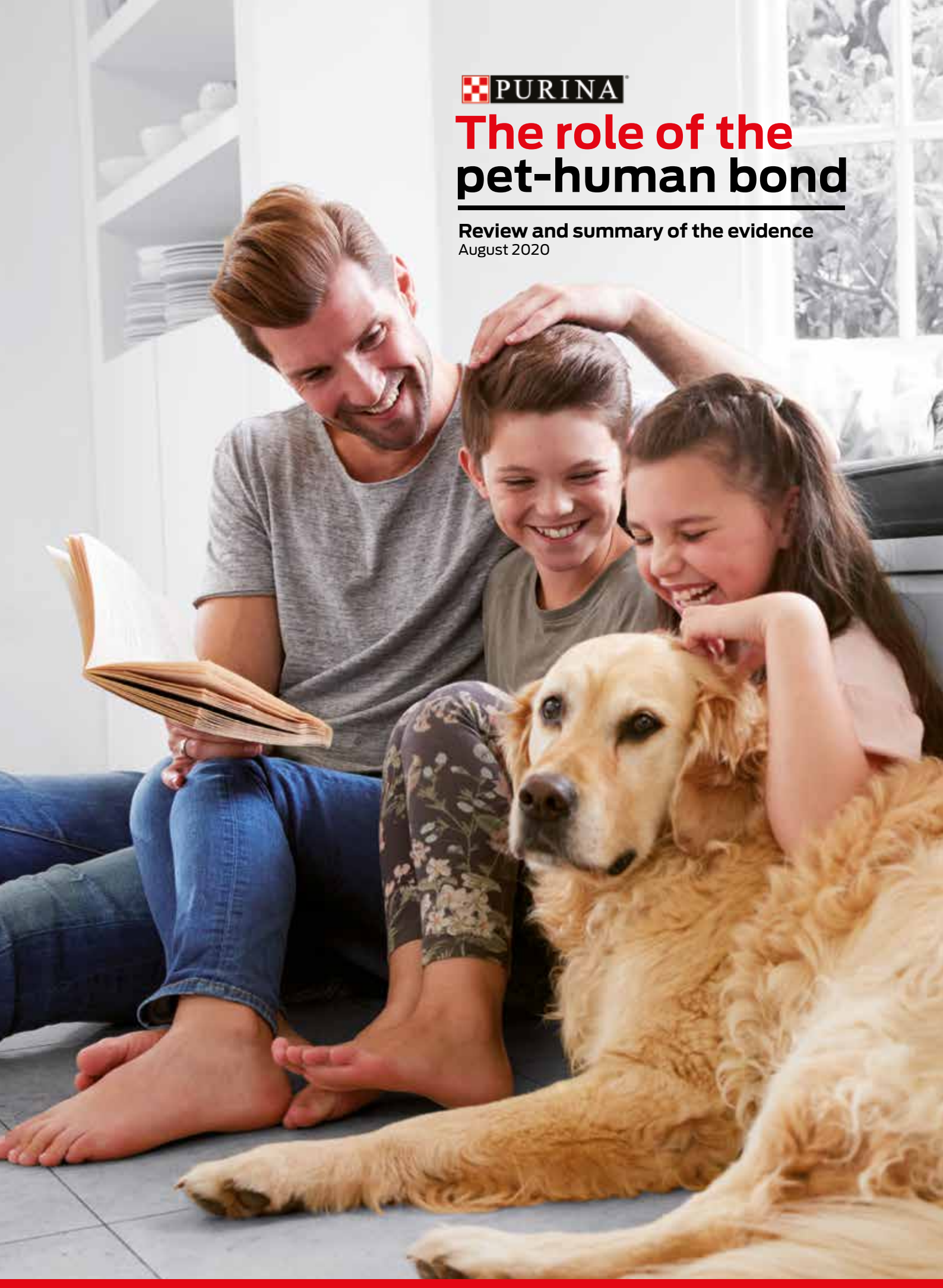


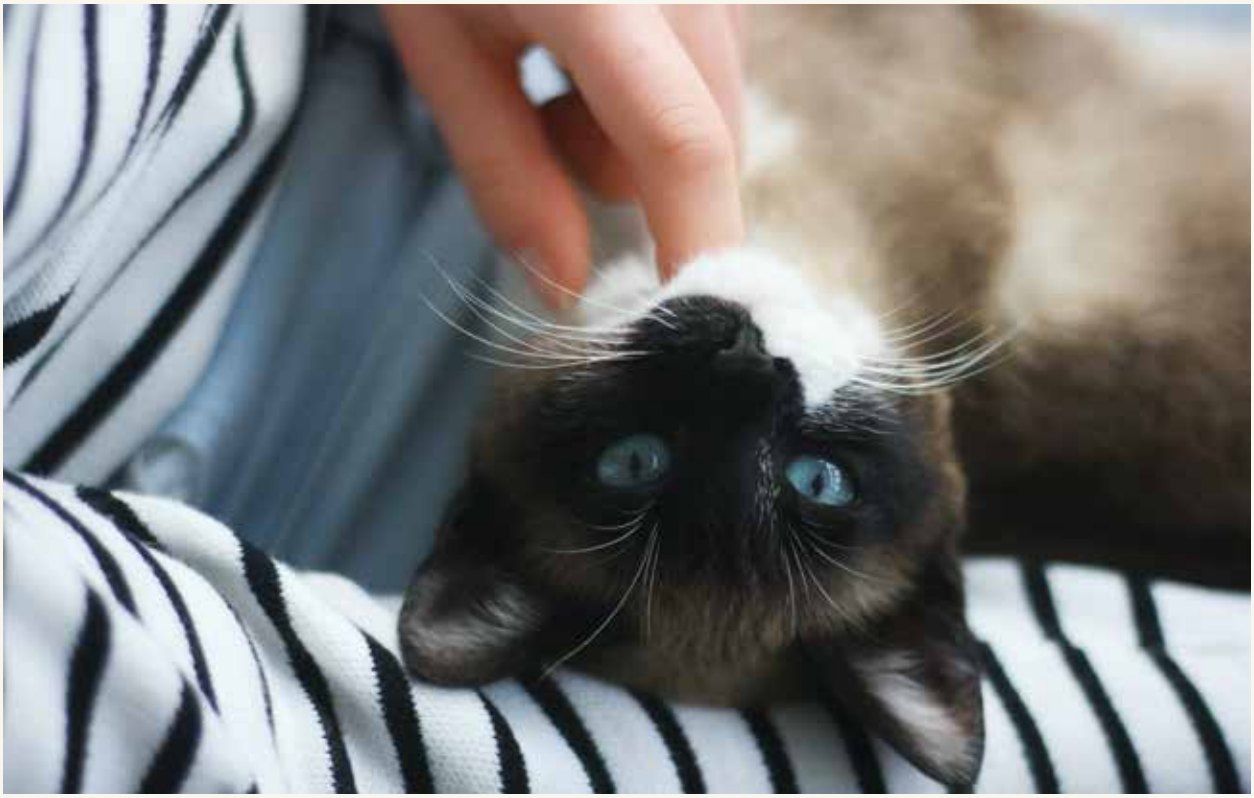
PURINA

The role of the pet-human bond

Review and summary of the evidence

August 2020

Contents



Introduction

CONTEXT

Nestlé Purina PetCare EMENA's (NPPE) purpose is to create richer lives for pets and for the people who love them. NPPE have the fundamental belief that **'People and Pets are Better Together'**.

With this purpose in mind, in 2015 NPPE commissioned research to find and review the peer reviewed evidence relating to the shared impact of the pet-human bond. This has been subsequently refreshed and built on in 2016, 2019 and 2020.

WHY THE PET-HUMAN BOND MATTERS

There is a long history of anecdotal and observational evidence of the mutual benefits of the pet-human bond.

The peer reviewed studies illustrate the myriad beneficial effects of pet ownership to humans, including the direct positive benefits on human health and wellbeing (e.g. through exercise promotion). Indirect effects include the role of pet ownership in enhancing social interactions with other people. There is less peer reviewed evidence of the beneficial effect on pets, and this is an area where Purina have focused and published work.

The findings to date confirm the significant social and societal potential that the pet-human bond offers in delivering national and regional priorities including healthcare. Further details on evidence relating to healthcare economics and the pet-human bond are covered in section 5.6.

Summary findings

The breadth and quality of evidence and research of the substantive benefits to humans from the bond is growing. These benefits range through prevention of disease, lessening of disease severity, stress reduction, treatment and care enhancement.

The findings demonstrate three areas of emerging / strengthened evidence:

1. **Positive impact of the bond on psychological wellbeing, social inclusion and mental health promotion** – an important area for more research given increasing isolation, older populations and rapid urbanisation and the associated social challenges
2. **Positive impact of the bond on early human development**, however there are still significant gaps in the evidence base
3. **Positive impacts for people in prison and marginalised and disadvantaged people**, for instance new and growing evidence that the bond can have positive impacts for people in prison and / or people subject to offending reduction programmes. There is also emerging evidence that the bond can assist marginalised and disadvantaged people if they are appropriately supported.

However, there are still significant gaps in the evidence base with a strong case for further investment, particularly relating to:

1. **Animal assisted primary prevention**
2. **Ongoing care for the elderly and other people needing ongoing care**
3. **Assisting those professionals who work in conflict situations such as the armed forces or have experienced trauma**. Whilst there is some new and promising research this is another area that would benefit from further research investment
4. **The 'One health' concept and movement and its implications for practice**
5. **The benefits the bond bestows on companion and working animals as well as providing benefits to humans**.

How this evidence review was conducted

A rapid 'meta-evidence review' approach was adopted for each review (2016, 2019, 2020) and collated to form the evidence for this report.

The aim was to collate, assess and map the latest research around the benefits to humans associated with the pet-human bond. The review was limited to papers focused on cats and dogs. These were identified through a review of academic databases, online sources, grey literature and input from expert interviews. All papers were assessed and ranked based on research quality and the level of evidence relating to different areas of the pet-human bond.

The objective is to create better understanding of the pet-human bond in such a way that the findings can be used to focus new research and interventions in this field of study[1].

The structure of this report

The report is structured by topic and provides references to the key papers and body of evidence in the following areas:

1. **Pets and working animal contribution to the promotion of health and wellbeing across the human lifetime**, including childhood, early adulthood, adulthood, older life, end of life
2. **The contribution of animal assisted therapy (AAT) for the detection and treatment of degenerative and chronic diseases**, including cancer, CVD, atopy, autism, dementia
3. **The impact that pets can have on building a more inclusive society**, including human connectedness in cities, senior citizen companionship and assistance
4. **Innovation in new health and care technologies and approaches,** including AAT and One Health
5. **Wider reflections on the impacts of the pet-human bond and the themes of this review.**

(1) As well as the numerous benefits that are associated with dog and cat ownership there are a number of potential negative consequences. These need to be assessed for future areas of research and initiatives to mitigate the potential negative impact of the pet-human bond.

1. Promoting health and wellbeing across the lifetime

Research relating to the impact of the pet-human bond across the lifetime (of a human) can be grouped into six areas:

- Childhood physical, mental and emotional health and wellbeing
- Children's educational development
- Early adulthood
- Adulthood
- Older / later life physical, mental and emotional health and wellbeing
- Loneliness and social isolation across the lifetime.

1.1. CHILDHOOD PHYSICAL, MENTAL AND EMOTIONAL HEALTH AND WELLBEING

1.1.1. Child physical health and wellbeing

Previously there has been mixed research evidence relating to pet ownership and child physical activity. This updated review found new (if limited) research relating to the physical health of children in relation to the pet-human bond *(noting topics relating to animal assisted therapy and atopy are covered separately)*.

A cross-sectional sample of 9-10 year old children in the UK showed that 37.1% walked with a dog several times a week or more (Westgarth et al. 2013 [n=1,021]). A Western Australian study found that secondary school students who walked the dog or played with pets were significantly more likely to meet national physical activity recommendations than those who did neither of these things (Martin et al. 2015 *via HABRI*). However, another Australian study discovered that 75.1% of their adolescent study participants reported no activity involving pets over the surveyed days (Mathers et al. 2010 [n=928]).

Pet ownership, especially the ownership of dogs, lowers the risk of hypertension in children (Xu et al. 2017 [n=9,354]). In addition, for men, exposure to pet ownership in utero and having more than two pets is associated with decreased prevalence of hypertension. For women, having one pet was associated with lowering the risk of hypertension. Having other animals as pets was also associated with decreased hypertension.

An important development is the study which has examined the possible connection between maternal prenatal pet-keeping and attention deficit hyperactivity disorder (ADHD) by Cassidy-Bushrow et al. 2019[2]. This study drew upon participants in the Wayne County Health Longitudinal

Note: cancer, CVD, and asthma are covered in section 2 and AAT interventions in section 3.

(2) Study quality: high to medium. Despite adjustments, study difficulties include limited confidence in the association in a longitudinal study. The analysis was derived from WHEALS 10-12 years data, probability weighted to account for social status etc. bias within respondents at this point in the study. (At this long-running stage, respondents are likely to have been 'selected down' through class etc.) Research method: longitudinal study. Empirical robustness: 1.

Study (WHEALS [n=1,258]). Based on the final analytic sample of children with ADHD [n=93] and neuro-typical children [n=534], the study revealed greater odds of ADHD in boys whose mothers were exposed prenatally to dogs, but not in girls. Cat ownership was not associated.

1.1.2. Child mental and emotional health and wellbeing

There is strong evidence of the beneficial role of the pet-human bond in the emotional development and wellbeing of children. New research identified in this review has strengthened the evidence relating to the role of pets in the emotional development and wellbeing of children – broadly defined in relation to 'quality of life'.

In 1996, evidence showed that pet ownership was associated with greater social contact with friends (Paul and Serpell, 1996 [n=27]). Higher levels of pet attachment were positively associated with changes in a child's confidence as recorded via empathy and pro-social orientation scales (Vidovic et al. 1999 [n=826]). This greater empathy in childhood was suggested to be long lasting, extending into adult life (Daly and Morton, 2009).

Research also demonstrated that young people who are involved in pet ownership display greater understanding of, and empathy towards, animals (e.g. Geerdts et al. 2015 [n=24] and Bingiesser et al. 2013). A gender difference was discovered, with girls in general displaying more positive attitudes than boys. Pets featured prominently as providers of comfort, esteem, support and confidants for a secret (McNicholas, 2000).

An emerging theme was that having a pet dog in the home is associated with a decreased probability of childhood anxiety (Gadomski et al. 2015). It was noted that this study was a correlation study only, so no definitive cause-effect was inferred from its findings. Future studies were recommended by the authors to establish whether and, if so, how pet dogs alleviate childhood anxiety.

A survey of 7 to 12 year-olds in Scotland found children who participate in pet care behaviour may have a range of positive outcomes for both the children (such as better well-being and quality of life) and for the pets (such as better welfare and humane treatment) (Hawkins and Williams 2017[3], [n=1,217]). The authors also demonstrated that attachment to pets significantly predicts positive attitudes towards animals generally.

Marsa-Sambola et al. (2016[4]), describes the development and use of the Short Attachment to Pets Scale (SAPS), (n=7,159), and reports that positive SAPS scores are positively associated with quality of life among other things.

Pet ownership in toddlerhood, in Japan, has been shown to contribute to the development of emotional expression, although it is noted that while cohort size is impressive (n=31,453), the instrument used to measure expression is relatively unsophisticated (Sato, R et al. 2019[5]).

A recent study has examined the impact on dog welfare of the behaviour of neuro-typically developing (n=194) and neuro-developmentally disordered (n=208) children aged 4-10 (Hall et al. 2019[6]). Using a web survey of self-selected participants, the study reported that positive behaviour and interactions had a positive impact on dog welfare and vice versa.

An important area identified in this literature is how to measure the attachment between child and pet. Two measures are derived from the 29-item CENSHARE Pet Attachment Survey. It is suggested that these are psychometrically valid and are a practical method of measuring Human Animal Interaction (HAI) attachment (Bures et al. 2019). A 2018 study has discussed that the use of OXTR (oxytocin receptor) can predict a child's relationship and interaction with a pet. This research also documents individual differences that may influence children's interactions with animals, which will further support therapeutic interventions (Kertes et al. 2017, [n=97]).

1.2. CHILD EDUCATIONAL DEVELOPMENT

Research has identified some evidence relating to the positive benefits of the pet-human bond in participation and interaction in the classroom and in educational development, and this has been developed since 2015, as follows.

