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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.

1 Introduction

2 There is growing scientific and societal interest in the importance of assistance dogs, therapy
3 dogs (Sachs-Ericsson et al., 2002; Berry et al., 2013; Burgoyne et al., 2014; Audrestch et al.,
4 2015) and pet dogs (Carlisle, 2015; Wright et al., 2015; Hall et al., 2016; Purewal et al., 2017;
5 Ward et al., 2017; Silva et al., 2018) for promoting child quality of life, particularly those
6 with specific needs, such as autism spectrum disorder (O'Haire, 2013). The training received
7 and types of roles these dogs are expected to fulfil are varied. Whereas assistance dogs
8 working in animal assisted interventions, also referred to as service dogs in some literatures
9 (not to be confused with military or police working dogs), are typically trained to perform
10 certain tasks with their handler in the home environment (e.g., assisting with crossing the
11 road, providing deep pressure therapy during meltdowns or times of anxiety) on a daily basis,
12 therapy dogs work closely with an adult handler, who has been trained to deliver specific
13 therapies, usually within structured relatively short-sessions in a clinical/therapeutic setting.
14 The specific training received by assistance and therapy dogs will be partly determined by the
15 specific organisation, the standards of practice outlined by Animal Assisted Intervention
16 International (2019) offer little distinction in training practices between the two. In contrast,
17 pet dogs typically receive no formal training, but may offer informal emotional support
18 within the day to day home environment.

19
20 The complex nature of the environment in which these dogs work or live, inevitably means
21 their sensory systems are taxed with novel and potentially emotionally arousing stimuli,
22 which may place them in frequent or chronic states of stress (Mills et al., 2012), which can
23 have long term effects for the animal's quality of life. In order to form a comprehensive
24 regulatory framework in which to practice animal assisted interventions (AAI) with dogs, it is
25 essential that we identify the specific risk factors (i.e., triggers) in interacting with children
26 which may have an immediate effect on dog well-being and general quality of life. Not only
27 will this inform appropriate care practice from the dog's perspective, but it will also reduce
28 risk of harm to the child which is associated with interacting with a stressed dog (i.e., dog
29 bites), and improve the quality of therapy through the promotion of a mutually beneficial and
30 positive environment.

31
32 Whilst research has identified a number of risk factors in dog management which can
33 increase dog stress, such as spatial restrictions, social isolation, changes in routine (Beerda et

34 al., 1999a,b), loud noises and unexpected events (Beerda et al., 1998a; Blackwell et al.,
35 2013), there appears to have been little attention paid to the risk factors associated with child
36 interactions. Additionally, methods to measure dog stress in controlled laboratory type
37 environments often focus on assessment of immediate behavioral or physiological responses;
38 whereas for dogs performing long-term therapeutic duties it may be more appropriate to
39 consider broader and enduring effects on quality of life. In terms of immediate behavioral
40 responses, it is widely suggested that a range of dog behaviors such as shaking, cowering,
41 scratching, yawning, vocalisations, biting, as well as more subtle behaviors such as lying
42 down, pawing, moving close to handlers/owners, blinking and lip-licking may indicate stress
43 in the dog (Hargrave, 2015; Beerda et al., 2000). However, the ability to identify these
44 behaviors may be problematic particularly for untrained owners/handlers, and the behavioral
45 signs associated with low level stress are often missed (Kerswell et al., 2009; Mariti et al.,
46 2012). Physiological responses associated with stress in dogs include changes to urinary
47 epinephrine to creatinine ratios, urinary cortisol to creatinine ratios (Beerda et al., 2000),
48 salivary cortisol and heart rate (Beerda et al., 1998a). However, the ways in which stress are
49 evidenced can be highly variable between dogs (Beerda et al., 1997) and physiological
50 measures may be a better proxy of arousal rather than emotional valence (Beerda et al.,
51 1998a; Hewison et al., 2014; Barnett and Hemsworth, 1990), as such a triangulation of
52 measures may be the most reliable form of assessment (Mills et al., 2014).

