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Are children and dogs best friends? A scoping review to explore the positive and negative effects of child-dog interactions

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Abstract

Our wellbeing is greatly influenced by our childhood and adolescence, and the relationships that we form during those phases of our development. The human-dog bond started thousands of years ago. The higher prevalence of dog ownership around the world, especially in households including children along with the growing number of people studying dogs most likely explain the growing literature focusing on child-dog interactions. We review the potential effects of child-dog interactions on the physical, mental, and social wellbeing of both species. A scoping search of the SCOPUS database found several hundred documents meeting selection criteria. It allowed us to define the numerous ways in which children and dogs can interact, be it neutral (*e.g.*, sharing a common area), positive (*e.g.*, petting), or negative (*e.g.*, biting). Then, we found evidence for an association between interacting with dogs during childhood and an array of health and mental benefits like stress relief and the development of empathy. Walking a dog and playing with one are perfect physical activity opportunities. Additionally, interacting with a dog can help lower stress and may have a role in the development of empathy. Nonetheless, a number of detrimental outcomes have also been identified in both humans and dogs. Children are the most at-risk population regarding dog bites and dog-borne zoonoses, which may lead to a subsequent fear of dogs or even death. Moreover, pet bereavement is generally inevitable when living with a canine companion and should not be trivialized. In terms of dogs, children sometimes take part in caretaking behaviors toward them which include going on walks. They are opportunities for dogs to relieve themselves outside, but also to exercise and socialize. In contrast, a lack of physical activity can lead to the onset of obesity. Dogs may present greater levels of stress when in the presence of children. Finally, the welfare of assistance, therapy, and free-roaming dogs remains underexplored. Overall, the study of the effects, positive as well as negative, on

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both species still requires further development. We call for more longitudinal studies and hope for cross-cultural research in the future in order to better understand the impact child-dog interactions might have.

Keywords. animal-assisted interventions, child development, dog bites, dog-borne zoonoses, dog ownership, dog welfare, human-animal interactions

1. INTRODUCTION

The distribution of domestic dogs across almost every ecological niche of our planet has been attributed to their ability to directly interact with humans (Miklósi & Topál, 2013). It has been millenia since dogs were domesticated and began interacting with humans (Zhang, Khederzadeh & Li, 2020). Dogs (*Canis familiaris*) descended from the ancestral gray wolf (*Canis lupus*) tens of thousands of years ago, making canines one of the first domesticated taxa (Ostrander *et al.*, 2017). Scientific discovery continues to expose exactly how and where dog domestication occurred. One theory suggests that initially, highly specific behaviors valued by hunter-gatherers such as tracking prey drove the initial evolution of proto-dogs (Ostrander *et al.*, 2017). Subsequently, natural and artificial selection processes have shaped dogs into what we know today as “man’s best friend”. It has been suggested that various features of the species including but not limited to morphology, behavior, and cognition have newly emerged specifically as adaptations to living in social groups with people and to aid communication with humans (Range & Virányi, 2014). For example, domestication has transformed the facial muscle anatomy of dogs to improve communication with humans (Kaminski *et al.*, 2017). A muscle (levator anguli oculi medialis) uniformly found in dogs but not in wolves allows dogs to perform a distinct facial movement called “inner eyebrow raise” which is perceived as particularly attractive by humans (Waller *et al.*,

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2013; Kaminski *et al.*, 2019). In addition, this movement gives dogs paedomorphic features (*i.e.*, retention in the adult of infantile or juvenile characteristics), and both human adults and children prefer dog faces that present these features (Archer & Monton, 2010; Borgi *et al.*, 2014; Borgi & Cirulli, 2016).

The global domestic dog population is estimated to be 900 million (Gompper, 2013), of which 20-30% are considered companion animals, the rest being free-ranging individuals (Hughes & Macdonald, 2013). Culture and context can define if a dog is considered a companion, a divinity, pest, or food (Jackman & Rowan, 2007; Gray & Young, 2011). Companion dogs, or pets, live in or alongside homes, have a given name, and are very often considered as family members (Jackman & Rowan, 2007). Such type of dog ownership is common, with 38% of American, 40% of Australian, 33% of English, and 21% of French households reporting to care for at least one dog (AVMA, 2018; FACCO, 2018; AMA, 2019; PFMA, 2021). Our understanding of companion dogs practices throughout Asian countries is growing, with China, India, South Korea, and Japan reporting 25%, 5%, 20%, and 17% of dog ownership, respectively (GfK, 2016; Minatoya *et al.*, 2019; Cherian, Dugg & Khan, 2020). People also live alongside the many free-roaming dogs, unrestricted animals commonly found in urban and regional areas of Brazil, China, and India for example (Kwok *et al.*, 2016; Tian *et al.*, 2018; Corfmat *et al.*, 2022). With so many people living alongside domestic dogs, scientific investigations of the effects of human-animal interactions relating to dogs are growing.

Children and adolescent development are fundamentally affected by the relationships they form with others (Osher *et al.*, 2020), and the relationship that links humans to dogs is special. Interacting with animal companions, or pets, has become a normal part of growing up for many children (Melson & Fine, 2015). If not at home, children may encounter dogs in the homes of extended family or friends, or school settings as animals are increasingly involved

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in education (Gee, Griffin & McCardle, 2017a). Furthermore, assistance and therapy dogs are helping globally in roles such as alerting epileptic seizures or visiting classrooms to benefit children learning (Brelsford *et al.*, 2017; Correale *et al.*, 2017; Catala *et al.*, 2018), and are receiving wider recognition. Moreover, the COVID-19 pandemic resulted in much greater dog adoption rates and the strict lockdowns in many countries amplifying time shared with dogs as people transitioned to working and learning from home for extended periods (Morgan *et al.*, 2020; Christley *et al.*, 2021). This demonstrates there are many settings in which a child and a dog might interact. Child-dog interactions studies represent a broad area under investigation with research being conducted with varying aims, methodologies, and measures. This has resulted in somewhat contradictory results between studies, with human-dog interactions being classed as beneficial, neutral or non-existent, and sometimes harmful (Herzog, 2011; Friedman & Krause-Parello, 2018; Wells, 2019). Additionally, few studies have addressed the impact of such interactions with people to dogs (Hall, Finka & Mills, 2019; Glenk & Foltin, 2021).

The purpose of this review is to present an overview of the scientific research on child-dog interactions. We acknowledge that reviews of the effects of child-dog interactions already exist, but these were focused on one type of interaction in particular (*e.g.*, walking or biting). Herein, we aim to compile the results of various studies on both positive and negative interactions for the two species in order to consider the possible effects of such interactions on the quality of life. To do so, we take into account the three domains (*i.e.*, physical, mental, and social) which are considered as fundamental dimensions of the quality of life (WHO, 1995). We have opted for a scoping review approach as it is designed to answer broad questions (Munn *et al.*, 2018). The specific goals are to (a) describe the variety of child-dog interactions, and (b) summarize the reported outcomes of such interactions on both species. Finally, we close the review by pointing out the current gaps and by providing some

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recommendations for future research to help advance the field of child-dog interactions. The results of this scoping review are likely to benefit people in and outside of the scientific community. It is of relevance for pediatricians, psychologists, and veterinarians working with dog-owning people. It can also be used by scientists studying dogs and human-animal interactions to plan future research that will help advance the field. Moreover, it is an opportunity for current and prospective dog owners to extend their knowledge of the various outcomes possibly derived from child-dog interactions, hopefully encouraging future positive interactions.