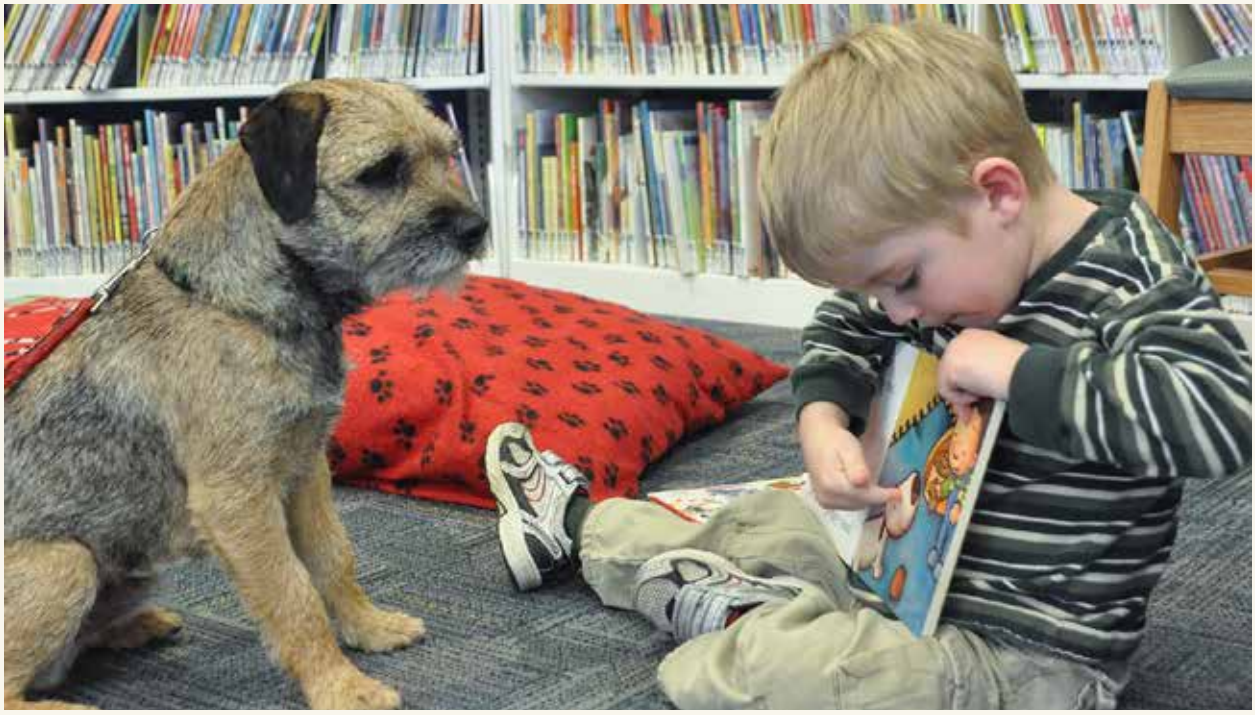
For instance, animal assisted activity has been shown to lead to greater social functioning amongst children with Autism Spectrum Disorder (ASD) and to higher school adjustment for young people undergoing animal-assisted psychotherapy due to psychosocial adaption (O'Haire et al. 2014). The Pets at Home report (2015) found that 55% of parents responding (n=4,321) were broadly supportive of greater pet presence in schools. However, this research primarily focused on specific cases (e.g. children with ASD) so limited conclusions could be drawn.

(3) Study quality: high to medium. The sample size is reasonable and there is evidence of careful study conduct. Research method: self-completion survey. Empirical robustness: 1.

(4) Study quality: high to medium. This association and its featuring of a range of socio-demographic variables makes it a helpful measure. The use of qualitative and quantitative methods to test the tool is a research strength. Research method: scale development and testing. Empirical robustness: 2.

(5) Study quality: medium to low. While cohort size is impressive, the instrument used to measure expression is blunt and the 'gap' between ownership and expression assessment is very small. Research method: birth cohort analysis. Empirical robustness: 2-3.

(6) Study quality: medium. Importance lies in the development of the assessment tool for the impact of child behaviour on dogs, and in the behavioural constructs developed. But self-selection, self-reporting and the validation of the constructs themselves are difficulties. Research method: self- completion survey. Empirical robustness: 2.



Teachers in one study have reported a number of changes in the social and academic effects of the presence of small, resident classroom animals for third and fourth-grade students in the United States (McCullough et al. 2019, [n=591]). This included increases in social skills, social competence, and academic reading competence, as well as reductions in internalising and hyperactivity / inattention behaviours, among students in the intervention cohort as compared to those without a classroom pet. However, the lack of consistent findings across groups indicates the need for further examination of these types of programs and their potential impact on students.

Reilly (2020) conducted a meta-analysis to assess the impacts of dogs within the school or classroom environment. Based on data from 20 studies, Reilly concludes that the inclusion of dogs within learning environments produces positive learning outcomes for students.

New research in 2020 found that dog ownership is associated with improvements in wellbeing and social-emotional development in children. Drawing upon survey data from 1,646 households, researchers from the University of Western Australia found that in comparison to children in non-dog-owning households, those from dog-owning households were 23% less likely to have difficulties with their emotions and social interactions; 30% less likely to engage in anti-social behaviours; 40% less likely to have problems interacting with other children; and 34% more likely to engage in considerate behaviours, such as sharing (Wenden et al. 2020).

1.3. EARLY ADULTHOOD – MENTAL AND PHYSICAL HEALTH

One emerging theme is the positive impact of the pet-human bond in relation to the mental health and wellbeing of young adults, in particular within academic settings.

The strongest evidence is in the randomised study to evaluate the efficacy of a therapy dog programme in improving the well-being of university students. It identified benefits including reduced stress and increasing happiness and energy levels (Ward-Griffin 2018 [n=246]). Results

suggest that single, drop-in, therapy dog sessions have significant and immediate effects on students' well-being, but also that the effect reduces rapidly after several hours. A randomised controlled trial examined the efficacy of incorporating various levels of HAI into a four-week long university-based stress prevention program (Pendry et al. 2019 via Waltham [n=307]). Programmes that incorporate both interactions with animals and evidence-based stress prevention were associated with higher levels of enjoyment, perceived usefulness, and likelihood of recommendation. Interacting with a dog resulted in greater declines in anxiety and improved mood scores (more so than watching a video) amongst university students (Thelwell 2019 [n=82]).

An exploratory study in South Korea has identified that young (19-39) adults' attitudes toward their companion dogs are associated with the owners' depression symptoms. Owners who had less favourable attitudes toward their dogs tended to have such symptoms. It is important to note the authors could not determine a causal direction (Min et al. 2019[7] [n=654]).

In relation to physical health, 2017 research, using the Avon Longitudinal Birth Cohort Study, found no evidence for a relationship between adolescent dog ownership and physical activity (Westgarth et al. 2017[8] [n=2055]). This provides greater detail to, and challenges, Westgarth et al.'s previous research (2013) which identified a general relationship between dog ownership and increased levels of physical activity through walking (amongst the general population) as cited in the 2016 review.

1.4. ADULTHOOD

1.4.1. Adulthood – at home inventions

Past research has identified a number of studies which offered strong evidence of the positive impact of animal ownership on adult physical activity, and consequently upon body weight and obesity, of both the human and the animal (for example see Kushner et al. 2006). More recent research has strengthened the evidence of the benefits of the pet-human bond for adults, in particular relating to physical activity (pet walking) which is negatively associated with being overweight.

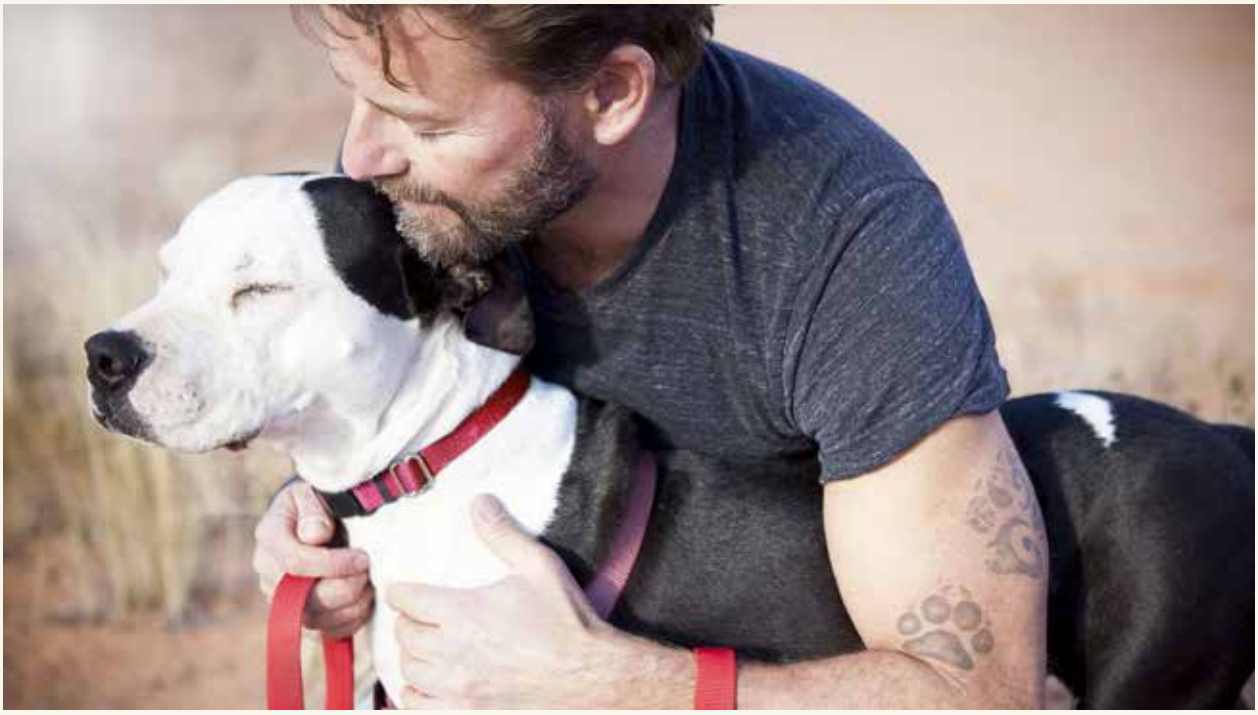
In 2013, The American Heart Association review found conflicting results on weight status variation among households with and without pets (Levine et al. 2013). In contrast, dog walking, as opposed to pet or dog ownership, does appear to be associated with a lower incidence of obesity.

A randomised controlled intervention was conducted to assess motivations to walk, based on two groups: adult dog owners and non-dog owners. The intervention consisted of general motivational emails for the non-dog owners, and messages related to dog walking for dog owners. Both intervention groups increased walking at 6 months and maintained this at 12 months, with dog owners experiencing the greatest increases (Richards et al. 2016[9] [n=105]). Compared with non-

(7) Study quality: medium. Self-reporting and the particular sample group (young and urban) are study weaknesses. Research method: self-completion survey. The questionnaire was developed from accepted tools (e.g. Pet Attitude Scale) and statistical adjustments were made. Empirical robustness: 2.

(8) Study quality: high to medium. Research method: birth cohort analysis. Sample is a reasonable size and the cohort study it is derived from is well regarded. Although the authors defend the retrospective nature of the study, this is likely to be a weakness, as is its self-reporting element. Retrospective analysis of dog walking habits and physical activity among adolescents. Empirical robustness: 2.

(9) Study quality: medium to low. Problems include the small sample, self-reporting and lack of clarity over attention to other variables. Research method: randomised controlled intervention and self-reporting survey. Empirical robustness: 2-3.



dog owners, dog owners walk more and spend more time in outdoor environments, especially those living in greener areas. However, a study in 2019, has reported no consistent associations between dog ownership and perceived general or mental health status (Zijlema 2019 [n=3,586 adults from Spain, the Netherlands, Lithuania and UK]).

For owners and their emotion disclosures, dogs appear to play a similar role to partners. Both owners and non-owners displayed no significant difference in willingness to talk to partners, indicating that 'dog talking' does not negatively affect human relationships and therefore the results have positive implications for psychological health (Evans-Wilday et al. 2018[10] [dog owners n=286; non-owners n=64]).

Despite the emerging empirical evidence from individual studies, there is still a gap in high-quality evidence clearly linking dog walking and disease prevention. A wide-ranging literature review has been conducted of the evidence for dog walking and disease prevention, and of the effectiveness of strategies to encourage dog walking (Christian et al. 2018[11]). The authors report that the evidence is almost exclusively in the form of longitudinal observation and intervention studies, with no especially high-quality evidence noted. The focus on sympathetic environments and the propensity to dog-walking leads to the conclusion that population-based interventions are at least as important as individual behaviour change. The authors also highlight that promoting dog walking among dog owners, who do not routinely walk their dogs, may be an effective strategy for increasing and maintaining regular physical activity. The role of organising buddy systems via 'loaner' dogs also was found to facilitate informal walking by dog owners and non-dog owners.

(10) Study quality: medium. Self-reporting nature and widely differing sample sizes between owners and non-owners pose difficulties for the study. Research method: self-reporting survey seeking information about emotional disclosure. Empirical robustness: 2-3.

(11) Study quality: medium. The wide focus of the paper leading to this conclusion suggests a reasonable ranking in terms of study quality. Research method: non-systematic literature review. Empirical robustness: 2.

1.4.2. Adulthood – at work inventions

Past research has found some evidence that pet ownership enhances employment prospects, and/or worker efficiency. Recently, there has been further research that strengthens the evidence relating to the benefits of the pet-human bond in the workplace context.

Research in 2012, found the level of stress felt by employees is lower for people with their dogs' present than for others (Barker et al. 2012). On dog absent days, owners' stress increased throughout the day mirroring the pattern of the group of employees without dogs. This study also reveals that the level of job satisfaction is higher for people who bring their dog to work.

A survey of dog owners has found participants responded positively to dogs in the workplace with the main potential problems being lack of workplace policies and other colleagues' dislike of dogs (Hall et al. 2017[12] [n=776]). Employees who 'often' took their dog to work reported higher than average work engagement on all factors: vigour, dedication, absorption, total (Hall and Mills 2019 – Nestlé Purina [n=749]). Turnover intention was also significantly lower and work-based friendship acuity higher for employees who 'often', compared to 'never', took their dog to work. Authors stressed that it is likely that the potential benefits of allowing dogs in the office will only be maximised through the implementation of well-designed policies. A key difficulty with this research is participant bias, with respondents who were dog owners likely to have a degree of favourability towards the issue.

A systematic literature review focussing on the impact of disability-assistance animals in the workplace reported three benefits. It positively affects disability support; it improves the productivity and psychological health of employees; and it increases workplace attractiveness (Hunter et al. 2019). The author acknowledges potential negative effects, such as allergies, phobias and disruptions when animals are introduced to a workplace.

1.5. OLDER / LATER LIFE HEALTH AND WELLBEING

Previous research identified some evidence of the positive benefits of the pet-human bond on the general health and wellbeing of older people. There is also a wider body of literature which focuses on the role of animal assisted therapy (AAT) and older people, which is explored in a later section. More recent work has strengthened the research on the general health and wellbeing benefits of the pet-human bond for older people, in particular relating to social isolation and promoting physical exercise /activity.

Raina et al. (1999) found that the physical activity levels of older people who are not pet owners deteriorated to a greater extent than those who owned pets. Older dog owners also report significantly more walking, higher total functional ability and greater perceived behavioural control than non-owners (Gretebeck et al. 2013[13]). In relation to the importance of pets for the mental and social wellbeing for older people, the 'Observatory Senior Italy'(2015)[14] found 93%

(12) Study quality: low. The key difficulty with this research is participant bias. All respondents were dog owners and therefore likely to have a degree of favourability towards the issue. International survey though primarily UK respondents. Research method: self-reporting survey. views about taking their dog to work (in the context of the 'Take Your Dog to Work' campaign). Empirical robustness: 3.

(13) Note only 77 of the total sample of n=1091 owned a dog.

(14) http://www.senioritalia.it/2015/07/federanziani-boom-animali-domestici-over-uno1/

of respondents (aged over 65) stated their pet was important or very important to their wellbeing and 97% felt that their pet was important in giving relief from illness or in improving their psychological state.

More recently, a systematic literature review of published research into the effect of companion animals on older peoples' physical and mental health indicates improvements in some aspects of older peoples' health as a result of animal companionship (Hughes et al. 2020)[15]. The study reviewed 70 articles investigating the effect of companion animals (whether as pets or in more formal intervention approaches) on the physical and mental health of older adults (aged 60+). In 52 of the articles examined, companion animals positively contributed to the mental and/or physical health of older adults. With respect to mental health, involvement with a companion animal improved participant quality of life and effectively attenuated symptoms of depression, anxiety, cognitive impairment, and the behavioural and psychiatric symptoms of dementia (BPSD). In relation to physical health, marked increases in physical activity and improvements in blood pressure and heart rate variability were consistent with physical health improvements observed from companion animal interactions.

Life satisfaction

Data from the Canadian Longitudinal Study on Ageing shows that pet ownership for over 65 year olds appears protective of life satisfaction in some circumstances where barriers exist to social participation (Toohey 2018 [n=7,474])[16]. Data from a nationally representative sample (from the German Ageing Service) was used to determine whether individuals (65 +) without a partner suffered in terms of depression, loneliness and social isolation according to whether or not they had a pet (Hajek and Konig 2019[17] [n=1160, pet ownership=952]). The study concluded there were no observable differences in men, but female dog owners were less socially isolated than women without pets.

Physical activity

A 2017 study investigated dog ownership and walking as a means of supporting the maintenance of physical activity in older adults during periods of inclement weather (Wu et al. 2017 [n=3,123]). In days with the worst conditions, those who walked their dogs had 20% higher activity levels than non-dog owners.

A further study evaluated the influence of dog ownership on health, enhancing physical activity and sedentary behaviour in independently-mobile, community-dwelling older adults (D'Aniello et al. 2017). The authors found that owning a dog indicated a large, potentially health improving effect, with the average effect of 22 minutes additional time spent walking (n=43 using activPAL monitors). Dog owners had significantly fewer sitting events, although no significant differences were reported relating to the total time spent sitting, or the number or duration of prolonged sedentary events.