53
54 QoL is a multi-dimensional concept which encapsulates satisfaction across a number of
55 domains (e.g., psychological, physical and social) given the circumstance, and so it may be a
56 preferable point of reference than the dog's physical well-being when examining the effect of
57 risk factors on dogs working in a long-term role. Nonetheless, assessing QoL in companion
58 animals is subject to two fundamental barriers. Firstly, QoL is notoriously challenging to
59 define, particularly in the animal population (McMillan, 2000, Taylor and Mills, 2007),
60 because the widely used definition provided by the World Health Organisation (WHO) to
61 conceptualise human QoL refers to cultures and values (WHO Group, 1995, Belshaw et al.,
62 2015) which is not directly applicable to dogs. Secondly, there is a current lack of validated
63 instruments to assess dog quality of life. Although a range of disease specific instruments
64 have been developed (e.g., Favrot et al., 2010; Freeman et al., 2005; Noli et al., 2011a,b;
65 Iliopoulou et al., 2013), relatively little attention has been paid to dog general quality of life
66 (Belshaw et al., 2015). This is an issue when assessing the welfare effect of factors such as

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

69

70 In spite of these challenges, evidence from working dog literature highlights the importance
71 of considering quality of life in assistance, therapy and pet dogs who have regular contact
72 with children. Both the nature and quality of interactions between adult owner/handler and
73 dog have been found to affect not only performance but also well-being in pet dogs, military
74 dogs and search dogs (Lefebvre et al., 2007; Horváth et al., 2008; Arhant et al., 2010; Rooney
75 and Cowan, 2011; Diverio et al., 2017). It is therefore likely that child-dog interactions will
76 also effect on the performance and well-being of assistance, therapy and pet dogs. This may
77 be particularly pertinent given children's unpredictable and active mannerisms (Morrongiello
78 et al., 2007), lack of perspective taking skills (Selman, 1980), and reduced awareness of
79 subtle signs of dog aggression (Lakestani et al., 2014; Meints et al., 2014), which may lead to
80 interactions which place greater stress on the dog – and thereby increasing the risk of displays
81 of aggression (Rooney et al., 2009). Indeed, children are at a greater vulnerability for
82 receiving a dog bite than adults (Matthias et al., 2015; Westgarth et al., 2018). Displays of
83 human-directed aggression in dogs can have devastating consequences for the individual,
84 potentially leading to their relinquishment (Salman et al., 2000) and euthanasia (Fatjó et al.,
85 2006; Welsh, 2015) as well contributing to a negative societal attitude towards the species
86 more generally (Arluke et al., 2017). Therefore, not only may some child-dog interactions be
87 unacceptable because of their immediate effect on dog quality-of-life (e.g., in terms of
88 creating physical or emotional discomfort to the dog), but also because of their potential to
89 lead to a breakdown in the relationship.

90 **Aim**

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

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

104 **Methods**

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

108
109 **Participants, interventions and comparators.** Participants for this study were taken
110 from the scientific peer-reviewed literature and included assistance dogs, therapy or pet dogs
111 and children (≤ 17 years) who had contact with the dog(s) in question. The
112 interventions/exposure was stipulated as dogs who had contact with children, in a family,
113 assistance or therapy dog role. Given that this is a scoping review, and the authors were
114 uncertain about the quality and quantity of available literature there was no stipulation set on
115 comparators for this review.

116
117 **Systematic review protocol.** The inclusion criteria for selection of articles were:
118 publication in a peer reviewed journal in English; a study of any design focusing specifically
119 on the effect of children (≤ 17 years) on dog quality of life, including physical, behavioral or
120 social effect (as per our chosen definition of quality of life); assistance dogs, therapy dogs
121 and untrained pet dogs were included. No exclusion was made based on dog or child
122 demographics. Papers were excluded if they did not meet the inclusion criteria, or if they
123 reported a review or meta-analyses of existing data.