2. METHODS

Protocol

The PRISMA Guidelines were used to perform this scoping review (Tricco *et al.*, 2018). To identify potentially relevant documents, the SCOPUS electronic database was searched. The keywords used to conduct the search were: 'Dog*', 'Child*', 'Adolescen*', 'Child-dog', 'Dog-child', 'Education*', and 'Bite*' (Table 1). The following inclusion criteria were used to select relevant documents, including articles, book chapters, conference papers and reviews: (a) publication after 1980, ranging from January 1980 to April 2022, (b) publication in English language, (c) focus on the effect of dog(s) on children (aged ≤17 years) or conversely, the effect of children on dogs. Physical, mental, and social effects were considered where described. Pet dogs, assistance and therapy dogs as well as free-roaming individuals were included. Information was extracted from each included study to achieve the aim of this scoping review. To achieve the first aim, *i.e.*, describe the kinds of child-dog interactions, data items included child characteristics, dog characteristics, behaviors involved,

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and contexts. To achieve the second aim, *i.e.*, summarize study outcomes, data items included the results of each study.

Table 1. Search strategy to identify documents for inclusion using the SCOPUS database. Key criteria included publication in English language between January 1980 and April 2022. Scientific articles, book chapters, conference papers, and reviews were considered. Additional documents were selected from the references following the same inclusion criteria.

Query strings	Number of documents found	Number of documents included after checking for key criteria	Number of total documents after removing duplicates	Number of additional documents retrieved from the references
KEY (dog* AND child* OR adolescen*) AND TITLE (dog* AND child* OR adolescen*)	441	297	313	80
KEY (dog-child OR child-dog) OR TITLE (dog-child OR child-dog)	35	23		
KEY (dog* AND education*) AND TITLE (dog* AND education*)	38	17		
KEY (dog* AND bite* AND child* OR adolescen*) AND TITLE (dog* AND bite* AND child* OR adolescen*)	133	90		
TOTAL	647	427		393

Synthesis of results

Our preliminary search resulted in 647 documents (Table 1). We screened results for relevance by reading abstracts and applying the criteria detailed in the protocol above. A total of 313 documents were identified after checking for key criteria and removing duplicates (Table 1). We then inspected the references of these papers for additional studies not yielded by the search, identifying an additional 80 sources (Table 1). In the end, a diverse sample of 393 documents was selected for the final review, which included studies with a variety of

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designs, participant ages, types of intervention, and outcome measures. We have opted for focusing on a descriptive and qualitative synthesis of the results rather than a meta-analysis, especially considering the heterogeneity across studies.

3. HOW CHILDREN AND DOGS INTERACT WITH EACH OTHER

Families may include a dog before the arrival of a baby in the home, or families including a child may acquire a canine companion during the infant's childhood. The likelihood of owning a dog increases in households with children (Downes, Canty & More, 2009; Holland, 2019). Moreover, the age of the children appears as an important factor affecting dog ownership. Having a companion dog is more reported in families with children between six and 10 years old while dogs are less likely to be owned by families with children in other age groups (Westgarth *et al.*, 2007; Murray *et al.*, 2010). Limited information is known from other parts of the world where less research has been undertaken. For example, in Seoul, South Korea, dogs are mostly owned by single, educated, high-income men, possibly due to a lower proportion of families with children in their sample population than in studies from comparable countries such as Great Britain (Westgarth *et al.*, 2007; Kim *et al.*, 2020).

At home, children and adolescents talk to their dogs, share secrets with them and seek comfort from them when sad (McNicholas & Collis, 2001; Kurdek, 2008; Hawkins, Williams & Scottish SPCA, 2017; Hull, Guarneri-White & Jensen-Campbell, 2022). They may partake in caretaking behaviors toward their dog, as a formal responsibility or by choice (Muldoon, Williams & Lawrence, 2015; Hall *et al.*, 2016; Kerry-Moran & Barker, 2018). Such behaviors include but are not limited to feeding, giving water, and grooming. The impacts of co-sleeping with pets (*i.e.*, action of sharing a bed/bedroom) has been investigated and no

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differences have been found regarding sleep dimensions (*e.g.*, quality, duration) between children who co-sleep with their dogs and those who do not (Rosano *et al.*, 2021; Rowe *et al.*, 2021). Dogs need to be taken outside for different reasons, such as toileting, exercise, and to socialize with people or other dogs. Children and adolescents can take part in dog walking with or without the rest of their family (Wenden *et al.*, 2021; Coci, Saunders & Christian, 2022; Christian *et al.*, 2022). Additionally, dog training can play a major role in the good functioning of human and dog cohabitation and children sometimes participate. Children and dogs can also be excellent playmates (Boisvert & Harrell, 2021). However, play can become an unpleasant interaction for dogs when children are too rough or want to play special games such as "dressup" (Hall, Finka & Mills, 2019). Such interactions could lead to the dog biting in retaliation (Messam *et al.*, 2018; Owczarczak-Garstecka *et al.*, 2018). Children cruelty toward animal also exists and should be taken very seriously (McDonald *et al.*, 2018; Hawkins, Scottish SPCA & Williams, 2020), especially in light of the literature linking animal cruelty and other forms of violence (*e.g.*, Gullone & Robertson, 2008).

The purpose of animal-assisted interventions is to enhance human quality of life with animals as therapeutic adjuncts. Due to their ease of training and availability, dogs are the most commonly used animals (Glenk & Foltin, 2021). Animal-assisted education has become more and more common in numerous nations, particularly in Australia and the United States (Gee, Griffin & McCardle, 2017b; Grové *et al.*, 2021), which has given rise to studies investigating the impact of "the presence of a dog in the classroom" (Gee, Fine & Schuck, 2015; Brelsford *et al.*, 2017). Animal-assisted education can take the form of dogs actually assisting during children education, for example when a child has the opportunity to read to a dog (Hall, Gee & Mills, 2016; Lenihan *et al.*, 2016; Noble & Holt, 2018; Henderson *et al.*, 2020). Japanese programs are different because they rather take the form of "education through assisting animals", meaning that pupils are taught animal-rearing (Nakajima, 2017).

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In medical settings, it is sometimes possible to interact with a dog prior to, during, or after a medical exam as part of programs where dogs regularly visit hospitals and clinics (Chur-Hansen *et al.*, 2014; Vagnoli *et al.*, 2015; Vincent, Heima & Farkas, 2020). In those studies, dogs are not just present as static ornaments in the room. Children are encouraged to interact with the animals, here classified as therapy-dogs, by petting them or engaging with them, for example, by asking them to perform a trick in exchange of a food reward (Gee, Harris & Johnson, 2007; Gee, Crist & Carr, 2010; Gee *et al.*, 2012). Dogs classified as assistance-dogs are trained to assist people in their daily lives. Nowadays, such dogs can be found assisting people with epilepsy to know when seizures are imminent (Catala *et al.*, 2018) and children on the autistic spectrum to reduce symptom severity and repetitive behaviors, as well as improve motor skills and communication (Wright *et al.*, 2015; O'Haire, 2017; Ben-Itzchak & Zachor, 2021; Nieforth, Schwichtenberg & O'Haire, 2021).

The stray dogs that can be found in many countries are those that live unrestricted lives and do not depend on any specific human for food (Jackman & Rowan, 2007; Rahaman, 2017). Partly due to the difficulty in finding a universal definition, there is considerable variation between countries regarding the percentage of stray dogs. These dogs are often blamed for disease spread and attacks, which may explain why they are sometimes harassed or killed inhumanely using poison (Cleaveland *et al.*, 2006; Jackman & Rowan, 2007).

In this section, we outline many of the ways and settings in which dogs and children can interact. To better understand the importance of these interactions to both children and dogs, we describe the valence of the interactions, considering physical, mental, and social effects.