(15) Study quality: high to medium. The review conforms to most of the requirements of a SLR, although the authors are clear that their search concentration was limited, and they did not submit the research reviewed to tests of strength of evidence. They assert that the latter was not the focus of what they conceived of as a narrative review, but it needs to be noted that evidence quality is established within the highest standard SLRs, both in relation to quantitative and, increasingly, qualitative evidence.

(16) Study quality: high to medium. Strengths include longitudinal extraction, but account of variables may be incomplete. Research method: data extraction from longitudinal study. Study to estimate associations between social participation and life satisfaction for pet owners and non-pet owners 65 plus. Empirical robustness: 2.

(17) Study quality: medium. Study weakness is its 'snapshot' status, where long-term observation might reveal more meaningful data about the mental health problems considered.

Mickova (2019) evaluated the effect of dog ownership on physical activity in older adults as well as its positive impact on perceived degree of health and sleep (n=44). Dog owners reported higher total physical activity time, time spent in walking, and spent calories per week. The results suggest that dog ownership may affect the overall physical activity and health of older adults.

Wellbeing and therapeutic effects

A study of the therapeutic effects of dog visits in nursing homes for the elderly found that dog visits did not affect measures of depression, cognitive function, or BMI (Thodberg 2016). A transient effect was found on sleep duration, but because this is the first study measuring sleep quality as an effect goal of AAT, the study authors recommended that more experiments are needed to determine whether this is a valid parameter to measure the effects of dog visits in this population.

Brooks et al. (2018) has reviewed the wider literature of evidence relating to the benefits of pet dogs as promoters of wellbeing in older people. It reports that for those who like dogs there is evidence that their presence can offer both psychological and physical health benefit. However, meeting their care needs may place an additional strain on an older person and/or a carer who has limited resources or physical capabilities.

In a population of older adults, pet ownership was significantly associated with a higher likelihood of ever having had depression (Mueller 2018 [n=1,657]). However, the study highlighted that it is impossible to determine the directionality of that relationship. It is possible that owning a pet may put a person at an increased risk of developing depression, or individuals who are at risk, or who have already developed depression, may acquire a pet as a way of managing their depressive symptoms.

Overall, the evidence is predominantly focused on dogs and there is limited evidence relating to cats. A study found older pet owners had fewer health conditions, although older cat owners differed from older dog owners, with higher BMIs, less physical activity, and less supplement usage (Heuberger, 2017).

1.6. LONELINESS AND SOCIAL ISOLATION ACROSS THE LIFETIME

An emerging theme in the evidence of the positive impact of the pet-human bond is related to human loneliness and social isolation. This includes pets acting as 'social catalysts' leading to greater social contact and interactions with other people, alleviating feelings of loneliness and social isolation. For example, McNicholas and Collis (2001, [n=3,465]) has reported that being accompanied by a dog increased the frequency of social interactions, especially interactions with strangers. Whilst Powell et al. (2018) found 61% of prospective adopters cited reduced loneliness as a benefit of dog ownership, and Powell et al. (2020) found companion dog acquisition may reduce loneliness among community dog owners.

Recent market research run by HABRI in collaboration with Mars Petcare found 80% of pet owners say their pet makes them feel less lonely. A quarter of pet owners interviewed stated they got a pet to improve their mental health, with respondents aged over 55 years old doing so more frequently (55%). Evidence from research conducted by WALTHAM shows that 54% of pet owners found socialising 'easier' upon getting a pet.

Evidence can be identified relating to the role of the pet-human bond with people at risk of social isolation due to physical disabilities, or who may lack opportunities for social interactions (McNicholas et al. 2005), including:

- Younger people (including homeless young people)
- Older people (including those living alone and women).

Important themes within this research are pet ownership as a possible protection against loneliness rather than a response to loneliness, and the impact of pet death on loneliness.

Younger people including those who are homeless

Black (2012) explored the relationship between loneliness and companion animal bonding (n=293). Pet owners reported significantly lower loneliness scores than non-pet owners. Companion animal attachment was positively related to the number of humans in the social support network. The results indicate that interventions promoting a pet relationship may be valuable in reducing loneliness among adolescents.

Rhoades et al. (2015) examined pet ownership amongst homeless youth in Los Angeles (n=398). The majority of pet owners reported that their pets kept them company and made them feel loved, with pet owners reporting fewer symptoms of depression and loneliness than their non-pet owning peers. On the other hand, nearly half reported that their pets made it more difficult to stay in a shelter. Cleary et al. (2020) presents similar findings with the advantages of companionship being a sense of responsibility and improved mental and emotional health, including alleviation of loneliness. Scanlon et al. (2020) draws on interviews from twenty homeless people and reports participants' descriptions of their pets as kin; the responsibility they felt towards their pet; and anticipatory grief when contemplating a future without their companion animal.

Older people

Banks and Banks (2002) have explored the role of pets and loneliness in older people, in relation to animal-assisted therapy (AAT) for the resident population in long-term care facilities (n=45). The study found residents volunteering for the study had a strong life-history of emotional intimacy with pets and wished that they currently had a pet. The study concluded AAT reduces loneliness in residents of long-term care facilities.

Stanley et al. (2013) explored the association of pet ownership and loneliness amongst older adult primary care patients (n=830, age > 60 years). The study found pet owners were 36% less likely than non-pet owners to report loneliness. An interaction was found in which living alone and not owning a pet was associated with the greatest odds of reporting feelings of loneliness.

Gan et al. (2019) conducted interviews with 14 community-dwelling older adults aged 65 and above, and concluded that pet ownership may provide companionship, giving a sense of purpose and meaning, reducing loneliness and increasing socialisation. Carver et al. (2018) explored factors influencing social participation and successful aging among rural-dwelling older adults. It cites the importance of supports which enable older people to spend time with others, including their pets.

Jain et al. (2020) reviewed forty-three studies on dog-assisted interventions (DAIs) among older people in residential long-term care facilities (RLTCFs). Almost half of the quantitative studies (n=18, 46%) found no significant changes over time or between groups across outcomes measured. The most salient intervention effects that could be identified included improved social functioning (n=10), reduced depressive symptoms (n=6) and loneliness (n=5). The findings of this review

indicate that while DAI has value for older people in RLTCF, challenges remain in accurately measuring its impact to provide a stronger evidence-base.

Older people – women

The role of pets in addressing loneliness amongst older people has also been explored by Krause-Parello (2012). The study focused on older women residing in the community (n=159). It found that pet attachment support, but not human social support, influenced the relationship between loneliness and depressed mood, indicating the importance of pet attachment as a greater form of support in this sample. Pikhartova et al. (2014) examined whether pet ownership is a response to, or protection against, loneliness (n=5,210). The study found owning a pet significantly influences later reporting of loneliness in women. In the reverse direction, reported loneliness influences pet ownership. In both directions, the relatively strong gender interaction suggests the association is limited to women with effects for men minimal or non-existent.

Hajek and Konig (2019) have examined whether cat owners, dog owners and individuals without pets differ in terms of depressive symptoms, loneliness and social isolation among individuals in old age without a partner (n=1,160). While there were no differences observed in men, female dog owners were less socially isolated and less lonely than women without pets. The study notes that additional longitudinal studies are required to deepen the understanding of this association.

Cats

A recent report by the All-Party Parliamentary Group on Cats (2020) examined the specific role of cats as companions and helping to tackle loneliness[18]. The report cites UK Government research which found 23% of UK adults feel lonely often. Key statistics were also cited from the 2019 PDSA Animal Wellbeing Report[19] relating to the role of cat ownership and loneliness, include:

- 91% of 18-34 year olds agreed that owning a cat made them feel less lonely
- 35% of owners said they got a cat to provide love and affection
- 26% of cat owners said they got a cat for companionship.

COVID-19 and loneliness and social isolation

Recent evidence has been published relating to the pet-human bond during the COVID-19 pandemic, with anecdotal evidence that people are relying on their pets to a greater extent and that pets have become more important to them during the pandemic[20]. Dog adoption has also increased during the pandemic (Morgan et al. 2020). However, there is also limited evidence of pets impacting overall life satisfaction and feelings of anxiety during this period (de Pedraza et al. 2020).

For further details relating to pet-human bond and COVID-19, see World Small Animal Veterinary Association (WSAVA)[21].

(18) http://www.apgocats.org.uk/wp-content/uploads/2020/06/APGOCATS_Loneliness-Report.pdf

(19) https://www.pdsa.org.uk/media/7420/2019-paw-report_downloadable.pdf

(20) https://www.independent.co.uk/life-style/coronavirus-pets-lockdown-emotional-mental-support-wellbeing-a9435651.html

(21) https://wsava.org/news/highlighted-news/the-new-coronavirus-and-companion-animals-advice-for-wsava-members/

2. Treatment of degenerative and chronic diseases

The research on the pet-human bond, in particular through the use of animal assisted therapy (AAT), in relation to degenerative and chronic diseases covers both physical and mental conditions and spans prevention, treatment (e.g. pain relief) and recovery (e.g. rehabilitation and assisting with anxiety / loneliness). These challenges can be grouped as follows:

- Cancer
- Cardiovascular disease (CVD)
- Atopy[22] / allergies / asthma
- Autism and childhood development disorders
- Chronic mental health conditions (dementia, Alzheimer's disease)
- Fibromyalgia (pain management).

This section also covers the emerging dimension of the impact of AAT research and therapy sessions on the wellbeing of the therapy dogs.

2.1. CANCER

Previously **limited evidence** has been identified associated with the role of the pet-human bond in relation to cancer. This review has found some **further evidence, which is mixed**, relating to the beneficial role of pets and cancer. This remains an area with limited studies.

A multi-centre randomised trial on the effects of therapy dog interventions on children with cancer reported benefits for children and parents in the initial stages of treatment, although differences between intervention and control groups lessened over time (McCullough 2018[23] [n=107]).

A 2018 study examined the relationship between pet ownership and risk of dying from cancer using data from 1988-94 (Buck et al. 2018[24] [n=13,725]). Keeping birds and cats in households was associated with an increased risk of dying from cancer, especially in women.

A limited review of literature relating to pet ownership and cancer notes that benefits include the positive effect on emotional well-being for some patients, but also highlights concerns relating to the potential threat of zoonotic infections (Chan and Tapian 2019[25]).

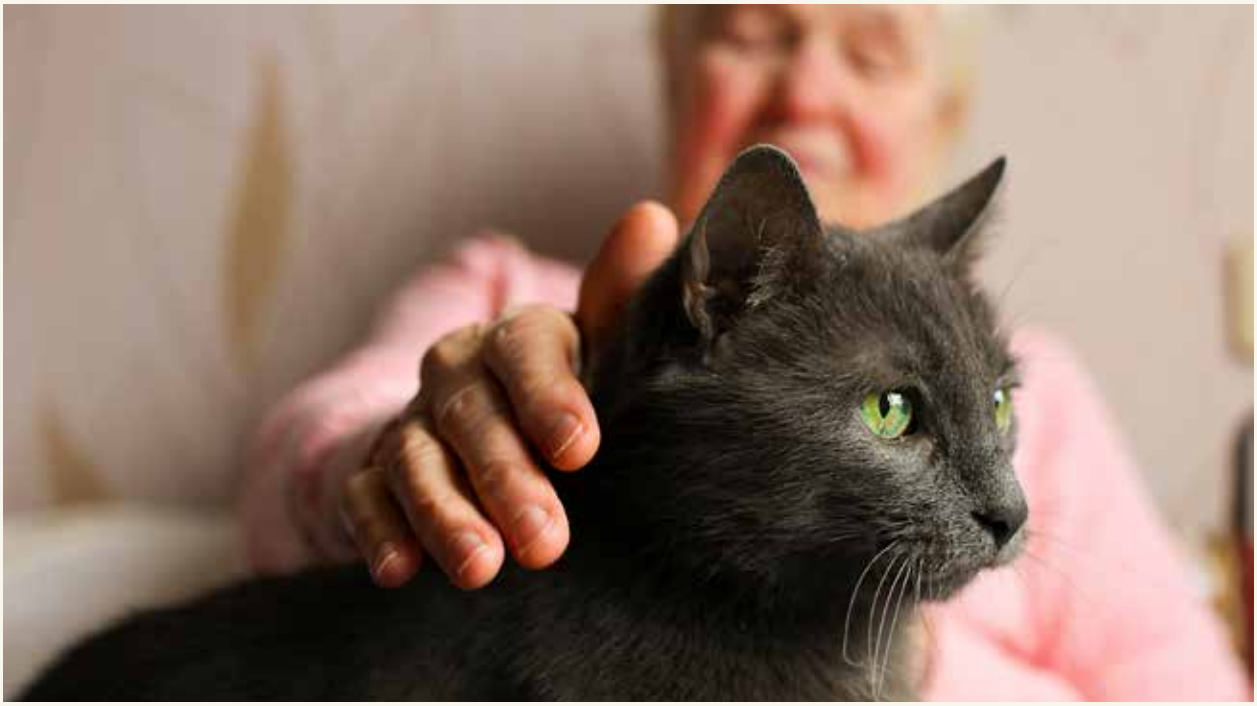
Note: this section includes specific studies relating to AAT. More general and theoretical studies relating to AAT are covered in section 4.

(22) Atopy (atopic syndrome) is a syndrome characterised by a tendency to be 'hyperallergic'. A person with atopy typically presents with one or more of the following: eczema (atopic dermatitis), allergic rhinitis (hay fever), or allergic asthma.

(23) Study quality: high to medium. Relatively small sample size and self-reporting are potential study weaknesses. Self-reported data collection over four months of treatment. Research method: randomised controlled self-completion survey. Empirical robustness: 2.

(24) Study quality: high- medium. NHNES relies on self-reported data, although it employs robust adjustment methodologies. Research method: longitudinal survey. Empirical robustness: 1-2.

(25) Study quality: low. The areas chosen for review appear as self-selected and based on the authors' experience and interests: this is not a systematic review. Research method: non-systematic literature review. Empirical robustness: 3.



2.2. CARDIOVASCULAR DISEASE (CVD)

Earlier research identified that the strongest evidence of benefits to human physical health from the pet-human bond relates to CVD. Studies explored different dimensions of the pet-human bond and specific CVDs including blood pressure, heart rate, blood lipids and autonomic tone and cardiovascular reactivity.

The current review found further research which support and strengthen this evidence. Starting with two of the strongest studies:

The comprehensive review conducted by the American Heart Association which found that *"some, but not all, studies of pet ownership and systemic blood pressure have found an association between pet ownership and lower blood pressure*". Further *"a positive or beneficial relationship between cat and dog ownership and autonomic function or cardiovascular reactivity to stress has been reported in most studies"*, although the review found *"there is minimal data on the association of pet ownership and lipid levels"* (Levine et al. 2013).

A recently published high-quality study is the systematic review and meta-analysis of studies published between 1950 and 2019. The authors found ten relevant studies yielding data from 3,837,005 participants. From this review, dog ownership was associated with a 24% risk reduction for all-cause mortality as compared to non-ownership. For individuals with prior coronary events, living in a home with a dog was associated with an even more pronounced risk reduction for all-cause mortality. Restricting analyses to studies evaluating cardiovascular mortality, dog ownership conferred a 31% risk reduction for cardiovascular death (Kramer et al. 2019[26]).

(26) Study quality: high. However, while this SLR itself is sound, there seem to be difficulties with the quality of the research examined. Research method: systematic literature review. Empirical robustness: 1-2.

(27) Study quality: medium. The limited association adjustment is a weakness, although the sample size is reasonable. (The data interpreted was from a more extensive data set.) Research method: longitudinal data interpretation. Empirical robustness: 2.

El-Qushayri et al. (2020) assessed the association between pet ownership and cardiovascular risk factors and mortality. Based on a review of 26 studies, higher survival rate was observed in the pet owners' group. Pet owners had significantly lower heart rate, mean arterial pressure and systolic blood pressure but not diastolic blood pressure. No significant difference was observed between pet owners and non-pet owners in prevalence of hypertension.

A longitudinal study of American adults aged over 50 years without established cardiovascular disease concluded that pet ownership is associated with low rates of CVD deaths / stroke. This is largely attributed to cats rather than dogs, although the authors did not offer any specific conclusions relating to the positive impacts of cats (Ogechi et al. 2016[27] [n=3,964]).

One study draws upon the Swedish National Patient Register to offer an association of dog ownership with reduced risk of hospitalisation for recurrent myocardial infarction, although the authors note confounding factors such as smoking prevent conclusions regarding a possible causal effect (Mubanga et al. 2019 [n=321,430]).

For men, exposure to pet ownership in utero and having more than two pets decreased the prevalence of hypertension. For women, having one pet lowers the risk of hypertension. Pet ownership, having one pet and having other animals as pets, decreased hypertension (Xu et al. 2016). A literature review on the *Impact of Pets on Cardiovascular Risk Prevention* notes that the benefits of companion animals are most likely to be through reduction in depression, anxiety, and social isolation, but the studies have been largely cross sectional[28] and may depend on the degree of bonding of the owner with the animal (Schreiner 2016).