124
125 **Search Strategy.** Different combinations (OR / AND) of the search terms relating to the
126 question were used to identify the majority of relevant papers referring to the effect of
127 children on dog quality of life were found (see Table 1). Search terms were decided following
128 expert consultation with established researchers in the field and through evaluation of
129 common terms used in titles and abstracts of papers known to the researchers. At each stage
130 of the review process, a selection of articles were cross-checked by another researcher to
131 ensure agreement on inclusion and exclusion decisions. Full text articles for all papers were

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

134

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

150

151 **Data Analysis.** Given the early stage of enquiry within this field, it was appropriate to
152 map the evidence in this area more broadly rather than conduct meta-analyses (Pham et al.,
153 2014, Peters et al., 2015). Data is reported in tabulated and descriptive form with evaluation
154 of the robustness (i.e. evidence of reliability and validity) of outcome measures, in addition to
155 a synthesis of the literature, in order to provide clinically relevant information associated with
156 child-dog interactions and their effect.

157

158 **Results**

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

161

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

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

172
173 **Synthesised findings.** Details of our data extraction and assessment of the effect of child-
174 dog interactions on dog quality of life are reported in Table 2a, 2b and 2c and elaborated
175 below.

176 177 **Characteristics of the sample**

178 *Dog characteristics.* Only one of the five papers considered the quality of life of pet dogs
179 around children (Hall et al., 2017). The remaining four papers discussed trained dogs which
180 were referred to by the terms; therapy dog (Palestrini et al., 2017; McCullough et al., 2018)
181 animal assisted intervention dog (Marinelli et al., 2009) and service dog (Burrows et al.,
182 2008). All papers reported the number of dogs involved. In general sample sizes were small,
183 varying from a single case study (Palestrini et al., 2017) to 36 dogs (Hall et al., 2017). The
184 youngest dogs included in the studies were 6 months old (Marinelli et al., 2009) and the
185 oldest were 13 years (McCullough et al., 2018), one study did not report dog age (Burrows et
186 al., 2008). All studies reported either dog breeds (Burrows et al., 2008; Marinelli et al., 2009;
187 Palestrini et al., 2017, McCullough et al., 2018), or dog size (Hall et al., 2017). Breeds varied
188 widely, but large breed dogs (e.g., Labradors and retrievers; Burrows et al., 2008, Marinelli et
189 al., 2009; Palestrini et al., 2017; McCullough et al., 2018), were more commonly included
190 than small breed dogs (e.g., dachshund; McCullough et al., 2018). All studies reported dog
191 sex, but two failed to report neuter status (Burrows et al., 2008; McCullough et al., 2018).

192
193 *Child characteristics.* Sample sizes were again relatively small, varying from 11 children
194 (Burrows et al., 2008) to 60 children (McCullough et al., 2018). Two papers reported on
195 children with developmental disorders; autism spectrum disorder and attention deficit
196 hyperactivity disorder (Burrows et al., 2008; Hall et al., 2017). Two papers reported children
197 with specific medical health problems including cancer and those requiring surgical
198 procedures (Palestrini et al., 2017; McCullough et al., 2018). One paper failed to specify the
199 child's specific needs (Marinelli et al., 2009). The youngest children included in the studies

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

203

204 **Methodological considerations**

205 Two papers (Burrows et al., 2008; Hall et al., 2017) adopted a primarily qualitative approach
206 utilising parent-owner interviews. Although only one of these papers reported inter-rater
207 reliability of qualitative coding procedures (Hall et al., 2017), the other paper used researcher
208 observations as well as parent based interviews to substantiate findings, providing a degree of
209 convergent validity (Burrows et al., 2008). Two studies (Hall et al., 2017; Marinelli et al.,
210 2009) used a handler/owner checklist of behaviors. One of these studies provided handler
211 training on how to recognise stress behaviors in dogs (Marinelli et al., 2009). Two studies
212 used an arguably more objective researcher-completed behavioral ethogram to record therapy
213 dog behaviors, both of which reported good inter-rater reliability statistics amongst coders
214 (Palestrini et al., 2017; McCullough et al., 2018), although neither paper reported whether
215 coders were blind to the study aim. Only one paper reported the use of a validated scale to
216 assess dog behavior (McCullough et al., 2018), however in this case the Canine Behavioral
217 Assessment and Research Questionnaire (C-BARQ; Hsu and Serpell, 2003) was used to
218 describe the dog's behavioral characteristics, rather than as a direct assessment of the effect
219 of interacting with children on dog behavior. Two papers reported behavioral ethograms and
220 physiological (salivary cortisol: McCullough et al., 2018; heart rate: Palestrini et al., 2017),
221 assessments of dog well-being, thereby proving an arguably more objective and reliable
222 assessment of the effect of child-dog interactions.