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4. BENEFICIAL EFFECTS OF CHILD-DOG INTERACTIONS FOR CHILDREN

4.1. PHYSICAL BENEFITS

Regular physical activity is vital for the development and growth of children (WHO, 2019), with strong evidence supporting numerous health benefits for children and adolescents (Poitras *et al.*, 2016). Conversely, sedentary behaviors have been identified as a major public health concern linked to poor health outcomes (Carson *et al.*, 2016). Strict lockdowns and similar COVID-19-related policies are believed to have exacerbated sedentary behaviors because of the transition to working and learning from home and advice to "stay home" or indoors (Bates *et al.*, 2020). For children and adolescents, living with a dog increases the likelihood of getting the recommended level of weekly physical activity either through dog walking or through active play with a dog (Christian *et al.*, 2013; Engelberg *et al.*, 2015; Martin *et al.*, 2015). Several studies have argued that the amount of physical activity in those children is strongly associated with their level of attachment to their dogs (Westgarth *et al.*, 2013; Gadomski *et al.*, 2017; Linder *et al.*, 2017).

Walking is one of the many activities people and dogs can share. Children that live with a dog spend more time walking and are more physically active (Salmon *et al.*, 2010; Christian *et al.*, 2013; Martin *et al.*, 2015). Children who walk their dog are more likely to be independently mobile (*i.e.*, walking or cycling without adult supervision) than those who do not (Christian *et al.*, 2014, 2022). Moreover, therapy-dog walking can also significantly increase physical activity in children with special needs such as orthopedic limitations (Vitztum, Kelly & Cheng, 2016). However, not all children owning a dog actually partake in dog walking. In Australia, 41% to 45% of children who live with a dog do not actually walk it (Salmon *et al.*, 2010; Christian *et al.*, 2014) while 43% of English dog-owning children are reported to not participate in routine dog walking (Westgarth *et al.*, 2013). Hence, even

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though children who live with a dog seem to present higher levels of physical activity on average (Engelberg *et al.*, 2015; Christian *et al.*, 2022), it is not the case for every child and may be through other activities than dog walking.

Playing is an activity that children value and need and children believe that dogs share their love of play (Muldoon, Williams & Lawrence, 2015; Boisvert & Harrell, 2021). Children consider their dogs as special friends and playmates (Melson, 1990; Muldoon, Williams & Lawrence, 2015; Muldoon *et al.*, 2019). They enjoy engaging in many sorts of play with their companions such as running around with the animal and engaging in fetch activities for example (Boisvert & Harrell, 2021). Living with a dog also increases children's time spent in outdoor play which is associated with higher levels of independent mobility (Christian *et al.*, 2014, 2022). However, the prevalence of pet play appears negatively associated with age. Indeed, children in primary school are more likely to play with their dog compared to children in secondary school (Martin *et al.*, 2015). This could be due to the general trend of physical activity decline during adolescence (Dumith *et al.*, 2011). While playing is an enjoyable activity for both children and dogs, it can also lead to accidents and injuries. Hence, experts recommend that dog-child interactions should always be supervised so as to avoid mishaps (Rezac, Rezac & Slama, 2015; Jakeman *et al.*, 2020).

Given children who live with a dog demonstrate a higher likelihood of achieving the recommended levels of physical activity (Christian *et al.*, 2013), it is worth considering if dogs may impact childhood obesity. Dogs have the potential to motivate obese children for physical activity thanks to the provision of a surrogate support network; this could trigger implicit motives which enhance motivation for activity (Wohlfarth *et al.*, 2013; Linder *et al.*, 2017). Although other studies agree on the potentially beneficial effect of dogs, results regarding dog interactions and children's weight status are inconsistent, likely reflecting the complexity of factors which relate to childhood obesity (Timperio *et al.*, 2008; Westgarth *et*

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al., 2012, 2017; Christian *et al.*, 2013; Gadomski *et al.*, 2017). One explanation could also be that interacting with a dog might not be vigorous or sustained enough as physical activity to significantly affect childhood weight status (Westgarth *et al.*, 2017).

During potentially stressful tasks such as medical examinations, knowledge tests, or interviews, the presence of a friendly dog (familiar or not) can impact human physiology by helping lower children's heart rate and blood pressure (Friedmann *et al.*, 1983; Vormbrock & Grossberg, 1988; Nagengast *et al.*, 1997; Krause-Parello *et al.*, 2018); although not all studies agree with that conclusion (Grossberg, Alf & Vormbrock, 1988; Schretzmayer, Kotrschal & Beetz, 2017; Kerns *et al.*, 2018). Such results may be derived from and/or enhanced by physical contact such as petting a dog, which might affect sympathetic arousal (Beetz *et al.*, 2011).

Research on the association between dog exposure and the incidence of allergies in children has provided mixed results (Apfelbacher *et al.*, 2016). Some findings suggest that living with a dog may increase exposure to endotoxins, which can enhance children's immune systems and reduce the likelihood of becoming sensitized, therefore protecting them from the development of allergies (Campo *et al.*, 2006; Lødrup Carlsen *et al.*, 2012). Epstein *et al.* (2011) concluded that living with a dog significantly reduced the risk for eczema in young children. Conversely, other research concluded that living with a dog was associated with higher incidence of pet allergy and asthma in children (Collin *et al.*, 2015; Pyrhönen, Näyhä & Läärä, 2015; Luo *et al.*, 2018; Mendy *et al.*, 2018). These results will be discussed later in this review (see 5.2.).

4.2. MENTAL AND SOCIAL BENEFITS

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For children and adolescents, living with a dog has been associated with a decreased likelihood of anxiety and stress (Covert *et al.*, 1985; Gadomski *et al.*, 2015). Children aged 7-8 years see dogs as useful protectors and supporters in scary situations (McNicholas & Collis, 2001). As children grow, their use of parental support for stress coping diminishes and they partially replace it with other social support figures, which may include pets (Kertes *et al.*, 2017). Dogs seem to be able to provide a "social buffer" via neurochemical responses, in particular by reducing the levels of plasma cortisol (Beetz *et al.*, 2012), thus reducing children and adolescents anxiety, specifically separation and social anxiety (Gadomski *et al.*, 2015; Wright *et al.*, 2015). Adolescents living with a dog reported lower feelings of loneliness, a precursor for anxiety, depression and low self-esteem (Black, 2012). Scientists argue that the support and benefits in stress reduction derived from dogs is strongly correlated with the time spent in physical contact with them: the more time spent stroking a dog, the more apparent and longer-lasting the benefits (Beetz *et al.*, 2012).

Consistent with studies examining human adults, pets facilitate social interactions between children (Christian *et al.*, 2020). Children interacting with dogs tend to have increased confidence and decreased fear of social rejection (Purewal *et al.*, 2017). Child-dog interactions also reduce the incidence of aggressive behaviors from at-risk students and increase positive social behaviors and empathy (Gee, Griffin & McCardle, 2017a). Thereby, children and students living with dogs or with pets in general can be considered as better socially integrated, with wider social networks, and more popular with their classmates (Beetz *et al.*, 2012). Dogs may protect children from developing peer relationship problems, emotional symptoms, and deficits in prosocial behaviors (*e.g.*, sharing, helping, and cooperating) (Christian *et al.*, 2020). It may be that interacting with dogs offers opportunities for children to learn about social concepts through mimicking the interactions that they would have with other humans (Christian *et al.*, 2020). Additionally, the "stay-at-home" orders as

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well as the social distancing measures that came with the COVID-19 restrictions have brought challenges to many. Studies from all over the world agree that during the lockdowns, dogs helped prevent loneliness in adults and children (Morgan *et al.*, 2020; Young *et al.*, 2020; Bussolari *et al.*, 2021; Martin *et al.*, 2021; Oliva & Johnston, 2021; Lee, Song & Lee, 2022). Before the pandemic, the positive effect of dogs against loneliness for children was already being highlighted (Rew, 2000; Black, 2012; Purewal *et al.*, 2017).

