzgerald, S. 2002. Benefits of assistance dogs: A review. Rehab. Psychol. 47**,** 251.

Salman, M.D., Hutchison, J., Ruch-Gallie, R., Kogan, L., New Jr, J.C., Kass, P.H. & Scarlett, J.M. 2000. Behavioral reasons for relinquishment of dogs and cats to 12 shelters. J. Appl. Anim. Welf. Sci. 3**,** 93-106.

Selman, R.L. 1980. Growth of Interpersonal Understanding. Academic Press.

Sherman, B.L. & Mills, D.S. 2008. Canine anxieties and phobias: an update on separation anxiety and noise aversions. Vet. Clinics N. Am: Small Anim. Pract. 38**,** 1081-1106.

Silva, K., Lima, M., Santos-Magalhães, A., Fafiães, C. & De Sousa, L. 2018. Can dogs assist children with severe autism spectrum disorder in complying with challenging demands? An exploratory experiment with a live and a robotic dog. The J. Alt. Comp. Medic. 24**,** 238-242.

Spofford, N., Lefebvre, S.L., Mccune, S. & Niel, L. 2013. Should the veterinary profession invest in developing methods to assess quality of life in healthy dogs and cats? J. Am. Vet. Medic. Assoc. 243**,** 952-956.

Storengen, L.M. & Lingaas, F. 2015. Noise sensitivity in 17 dog breeds: Prevalence, breed risk and correlation with fear in other situations. Appl. Anim. Behav. Sci. 171**,** 152-160.

Taylor, K. & Mills, D. 2007. Is quality of life a useful concept for companion animals? Anim. Welf. 16**,** 55-65.

Ward, A., Arola, N., Bohnert, A. & Lieb, R. 2017. Social-emotional adjustment and pet ownership among adolescents with autism spectrum disorder. J. Comm. Disord. 65**,** 35-42.

Welsh, L. 2015. The euthanasia of aggressive dogs. The Vet. Nurse. 6**,** 517-521.

Westgarth, C., Brooke, M., & Christley, R.M. 2018. How many people have been bitten by dogs? A cross-sectional survey of prevalence, incidence and factors associated with dog bites in a UK community. J Epidemiol Comm. Health. 72**,** 331-336.

WHO Group, W. 1995. The World Health Organization quality of life assessment (WHOQOL): position paper from the World Health Organization. Soc. Sci. & Medic. 41**,** 1403-1409.

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

Yaffe, J., Montgomery, P., Hopewell, S. & Shepard, L.D. 2012. Empty reviews: a description and consideration of Cochrane systematic reviews with no included studies. PLoS One. 7**,** e36626.