2.3. ATOPY, ALLERGIES AND ASTHMA

Previous research has discussed the long running debate in the scientific literature on the negative or positive impact of pets on atopy[29]. In particular, the epidemiological study from Sweden, which studied over a million children, conclusively showed that *"exposure to dogs and farm animals during the first year of life reduces the risk of asthma in children"* (Fall et al. 2015). Specifically, toddlers who grow up with a dog in the home before the age of one have a 13% lower risk of asthma by the age of six (Fall et al. 2015). The 2019 review identified important developments within the evidence-base associated with the pet-human bond and human allergies and asthma, in particular relating to the number of pets (mini-farm effect) and the rural-vs-urban context. As a result, the evidence remains mixed with potential conflicting findings between studies (Mendy et al. 2018; Simoneti et al. 2018).

Cross sectional (n=1,029) and birth (n=249) cohorts of children aged 7-9 in two Swedish rural areas were drawn upon to investigate dose-dependent association between cat / dog ownership in the first year of life and subsequent allergy development (Hesselmar et al. 2018[30]). Increasing the number of household cats and dogs during the first year of life was associated with fewer allergic manifestations (asthma, allergic rhino-conjunctivitis, eczema), with the authors suggesting a 'mini-farm' effect (i.e. the greater the number the more the reduction). A second study also

(28) A cross sectional study analyses observational data from a population, or a representative subset, at a specific point in time.

(29) Atopy (atopic syndrome) is a syndrome characterised by a tendency to be 'hyperallergic'. A person with atopy typically presents with one or more of the following: eczema (atopic dermatitis), allergic rhinitis (hay fever), or allergic asthma.

(30) Study quality: high to medium. Study weakness may lie in particularity of its settings and a broader 'allergen-protective' environment contained within these. Research method: cross-sectional self-completion survey, longitudinal interviews and clinical markers. Cross-sectional data gathered through questionnaires: birth data through interviews and clinical markers. Empirical robustness: 1-2.

discovered a dose-response relationship between pet keeping and allergies (Luo, S 2018[31] [n=7,360 children]). However, it is not clear to what extent the findings were adjusted for other possible variables and the self-reporting nature of participant responses may be problematic.

A further 2018 study assessed the effect of fur-bearing pets on humans with allergic conditions and identified a key difference between pet ownership in rural areas (where a preventative effect was identified) and in urban areas, where allergic symptoms were exacerbated (Krzych-Falta et al. 2017[32] [n=18,617]).

Other studies have challenged the positive relationship between pets and allergen prevention.

A 2018 study examined whether exposure and sensitisation to dog and cat modifies the relationship between endotoxin exposure and asthma and wheeze (Mendy et al. 2018 [n=6,051]). It found that exposure to dog and cat allergens enhances the association of endotoxin with asthma and wheeze. The authors concluded that future studies should evaluate whether environmental measures to reduce levels of cat and dog allergens as well as endotoxin can be effective in reducing asthma and wheeze symptoms in the long term.

This research is supported by another study investigating the prevalence of asthma and lung function status among dog and cat owners (focus on exposure in adults). Data demonstrated that exposure to cats was associated with increased risk of asthma, while exposure to dogs is associated with reduced lung function. Reduction of pulmonary function can be associated with endotoxin exposure, which causes inflammation and may rapidly lead to changes in lung function (Simoneti et al. 2018 [n=125]).

A further study found exposure to dogs but not cats is associated with a decrease in the prevalence in atopic dermatitis amongst school children. Exposure to outdoor dogs was associated with nocturnal coughing and with atopic dermatitis. Exposure to outdoor cats was associated with nocturnal coughing and current rhinitis symptoms. After carrying out the multivariate analyses[33], only exposure to dogs, both indoor and outdoor, was significantly associated with a decrease in the prevalence of atopic dermatitis (Bedolla-Barajas et al. 2018 [n=30,254]).

More recently, in 2020, Ojwang et al. investigated independent and synergistic associations between exposure to indoor pets and farm animals during infancy and the risk of asthma and allergy by age 5 [n=3,781]. Having a dog in the house was found to be inversely associated with the risk of asthma. Having a cat was associated with a decreased risk of atopic eczema. The authors conclude having a dog or cat in the house during the first year of life may protect against childhood asthma and allergy.

A useful study on the state of research on allergens highlighting the changing nature of the association between early-life cat exposure and specific sensitisation during childhood. The assessment of outcomes shows the key role of the time of the exposure (Ihuoma et al. 2018).

(31) Study quality: medium to low. It is not clear to what extent the findings were adjusted for other possible variables, and the self-reporting nature of participant responses may be problematic. Research method: cross- sectional survey. Empirical robustness: 2.

(32) Study quality: High to medium. Sample size and mixed methods are study strengths but (as the authors acknowledge) environmental differences between urban and rural areas will have an effect, so the pet association cannot be specific. Research method: self- completion survey and clinical testing. Study group (n=18617) from urban (16562) and rural (2055) areas of Poland. A web-based questionnaire preceded (in 7000 cases) clinical testing. Empirical robustness: 1.

(33) Multivariate analysis (MVA) is based on the statistical principle of multivariate statistics, which involves observation and analysis of more than one statistical outcome variable at a time. Typically, MVA is used to address the situations where multiple measurements are made on each experimental unit and the relations among these measurements and their structures are important.

2.4. AUTISM SPECTRUM DISORDER (ASD)

Previous research has found a strong level of evidence of the benefits associated with the pet-human bond relating to children with ASD. More recent publications have provided further evidence of these benefits, although small samples should be noted.

In 2015, Wright et al. found that, in families where a child had ASD, dog presence significantly improved total stress management / reduction, parental stress management / reduction and the behaviour of 'difficult' children, although some methodological weakness in the study was noted. These findings were supported by a further study involving children with ASD which found parental reporting of an increased interest in attending school (O'Haire et al. 2014).

More recently, ASD patients under the care of a Dutch mental health organisation who received sessions with therapy dogs have reported increased social awareness and communication, and improvement in symptoms of agoraphobia (Wijker et al. 2020[34] [n=53]).

The benefits of animal-assisted activities for psychiatrically hospitalised youth with ASD were investigated (Germone et al. 2018[35] [n=47]). Overall, the study found social-communication behaviours (positive emotional facial expressions, talking, use of gestures looking at both adults and peers) significantly improved in the animal-assisted activities experimental conditions.

Parent and therapist perception of the role of Animal-Assisted Activity (AAA) for children with ASD were investigated by Michelotto et al. 2019 [n=15]). According to therapists, AAA increased positive gestures and facial expression in children and improved peer interaction. Parents also reported a reduction in self-aggression and repetitive stereotyped movements, as well as an improvement in speech communication and creativity.

More recently, Silva (2020) evaluated whether contact with dogs may be a useful approach to elicit spontaneous imitation in people with ASD (n=25). The study found children appeared more motivated and engaged more frequently in spontaneous imitation in the live dog condition than in the conditions without the dog. The authors note that the results are preliminary. Other recent studies include Protopopova et al. (2020) who examined animal-assisted intervention (AAI) within early community care for children with ASD and Avila-Alvarez (2020) who examined the role of AAI for ASD in Spain).

2.5. DEMENTIA AND ALZHEIMER'S DISEASE (AD)

Previous research has shown some / strong evidence to suggest that the pet-human bond (in particular via AAT) may ameliorate some of the behavioural and psychological symptoms associated with dementia, but the duration of the beneficial effect has not been fully explored (Filan, 2006). AAT also appears to have positive impact on the management of schizophrenia (Chu et al. 2009) and to enhance ACE[36] inhibitor therapy aimed at lowering blood pressure associated with mental distress (Allen et al. 2001). The 2019 review found limited new research to strengthen

(34) Study quality: medium. Accepted scales (mainly self-administered) were used to gather results but the authors acknowledge that sample size was small, and the sample itself relatively homogenous. Research method: randomised controlled study, randomised in control and intervention groups. Empirical robustness: 2.

(35) Participants' data captured via video and coded using Observation of Human-Animal Interaction for Research, a tool specifically developed to capture human interactions in the presence of animals.

(36) An angiotensin-converting-enzyme inhibitor (ACE inhibitor) is a pharmaceutical drug used primarily for the treatment of hypertension (elevated blood pressure) and congestive heart failure.

the evidence of the pet-human bond for the treatment of degenerative mental health conditions such as dementia including Alzheimer's disease.

Engagement in a group AAA seems to create engagement and might be a suitable health promoting intervention for persons with dementia. However, the degree of dementia should be considered when planning AAA (Olsen et al. 2019 [n=49]).

Olsen et al. (2016) reports the result of a 12-week intervention with AAA in nursing homes (n=58) and found a significant effect on depression and quality of life for participants with severe dementia at follow-up. For quality of life, a significant effect of AAA was also found immediately after the intervention. No effects on agitation were found. The study concluded that AAA may have a positive effect on symptoms of depression and quality of life in older people with dementia, especially those in a late stage.

AAT may contribute to enhancing quality of life for persons with dementia in an aged care home. However, quality of life improved in both the intervention and the control group, with no significant difference between groups (Briones et al. 2019 [n=34]).

A small study used video-recorded observations of interactions between a person with Alzheimer's disease and dogs. The research reported feelings evoked in the people with AD included empathy and altruism, which allowed for a sense of joy and tenderness, which may induce a sense of self-worth, of being needed, and of being meaningful (Swall et al. 2017 [n='Four wards' of people]).

Hu et al. (2017) examined the efficacy of AAI for cognitive impairment patients, including reviewing five randomised controlled trials and five quasi-randomised controlled trials involving 413 participants. Compared with control groups, AAI groups exhibited significantly fewer behavioural and psychological symptoms of dementia (BPSD), especially depression and agitation. In both the short and long term, AAI had beneficial effects on BPSD in cognitive impairment patients. However, no significant improvements were found in daily living activities,

quality of life or cognitive score. The meta-analysis showed that AAI can be effective in reducing BPSD in patients with cognitive impairment.

Lai (2019) evaluated the efficacy and safety of AAT for people with dementia, reviewing nine RCTs. Comparing AAT versus no AAT, participants who received AAT were slightly less depressed after the intervention, but they did not appear to have improved quality of life. The authors found low-certainty evidence that AAT may slightly reduce depressive symptoms in people with dementia.

2.6. FIBROMYALGIA (PAIN MANAGEMENT)

Marcus et al. (2013) evaluated the effects of brief therapy dog visits for fibromyalgia patients attending a tertiary outpatient pain management facility compared with time spent in a waiting room (n=106). The study reports significant improvements for pain, mood, and other measures of distress among patients after the therapy dog visit but not the waiting room control. Clinically meaningful pain relief (≥2 points pain severity reduction) occurred in 34% after the therapy dog visit and 4% in the waiting room control.

2.7. IMPACT OF ANIMAL ASSISTED THERAPY ON WELLBEING OF THERAPY DOGS

An emerging dimension of AAT research and practice is the impact of AAT activity and therapy sessions on the wellbeing of the therapy dogs. Clark et al. (2020)[37] has examined the effects of these interactions on the dogs by considering multiple physiological measures known to be associated with emotional state (continuous heart rate, heart rate variability, pre- and post-session tympanic membrane temperatures, and salivary cortisol and oxytocin concentrations). The study draws evidence from nineteen canine therapy dogs who completed five 20-minute AAA visits each in an outpatient clinical setting (Mayo Clinic Fibromyalgia and Chronic Fatigue Clinic). From a physiological perspective, the dogs showed a neutral to positive response to the AAA sessions. Heart rate was significantly lower at the end of the session compared with the beginning. The right tympanic membrane temperature was lower post-session. All other emotional indicators remained stable between pre- and post-session. These results suggest that the dogs involved were not negatively affected by their participation in the AAA. Moreover, there was some evidence suggesting the dogs may have been in a more relaxed state at the end of the session (lower heart rate and lower right tympanic membrane temperature) compared to the beginning.

Effect on dogs of AAT – ADHD

Melco (2020) has evaluated the impact that participation in sessions with children with Attention-Deficit Hyperactivity Disorder (ADHD) has on therapy dogs. At the end of each activity, heart rate was monitored, and a saliva sample was obtained for cortisol analysis. Dogs demonstrated only occasional behavioural responses and no significant findings related to cortisol or heart rate. The results indicate that with proper supervision and well-trained therapy staff, including suitable therapy dogs and their handlers, canine stress can be minimal in a therapy setting.

(37) Nestlé Purina Research.

3. The role of the bond in building a more inclusive society

Previous research has identified relatively few studies that applied a broad sociological, economic, environmental or systems perspective to generate data and understanding of wider social benefits of the bond, in particular the role of the pet in creating individual social capital[38] and supporting a more inclusive society.

The 2019 review has sought to further understand this area of the bond, and considers five areas in which the pet-human bond may support a more inclusive society (either for individuals or communities):

- People with disabilities (and assistance pets)
- Military and service people, post trauma
- People in prison including young offenders and substance misusers
- Marginalised and disadvantaged people (including homeless)
- Improving social cohesion in cities.

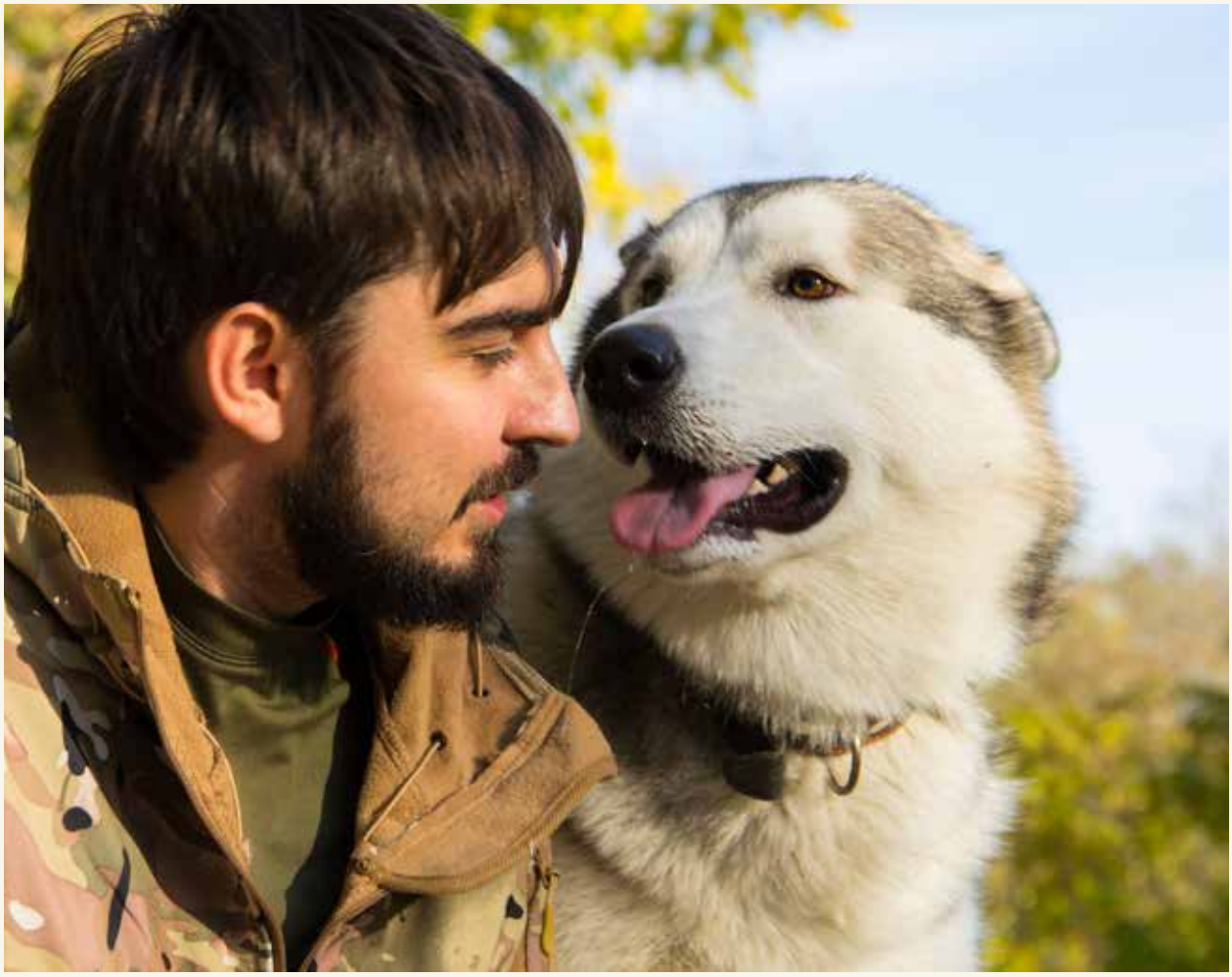
3.1. PEOPLE WITH DISABILITIES (AND ASSISTANCE PETS)

Whilst the benefits of dogs to blind people is universally acknowledged, only a small number of scientific studies (and some evidence) have covered the wider range of disabilities which could benefit from AAT, including people with chronic ambulatory disabilities (Allen & Blascovich 1996), people suffering from epilepsy (Strong et al. 1999) and the deaf (Guest et al. 2006). The 2019 review identified some additional research to strengthen the acknowledged benefits of assistance animals for people with disabilities.

Whilst guide dog ownership was not associated with a better Quality of Life (QOL), yearly medical cost expenditures were described as lower in guide dog owners, who were also more likely to believe that guide dogs can increase their independence and exert positive effects on health (Glenk (2019 [n=36]).

An online survey aimed to increase understanding of Psychiatric Assistance Dog use for people living with mental health disorder. Every participant described the relationship with their dog as positive (Lloyd et al. 2019 [n=199]). Tasks the dogs performed for their owners included: reduction of anxiety through tactile stimulation (94%); nudging / pawing to bring back to the present (71%); interrupting undesirable behaviour (51%); constant body contact (50%); deep pressure stimulation (45%) and blocking contact from other people (42%).