Children who live with a dog may display better development of empathy and emotional wellbeing (Vidović, Štetić & Bratko, 1999; Svensson, 2014). Conveying one's emotions is a key aspect of communication, and the ownership of pets in toddlerhood may promote a child's ability to express their emotions (Sato *et al.*, 2019). Because dogs are seen as non-judgmental partners to whom they can confide in (Kerns *et al.*, 2018; Gee *et al.*, 2021), interacting with a dog can show to children that they are allowed to express their emotions. Child-dog interactions in the school setting have been linked to reduced aggression in at-risk students and increased positive social behaviors and empathy (Hergovich *et al.*, 2002; Gee, Griffin & McCardle, 2017a). Children as young as seven years old who share their home with dogs can demonstrate extensive knowledge about their needs, although they sometimes lack the confidence to share their knowledge (Muldoon, Williams & Lawrence, 2016). Interestingly, an emotional connection seems to be a necessary prerequisite to the recognition of needs (Muldoon, Williams & Lawrence, 2016). Moreover, children from these households were significantly less accepting of animal cruelty (Hawkins, Scottish SPCA & Williams, 2020). These studies show that dogs can be important to the development of empathy in children, also relating to childhood and adolescents' regulation and expression of emotions and appropriate behaviors in social settings, such as schools. Empathy is recognized as an important component trait underlying our duty of care, or responsibility, toward other people and animals.

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Taking care of a dog, taking it for walks, feeding it, and playing with it can promote children certain social values and skills, for example a sense of responsibility for the welfare of others (Muldoon, Williams & Lawrence, 2016). Parents often report acquiring a dog with the goal of teaching their children responsibility (Melson & Fine, 2015; Jalongo & Ross, 2018); the benefits of caring for animals are viewed positively by parents (Covert *et al.*, 1985). We believe it important to clarify the difference between "caring about" and "caring for". Despite the fact that dogs are among children's favorite animals (Borgi & Cirulli, 2015), thus many children genuinely care about them, it does not always result in direct caretaking behaviors. For example, pet care is not routinely performed by pre-adolescents (Davis, 1987). For different reasons, children may not specifically interact with their dogs apart from playing with them and joining in on family walks. It may be by choice from the child, or because they rely on their parents (most often mothers) to take care of their companions (Davis, 1987; Muldoon, Williams & Lawrence, 2015). However, some children report that their parents will not allow them to directly care for the family dog or interact with them in ways they would like (Muldoon, Williams & Lawrence, 2015, 2016). Covert *et al.* (1985) showed that adolescents who took care of animals including dogs reported gaining responsibility but their study did not examine the degree of involvement in caretaking behaviors. Moreover, gender may play a role in task distribution with girls more often assuming the role of the caregiver for example (Muldoon, Williams & Lawrence, 2015). Research on the effects of gender in child-dog interactions should be carried out in more countries in order to allow generalization. Nonetheless, when possible, interacting directly to care for dogs may facilitate the acquisition of certain habits that could contribute greatly to skills both at home and at school such as autonomy, self-reliance, and empathy (Vidović, Štetić & Bratko, 1999; Muldoon, Williams & Lawrence, 2016).

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Dogs can be beneficial to educational outcomes for young people. For children four to five years of age, living with a dog may aid to facilitate their learning and development (Svensson, 2014). Children believe that animals, especially dogs, give them their full attention which can increase their sense of importance, satisfaction in learning, and their motivation to learn more (Svensson, 2014). Living with dogs during childhood may diminish the risk of developmental delay in the communication and gross motor domains (Minatoya *et al.*, 2019). In schools, dogs create an enjoyable atmosphere which has the potential to improve children's adherence to instructions and to affect pupils engagement, motivation and self-efficacy (Beetz, 2013; Gee, Griffin & McCardle, 2017a). Weekly visits from dogs can improve classroom attitudes toward school attendance and learning (Beetz, 2013). Evidence suggests that dog-assisted reading programs may have a beneficial effect on a number of behavioral processes, all of which can contribute to a positive effect on the environment in which reading is practiced, leading to enhanced reading efficiency (Hall, Gee & Mills, 2016). However, a review by Hall *et al.* (2016) pointed out the low quality of the evidence base in many studies looking at the effects of dog-assisted reading programs. The growing attention being given to such programs should enable future studies to yield bigger sample sizes as more children may get access to said programs. The peer-review process is a fundamental aspect of scientific publishing that should be favored.

It appears that interacting with a dog, either at home or at school, is generally beneficial for children and teenagers' development when looking at their cognition, socialization, emotions, behaviors, and education (Purewal *et al.*, 2017). Thus, the potential of dogs to influence even one of these aspects could impact all the others, possibly for the best.

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5. RISK OR DETRIMENTAL EFFECTS OF CHILD-DOG INTERACTIONS FOR CHILDREN

5.1. DOG BITES

Dog bite injuries are a world-wide problem and every year, thousands of cases of dog bites in children are recorded (*e.g.*, Australia, Chiam *et al.*, 2014; Bhutan, Tenzin *et al.*, 2011; Canada, Morzycki, Simpson & Williams, 2019; Gouin *et al.*, 2021; Chile, Barrios *et al.*, 2021; China, Shen *et al.*, 2014; Israel, Cohen-Manheim *et al.*, 2018; Italy, Zangari *et al.*, 2021; Nigeria, Ogundare *et al.*, 2017; Hassan *et al.*, 2022; South Africa, Weyer *et al.*, 2020; UK, Westgarth, Brooke & Christley, 2018; USA Patterson *et al.*, 2022). Furthermore, those numbers are most likely not representative of the reality as many incidents go unreported (Beck & Jones, 1985). While the majority of reported accidents involve family or neighbor companion dogs biting children (Bernardo *et al.*, 2002; Park *et al.*, 2019), free-roaming dogs can also present a threat in some countries (Georges & Adesiyun, 2008; Tenzin *et al.*, 2011; Mustiana *et al.*, 2015).

Dog bite accidents are generally attributed to the ignorance of indicators of early discomfort in dog behavior, such as lip licking or head turning away (Bradshaw & Rooney, 2016; Mariti *et al.*, 2017). This can lead to dogs escalating their behavior when feeling threatened, consequently increasing the risks of growling and bites (Owczarczak-Garstecka *et al.*, 2018). Some dogs may skip early behavior signals of discomfort (for example, if acutely hurt) depending on the situation, context and history of that individual dog. For this reason, dogs can be unpredictable. Dogs have strong jaws and teeth designed for tearing and crushing (De Munnynck & Van de Voorde, 2002), making them capable of hurting and even killing people. There is a widespread lack of understanding and knowledge of safety practices for dog-child interactions among owners (Meints, Brelsford & De Keuster, 2018), which can

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contribute to the incidence of children being bitten by dogs. In adults, dog bites most commonly involve the extremities (*e.g.*, hands) (Overall & Love, 2001), but because of their small size, children are more prone to bites to the head and neck (Oginni *et al.*, 2002; Eppley & Schleich, 2013; Cavalcanti *et al.*, 2017; Hurst *et al.*, 2020). Such events can understandably lead to children developing a subsequent fear of dogs, life-threatening medical conditions, or psychological consequences like Post-Traumatic Stress Disorder (Peters *et al.*, 2004; Ji *et al.*, 2010). Sadly, in some cases, severe dog bites can even result in death (Cataldi, Yamout & Glick, 2011; Mora *et al.*, 2018).

Children, especially toddlers, are capable of unpredictable behaviors and can be prone to risk-taking (Davis *et al.*, 2012). Most dog bites happen when a child is left alone with a dog without adult supervision (Schalamon *et al.*, 2006). Boys seem at a higher risk of being bitten than girls (Schalamon *et al.*, 2006; Dwyer, Douglas & van As, 2007; Messam *et al.*, 2018; Zangari *et al.*, 2021). The nature of human-dog interactions may differ based on gender and therefore play an etiological role in the differences of dog bite frequency between males and females (Overall & Love, 2001). Indeed, gender differences in owner-dog interactions have been highlighted (*e.g.*, verbal communication: Prato-Previde, Fallani & Valsecchi, 2006; caring behavior: Muldoon, Williams & Lawrence, 2015; Hawkins, Williams & Scottish SPCA, 2017). Moreover, it has been determined that children younger than five are at the highest risk for severe dog bites and those children are most often bitten in their own home by the family dog (Bernardo *et al.*, 2002). This has resulted in strong recommendations for child-interactions to always be supervised by adults, or for dogs and young children to be physically separated, in order to prevent injuries and deaths to children (Messam *et al.*, 2018; Meints, Brelsford & De Keuster, 2018).