223 It is evident that there is lack of use of appropriate comparators in the available literature.
224 One study compared dog behaviors in the presence of adults and children (Marinelli et al.,
225 2009) and only one study made any sort of comparison (qualitative in this case) of dog
226 behavior in the presence of neuro-typically developing children and children with a neuro-
227 developmental disorder (Hall et al., 2017). In order to draw more robust conclusions on the
228 specific effect of child-dog interactions associated with a therapeutic setting on dog quality of
229 life it is important that comparison is made with a control group (ideally children of a similar
230 age, but without the condition requiring help from the AAI. Pre-post interaction assessments
231 (another important measure of effect from a session) were made in one study (McCullough et
232 al., 2018), but these were not considered in relation to an appropriate comparator group.

233

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

234 One paper (sample size: $n = 1$) reported that child-dog interactions did not significantly
235 correlate with dog stress behaviors (Palestrini et al., 2017). The remaining four papers
236 reported a number of child-dog interactions that were potential sources of stress for both
237 assistance dogs, therapy dogs and pet dogs, as identified through parent/handler (Burrows et
238 al., 2008; Hall et al., 2017) and trained researcher observations (Burrows et al., 2008;
239 McCullough et al., 2018). These inputs can be broadly grouped into three categories of
240 interactions; (i) unprovoked attention from the child, (ii) interactions and environmental
241 predictability, (iii) child games with the dog.
242

243

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

263

264 *Interactions and environmental predictability.* Two papers identified that environmental
265 instability, including lack of a predictable routine erratic and loud noises (Burrows et al.,
266 2008; Hall et al., 2017), particularly from child visitors (Hall et al., 2017) and lack of
267 peaceful time without child interruptions (Burrows et al., 2008; Hall et al., 2017) were a

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

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

284

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

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

290 *Psychological (behavioral) Effect.* One paper did not mention any specific reference to
291 dog behaviors which may indicate the psychological effect associated with child-dog
292 interactions (Marinelli et al., 2009). The remaining four papers highlighted increased
293 observations of oral behaviors displayed by the dog during child-dog interactions in an
294 assistance dog, therapy dog and pet dog role, including; chewing, lip-licking, grooming,
295 yawning and panting (Burrows et al., 2008; Hall et al., 2017; Palestrini et al., 2017;
296 McCullough et al., 2018), all of which may be indicators of heightened stress levels (Beerda
297 et al., 1998a). Two papers reported that dogs showed behaviors indicative of high stress,
298 including; running away, shaking, urinating and defecating (Burrows et al., 2008; Hall et al.,
299 2017), in addition to safety seeking behaviors (such as hiding, going to their safe place, or

300 seeking the parent/handler) when interacting with children (Burrows et al., 2008; Hall et al.,
301 2017). These two studies explored the well-being of dogs living full time with children, with
302 one focussing on trained assistance dogs (Burrows et al., 2008) and the other untrained pet
303 dogs (Hall et al., 2017). Behaviors associated with high stress do not appear to be reported
304 from studies involving relatively shorter, more structured therapy-based interactions with
305 children.

306 *Physical Effect.* One paper did not provide specific mention of the physical effect
307 associated with child-dog interactions (Marinelli et al., 2009). Two studies took direct
308 measures of physiological functioning and did not find any significant effects of interacting
309 with children on dog heart rate (Palestrini et al., 2017) or cortisol levels (McCullough et al.,
310 2018), potentially indicating a lack of physiological distress. However, both of these studies
311 explored the effect of child-dog interactions during structured animal assisted intervention
312 sessions, whereby interactions with the child were relatively short and controlled. In contrast,
313 dogs living in an assistance or pet role within the family home have more prolonged exposure
314 and interactions are much less controlled. Indeed, the two studies which reported (via parent
315 interviews and observations) on dogs living full time with children identified a range of
316 physical health conditions which may be associated with the presence of chronic stress (Mills
317 et al., 2014), including; ear, eye and skin infections (Burrows et al., 2008; Hall et al., 2017).