(38) Social capital theory holds that social capital exists and can be measured in a community and that it is made up of the quantity and quality of social networks, personal relationships and the co-operative quality of a society's social interactions. Three types of social capital are often distinguished: bonding social capital (e.g. among family members or ethnic groups); bridging social capital (e.g. across ethnic groups); and linking social capital (e.g. across political classes). Variations in the strength or weakness of social capital are reflected in and may partly explain variations in key social outcomes. These outcomes include reduced crime rates, higher educational performance, lower mortality and morbidity and better economic performance (French and Gordon 2015).



A literature review on hearing dogs concludes that they play an important role in improving the quality of life of people with hearing impairment, especially for those who have particular concerns about their safety or with problems of social isolation (Martellucci 2019).

3.2. MILITARY AND SERVICE PEOPLE – POST TRAUMA

A new theme identified by the 2019 review relates to the emerging evidence of the role of pets and assistant animals in supporting current or ex-military or service people.

Military individuals with a service dog have been found to exhibit significantly better psychosocial health including higher social, emotional, and work / school functioning, compared to those without service dogs (Bibbo et al. 2019 [n=154]). However, there was no significant effect of having a service dog on anger, companionship, or sleep disturbance.

Animal Assistance Interventions (AAI) have been shown to reduce stress in aeromedical evacuation military patients (Krause-Parello 2019 [n=120]). The study showed that cortisol decreased significantly in the AAI group, particularly for those who report higher post-traumatic stress syndrome. Some evidence was found that service dogs provide better emotional health-related quality of life beyond the recipient to family members' psychosocial health and functioning (Bibbo 2019).

3.3. PEOPLE IN PRISON, INCLUDING YOUNG OFFENDERS AND SUBSTANCE MISUSERS

An emerging theme relates to the role of the pet-human bond and AAI in supporting people within prison settings (noting small sample sizes).

The levels of empathy in the journal writing of youth inmates in detention centres in the USA who were participating in the Teacher's Pet programme were assessed (Syzmonski et al. 2018[39] [n=73]). The randomised sample was controlled between youth who trained the dogs (intervention group) and those who simply walked them (control group). The intervention group demonstrated greater levels of empathy, attachment and social-cognitive growth than the control group.

The experiences of male young offenders following completion of a dog training programme were examined (Leonardi et al. 2017[40] [n=70]). Positive effects included increases in motivation, charitable purpose, self-efficacy, improved skills, impulsivity, and emotional management.

The impact of a canine AAT program in a Canadian psychiatric prison was assessed. Results included prisoners demonstrating increased recognition of their personal feelings and emotions and positive impact on conduct (Dell et al. 2019: sample size unclear [24 sessions]).

The effectiveness of Prison-based Animal Programs in the Netherlands is currently being examined: Dutch Cell Dogs (Schenk 2018) covers 256 people from 12 justice centres including psychiatric, juvenile and adult facilities. The result is expected to be published in 2020-2021.

A 2018 study examined key themes that drive the success of a dog programme aimed at incarcerated youth serving time in an adult prison, including the symbolism of the dog, its role in therapy, perceptions of positive behaviours and rehabilitation, a sense of normality, and universal support by inmates (Smith and Smith 2019[41] [n=31]).

A pilot study reports that drug addicted male inmates in Italy involved in dog assisted therapy sessions have significantly improved their social skills, reducing craving, anxiety and depression symptoms compared to the control group (Contalbrigo et al. 2017 [n=22]).

3.4. MARGINALISED AND DISADVANTAGED PEOPLE (INCLUDING HOMELESS)

Previous research has found some evidence that pet ownership may be especially important for those young people who are marginalised or disadvantaged. More recent publications provide limited additional evidence to strengthen the role of the pet-human bond in supporting marginalised and disadvantaged people. However, one emerging area related to the role of AAA for children who have been exposed to gender-based violence.

In 2015, a cross-sectional survey discovered that young people who were homeless and pet-owning reported positive emotional and mental health benefits, including fewer symptoms of depression and loneliness. There were also difficulties associated with ownership, including access to appropriate accommodation (Rhoades et al. 2015 [n=398]).

(39) Study quality: high to medium. While the study is carefully constructed, with particular attention to the coding of texts, there are difficulties including skewed sample sizes and uneven randomisation. Troubled youth are paired with hard-to-adopt shelter dogs for multi-week workshops. Research method: textual analysis. The size of the divide was in favour of the intervention group for practical reasons. Empirical robustness: 2.

(40) Study consisted of semi-structured interviews with 70 male young offenders.

(41) Male youth (n=31) were provided survey questions.

More recently, an integrated literature review indicates a strong bond between those who are homeless and their companion animals. This relationship provides a number of benefits to the homeless person as well as to the animal, including safety, responsibility and improved emotional and mental health. However, the relationship can also add challenges, including decreased access to accommodation, decreased effort to find shelter and emotional vulnerability relating to fear of losing their companion pet (Cleary, 2019).

A study examined 'Leaving a Mark', an AAI programme for children who have been exposed to gender-based violence, and its effect on their associated clinical symptoms. Clinical symptoms were assessed using the Child Behaviour Checklist. After taking part in the AAI programme, the children showed a reduction in internalising symptoms and in symptoms associated with post-traumatic stress disorder. However, no significant changes were observed in externalising symptoms or in affective and behavioural dysregulation. Results provide preliminary support for the use of the Leaving a Mark programme (Muela et al. 2019 [n=19 children, 13 boys and 6 girls]).

3.5. IMPROVING SOCIAL COHESION IN CITIES

A new, emerging area of research was the role of pets in supporting wider community cohesion, in particular within cities.

Research suggests that socio-demographic variables (i.e. age, gender, housing, and education level) have stronger predictive values than companion animal ownership status with respect to the well-being of people in Hong Kong. However, results suggested that companion animals may still serve as a social lubricant between the owners and their significant others, thereby playing a heightened role in enhancing general social connectedness in a metropolis (Wong et al. 2019 web-based survey [n=986]).

A small randomised controlled trial, to understand the role of received AAT as an adjunct to intensive family preservation services, found that all four targeted family functioning outcomes were significantly increased. These improvements were sustained in two of the subscales (Flynn et al. 2019 [n=14]).

4. Innovations for health and care technologies and approaches

There are a number of developments within the pet-human bond which offer potential innovations for supporting the wider prevention and treatment of healthcare of human populations across Europe:

1. AAT related to wider health care developments in Europe.

2. One Health, in particular for prevention and treatment of obesity (human and pet).

4.1. ANIMAL ASSISTED THERAPY (AAT)

Previous research has recognised that AAT represented an important concept across the pet-human bond literature and found more research papers, and strong evidence, focused on AAT than on any other single field of study. Such research predominately describes either benefits that accrue from animal involvement in managing short term conditions or benefits to those who need long term support, for example the positive impact of animals in care homes for the elderly. Most studies focused on particular treatment pathways and / or support for people with particular health or social isolation issues. The evidence also tended to focus on older people or children, with fewer studies focused on the middle years of life.

In addition to the applications of AAT as discussed in relation to specific degenerative or chronic non-communicable diseases (cancer, CVD, autism, dementia), this review has found further evidence relating to the wider role of AAT in health care and treatment across Europe, which can be grouped in to three areas (as below). *However, the majority of this research is still focused on specific case-studies. In addition, the sample sizes of the majority of these new studies are small.*

Practicalities of animals in a healthcare setting

One study evaluated whether AAT with the presence of a dog affects the stress level of nurses, using salivary cortisol level testing as a stress biomarker (Mickova et al. 2019 [n=20]). The results demonstrated a reduction of cortisol levels in certain situations, with the recommendations including the use AAT with a dog in healthcare facilities where nurses are at a high risk of stress.

A survey of Dutch nursing homes revealed 108 using dogs and 76 using rabbits in animal assisted interventions. However, their use was recreational rather than therapeutic. In terms of protocol / animal selection, little had been established in terms of impact on residents' wellbeing (Schuurans et al. 2016[42] [n=244]).

Note: this section focuses on the bigger picture of AAT as part of healthcare within Europe. Specific AAT studies relating to specific NCD are covered in the previous sections.

(42) Study quality: low. Interesting snapshot survey but its overall substantive value is unclear. Research method: self-reporting survey. Empirical robustness: 3.

AAT and children in hospital

Two studies have reviewed the role of AAT in relation to children in healthcare situations, in Sweden and Spain respectively (Lindström Nilsson et al. 2020 and Elizalde et al.[43]). Children's well-being increased from moderately good to very good after AAT and the children assessed the hospital stay as better after than before (Lindström Nilsson et al. 2020 [n=50]). The use of AAT for children undergoing magnetic resonance imaging (MRI) can result in a beneficial effect on patients' emotional status, easing anxiety, without impacting MRI quality or duration (Perez et al. 2019 [n=21]).

AAT in treatment and pain management

There is some evidence of AAT in other treatment areas of hospitalisation e.g. the effect of therapy dogs on pain and anxiety. However, these are emerging findings with small samples. For example, one study assessed patients in a busy hospital emergency department for the effect of therapy dogs on their pain and anxiety (Kline et al. 2019[44] [n=40]). Dog patients reported statistically significant decreases in anxiety compared with non-dog patients and required less pain relief.

A randomised control trial investigated the immediate effects of AAT on the concentration and attention span of brain-injured patients. Patients' attention span did not differ whether an animal was present or not. However, patients displayed more instances of distraction during AAT (Gocheva et al. 2019 [n=19]). AAT leads to higher consciousness in patients in a minimally conscious state during a therapy session. Patients showed more eye movements and active movements per tactile input during AAT. No difference was found for positive emotions (Hediger et al. 2019 [n=10 patients, randomised trial]).

The role of AAT in the postoperative recovery of patients after total hip arthroplasty and total knee arthroplasty was evaluated. A therapy dog has a positive effect on patients' pain level and satisfaction with their hospital stay (Harper 2016 [n=72]).

Having pets can facilitate behaviours and thoughts that may enhance coping strategies for older adults with chronic pain e.g. mood management, relaxation / distraction, physical activity, behavioural activation, social activation and sleep (Janevic 2019 [n=25[45] people over 70 years old]).

4.2. ONE HEALTH – FOR OBESITY PREVENTION

Previous research has discussed the emerging shift in thinking on the animal-human relationship calling it 'One Health' (e.g. Takashima and Day 2014).

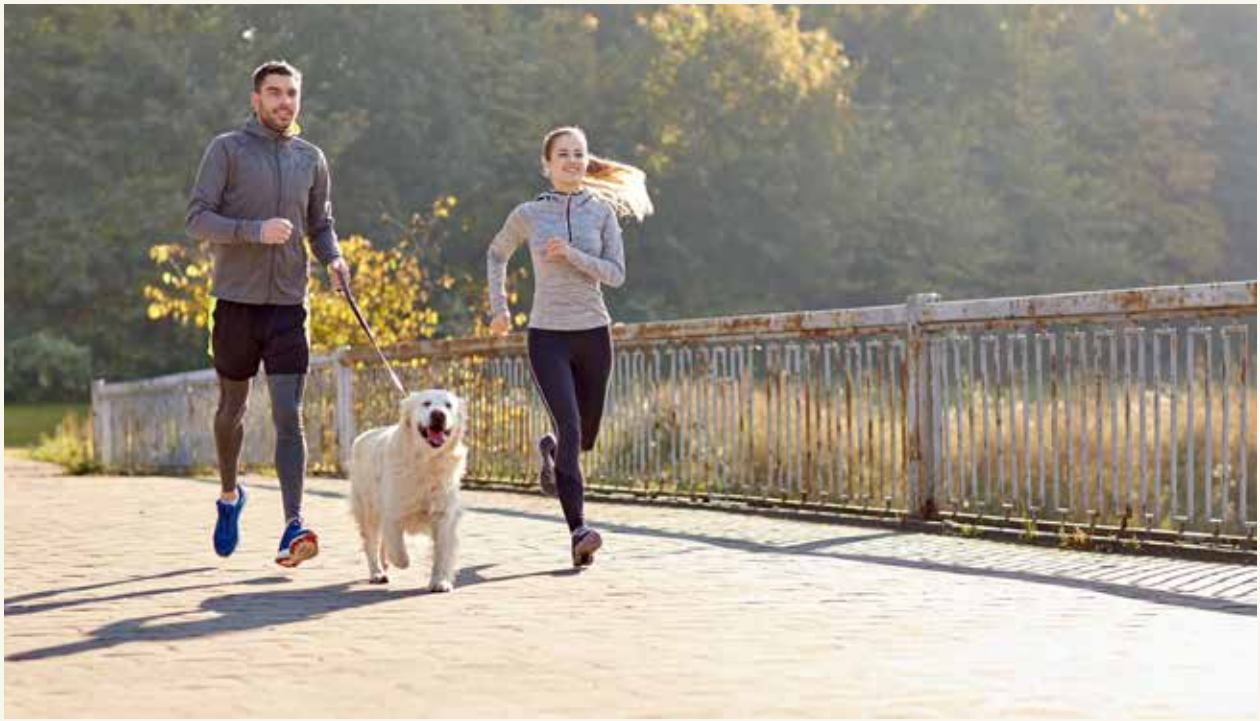
The international 'One Health' movement advocates greater integration of animal with human medicine, changing the relationship from humanity's historic concerns with animal surveillance and threat[46]. In this context, there is a range of literature which discusses One Health and

(43) Study quality: low. Descriptions are interesting and quite detailed, but it is not clear what methodology and methods have been used to justify the claims of benefit. Elizalde, E-D et al. Hospital Sant Joan de Deu, Barcelona, Spain. Description and attempt at evaluation of animal assisted intervention (IAA) (dogs) with children and adolescent patients at this Spanish hospital. Research method: descriptive evaluation. Empirical robustness: 3.

(44) Study quality: high to medium. Patients, physicians and dog handlers were asked to rate the experience (physicians were blinded to patient responses). The relatively small number of participants is a study weakness, against the strengths of the controls and the use of multiple data sources. 81% of study participants were women, with researchers suggesting that this might relate to the over-identification by ED staff of women as anxious and thus more likely to be chosen as research participants. Research method: self-completion survey, interviews, clinical markers. Empirical robustness: 2.

(45) Through analysis of transcripts.

(46) To improve health and well-being through the prevention of risks and the mitigation of effects of crises that originate at the interface between humans, animals and their various environments.



Zoonosis[47] (e.g. Day 2016). As this review is focused on the pet-human bond, this is not included here, for further details, see World Small Animal Veterinary Association (WSAVA)[48].

In addition, recent publications have explored the role of One Health as a tool / technique for improving human and pet health particularly to promote physical exercise to address pet and human obesity. A review of the literature discusses the costs, behaviours and psychology related to obesity in people and pets and proposes potential techniques that can be considered for prevention and treatment of this disease in pets (Bomberg et al. 2017). A 'One Health' approach to obesity suggests that an understanding of human obesity may elucidate some of the factors driving the more recent rise in pet obesity.

A cross-sectional study was conducted to determine the possible correlation between owner psychology and the development of cat overweight / obesity, using data from a multinational online questionnaire on owner psychology and cat health (Wall et al. 2019[49] [n=6,835]). A range of owner- (e.g. conscientiousness) and cat- (e.g. age and gender) factors were identified, indicating the complexity of the problem of cat obesity. An online survey identified that duration and frequency of walking were negatively associated with being overweight[50] (German 2017 [n=11,154]).

(47) Disease which can be transmitted to humans from animals.

(48) https://wsava.org/committees/one-health-committee/

(49) Study quality: high. Owner self-reporting of obesity / overweight is a study difficulty. Research method: self-reporting survey. Empirical robustness: 2.

(50) Study quality: medium. Strength is survey size, but weaknesses include cross-sectional nature and survey self-selection / self-reporting. Research method: cross-sectional self-reporting survey. Empirical robustness: 2.

The impact of obesity reduction measures in humans and their companion animals was assessed (Bartges et al. 2017[51]). Two groups of pet owners (n=36) and non-pet owners (n=56) were subject to diet and physical activity interventions. Self-reported change after one year was relatively insignificant, although the pet-owner group expressed emotional importance in the 'One Health' approach that they had adopted.

A cross-sectional survey across 10 European countries aimed to assess dog owners' perceptions of their own and their pets' levels of obesity, and factors associated with obesity (Munoz-Prieto et al. 2018[52] [n=3,418]). Among findings, factors associated with obesity include age, gender and dog owner attitudes towards physical activity and diet. Dog owners who did not consider obesity to be a disease were more likely to have obese dogs. The study also describes and discusses the development of a pan-European tool aiming to identify factors associated with obesity in dog owners and their dogs, as part of the European 'Network for Evaluation of One Health' (NEOH).

A study has examined the association between dog ownership and mortality and whether this depends on having a spouse or being alone (Sorensen et al. 2018[53]). Using a population- based registry, examining all Danish citizens (n=45,864), the study found that all-cause mortality was slightly lower for dog owners, but the association was weaker for those with a spouse.