Biting incidents are influenced by a variety of factors. First, there are risk factors associated with dog aggressiveness such as a previous history of aggressive behavior,

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sexually intact males, and purebred dogs (Shuler *et al.*, 2008; Casey *et al.*, 2014). However, the cause of dog bites is often attributed to humans rather than dogs. The most common reasons for a bite to occur are resource guarding and pain-inducing interactions (Reisner, Shofer & Nance, 2007). Up to 86% of accidents at home are triggered by child-initiated interactions such as approaching the dog while eating or surprising it while sleeping (Kahn, Bauche & Lamoureux, 2003). The safety of young children mainly relies on adequate observation through adult supervision, their understanding of dog behavior, and anticipatory guidance of the adults around them (Meints, Brelsford & De Keuster, 2018). Yet, it is sometimes parents who demonstrate risky reactions and even encourage their children to interact with dogs despite knowing very little about the animal's safety or disposition (Morrongiello *et al.*, 2013). For example, posing of babies, toddlers, and young children on or inappropriately close to dogs for photographs. Hence, it is crucial for parents to realize that a safe cohabitation is based on mutual understanding of interspecific signaling, social gestures, and interactions.

Dogs have been shown to be good at interpreting human signaling, they are quite sensitive to our attentional state (Kaminski *et al.*, 2017). People, on the other hand, do not seem to share the same capacity to read dog visual signaling (Borgi & Cirulli, 2016; Jalongo, 2018; Csoltova & Mehinagic, 2020). Although aggression is generally the most readily recognized expression (Lakestani, Donaldson & Waran, 2014), children often misinterpret aggression in the facial expression of dogs (*i.e.*, baring of teeth, Bradshaw & Rooney, 2016) as happy and smiling (Meints, Racca & Hickey, 2010; Meints, Brelsford & De Keuster, 2018) with dangerous consequences. Some adults have also been noted to interpret dog behavior in this way (Demirbas *et al.*, 2016). Because of their paedomorphic, or baby-like, features (Waller *et al.*, 2013; Kaminski *et al.*, 2019), dog facial configurations are often

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perceived as cute, which may result in humans giving a positive appraisal when interpreting canine behavior (Borgi *et al.*, 2014; Borgi & Cirulli, 2016).

Children as well as adults regularly do not notice dog stress signaling or misinterpret dog attempts to signal their distress (Meints, Brelsford & De Keuster, 2018). What is even more disturbing is that even when children do recognize a fearful dog, many are still inclined to approach it which demonstrates a lack of understanding of how to behave appropriately around dogs (Aldridge & Rose, 2019). However, adults are able to recognize and classify dog-barking situations (Pongrácz *et al.*, 2005; Silva *et al.*, 2021) as well as dog growls (Faragó *et al.*, 2017). Children also show capacity to understand basic inner states of dogs when listening to acoustic signals from a young age, with older children able to classify barks with superior accuracy (Pongrácz *et al.*, 2011; Eretová *et al.*, 2020).

There has been a surge in the number of dog bite cases in children during the COVID-19 pandemic (*e.g.*, three-fold increase in an American hospital, Dixon & Mistry, 2020; 69% increase in an Italian hospital, Parente *et al.*, 2021; 78% increase for boys and 66% increase for girls in a British hospital, Tulloch *et al.*, 2021). Because of the “stay-at-home” orders put in place around the world, dog exposure increased for children living with dogs, representing more time together and subsequently more opportunities for dog bites to occur (Christley *et al.*, 2021). Dixon and Mistry (2020) offered three main contributing factors to this rise in dog bites: 1) increased child-dog exposure, similar to summer months when the highest number of dog bites are reported annually, 2) increased level of dog stress, and 3) decreased level of adult supervision. All studies, either pre- or during the pandemic, come to the same conclusion: public communication is needed if not urgent. It is possible to prevent these avoidable incidents.

There are two main ways to prevent dog bites, namely educating people or modifying the environment, for example by installing fencing barriers within the home to ensure

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physical separation between dogs and children (Shen *et al.*, 2016). A sterilization program in India led to a decrease of the number of dog-bite cases, possibly by reducing the maternal protective behavior of street dogs, as well as reducing the total number of roaming dogs (Reece, Chawla & Hiby, 2013). Furthermore, different educational interventions have emerged over the years, from books to websites (Schwebel *et al.*, 2016; Jakeman *et al.*, 2020). Bite prevention programs are being used in many countries, targeting both children and adults, and present promising results with a reduction in the prevalence of dog bites and/or a decrease in injury severity (Isparta *et al.*, 2021; Kienesberger *et al.*, 2022).

Different types of education programs designed to decrease the incidence of dog bites exist. With the help of an accredited handler and their dog, introducing primary children for 30 minutes to the "do's and don'ts" of how to behave around dogs increased precautionary behavior (Chapman, 2000). Training children and adults to recognize dog signaling behavior using pictures or videos can increase accuracy in their interpretations (Wilson, Dwyer & Bennett, 2003; Lakestani & Donaldson, 2015; Meints, Brelsford & De Keuster, 2018), while presenting children with testimonials of actual dog-bite experiences from adults increased child safety knowledge and lowered their risk-taking around dogs (Shen, Pang & Schwebel, 2016). It is very important to educate adults as well as children, given the high proportion of bites that occur when children are still too young to be taught (Ogi & Colossi, 2016; Fein *et al.*, 2019). The benefits of teaching people how to understand dogs extend beyond the associated decrease in dog bites; education programs can enhance the probability of future positive child-dog interactions.

5.2. ZOONOTIC INFECTIONS, ASTHMA, AND ALLERGIES

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Dogs are a major reservoir of various zoonotic diseases (Ghasemzadeh & Namazi, 2015; Pathak & Kaphle, 2019). The numerous ways humans and dogs can interact, be it neutral (*e.g.*, sharing a common area), positive (*e.g.*, petting), or negative (*e.g.*, biting incident), can represent opportunities for diseases to be transmitted between both species. At the beginning of the 21st century, over 60 zoonotic infections transmissible to people by dogs had been identified (Macpherson, Meslin & Wandeler, 2012). With the COVID-19 crisis, public interest in diseases transmissible by animals, including those we live with as companions like dogs, has grown anew, as research on the role of pets in the transmission of the virus can attest (Bosco-Lauth *et al.*, 2020; Shi *et al.*, 2020; Dróżdż *et al.*, 2021).

The proportion of dogs carrying human pathogens is very substantial (Baxter & Leck, 1984) and infectious diseases that develop in dogs can have a high zoonotic significance and may transmit to humans (Pathak & Kaphle, 2019; Overgaauw *et al.*, 2020). One example is the high prevalence of rabies such as in Nigeria and Tanzania (Mshelbwala *et al.*, 2021; Sikana *et al.*, 2021), despite the existence of a vaccine for both people and dogs (Ghasemzadeh & Namazi, 2015). To this day, several thousand people die each year (estimated at 59,000 annually, Hampson *et al.*, 2015) due to rabies, and up to 99% of these deaths are attributed to the transmission of the virus through dog-bites (WHO, 2021). This disease particularly affects children, especially in poor communities (WHO, 2013). In Bangladesh for example, most of the victims are children below 15 years old living in lower socio-economic rural communities (Hossain *et al.*, 2012). This is attributed to a lack of access to the vaccine and life-saving treatment (*i.e.*, post-exposure prophylaxis) for economic and/or availability reasons, as well as a lack of knowledge about the disease (Knobel *et al.*, 2005). Numerous dog rabies' prevention and control programs exist (*e.g.*, China: Miao *et al.*, 2021; India: Gibson *et al.*, 2022; Namibia: Athingo *et al.*, 2020; Nigeria: Mshelbwala *et al.*, 2021; Philippines: Amparo *et al.*, 2019), which aim to eradicate the disease.