318 *Social Effect.* Three out of the five papers included in the review referred to the social
319 effect associated with child-dog interactions. Two studies noted that the dog would show
320 distress at separation from the parent when left with the child as indicated by whining,
321 scratching, seeking behavior, and excessive greeting upon reuniting (Burrows et al., 2008,
322 Hall et al., 2017), particularly if the dog was made to sleep in the same room as the child
323 (Burrows et al., 2008), or if the child was creating a stressful situation for the dog (Hall et al.,
324 2017). These studies looked at dogs living full time with children, but similarly a study
325 exploring the effect of children on dogs in a structured AAI setting revealed that the dog
326 chose to interact more with the adult handler than the child, however they showed little
327 evidence of withdrawal behavior from the child (Palestrini et al., 2017). Other evidence also
328 suggested dogs were willing to socialise with the child in both the family home and therapy
329 setting, with reports of the dog being happy to greet the child (Hall et al., 2017).

330

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

333 **Discussion**

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

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

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

363 specific to social functioning. This is likely to be because behavioral signs can be easier to
364 identify as they do not require sophisticated equipment and/or complicated collection
365 techniques, or necessarily expert clinical knowledge associated with some physical indices.
366 However, this also raises a point of concern, since it seems both children and adults can have
367 difficulty recognising signs of stress in their dogs, particularly those associated with low level
368 arousal (Meints et al., 2010; Mariti et al., 2012; Lakestani et al., 2014; Meints et al., 2014;
369 Campbell, 2016), thus whilst behavioral indicators may be the most practical to collect, they
370 may not be the most valid or reliable, especially when they come from owners or those less
371 expert with dogs. Nonetheless, the two studies which used physiological measures reported
372 no meaningful changes to heart rate or cortisol levels associated with child-dog interactions
373 (McCullough et al., 2018; Palestini et al., 2017), which appears to be in contrast with
374 behavioral observations of stress. As such, physiological measures may also not prove
375 reliable as stand-alone measures of dog quality of life, and may be a proxy of immediate
376 arousal rather than general quality of life (Beerda et al., 1998b, Barnett and Hemsworth,
377 1990). Physical health related proxies of stress (e.g., eye, ear and skin infections) were only
378 reported in two studies where the dog lived full-time with the child (Hall et al., 2017;
379 Burrows et al., 2008). Although such issues have been associated with chronic stress (Mills et
380 al., 2014), based on the nature of these studies it is difficult to purely isolate the role of child
381 interactions in creating any prolonged stress which may lead to these conditions, amongst a
382 combination of a number of other contributing factors (e.g., stress from general management
383 practices, or poor owner maintenance/grooming).

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

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

408 Based on the studies included in this review it appears that child-dog interactions can
409 have implications for dog quality of life, however identifying and measuring these poses
410 practical challenges. Indeed, in general there is a clear lack of validated assessment tools to
411 assess the general quality of life of dogs (Spofford et al., 2013), as well as a lack of
412 knowledge for identifying dog behaviors associated with different affective states (Mills,
413 2017; Mariti et al., 2012; Lakestani et al., 2014) not to mention the high costs and practical
414 limitations associated with obtaining physical assessments. However, the identification of
415 practical solutions that help to avoid key triggers associated with dog stress responses within
416 child-dog interactions may help to mitigate the negative effects on dog quality of life. For
417 example, Hall et al (2017) detail nine child-dog interactions, identified through interviews
418 with parents of neuro-typically developing children and those with neuro-developmental
419 disorders, which may pose a threat to dog quality of life (meltdowns and tantrums, having
420 child visitors in the home, the child and dog being together in the car, the child
421 bathing/grooming the dog, the child striking out and tail-pulling, the child playing fancy dress
422 with the dog, the child jumping around near the dog, the child playing with loud and wheeled
423 toys, and the child cuddling and kissing the dog). A number of these interactions were also
424 reported in the studies included in this review paper which involved trained therapy dogs
425 (Burrows et al., 2008; McCullough et al., 2017), highlighting the generality of the potential
426 importance of considering these interactions. It is suggested that further research is conducted
427 to assess the potential relationship between these triggers and pet dog quality of life in order
428 to create effective intervention strategies.