The 'PPET' study has examined the effectiveness of a combined people and pets exercising together weight loss program (Kushner et al 2017). Thirty-six pairs of overweight or obese people with an obese pet participated in a 1-year weight loss study. People received dietary and physical activity counselling, and dogs were fed a calorie-controlled prescription diet. Physical activity was recorded using the physical activity recall questionnaire. The PPET study was one of the first programmes to demonstrate the effectiveness of a combined people and pets weight loss program.

An online self-completion cross-sectional survey of Hungarian dog owners assessed the link between dog age / health and owner / dog demographics (Wallis et al. 2018[54] [n=1,207]). Older dogs were more likely to be classified as unhealthy, and ill-health was linked to previous trauma (e.g. spending time in an animal shelter).

A literature review focused on an assessment of synergistic effects of AAI as this area of research has been poorly addressed to date. The aim was to develop a methodical framework for One Health approaches in AAI research. The paper shows that a One Health study design approach is necessary to ensure that a trade-off in the health of animals for an increase in human health is prevented and that an added value, or synergistic benefit, can be achieved on both sides during AAI (Hediger 2019).

(51) Study quality: low. However, this importance is conferred (and thus its significance limited) through self-selection. Research method: controlled study. Empirical robustness: 3.

(52) Study quality: medium. Study's key weakness is participant self-selection and self-reporting. Research method: cross-sectional self-completion survey. Empirical robustness: 2.

(53) Study quality: medium. Centre for Public Health in Greenland / University of Southern Denmark, Copenhagen, Denmark. This was a cross-sectional sample of a total population sample and therefore in theory should be empirically strong, but it is not clear to what extent confounding factors were identified or taken into account. Research method: cross-sectional database study. Empirical robustness: 2.

(54) Study quality: medium to low. ELTE University, Budapest, Hungary. Difficulties include the relatively small sample size of this demographic survey and the self-selecting nature of the sample. Research method: cross sectional self-reporting survey. Empirical robustness: 3.

5. Wider reflections on the impacts of the pet-human bond and the themes of this review

In addition to specific benefits already discussed, this review identified a number of wider themes relating to research on the pet-human bond. They capture both positive and negative dimensions:

1. The 'shared interest' of human and companion animal health and wellbeing

2. The difficulty of researching human and companion animal health and wellbeing

3. Understanding the mechanism of the bond (including for cats)

4. Less discussed aspects and consequences of the pet-human bond

5. The impact of loving and responsible ownership on pets

6. The role of the pet-human bond and healthcare economics.

5.1. THE 'SHARED INTEREST' OF HUMAN AND COMPANION ANIMAL HEALTH AND WELLBEING

A central theme throughout the research is the One Health agenda[55] and the interdependence between companion animals and humans (e.g. Bartges et al. 2017, Munoz-Prieto et al. 2018, Christian et al. 2018).

The One Health literature identifies the strong sense of 'shared interest' in the particular human problem of facing adversity. For example, the emotions and cognition provoked within US youth offenders as a result of their engagement with hard-to-adopt shelter dogs (Syzmonski et al. 2018) or the value of animals with vulnerable groups (e.g. old people, people with mental health problems such as ASD, and youth offenders). This shared interest even extends to reciprocal human-animal understanding of emotions and emotional state, for example the attribution of emotions on the part of owners to their companion animals (Martens et al. 2016) and owners' emotional disclosures to their companion dogs (Evans-Wilday et al. 2018).

Some view One Health as a positive route to address health problems 'shared' by both humans and companion animals, for instance to address obesity in humans and their companion animals (Bartges et al. 2017) or the mutually respectful relationship between neuro-typical and neuro-atypical children and the animals they live with (Hall et al. 2019).

Others view One Health in negative terms, contrary to the 'shared interest' view. Companion animals and pets are identified as a risk or threat to individual (or population) human health. For instance, the threat to humans from animals and vice versa, through the problem of Antimicrobial

(55) Described by the WHO as collaborative working to achieve optimal health through recognition of the interconnectedness between people, animals, plants and their shared environment.

Resistance (AMR) (Ceric et al. 2019 and Iannino et al. 2019) or the effect of owner personality on pet training and behaviour (Dodman et al. 2018).

The contradictory evidence for animal companionship as a factor in childhood sensitisation to allergy (Ihuoma et al. 2018), dose-dependent reduction in sensitivity due to the presence of animals (Hesselmar et al. 2018) and an argument for greater or less risk of allergy development according to where geographically speaking the individual and their pet live (Krzych-Falta et al. 2018) have all been cited. Studies identify greater cancer disease risk from animal ownership (Buck et al. 2020), or conversely, some kind of therapeutic effect among children with cancer from PAT interventions (McCullough et al. 2017).

Whilst there is clear evidence that humans and animals have a shared interest in their collective health and well-being (One Health), this needs to be set within the framework of loving responsible pet-ownership, thereby mitigating negative dimensions (or threats / risks) of the bond (e.g. AMR). There is also a need for greater evidence on the relationship between humans and their animal companions in relation to specific human health challenges (e.g. allergies).

5.2. THE DIFFICULTY OF RESEARCHING HUMAN AND COMPANION ANIMAL HEALTH AND WELLBEING

At the heart of much of the research reviewed is a concern to explore and ascertain the value of the human-animal bond, and authors are creative in their selection of research methods to explore this relationship. For example, there are cross-sectional surveys using established longitudinal studies (e.g. Westgarth et al. 2017), visual stimuli as a prompt to participant involvement (e.g. Dawson et al. 2019) and spatial mapping (Aeguter et al. 2017). There are also attempts to control for the effects of companion animals and their impact on humans (e.g. McLeod et al. 2017, Wijker et al. 2019).

The difficulty of control studies in this area is enormous. Whilst this problem is not unique to those investigating the nature of the human-animal bond, it is compounded by the sampling strategies and techniques often used by researchers in the area, with a number of particular methodological limitations and challenges identified across the research.

1. **Participant pre-existing interest**. Understandably, the views, attitudes and experiences of companion animal owners themselves are often sought by investigators (e.g. Hart et al. 2018, Piltman et al. 2019). The difficulty is that owners already have a commitment (likely to be positive) to the human- animal bond.

2. **Self-reporting**. Researchers in the area often rely on convenience or voluntary sampling involving owners, and also rely heavily on owners self-reporting.

3. **Real-world**. Research is often confounded by its 'real world' nature and the wide range of variables involved, which are unlikely to be ever wholly understood and provide significant challenges for causality to be determined.

This combination of pre-existing interest and commitment (potentially 'bias'), self-reporting and determining causality is a significant barrier to wholly reliable research in the area. However, there are areas in which methodological practice is being strengthened, for instance in relation to the practical considerations of using animals in healthcare settings. Pérez-Camargo et al. (2018) is one of the first studies outlining the mechanics, engineering concepts, and background of providing the appropriate facility to connect the hospitalised patient with their companion animal. Whilst Menna et al. (2019) draws upon the wider literature review to recommend tests and parameters to better select appropriate animals as well as appropriate educational training methods and health protocols to assess potential risks.

There is a need for support to strengthen the empirical robustness of research in this field. This includes longer-term studies, high quality replication studies, larger sample sizes, outcome measures and longitudinal studies.

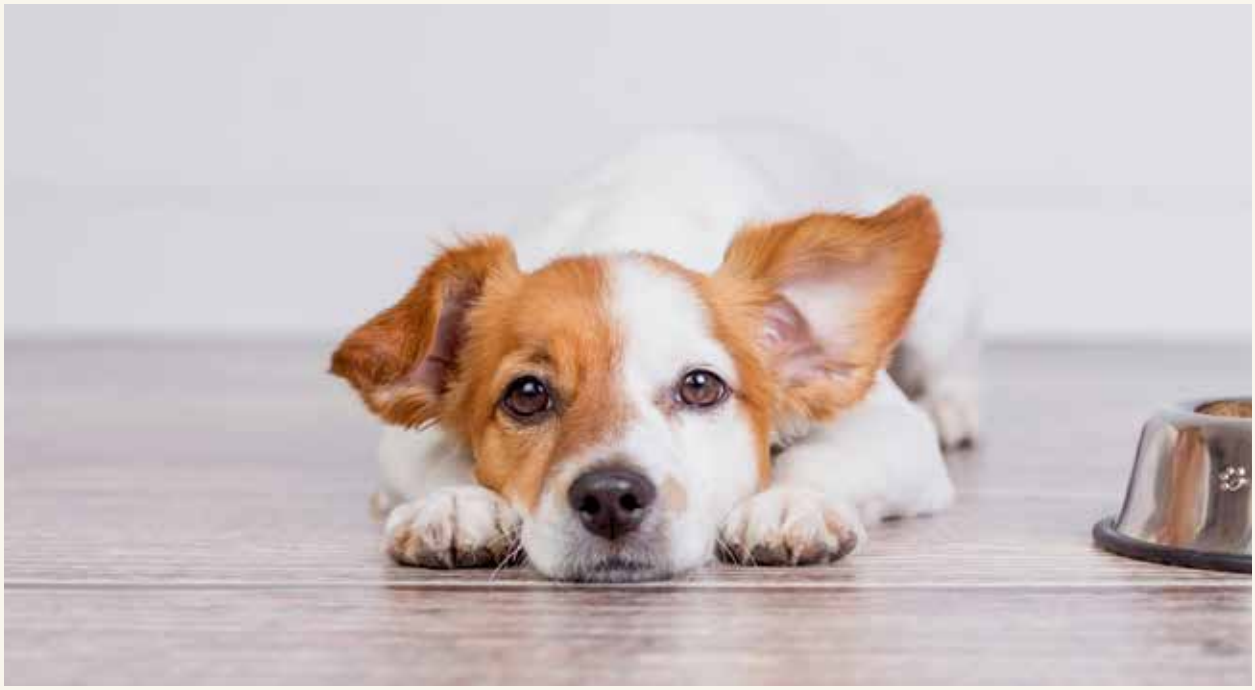
5.3. UNDERSTANDING THE MECHANISM OF THE BOND (INCLUDING FOR CATS)

Existing research has examined the biological basis for benefits that arise from the bond between pets and owners. This included both subjective ('felt') benefits and harder, measurable physiological and physical health benefits and key mechanisms that trigger and explain the human and pet physiology and physical response. The key hormonal triggers included cortisol, oxytocin, and a number of other hormones and neurotransmitters.

There have been recent studies which have progressed the evidence relating to our understanding of the physiological and psychological benefits arising from the pet-human bond. These can be grouped into:

1. Understanding the bond (dogs)

2. Understanding the bond (cats).



Understanding the bond (dogs)

One area of recent research has focused on the existence of emotions in nonhuman animals. Dogs can discriminate between positive and negative emotions from both humans and dogs (Albuquerque et al. 2016 [n=188][56]). Owners attribute several emotions to their pets, with the dog mirroring their owners' own emotions for basic (anger, joy, fear, surprise, disgust, and sadness) and complex (shame, jealousy, disappointment, and compassion) emotions. For cats, this relationship was significant only for joy, sadness, surprise, shame, disappointment, and compassion (Martens et al. 2016[57] [n=1,023]). Authors note that recognition of emotions in animals is of great value to the improvement of animal welfare: we are likely to be kinder ourselves to animals if we attribute emotion to them. This is extended by research which has shown that dogs use 'looking away' and 'licking lips' as appeasement strategies towards humans and also that in the face of situations of major threat, dogs used other strategies e.g. rolling over (Firnkes et al. 2017[58] [n=116]).

Studies have also shown both dogs and their owners show an increase in oxytocin levels following socio-positive interactions. Previous studies had not looked at oxytocin levels for a familiar (but not bonded) person interacting with a dog. However, results did not find an increase in either, dogs' or humans' oxytocin level, after a positive social interaction. (Marshall-Pescini et al. 2019 [n=>20 dogs and owners]).

(56) Difficulties include the small size of the actual sample, and the test being in artificial, 'laboratory' conditions.

(57) Study quality: medium to low. Study weaknesses include self-reporting, female participant bias and anthropomorphising (attributing human characteristics to animals where none exist). Research method: self-reporting survey. Empirical robustness: 3.

(58) Study quality: medium to low. The study is interesting, but the study's substantive value is unclear, other than possibly demonstrating attempts at dog-human rapport. Research method: observation study. Empirical robustness: 3.

New research has further explored the role of oxytocin in understanding animal behaviour and socialisation. Wong et al. (2019)[59] reports the development of a simple, sensitive, and accurate liquid chromatography-mass spectrometry (LC-MS) method for quantifying oxytocin in dog saliva which has been developed and validated. The study reports that the method was characterised to be with high sensitivity and high reliability and was successfully applied to measure oxytocin concentrations in hundreds of dog saliva samples. The authors conclude that this accurate and sensitive method could be a promising tool to facilitate studies aiming to use oxytocin as a biomarker for human-animal interaction studies.

A second area is understanding the relationship between dogs and their owners. A study investigating whether owner personality, gender and age are associated with pet ownership, found that dogs that searched for proximity of their owners during a threatening situation had owners scoring higher in 'Owner Warmth' (Cimarelli et al. 2016 [n=220]). A later study compared the relationships pet dogs form with their owner and with other dogs living in the same household. Results revealed that pet dogs' relationships are characterised by three components (reference, affiliation and stress). The type of relationship, rather than the partner species, predicts how dogs react to a social threat.

An emerging measurement tool for this area is the Coleman Dog Attitude Scale (C-DAS), which examines how to predict certain behavioural intentions toward animals and nature generally. The authors suggest that C-DAS has the potential to allow researchers to control for attitudes toward dogs in future studies examining human-animal interactions (Coleman et al. 2016[60]).

Other studies in this area include a review of research related to dog owner attachment, using concepts from human psychology to clarify the terms of anthrozoology. Among recommendations is a more inclusive (dog and owner) approach to analysing the problem (Rehn and Keeling 2017[61]).

Cats – understanding the bond

Worldwide, domestic cats outnumber domestic dogs, yet dog social cognition has received considerably more scientific attention over the last several decades. Despite fewer studies, research suggests we may be underestimating cats' socio-cognitive abilities. A focus for the 2019 review was to examine the level of evidence associated with the cat-human bond, and studies to understand the biology of the bond. A range of studies was identified with some having a good level of evidence.

Firstly, there are a number of emerging measurement tools. They include a facial action coding system for cats (CatFACS), similar to that used for objectively coding human facial expressions. CatFACS is used to describe the relationship between facial expression and behaviour in confined cats (Bennett et al. 2017[62] [n=29]). Linked to this is research which has used video clips to assess whether participants could identify feline emotions from cats' faces (Dawson et al. 2019, [n=6,327]). Women were more successful at this task than men, and younger participants more successful than older, as were participants with professional feline (e.g. veterinary) experience. Authors

(59) Nestlé Purina Research.

(60) Study quality: medium. Unclear how the variable of test / participation was weighted in terms of understanding predicted behaviour and attitudes. Research method: scale development and testing. Empirical robustness: 2.

(61) Study quality: medium to low. Not a systematic review. Research method: non-systematic literature review. Empirical robustness: 2.

(62) Study quality: high to medium. Research method: observation study. Empirical robustness: 1.

found that inference was possible, with some variations according to experience and gender but little related to cat ownership (Dawson et al. 2019, [n=6,327][63]). A separate measurement tool is the cat-owner relationship scale (CORS), which is designed to permit assessment of human-cat interactions as perceived by the cat's owner (Howell et al. 2017[64] [n=570]).

A second area of the research examines the relationships between cats and their owners. For instance, research has begun to assess the influence of human attentional state, population, and human familiarity on domestic cat sociability (Vitale and Udell 2019). This body of research indicates domestic cats cat detect human attentional state and modify their behaviour in response, demonstrating they are sensitive to human social cues and tend to be more social when presented with an attentive human. Similarly, research has found, using behavioural criteria established in the human infant literature, that cats display distinct attachment styles toward human caregivers. Cats show a similar capacity for the formation of secure and insecure attachments towards human caregivers previously demonstrated in children and dogs (Vitale and Udell 2019 [n=79 kittens]). Australian owners of free-ranging cats were subject to three different short video messages: two were 'intervention', one was 'neutral' (the control). The intervention messages altered owners' intention to contain their cats and cat containment behaviour changed at a 4-week survey follow-up (McLeod et al. 2017[65] [n=512]).

Thirdly, research has examined the relationship between children and cats. A study which aimed to assess children's relationships with cats found that European respondents rated children's

(63) Study quality: medium. Difficulties with self-reporting nature and sample, which was self-selected. Research method: visual stimuli and self- reporting survey. Empirical robustness: 2.

(64) Study quality: medium. The value of the authors' claim for the scale is limited by virtue of the fact that all of the qualitative participants were female.

(65) Study quality: medium. Other possible variables relating to intentional behaviour change are not considered, and the follow-up period is short, making the observation of long-term change impossible. Research method: randomised controlled study. Empirical robustness: 2.

interactions with cats more positively than US / Canadian respondents (Hart et al. 2018[66] [n=665]). Results also found young cats being more affectionate than older ones, and compatibility being influenced by children's reaction to the cat. European cats were more interactive than those in US / Canada, which the authors suggest may be explained by different adoption practices (2018[67], [n=665]). This links to Ihuoma et al. 2018[68] (n=1,004) research which has suggested that previous contradictory results of studies of cat sensitisation in childhood and adolescence can be explained by different trajectories of cat sensitisation between early-life cat owners and those without a cat.