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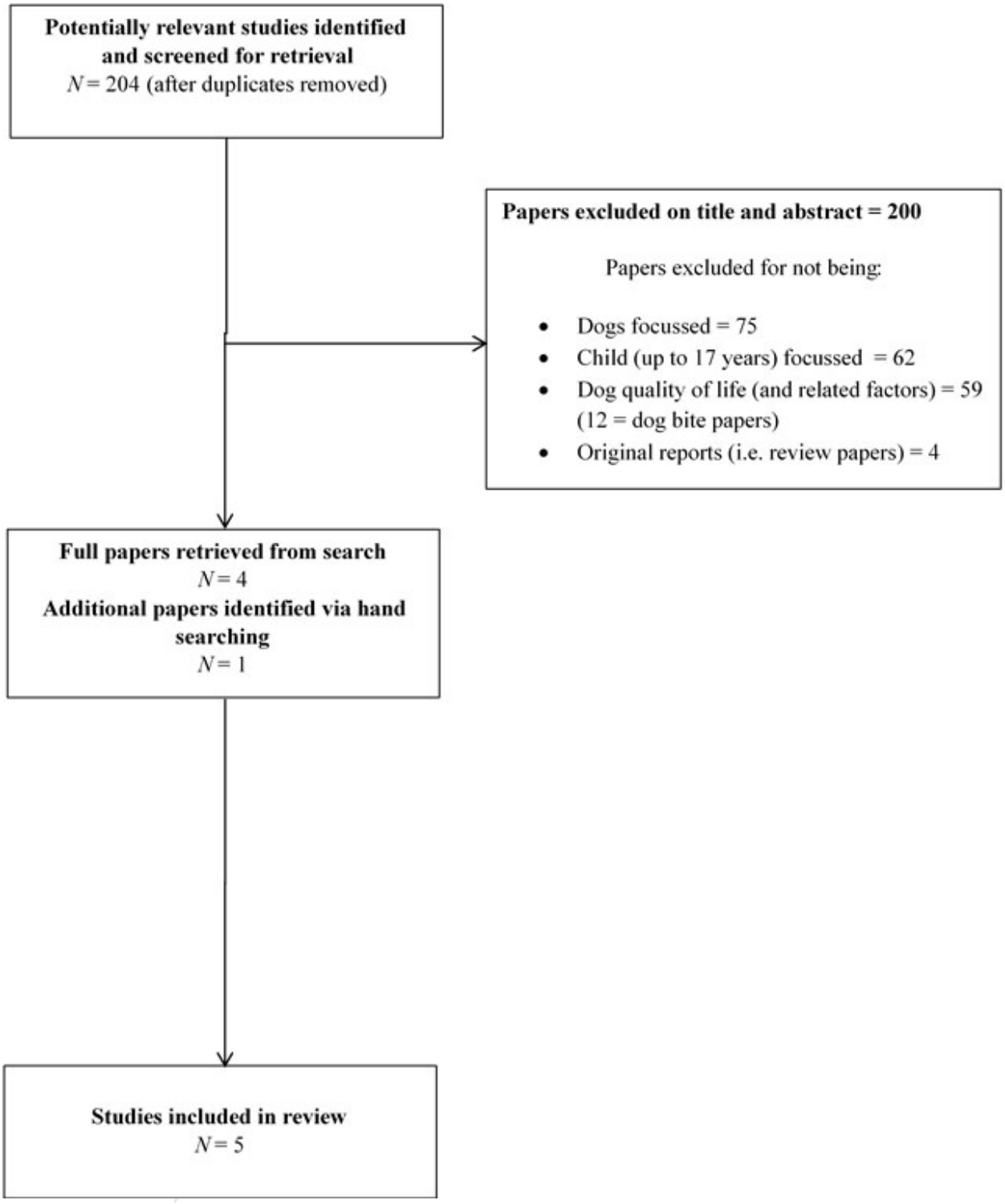
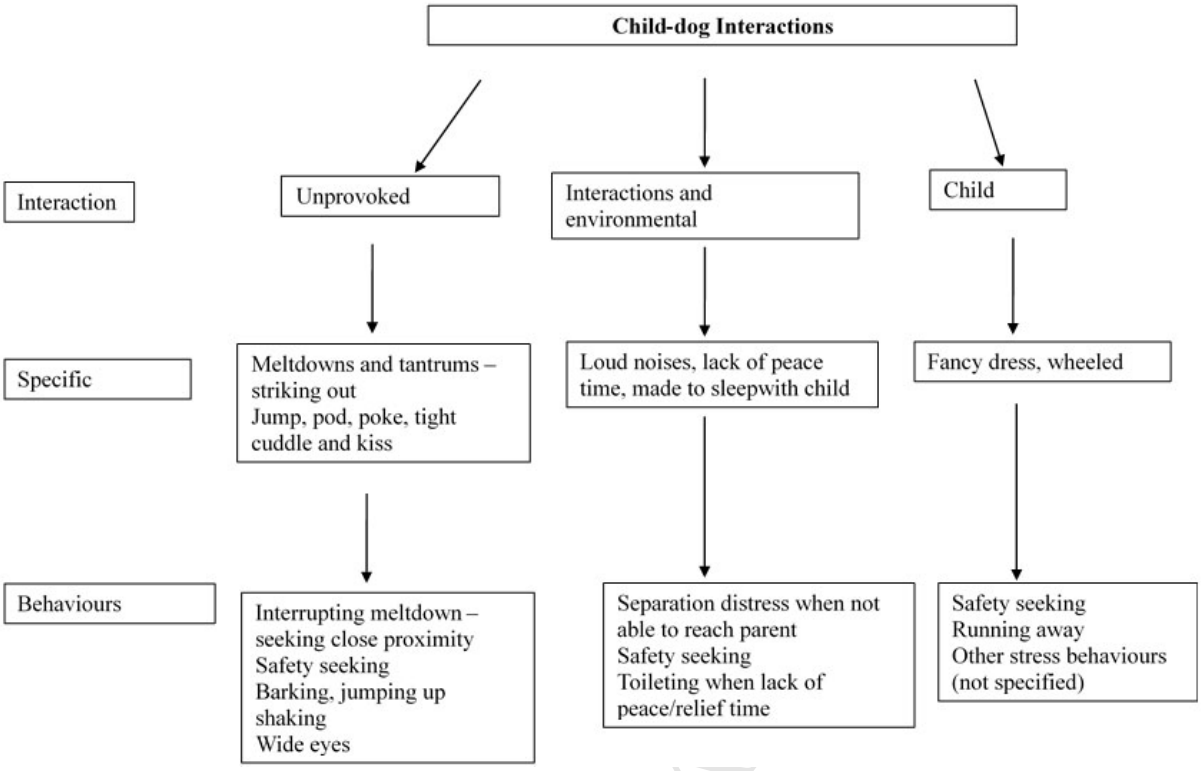

Potentially relevant studies identified and screened for retrieval
N = 204 (after duplicates removed)
Papers excluded on title and abstract = 200
Papers excluded for not being:
Dogs focussed = 75
Child (up to 17 years) focussed = 62
Dog quality of life (and related factors) = 59 (12 = dog bite papers)
Original reports (i.e. review papers) = 4
Full papers retrieved from search
N = 4
Additional papers identified via hand searching
N = 1
Studies included in review
N = 5



Highlights

Specific child-dog interactions may be risk factors to dog quality of life

Risk factors may be realised in terms of altered dog behaviours and physical wellbeing

Important to identify triggers which create tension in the child-dog relationship

Triggers include, rough contact, child games, lack of predictability