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

451 In conclusion, the review indicates that the following classes of activity are the most
452 overtly recognisable threats to dog quality of life: *unprovoked child attention* (e.g.,
453 accidentally or purposefully rough contact associated with lack of behavioral control or
454 displays of affection), *interaction and environmental unpredictability* (e.g., noise levels
455 associated with meltdowns and tantrums, the importance of recreational activities) and *child*
456 *games* (e.g., ‘dress-up’, wheeled toys). The effects of these may be realised in terms of
457 altered dog behaviors (e.g., displaying stress-related behaviors), physical consequences (e.g.,
458 eye, ear and skin irritations) and social-related behaviors (e.g., separation anxiety from adult-
459 parent). The review has highlighted that there is limited specific scientific literature which
460 investigates the risk of child-dog interactions to dog quality of life. Future research should
461 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.

479

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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

484 *NTD = Neuro-typically developing; **NDD = Neuro-developmental disorder; ¹ ASD = Autism Spectrum Disorder; ² = ADHD = Attention

485 Deficit Hyperactivity Disorder

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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
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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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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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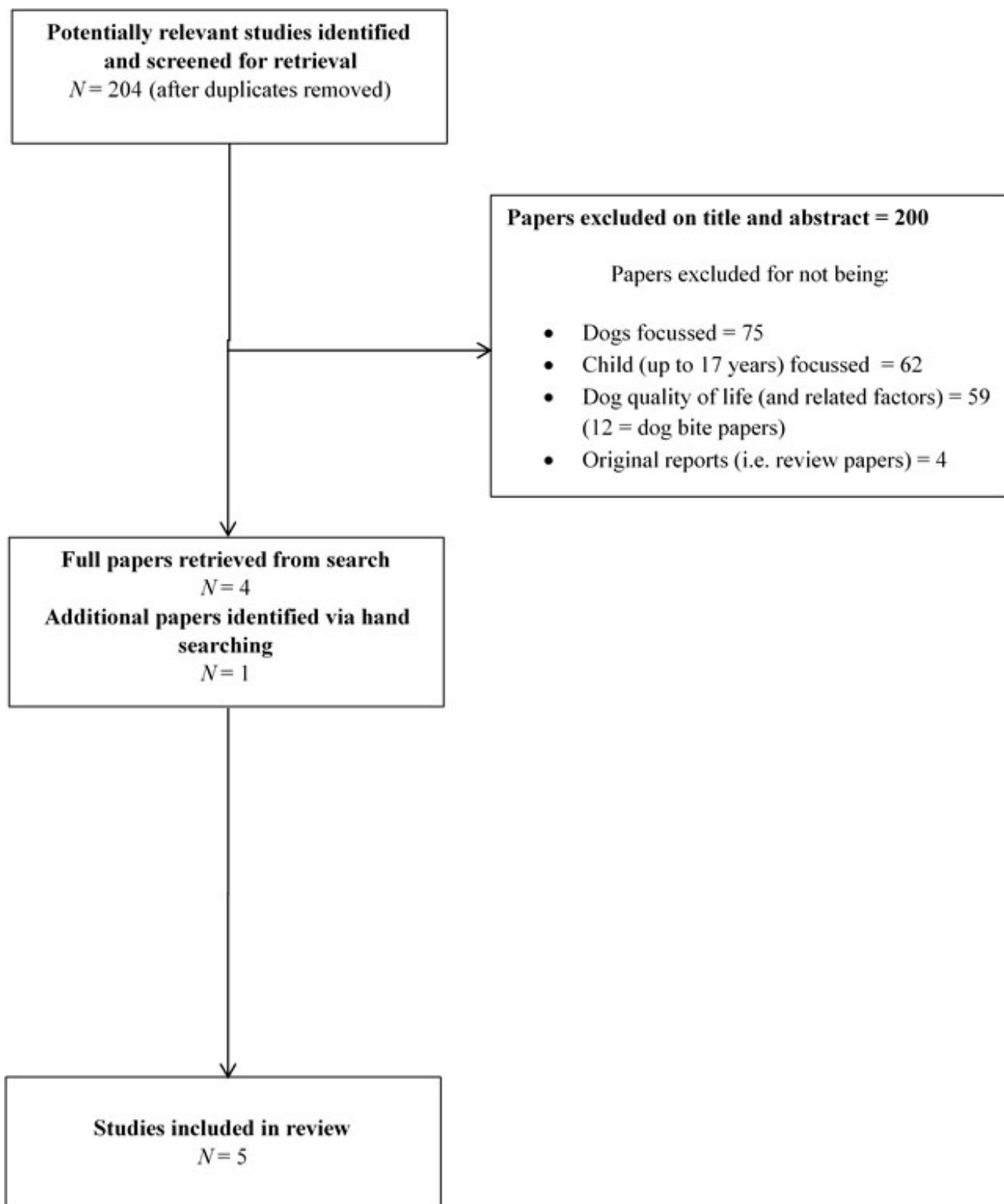
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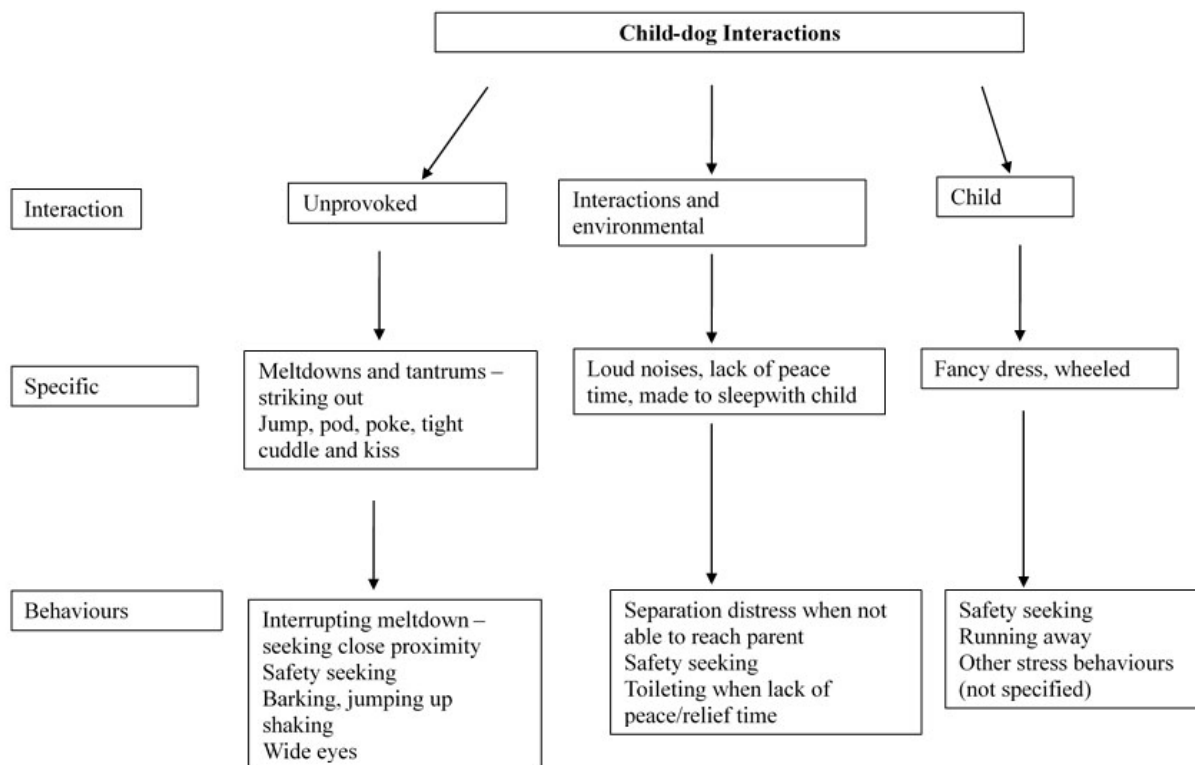
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Highlights

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

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