Other studies include the Turner, DC (2017[69]) review article on cat-human and human-cat interactions and relationships and Amengual Batle et al. (2019) literature review of the published literature and the author's personal experience exploring how emotions can influence feline behaviours. This found that understanding the importance of emotional health is a major factor in ensuring positive welfare for cats.

In another study, self-selecting cat owners completed an online survey about the acquisition of their animals. Differences were found between the owners of brachycephalic (wide-faced), pedigree and non-pedigree cats including the degree of owner research prior to acquisition. Brachycephalic owners were less likely to undertake this than pedigree owners (Piltman et al. 2019[70] [n=1,367]).

5.4. LESS DISCUSSED ASPECTS AND CONSEQUENCES OF THE PET-HUMAN BOND

As well as the numerous benefits that are associated with dog and cat ownership there are other less discussed aspects of the pet-human bond which include:

- The consequences to pets of abusive relationships by humans
- The consequences to humans of grief on loss of a pet.

Abusive relationships

Associations have been found between domestic violence, child abuse and animal abuse, with severe animal abuse as a predictor for severe domestic violence. However, some of the findings on the link have not been translated into practice. For example, domestic violence advocates and child protection workers frequently do not ask questions about pets in the family (Randour et al. 2019). While specific types of animal maltreatment are significant motivators for leaving an abusive partner, length of relationship and the physical abuse experienced by the woman better explain the degree to which concern for the well-being of the pet kept them from leaving their abuser earlier (Barrett et al. 2018 [n=86]).

(66) Study quality: medium. The study is interesting because it crosses national boundaries, but difficulties include self-selection and self-response. Research method: self-completion questionnaire. Empirical robustness: 2.

(67) Study quality: medium. Difficulties include the nature of the sample and its self-reporting. Research method: self-reporting survey. Empirical robustness: 2.

(68) Study quality: high to medium. The research cohort size is significant, but the single element of control (not owning a cat) is a study weakness. Research method: longitudinal observational study. Empirical robustness: 2.

(69) Study quality: low. The areas chosen for review appear self-selected and there is no evidence that the review is systematic. Research method: non-systematic literature review. Empirical robustness: 3.

(70) Study quality: medium. Study has implications for future debates on cat welfare, but problems include voluntary sample, self-reporting and sample bias (heavily female). Research method: self-reporting survey. Empirical robustness: 2.

Loss and grief

Research has begun to examine human grief after the loss of a dog. Results from a sample of Italian dog owners, who completed the Mourning Dog Questionnaire, have supported the generally held negative view of life after pet death, and the 'humanisation' of the pet, so that in many senses it did not matter that what was being mourned was an animal rather than a human (Uccheddu et al. 2019[71] [n=369]). A New Zealand survey examined how the loss of a companion animal may affect other animals in the household. Both dogs and cats were reported to demand more attention from their owners and/or display affiliative behaviour. Dogs were reported to reduce the volume and speed of food consumption. Cats were reported to increase the frequency and volume of vocalisations following the death of a companion (Walker 2016 [n=279]). Matte (2020) conducted an online questionnaire with pet owners who had experienced pet euthanasia within the last 10 years to explore the relationship between pet owners' experiences and their resulting satisfaction and grief following companion animal euthanasia. Overall, participants (n=2,354) reported high levels of satisfaction with their pet euthanasia experience, in terms of administration practices, emotional support, follow-up care and care for their pet's remains.

5.5. THE IMPACT OF LOVING AND RESPONSIBLE OWNERSHIP ON PETS

The 2019/2020 review looked at the level of evidence of studies which examine the impact of loving and responsible pet ownership on the pet itself. This includes pet ownership (training) practices and the interaction between pets and other household members.

Training practices

Examining owner personality / psychology and owners' interactions with their dog, especially with regard to training, has shown modest positive associations between owners' use of confrontational training methods and canine behavioural problems (Dodman et al. 2018[72] [n=1,564]). In relation to training methods and PTSD service dogs, more frequent use of positive punishment was associated with less closeness with the service dog, more fear, less eye contact and less trainability. More frequent use of positive reinforcement was associated with higher closeness to the service dog and perceived increased attachment behaviour and playfulness (LaFollette 2019 [n=111 veterans]).

The factors that influence owner use of positive reinforcement methods to manage aggressive behaviour were investigated by survey in an attempt to understand potential barriers and drivers. The perceived efficacy of positive reinforcement methods and the perceived ability of owners to effectively implement the technique are both key factors predicting future intentions and current reported use (Williams and Blackwell 2019 [n=630]).

Interactions in the home

The relationship between cats and dogs living in the same home was evaluated through an online survey of mixed-species homes. Most owners expressed the view that the relationship was

(71) Study quality: medium. Problems include the self-selecting sample, although the instrument itself seems carefully constructed. Research method: questionnaire development through self-reporting survey. Empirical robustness: 2.

(72) Study quality: medium. The cross-sectional nature of the study makes it hard to determine causation in human-dog relationship problems, and the self-reported assessments are likely to have yielded bias. Research method: cross-sectional self-completion survey. Empirical robustness: 2.

amicable, with influencing variables including the age of introduction (young age yielded greater amicability) (Thomson et al. 2018[73] [n=748]).

A recent study investigated whether different raising conditions shape social behaviour toward humans. Results found puppies housed separately from their mother interacted more with toys. Puppies housed in a kennel tended to stay closer to the experimenter than puppies raised in the house, and puppies housed in a kennel tended to stay in the proximity of the experimenter more than puppies raised in the house. Results provide evidence for early keeping conditions influencing social behaviour (Lenkei et al. 2019).

The impact on animal wellbeing – as a result of AAT

An emerging measurement tool is the recent development and validation of an owner-completed pet dog quality of life scale (Lincoln P-QOL) to enable professionals and families to monitor dog well-being. Studies found little evidence to support a difference in the overall quality of life of dogs living with neuro-typically developing children compared to those with a neuro-developmental disorder (Hall 2019 – and Dan Mills [n=402]). Results from other studies have also suggested that dogs were not stressed during AAI sessions (Corsetti et al. 2019 [n=9]).

A fully non-invasive methodology was applied to study sleep and memory in domestic dogs. The results of these two studies provide the first evidence of the interrelated effect of sleep and learning in dogs, suggesting that a sleep-dependent memory consolidation takes place in this species (Kis et al. 2017 – Purina [n=15 dogs]). The same team studied the effect of positive and negative social experiences on sleep macrostructure in dogs, a species proven to be a good model of human social cognition. Before sleep, dogs were exposed to emotionally positive or negative social interactions. Sleep macrostructure was markedly different between pre-treatment conditions. The result provides the first direct evidence that emotional stimuli affect subsequent sleep physiology in dogs. Sleep per se has been suggested as a good welfare indicator in dogs (Kis et al. 2017 – Purina [n=16 dogs]).

A 2016 review illuminates the need for a more clearly defined direction and methodology in future studies to systematically investigate the aetiology, treatment, and prevention of separation anxiety in dogs (Richards and Ogata 2017 – Purina).

Other studies

A study investigated the effects of companion robot Paro (a robotic seal) on people with dementia. Carers and dementia sufferers had sessions with Paro at day care centres, during which interactions were observed, followed afterwards by measurement of clinical markers and symptoms such as depression. Results included significantly improved communication with staff on the part of the dementia sufferers, with most effects demonstrated by those with lower levels of cognitive impairment. The study is small-scale and specific, and there may be an environmental effect, which does not seem to have been controlled for. But the combination of observation at the point of delivery and measures after the intervention is a study strength (Liang et al. 2017 University of Auckland, New Zealand [n=60 carers and dementia sufferers]). Tkatch et al. (2020) has also examined the use of animatronic pets to reduce loneliness and concluded that animatronic pets appear to provide benefits for the well-being of lonely older adults.

(73) Study quality: medium to low. Self-selection and self-reporting are key study weaknesses. Research method: self-reporting survey. Empirical robustness: 3.

5.6. THE ROLE OF THE PET-HUMAN BOND AND HEALTHCARE ECONOMICS

There is a small body of literature which discusses and seeks to quantify the economic value of the pet-human bond, in particular in delivering national and regional priorities including healthcare.

In 2002, Heady et al. identified that $3.86 billion healthcare savings over 10 years could be linked to pet ownership in Australia and Germany, with pet owners having better health and going to the doctor less than non-owners.

Heady and Grabka (2007) have also found that, in Australia and Germany, people who continuously own a pet are the healthiest group and people who cease to have a pet or never had one are less healthy. In both countries the data show that pet owners make about 15% fewer annual doctor visits than non-owners.

In 2015 The Human Animal Bond Research Institute (HABRI) calculated an $11.7 billion savings in U.S. healthcare costs as a result of pet ownership. This was based on evidence that pet owners go to visit a doctor less often than non-owners, and the incidence of obesity among people who regularly walk their dogs is 5% lower than non-pet owners (Clower and White, 2015).

A similar study, by Hall et al. in 2016, estimated that pet ownership in the UK may reduce use of health service by up to £2.45 billion per year.

OVERVIEW: ASSESSMENT OF CURRENT LEVEL OF EVIDENCE BY RESEARCH THEME[74]

Research theme	Benefit of the pet-human bond	Assessment of current level of evidence (July 2020)
1. Promoting health and wellbeing across the lifetime	Child physical health and wellbeing	Mixed
	Child mental and emotional health & wellbeing	Strong evidence
	Child education development	Some evidence
	Early adulthood – mental and physical health	Emerging evidence
	Adulthood – at home interventions	Strong evidence
	Adulthood at work interventions	Some evidence
	Older / later life enhancement	Some / strong evidence
	Loneliness and social isolation	Some / strong evidence
2. Detection and treatment of degenerative and chronic diseases	Cancer	Limited
	Cardiovascular disease (CVD)	Strong evidence
	Atopy, allergies and asthma	Strong evidence / mixed
	Autism spectrum disorder	Strong evidence
	Dementia and Alzheimer's disease	Some/strong evidence
	Fibromyalgia (and pain management)	Some evidence
	Impact of AAT on wellbeing of therapy pets	Some evidence
3. The role of the bond in building a more inclusive society	People with disabilities (and assistance pets)	Some evidence
	Military and service people – post trauma	Emerging evidence
	People in prison including substance misusers	Emerging evidence
	Marginalised, disadvantaged people (incl. homelessness)	Some evidence
	Improving social cohesion in cities	Emerging evidence
4. Innovation in new health and care technologies and approaches	Animal assisted therapy to support healthcare	Strong evidence
	One Health – approach for obesity	Some evidence

Note: This report was prepared for Nestlé Purina PetCare EMENA, by Professor Jeff French and Jane Fiona Cumming, Article 13 (www.article13.com).

(74) **'Strong evidence'** = 2-3 or more high quality papers.

'Some evidence' = 1 or more high quality paper or 3+ mid-quality papers.

'Limited/emerging evidence' = 1 or more mid-quality paper.

'Mixed evidence' = majority of publications say benefit but some caveats.

'Conflicting evidence' = 1 or more quality paper challenging the benefit.

References

Albuquerque, N., Guo, K., Wilkinson, A., Savalli, C., Otta, E. and Mills, D., 2016. Dogs recognize dog and human emotions. Biology letters, 12(1), p.20150883.

Amengual Batle, P., Rusbridge, C., Nuttall, T., Heath, S. and Marioni-Henry, K., 2019. Feline hyperaesthesia syndrome with self-trauma to the tail: retrospective study of seven cases and proposal for an integrated multidisciplinary diagnostic approach. Journal of feline medicine and surgery, 21(2), pp.178-185.

Aegerter, J., Smith, G (2017) A first estimate of the structure and density of the populations of pet cats and dogs across Great Britain.

Allen, K., Shykoff, B.E. and Izzo Jr, J.L., 2001. Pet ownership, but not ACE inhibitor therapy, blunts home blood pressure responses to mental stress. Hypertension, 38(4), pp.815-820.

Allen, K. and Blascovich, J., 1996. The value of service dogs for people with severe ambulatory disabilities: A randomized controlled trial. Jama, 275(13), pp.1001-1006.

All-Party Parliamentary Group on Cats (2020) - http://www.apgocats.org.uk/

Ávila-Álvarez, A., Alonso-Bidegain, M., De-Rosende-Celeiro, I., Vizcaíno-Cela, M., Larrañeta-Alcalde, L. and Torres-Tobío, G., 2020. Improving social participation of children with autism spectrum disorder: Pilot testing of an early animal-assisted intervention in Spain. Health & Social Care in the Community, 28(4), pp.1220-1229.

Banks, M.R. and Banks, W.A., 2002. The effects of animal-assisted therapy on loneliness in an elderly population in long-term care facilities. *The journals of gerontology series A: biological sciences and medical sciences*, 57(7), pp.M428-M432.

Barrett, B.J., Fitzgerald, A., Peirone, A., Stevenson, R. and Cheung, C.H., 2018. Help-seeking among abused women with pets: Evidence from a Canadian sample. Violence and victims, 33(4), pp.604-626.

Barker, R.T., Knisely, J.S., Barker, S.B., Cobb, R.K. and Schubert, C.M., 2012. Preliminary investigation of employee's dog presence on stress and organizational perceptions. International Journal of Workplace Health Management.

Bartges, J., Kushner, R.F., Michel, K.E., Sallis, R. and Day, M.J., 2017. One health solutions to obesity in people and their pets. Journal of comparative pathology, 156(4), pp.326-333.

Bedolla-Barajas, M., Morales-Romero, J., Bedolla-Pulido, T.I., Bedolla-Pulido, T.R., Meza-López, C. and Pulido-Guillén, N.A., 2018. Exposure to dogs but not cats is associated to a decrease in the prevalence in atopic dermatitis amongst school-children. Allergologia et immunopathologia, 46(5), pp.431-437.

Bennett, P.C., Rutter, N.J., Woodhead, J.K. and Howell, T.J., 2017. Assessment of domestic cat personality, as perceived by 416 owners, suggests six dimensions. Behavioural processes, 141, pp.273-283.

Bibbo, J., Rodriguez, K.E. and O'Haire, M.E., 2019. Impact of service dogs on family members' psychosocial functioning. American Journal of Occupational Therapy, 73(3), pp.7303205120p1-7303205120p11.

Binngießer, J., Wilhelm, C. and Randler, C., 2013. Attitudes toward animals among German children and adolescents. Anthrozoös, 26(3), pp.325-339.

Black, K., 2012. The relationship between companion animals and loneliness among rural adolescents. Journal of Pediatric Nursing, 27(2), pp.103-112.

Bomberg, E., Birch, L., Endenburg, N., German, A.J., Neilson, J., Seligman, H., Takashima, G. and Day, M.J., 2017. The financial costs, behaviour and psychology of obesity: a one health analysis. Journal of comparative pathology, 156(4), pp.310-325.

Briones, M.Á., Pardo-García, I. and Escribano-Sotos, F., 2019. Effectiveness of a Dog-Assisted Therapy Program to Enhance Quality of Life in Institutionalized Dementia Patients. Clinical nursing research, p.1054773819867250. Brooks, H.L., Rushton, K., Lovell, K., Bee, P., Walker, L., Grant, L. and Rogers, A., 2018. The power of support from companion animals for people living with mental health problems: a systematic review and narrative synthesis of the evidence. BMC psychiatry, 18(1), pp.1-12.

Buck, B., Muniz-Rodriguez, K., Jillson, S., Huang, L.T., Adhikari, A., Jacob, N., Wei, Y. and Zhang, J., 2020. Pet ownership and risk of dying from cancer: Observation from a nationally representative cohort. International journal of environmental health research, 30(1), pp.105-116.

Bures, R.M., Mueller, M.K. and Gee, N.R., 2019. Measuring human-animal attachment in a large US survey: two brief measures for children and their primary caregivers. Frontiers in Public Health, 7, p.107.

Carver, L.F., Beamish, R., Phillips, S.P. and Villeneuve, M., 2018. A scoping review: Social participation as a cornerstone of successful aging in place among rural older adults. Geriatrics, 3(4), p.75.

Cassidy-Bushrow, A.E., Sitarik, A.R., Johnson-Hooper, T.M., Phillips, J.M., Jones, K., Johnson, C.C. and Straughen, J.K., 2019. Prenatal pet keeping and caregiver-reported attention deficit hyperactivity disorder through preadolescence in a United States birth cohort. BMC pediatrics, 19(1), p.390.

Ceric, O., Tyson, G.H., Goodman, L.B., Mitchell, P.K., Zhang, Y., Prarat, M., Cui, J., Peak, L., Scaria, J., Antony, L. and Thomas, M., 2019. Enhancing the one health initiative by using whole genome sequencing to monitor antimicrobial resistance of animal pathogens: Vet-LIRN collaborative project with veterinary diagnostic laboratories in United States and Canada. BMC veterinary research, 15(1), pp.1-13.

Chan, M.M. and Rico, G.T., 2019. The "pet effect" in cancer patients: Risks and benefits of human-pet interaction. Critical reviews in oncology/hematology, 143, pp.56-61.

Chu, C.I., Liu, C.Y., Sun, C.T. and Lin, J., 2009. The effect of animal-assisted activity on inpatients with schizophrenia. Journal of psychosocial nursing and mental health services, 47(12), pp.42-48.

Christian, H., Bauman, A., Epping, J.N., Levine, G.N., McCormack, G., Rhodes, R.E., Richards, E., Rock, M. and Westgarth, C., 2018. Encouraging dog walking for health promotion and disease prevention. American journal of lifestyle medicine, 12(3), pp.233-243.