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Fortunately, not all dog-borne zoonoses have the capacity to be lethal. For example, a common tapeworm (*Dipylidium caninum*) of dogs and cats can occasionally be found in humans, especially in children, and causes pruritus in the infected host (Pathak & Kaphle, 2019). Dog transmitted infections often go unnoticed (Macpherson, 2005). Those diseases can be transmitted by simple contact with the infected dogs (petting, hugging), or by infected urine or feces, saliva, or aerosols (Pathak & Kaphle, 2019). Children, especially toddlers, are prone to geophagia (eating soil) and a positive association between this practice and the prevalence of toxocarosis (parasitic disease acquired by ingesting infective eggs) has been found in Polish children (Kroten *et al.*, 2018). As a consequence, children should be protected against such preventable conditions.

Pet ownership in families with children has also attracted considerable research attention due to its potential relationship in the development of asthma and allergies. Growing up with a pet corresponds to an early-life environmental exposure that may impact the development of respiratory conditions such as asthma and allergies (Medjo *et al.*, 2013; Pyrhönen, Näyhä & Läärä, 2015; Fall *et al.*, 2015; Mendy *et al.*, 2018). Living with a companion animal is common within households in countries where the incidence and prevalence of childhood asthma have changed considerably over the past decades (Collin *et al.*, 2015). Evidence of a positive association between childhood dog exposure and asthma has been found in several studies (Collin *et al.*, 2015; Alqahtani *et al.*, 2017; Luo *et al.*, 2018). Moreover, we are witnessing an increase in the frequency of allergy to these animals in Global North countries (Dávila *et al.*, 2018). Indeed, because of the increasing exposure to animals around the world linked to the growing popularity of pet ownership, more people are being diagnosed with pet-related allergies. Yet, the conclusion that living with a dog is linked with a higher incidence of pet allergy comes with no shock as it is no surprise that people exposed to animals are more likely to trigger an allergy to them. But what of the people who

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are allergic to pets but simply do not know it? There may be a bias of reporting in non-owners as the absence of exposure potentially inhibits the trigger of the allergy, a bias that should be investigated in the future.

Eight dog allergens exist, found in dog hair, saliva, and urine to cite a few (Li *et al.*, 2021). Allergies to dogs mainly affect a child's respiratory system, and have been identified as the causal factor for asthma, rhinoconjunctivitis, and atopic dermatitis (Li *et al.*, 2021). Identification of pet-related allergies is increasing in China, most likely due to the increasing pet ownership practices in the country (Li *et al.*, 2021). Even so, they mentioned that pet allergies are still less common in China than in European nations, such as in Sweden (Zhao *et al.*, 2006; Lødrup Carlsen *et al.*, 2012; Li *et al.*, 2021). It is argued that the area in which children live in plays a major role, with pet ownership in rural areas potentially serving to prevent allergies from developing, whereas in urban areas it may exacerbate them (Krzych-Fałta *et al.*, 2018). Part of the reason might be that pet owners in urban areas are more prone to allow their companion in the house and their bedroom, which is likely to be due to living space limitations (lack of yards) (Krzych-Fałta *et al.*, 2018).

Based on the current evidence, the debate on the usefulness of pet avoidance offers contradictory arguments (Chen *et al.*, 2010), hence no clear recommendation can be given. Keeping or not keeping a dog in the family should be decided based on other factors than the concern of developing asthma or allergies or of getting infected by a disease. It is essential to establish with the help of professionals (*e.g.*, veterinarians, behaviorists) efficient communication to help estimate the risk of zoonotic diseases as well as educate dog owners and non-owners (Lipton *et al.*, 2008; Speare *et al.*, 2015; Overgaauw *et al.*, 2020). Including rabies prevention in educational curriculum for example has been shown to improve children's knowledge regarding the disease (*e.g.*, Malawi: Burdon Bailey *et al.*, 2018; Philippines: Amparo *et al.*, 2019). It took the form of one or several lessons on the subject,

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with or without a specially developed manual, introducing children to the animals that can transmit the disease, the symptoms and prevention, as well as safety around dogs and responsible pet ownership. Compared to children who had not received these lessons, those who had displayed better knowledge about both canine rabies and bite prevention up to one year after the intervention (Burdon Bailey *et al.*, 2018; Amparo *et al.*, 2019). However, greater knowledge is not always linked with a decrease in dog bites, highlighting the fact that the relationship between knowledge acquisition and behavioral change is complex and necessitates further investigation (Amparo *et al.*, 2019).

5.3. FEAR OF DOGS (CYNOPHOBIA)

The fear of dogs, also called cynophobia, is the experience of an irrational and persistent fear when exposed to a domestic dog. It can be a distressing problem for children which can interfere with their normal routine as well as the play and recreational activities of children and their families. Adults can also suffer from cynophobia but they generally report that their fear arose during childhood (Doogan & Thomas, 1992), emphasizing the importance of understanding the role of dogs in the lives of children. Phobias can be complex, involving genetic, maturational, and environmental factors (King, Clowes-Hollins & Ollendick, 1997). Parents often report that their child's fear arose after a dog attack or because the parents were themselves afraid of dogs (King, Clowes-Hollins & Ollendick, 1997; May *et al.*, 2013). Beliefs play a significant role in the maintenance of phobias, stating that catastrophic predictions regarding a feared stimulus maintain phobic anxiety and that subsequent avoidance prevents disconfirmation (Byrne *et al.*, 2016). The difference between children and adults is that a child with dog phobia may genuinely believe that a dog will attack them if they were to pet it whereas an adult will be aware that this outcome is unlikely

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and yet still experience high anxiety. Cynophobic children hold overestimated beliefs regarding harm and that they were most concerned about dogs jumping on them (Byrne *et al.*, 2016).

Methods to help cynophobic persons overcome their fear of dogs include exposure techniques which consist of exposing a phobic person to the stimulus that causes them fear in a safe environment. Some favor an exposure approach with actual dogs (May *et al.*, 2013; Tyner *et al.*, 2016; Farrell, Kershaw & Ollendick, 2018) while others take advantage of the advancement in technology to develop virtual reality applications (Hnoohom & Nateeraitaiwa, 2017; Farrell *et al.*, 2021). Both methods have shown promising results with significant decreases in fear and sometimes "recovery". However, the control of the dog's behavior is usually a limiting factor for these techniques (Calvo *et al.*, 2013).

Seven criteria exist in the diagnosis of a specific phobia, among which an anxiety response (*e.g.*, panic attack) and intense distress when exposed to the phobic stimulus (APA, 2013). Knowing this, it could be argued that exposure therapy is unethical, especially with children where the concept of consent is debatable (Gola *et al.*, 2016). Here, the end may not justify the means. Hence, other ways to treat cynophobia instead of evoking distress in a person who may be unwilling to engage in the therapy in the first place should be explored. The use of bibliotherapy (*i.e.*, using print materials to provide instructions normally provided by a therapist) for seven children has recently been explored and yielded promising results with significant reductions in fear severity and avoidance behavior as well as displays of good treatment adherence and retention (Radtke *et al.*, 2022). Bibliotherapy and similar methods not relying on direct exposure to the source of fear should be further explored in future studies. In societies where it is possible to stumble upon a dog at any time, cynophobia can be a crippling condition and an important disturbance in child-dog interactions.

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5.4. ANIMAL COMPANION BEREAVEMENT

Society does not always acknowledge the significance of pet bereavement, which can result in unresolved or unrecognized grief. Companion animals can sometimes be perceived as more dispensable when compared to humans (Redmalm, 2015), which explains why societal norms can deny the appropriate expression of grief following the death of a pet (Kaufman & Kaufman, 2006). While pets can help to make the human-loss mourning process less painful for children and adults through provision of their social support (Kaufman & Kaufman, 2006), there comes a time when it is the pet itself who dies. For pet owners, there are no significant differences between the levels of grief severity experienced after the death of a human and a companion animal (Lavorgna & Hutton, 2019). As a matter of fact, the symptoms and characteristics associated with pet loss can be consistent with those associated with the death of a human, such as a close friend or family member (Packman, Carmack & Ronen, 2011).

Child grief is not expressed in the same manner as adults and is related to the child's developmental state (Kaufman & Kaufman, 2006), and this is consistent for their expression of pet bereavement (Jarolmen, 1998). The loss of a companion animal during childhood is no less important than the loss of a family member. It can be a life-changing event, especially for children for whom it may be their first significant loss with a profound grief response (Kaufman & Kaufman, 2006). Not being appropriately supported during this hard time may lead to the development of complicated grief (Kirwin & Hamrin, 2005). Child and adolescent bereavement can result in depression, anxiety, social withdrawal, and behavioral disturbances (Christ, Siegel & Christ, 2002; Kirwin & Hamrin, 2005; Kaufman & Kaufman, 2006). In addition, the severity and prevalence of grief symptoms can be gender specific, with women reported to experience higher depersonalization (*i.e.*, feeling disconnected or detached from

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one's self) and death anxiety (McCutcheon & Fleming, 2002). Apart from gender, other variables influencing grief severity include closeness to the animal, perceived social support, and the type of death experienced by the animal (McCutcheon & Fleming, 2002; Lavorgna & Hutton, 2019). Those variables are generally linked: children are commonly those who rely the most on their pets for social support and who show more anger once the animal passes away (McCutcheon & Fleming, 2002). This anger may also be explained by the fact that, because of their young age, children do not consider the possibility of death and therefore have more trouble with understanding and accepting the situation when it arises (Kaufman & Kaufman, 2006). Despite the harshness of this experience, it can also teach children about the life cycle which always includes death at some point (Russell, 2017; Bowman, 2018). It is important to appreciate the role pets and especially dogs can have in children's lives in order to not trivialize the child's bereavement for their deceased canine friend (Kaufman & Kaufman, 2006).

6. EFFECTS OF CHILD-DOG INTERACTIONS FOR DOGS

6.1. BENEFITS

As a minimum level of care, owned dogs are generally provided with food, shelter, and veterinary treatments. Children may take part in caregiving behaviors toward dogs (Hall *et al.*, 2016; Kerry-Moran & Barker, 2018). Apart from taking care of their basic physiological needs, direct interactions with humans including children may offer benefits to dogs. When living closely with humans, dogs are able to establish attachment bonds with people which in turn may modulate their behavioral and emotional responses (Nagasawa, Mogi & Kikusui, 2009; Merola, Prato-Previde & Marshall-Pescini, 2012; Wanser *et al.*, 2020). Interestingly, owner-dog dyads can present matching personalities. Indeed, using questionnaires (Big Five

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Inventory for humans and for dogs) completed by the owner and an independent peer person, Turcsán *et al.* (2012) found that all five personality dimensions examined (*i.e.*, neuroticism, extraversion, conscientiousness, agreeableness, and openness) showed significant positive correlations between adult owners and their dogs. This could be due to the "similarity-attraction hypothesis" which suggests that higher similarity between individuals lead to higher attraction between them (Byrne, Griffitt & Stefaniak, 1967).

Dogs can synchronize their behavior with that of children from their family (Wanser, MacDonald & Udell, 2021). During walking sessions, dogs exhibited activity, proximity, and orientation synchronization with the child who was walking with them at higher rates than would be expected by chance (Wanser, MacDonald & Udell, 2021). Although at lower rates than when walked by their adult caregivers (Duranton, Bedossa & Gaunet, 2018, 2019), those results demonstrate that dogs may perceive familiar children as social partners. Additionally, children provide dogs with a source of social companionship and create opportunities for recreational activities (Hall, Finka & Mills, 2019). Finally, petting (*e.g.*, tactile stroking, patting) has been shown to have marked effects upon the autonomic functioning of dogs. Indeed, while being petted, dog heart rate decreases which may relate to reduction of stress as a result of being touched (Csoltova *et al.*, 2017; Mariti *et al.*, 2018).

In the same way that dog walking can be beneficial for people, it is equally advantageous for dogs. Walking dogs has been identified as very important for dog wellbeing. For households that do not include a yard, walks enable the dogs to relieve themselves outside. In addition, walks beyond the house or property boundaries offer a perfect opportunity for the dog to exercise. This physical activity can help prevent dog obesity (Bland *et al.*, 2009), while also providing mental stimulation (AVMA, 2022) and opportunities to sniff in known and new environments (Kokocińska-Kusiak *et al.*, 2021). Using a cognitive bias test, Duranton and Horowitz (2019) showed that the practice of

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nosework, or an olfaction-based activity, with their owners increased optimism in dogs. They argued that when dogs practice nosework, they can express their natural behavior, a key point of animal welfare (Mellor, 2016). Walks can also offer the opportunity for dogs to socialize with conspecifics, either en route, or at a destination such as a dog park (Westgarth *et al.*, 2010). Proper walking practices (*e.g.*, allowing dogs to sniff their environment, giving them time to socialize) should be taught to dog owners and their families to favor positive dogs' experience when being walked and thus enhance their welfare.

6.2. RISKS

While a lot of attention has been given to the effects of children and dogs interactions for people, little attention has been paid to the risk of human interactions to dog quality of life (Hall, Finka & Mills, 2019). The complex nature of the environment in which dogs live may place them in recurrent or chronic states of stress which can have long-term outcomes for the dog quality of life. Children may be part of this environment and because of their unpredictable and active mannerisms as well as their difficulty in identifying subtleties of behavior (Meints, Brelsford & De Keuster, 2018), they may put their canine companion under distress, possibly increasing the risk of aggression toward children. However, euthanasia or relinquishment are often the consequences for dogs showing aggression towards people (Casey *et al.*, 2014). It is thus crucial to pinpoint the specific factors in interacting with children which may represent a threat to dog wellbeing and general quality of life.

Some risk factors which can distress dogs are spatial restriction, social isolation, changes in routine, loud noises, and unexpected events (Hall, Finka & Mills, 2019). A number of child-dog interactions may jeopardize dog quality of life: "unprovoked child

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attention" (*e.g.*, rough contact), "interaction and environmental unpredictability" (*e.g.*, meltdowns and tantrums, need for appropriate recreational activities), and "child games" (*e.g.*, playing "dressup", loud games) (Hall, Finka & Mills, 2019). Furthermore, while some dogs can respond favorably to being petted, it is important to consider that some common physical interactions may be perceived as unpleasant by certain dogs: some individuals dislike being touched on the top of the head or being hugged for example (Kuhne, Hößler & Struwe, 2014), others may have injuries or past experiences with people which make them unwilling to be touched. Although focusing on human-cat interactions, a set of guidelines aiming to enhance companion cats' comfort when interacting with humans was recently created (Haywood *et al.*, 2021). When people followed those guidelines, the frequency and duration of affiliative and positively-valenced behaviors in shelter cats were significantly greater, and human-directed aggression decreased (Haywood *et al.*, 2021). Future studies assessing similar guidelines in the context of human-dog interactions, and especially child-dog interactions in our case, should be undertaken. The principle of "consent test" appears promising: when petting a dog (or any other animal), take a pause to see what they do, then respond accordingly will give the opportunity for the animal to choose when and for how long they are being petted (Todd, 2022). Whereas the above examples depict interactions during which children do not intentionally intend to harm their companions, childhood acts of animal cruelty also exist (McDonald *et al.*, 2018; Hawkins, Scottish SPCA & Williams, 2020).

Despite having co-evolved with people, dogs do not choose their modern-day owners and the people with whom they will interact throughout their lifetime. Indeed, dogs and especially companion dogs are living in a "human's world" where we are the one largely defining and managing almost every aspects of their lives (Benz-Schwarzburg, Monsó & Huber, 2020). Some dogs will not get along with children in a way that is perceived

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positively. Dogs who have been in the family for longer than the child exhibit less affiliative behaviors toward them (Arhant, Beetz & Troxler, 2017). In the same study, parents of children aged 6 months to 3 years were the ones reporting the highest levels of child avoidance in their family dog (Arhant, Beetz & Troxler, 2017). While introducing dogs to children during their socialization period can enhance better behavior (Arai, Ohtani & Ohta, 2011), being obligated to engage in non-optimal relationships can increase dogs' chronic stress levels and consequently diminish their welfare (Cimarelli *et al.*, 2019).

Although dog walking can be very important for canines, a rather large proportion of dog owners do not walk their dogs (*e.g.*, Japan: 35%, Oka & Shibata, 2012; USA: 30%, Coleman *et al.*, 2008). Understandably, children are rarely allowed to walk the family dog on their own, rather they join their parents in walking activity (Salmon *et al.*, 2010). Thus, if adults do not walk their dogs, there are few chances that the dog will be walked at all. The lack of physical exercise, along with other factors dog- and/or owner-dependent (*e.g.*, being overfed), can lead to the onset of obesity in dogs (Holmes *et al.*, 2007; Mao *et al.*, 2013). Unfortunately, the incidence of canine obesity is ever increasing (German, 2006; German *et al.*, 2018). Cross-sectional studies in the UK, Spain, and China reported 65%, 41%, and 44% of overweight dogs respectively (Mao *et al.*, 2013; Montoya-Alonso *et al.*, 2017; German *et al.*, 2018). However, retrospective studies yield less alarming results. In the UK, Pegram *et al.* (2021) have estimated that 7% of dogs under veterinary care in 2016 were overweight using electronic patient records. Using the same method, results from New Zealand reported 28% of overweight dogs (Gates *et al.*, 2019). Veterinary clinical records may underreport overweight status in dogs, as this discrepancy of results between methodologies appears to highlight (Rolph, Noble & German, 2014). Canine obesity can be associated with numerous health issues such as osteoarthritis, cardiovascular disease, diabetes mellitus, and others, all

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of which can significantly reduce the quality of life as well as the lifespan of the dog (Laflamme, 2012; Endenburg *et al.*, 2018).

It is important to consider the welfare of working dogs, such as therapy and assistance dogs, that are involved in numerous settings around the world (Cobb, Otto & Fine, 2021). While therapy dogs take part in structured, therapeutic interventions accompanied by licensed professionals (Schoenfeld-Tacher *et al.*, 2017), assistance dogs (also called service dogs) permanently live with the humans whose daily life they are meant to assist (Winkle, Crowe & Hendrix, 2012). In contrast to the rather large literature on the effects of animal-assisted interventions on humans, few studies assessed their impact on dogs (Glenk, 2017). Research has used different physiological and behavioral measures as well as handler surveys to assess stress in this population (Burrows, Adams & Millman, 2008; Marinelli *et al.*, 2009; Palestrini *et al.*, 2017; McCullough *et al.*, 2018; Uccheddu *et al.*, 2019; Melco *et al.*, 2020). Although clear conclusions cannot yet be drawn about the impact of animal-assisted interventions on dog wellbeing (Glenk, 2017; Glenk & Foltin, 2021), there are records of inappropriate behaviors and mistreatment which can lead to the deterioration of dogs' health (Heimlich, 2001; Hatch, 2007).

The welfare of free-roaming dogs is generally described as very poor (Jackman & Rowan, 2007). Although not directly linked to child-dog interactions, those dogs commonly suffer from malnutrition, dehydration, and diseases (Matter & Daniels, 2000). These animals receive little veterinary care and thus present high rates of mortality (Jackman & Rowan, 2007). Because some are carriers of rabies and attack humans, especially children, and despite the vaccination effort in many countries, some take matters into their own hands and kill the canines (Cleaveland *et al.*, 2006; Jackman & Rowan, 2007). However, in some respects, these dogs live their lives with far greater agency in terms of social and environmental choices than dogs living in human homes (Cobb, Lill & Bennett, 2020).

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7. FUTURE DIRECTIONS

Future research should seek to better understand the role of attachment between dogs and children in relation to the health and mental benefits of dog ownership (Purewal *et al.*, 2017). Furthermore, the role of culture in attitudes towards animals and pet-keeping practices should be further explored (Jackman & Rowan, 2007; Gray & Young, 2011; Jegatheesan, 2015). Because some subjects have only been studied in a few specific countries, broad generalizations should not be made from their results. In countries where dog-borne zoonoses such as rabies are still prevalent, people perception of dogs could be highly impacted (Tiwari *et al.*, 2019). To the authors' knowledge, no study comparing the prevalence of cynophobia between countries exist to this day. Yet, in countries still experiencing deadly diseases such as rabies, it seems fair to believe that cynophobia could have an evolutional purpose. Indeed, it could increase survival as being afraid of dogs could potentially reduce the risk of getting bitten because of avoidance of the animal. Thus, future research could try to determine the moderating role of culture on child-dog interactions.

Human-animal interactions research most often concentrates on the impacts on humans. Consequently, there is a gap in the understanding of the impact of children on dogs and their welfare (Hall, Finka & Mills, 2019). Two themes may explain this dearth of knowledge, namely scientific communication and research funding (MacLean *et al.*, 2021). Dog popularity fuels public interest in canine science and the impact of dogs on human health and wellbeing. However, research in child-dog interactions often offers contradictory results. This is most likely due to the wide diversity in methodologies, small effect sizes, and homogenous samples (Purewal *et al.*, 2017). Cross-sectional and correlational study designs do not enable causal inferences to be clearly made. Yet, good scientific communication requires honesty,

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relevance and effectiveness (MacLean *et al.*, 2021). Although we realize the great amount of time and effort that it would necessitate, longitudinal studies would be better suited to understand the impact of child-dog interactions. Science continues to explore and identify situations that may undermine dog welfare, and safeguarding their wellbeing remains a crucial area of study, even more so in the context of animal-assisted interventions (Glenk & Foltin, 2021).

8. CONCLUSION

In summary, growing alongside one or several dog(s) has become a common occurrence in the life of numerous children around the world (Melson & Fine, 2015). Knowing the various outcomes possibly derived from child-dog interactions can help weigh the pros and cons of living alongside a companion dog. Current evidence suggests that child-dog interactions may be beneficial to both species. All the different aspects of wellbeing, *i.e.*, physical, mental, and social, are all interconnected, meaning that improving one's physical wellbeing may lead to an improvement of their mental and social wellbeing as well for example, creating a virtuous circle. Interpreting findings should be done with caution. Yet, in spite of the use of various methodologies that can lead to weaknesses (Purewal *et al.*, 2017), results show that dogs have the potential to improve children lives just like children can contribute to the quality of life of dogs. Nonetheless, such interactions can also bring about negative outcomes such as bite injuries, dog-borne zoonoses, or stress. By supervising those encounters and by increasing people's knowledge about all the possible aftermaths of child-dog interactions, we could aspire to increase the positive effects all the while reducing the negative ones that are for the most part preventable. The mechanisms through which both species can promote each other's wellbeing require further investigation. There is little

knowledge so far on the potentially differential effects of culture on physical, mental, and social outcomes. Lastly, longitudinal and controlled designs that allow repeatability should be favored in future studies.

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