Cimarelli, G., Turcsán, B., Bánlaki, Z., Range, F. and Virányi, Z., 2016. Dog owners' interaction styles: Their components and associations with reactions of pet dogs to a social threat. Frontiers in psychology, 7, p.1979.

Clark, S.D., Martin, F., McGowan, R.T., Smidt, J.M., Anderson, R., Wang, L., Turpin, T., Langenfeld-McCoy, N., Bauer, B.A. and Mohabbat, A.B., 2020. Physiological State of Therapy Dogs during Animal-Assisted Activities in an Outpatient Setting. Animals, 10(5), p.819.

Cleary, M., Visentin, D., Thapa, D.K., West, S., Raeburn, T. and Kornhaber, R., 2020. The homeless and their animal companions: an integrative review. Administration and Policy in Mental Health and Mental Health Services Research, 47(1), pp.47-59.

Clower T and White M (2015) The Economic Impacts of the U.S. Pet Industry - https://cra.gmu.edu/wp-content/uploads/2017/02/Economic-Impacts-of-the-Pet-Industry-2015-Final.pdf

Coleman, J.A., Green, B., Garthe, R.C., Worthington Jr, E.L., Barker, S.B. and Ingram, K.M., 2016. The Coleman dog attitude scale (C-DAS): Development, refinement, validation, and reliability. *Applied Animal Behaviour Science*, 176, pp.77-86.

Contalbrigo, L., De Santis, M., Toson, M., Montanaro, M., Farina, L., Costa, A. and Nava, F.A., 2017. The efficacy of dog assisted therapy in detained drug users: A pilot study in an Italian attenuated custody institute. International journal of environmental research and public health, 14(7), p.683.

Corsetti, S., Ferrara, M. and Natoli, E., 2019. Evaluating stress in dogs involved in animal-assisted interventions. Animals, 9(10), p.833.

Daly, B. and Morton, L.L., 2009. Empathic differences in adults as a function of childhood and adult pet ownership and pet type. Anthrozoös, 22(4), pp.371-382.

D'Aniello, B., Semin, G.R., Alterisio, A., Aria, M. and Scandurra, A., 2018. Interspecies transmission of emotional information via chemosignals: from humans to dogs (Canis lupus familiaris). Animal cognition, 21(1), pp.67-78.

Dawson, L., Niel, L., Cheal, J. and Mason, G., 2019. Humans can identify cats' affective states from subtle facial expressions.

Day, M.J., 2016. Pet-related infections. American family physician, 94(10), pp.794-802.

De Pedraza, P., Guzi, M. and Tijdens, K., 2020. Life Dissatisfaction and Anxiety in COVID-19 pandemic (No. 544). GLO Discussion Paper.

Dell, C., Chalmers, D., Stobbe, M., Rohr, B. and Husband, A., 2019. Animal-assisted therapy in a Canadian psychiatric prison. International journal of prisoner health.

Dodman, N.H., Brown, D.C. and Serpell, J.A., 2018. Associations between owner personality and psychological status and the prevalence of canine behavior problems. PLoS One, 13(2), p.e0192846.

Elizalde, E-D et al 2018 Assisted interventions with dogs in pediatrics Areas of intervention at the Hospital Sant Joan de Déu Barcelona - https://www.sjdhospitalbarcelona.org/en/pet-assisted-interventions.

El-Qushayri, A.E., Kamel, A.M.A., Faraj, H.A., Vuong, N.L., Diab, O.M., Istanbuly, S., Elshafei, T.A., Makram, O.M., Sattar, Z., Istanbuly, O. and al Mukit, S.A., 2020. Association between pet

ownership and cardiovascular risks and mortality: a systematic review and meta-analysis. Journal of Cardiovascular Medicine, 21(5), pp.359-367.

Evans-Wilday, A.S., Hall, S.S., Hogue, T.E. and Mills, D.S., 2018. Self-disclosure with dogs: Dog owners' and non-dog owners' willingness to disclose emotional topics. Anthrozoös, 31(3), pp.353-366.

Fall, T., Lundholm, C., Örtqvist, A.K., Fall, K., Fang, F., Hedhammar, Å., Kämpe, O., Ingelsson, E. and Almqvist, C., 2015. Early exposure to dogs and farm animals and the risk of childhood asthma. JAMA pediatrics, 169(11), pp.e153219-e153219.

Filan, S.L. and Llewellyn-Jones, R.H., 2006. Animal-assisted therapy for dementia: a review of the literature. In *Database of Abstracts of Reviews of Effects (DARE): Quality-assessed Reviews [Internet]*. Centre for Reviews and Dissemination (UK).

Firnkes, A., Bartels, A., Bidoli, E. and Erhard, M., 2017. Appeasement signals used by dogs during dog–human communication. Journal of Veterinary Behavior, 19, pp.35-44.

Flynn, E., Roguski, J., Wolf, J., Trujillo, K., Tedeschi, P. and Morris, K.N., 2019. A Randomized Controlled Trial of Animal-Assisted Therapy as an Adjunct to Intensive Family Preservation Services. Child maltreatment, 24(2), pp.161-168.

Gadomski, A.M., Scribani, M.B., Krupa, N., Jenkins, P., Nagykaldi, Z. and Olson, A.L., 2015. Peer Reviewed: Pet Dogs and Children's Health: Opportunities for Chronic Disease Prevention?. Preventing chronic disease, 12.

Gan, G.Z., Hill, A.M., Yeung, P., Keesing, S. and Netto, J.A., 2019. Pet ownership and its influence on mental health in older adults. Aging & Mental Health, pp.1-8.

Geerdts, M.S., Van de Walle, G.A. and LoBue, V., 2015. Daily animal exposure and children's biological concepts. *Journal of experimental child psychology*, 130, pp.132-146.

German, A.J., Blackwell, E., Evans, M. and Westgarth, C., 2017. Overweight dogs exercise less frequently and for shorter periods: results of a large online survey of dog owners from the UK. *Journal of nutritional science*, 6.

Germone, M.M., Gabriels, R.L., Guérin, N.A., Pan, Z., Banks, T. and O'Haire, M.E., 2019. Animal-assisted activity improves social behaviors in psychiatrically hospitalized youth with autism. *Autism*, *23*(7), pp.1740-1751.

Glenk, L.M., Přibylová, L., Stetina, B.U., Demirel, S. and Weissenbacher, K., 2019. Perceptions on Health Benefits of Guide Dog Ownership in an Austrian Population of Blind People with and without a Guide Dog. Animals, 9(7), p.428.

Gocheva, V., Hund-Georgiadis, M. and Hediger, K., 2018. Effects of animal-assisted therapy on concentration and attention span in patients with acquired brain injury: A randomized controlled trial. Neuropsychology, 32(1), p.54.

Gretebeck, K.A., Radius, K., Black, D.R., Gretebeck, R.J., Ziemba, R. and Glickman, L.T., 2013. Dog ownership, functional ability, and walking in community-dwelling older adults. *Journal of Physical Activity and Health*, *10*(5), pp.646-655.

Guest, C.M., Collis, G.M. and McNicholas, J., 2006. Hearing dogs: A longitudinal study of social and psychological effects on deaf and hard-of-hearing recipients. Journal of Deaf Studies and Deaf Education, 11(2), pp.252-261.

HABRI - https://habri.org/research/mental-health/social-isolation/#:~:text=A%20nationally%20representative%20survey%20of,pets%20can%20help%20reduce%20loneliness&text=72%25%20believe%20human%2Danimal%20interaction%20is%20good%20for%20their%20community

Hall, S., Wright, H., McCune, S., Zulch, H. and Mills, D., 2017. Perceptions of dogs in the workplace: the pros and the cons. anthrozoös, 30(2), pp.291-305.

Hall, S.S., Finka, L. and Mills, D.S., 2019. A systematic scoping review: What is the risk from child-dog interactions to dog's quality of life?. Journal of Veterinary Behavior, 33, pp.16-26.

Hall, S.S., Brown, B.J. and Mills, D.S., 2019. Developing and assessing the validity of a scale to assess pet dog quality of life: Lincoln P-QoL. Frontiers in Veterinary Science, 6, p.326.

Hall, S., Dolling, L., Bristow, K., Fuller, T. and Mills, D.S., 2016. Companion animal economics: the economic impact of companion animals in the UK. CABI.

Headey, B. and Grabka, M.M., 2007. Pets and human health in Germany and Australia: National longitudinal results. Social Indicators Research, 80(2), pp.297-311.

Hediger, K., Petignat, M., Marti, R. and Hund-Georgiadis, M., 2019. Animal-assisted therapy for patients in a minimally conscious state: A randomized two treatment multi-period crossover trial. PloS one, 14(10), p.e0222846.

Hajek, A. and König, H.H., 2019. How do cat owners, dog owners and individuals without pets differ in terms of psychosocial outcomes among individuals in old age without a partner?. Aging & Mental Health, pp.1-7.

Hart, L.A., Hart, B.L., Thigpen, A.P., Willits, N.H., Lyons, L.A. and Hundenski, S., 2018. Compatibility of cats with children in the family. Frontiers in veterinary science, 5, p.278.

Harper, C.M., Dong, Y., Thornhill, T.S., Wright, J., Ready, J., Brick, G.W. and Dyer, G., 2015. Can therapy dogs improve pain and satisfaction after total joint arthroplasty? A randomized controlled trial. *Clinical Orthopaedics and Related Research®*, *473*(1), pp.372-379.

Hawkins, R.D. and Williams, J.M., 2017. Childhood attachment to pets: Associations between pet attachment, attitudes to animals, compassion, and humane behaviour. International journal of environmental research and public health, 14(5), p.490.

Hesselmar, B., Hicke-Roberts, A., Lundell, A.C., Adlerberth, I., Rudin, A., Saalman, R., Wennergren, G. and Wold, A.E., 2018. Pet-keeping in early life reduces the risk of allergy in a dose-dependent fashion. PloS one, 13(12), p.e0208472.

Heuberger, R., 2017. Associations of pet ownership with older adults eating patterns and health. Current gerontology and geriatrics research, 2017.

Hunter, C., Verreynne, M.L., Pachana, N. and Harpur, P., 2019. The impact of disability-assistance animals on the psychological health of workplaces: a systematic review. Human Resource Management Review, 29(3), pp.400-417.

Howell, T.J., Bowen, J., Fatjó, J., Calvo, P., Holloway, A. and Bennett, P.C., 2017. Development of the cat-owner relationship scale (CORS). Behavioural processes, 141, pp.305-315.

Hu, M., Zhang, P., Leng, M., Li, C. and Chen, L., 2018. Animal-assisted intervention for individuals with cognitive impairment: A meta-analysis of randomized controlled trials and quasi-randomized controlled trials. Psychiatry Research, 260, pp.418-427.

Hughes, M.J., Verreynne, M.L., Harpur, P. and Pachana, N.A., 2020. Companion animals and health in older populations: A systematic review. Clinical gerontologist, 43(4), pp.365-377.

Iannino, F., Salucci, S., Di Donato, G., Badagliacca, P., Vincifori, G. and Di Giannatale, E., 2019. Campylobacter and antimicrobial resistance in dogs and humans:" One health" in practice. Veterinaria italiana, 55(3), pp.203-220.

Ihuoma, H., Belgrave, D.C., Murray, C.S., Foden, P., Simpson, A. and Custovic, A., 2018. Cat ownership, cat allergen exposure, and trajectories of sensitization and asthma throughout childhood. Journal of Allergy and Clinical Immunology, 141(2), pp.820-822.

Jain, B., Syed, S., Hafford-Letchfield, T. and O'Farrell-Pearce, S., 2020. Dog-assisted interventions and outcomes for older adults in residential long-term care facilities: A systematic review and meta-analysis. *International Journal of Older People Nursing*, p.e12320.

Janevic, M.R., Shute, V., Connell, C.M., Piette, J.D., Goesling, J. and Fynke, J., 2019. The role of pets in supporting cognitive-behavioral chronic pain self-management: Perspectives of older adults. Journal of Applied Gerontology, p.0733464819856270.

Kertes, D.A., Liu, J., Hall, N.J., Hadad, N.A., Wynne, C.D. and Bhatt, S.S., 2017. Effect of pet dogs on children's perceived stress and cortisol stress response. Social Development, 26(2), pp.382-401.

Kis, A., Szakadát, S., Gácsi, M., Kovács, E., Simor, P., Török, C., Gombos, F., Bódizs, R. and Topál, J., 2017. The interrelated effect of sleep and learning in dogs (Canis familiaris); an EEG and behavioural study. Scientific reports, 7, p.41873.

Kline, J.A., Fisher, M.A., Pettit, K.L., Linville, C.T. and Beck, A.M., 2019. Controlled clinical trial of canine therapy versus usual care to reduce patient anxiety in the emergency department. PloS one, 14(1), p.e0209232.

Krause-Parello, C.A., 2012. Pet ownership and older women: The relationships among loneliness, pet attachment support, human social support, and depressed mood. Geriatric Nursing, 33(3), pp.194-203.

Krause-Parello, C.A., Friedmann, E., Wilson, C., Hatzfeld, J.J., Kolassa, J., Hackney, A. and Morales, K.A., 2019. Relation of post-traumatic stress disorder symptom severity to the efficacy of an animal-assisted intervention for stress reduction after military aeromedical evacuation. Stress and Health, 35(4), pp.480-490.

Kramer, C.K., Mehmood, S. and Suen, R.S., 2019. Dog ownership and survival: A systematic review and meta-analysis. Circulation: Cardiovascular Quality and Outcomes, 12(10), p.e005554.

Krzych-Fałta, E., Furmańczyk, K., Piekarska, B., Raciborski, F., Tomaszewska, A., Walkiewicz, A., Samel-Kowalik, P., Borowicz, J., Namysłowski, A. and Samoliński, B.K., 2017. Extent of protective or allergy-inducing effects in cats and dogs. Annals of agricultural and environmental medicine: AAEM, 25(2), pp.268-273.

Kushner, R.F., Blatner, D.J., Jewell, D.E. and Rudloff, K., 2006. The PPET study: people and pets exercising together. Obesity, 14(10), pp.1762-1770.

LaFollette, M.R., Rodriguez, K.E., Ogata, N. and O'Haire, M.E., 2019. Military veterans and their PTSD service dogs: associations between training methods, PTSD severity, dog behavior, and the human-animal bond. Frontiers in veterinary science, 6, p.23.

Lai, N.M., Chang, S.M.W., Ng, S.S., Tan, S.L., Chaiyakunapruk, N. and Stanaway, F., 2019. Animal-assisted therapy for dementia. Cochrane Database of Systematic Reviews, (11).

Lenkei, R., Pogány, Á. and Fugazza, C., 2019. Social behavior in dog puppies: Breed differences and the effect of rearing conditions. Biologia Futura, 70(2), pp.134-142.

Leonardi, R.J., Buchanan-Smith, H.M., McIvor, G. and Vick, S.J., 2017. "You think you're helping them, but they're helping you too": Experiences of Scottish male young offenders participating in a dog training program. International journal of environmental research and public health, 14(8), p.945.

Levine, G.N., Allen, K., Braun, L.T., Christian, H.E., Friedmann, E., Taubert, K.A., Thomas, S.A., Wells, D.L. and Lange, R.A., 2013. Pet ownership and cardiovascular risk: a scientific statement from the American Heart Association. *Circulation*, *127*(23), pp.2353-2363.

Liang, A., Piroth, I., Robinson, H., MacDonald, B., Fisher, M., Nater, U.M., Skoluda, N. and Broadbent, E., 2017. A pilot randomized trial of a companion robot for people with dementia living in the community. Journal of the American Medical Directors Association, 18(10), pp.871-878.

Lindström Nilsson, M., Funkquist, E.L., Edner, A. and Engvall, G., 2020. Children report positive experiences of animal-assisted therapy in paediatric hospital care. Acta Paediatrica, 109(5), pp.1049-1056.

Luo, S., Sun, Y., Hou, J., Kong, X., Wang, P., Zhang, Q. and Sundell, J., 2019. Pet keeping in childhood and asthma and allergy among children in Tianjin area, China. PloS one, 13(5), p.e0197274.

Lloyd, J., Johnston, L. and Lewis, J., 2019. Psychiatric assistance dog use for people living with mental health disorders. Frontiers in veterinary science, 6, p.166.

Marsa-Sambola, F., Muldoon, J., Williams, J., Lawrence, A., Connor, M. and Currie, C., 2016. The short attachment to pets scale (SAPS) for children and young people: Development, psychometric qualities and demographic and health associations. Child Indicators Research, 9(1), pp.111-131.

Marcus, D.A., Bernstein, C.D., Constantin, J.M., Kunkel, F.A., Breuer, P. and Hanlon, R.B., 2013. Impact of animal-assisted therapy for outpatients with fibromyalgia. Pain Medicine, 14(1), pp.43-51.

Martellucci, S., Belvisi, V., Ralli, M., Di Stadio, A., Musacchio, A., Greco, A., Gallo, A., de Vincentiis, M. and Attanasio, G., 2019. Assistance Dogs for Persons with Hearing Impairment: A Review. International Tinnitus Journal, 23(1).

Martens, P., Enders-Slegers, M.J. and Walker, J.K., 2016. The emotional lives of companion animals: Attachment and subjective claims by owners of cats and dogs. Anthrozoös, 29(1), pp.73-88.

Marshall-Pescini, S., Schaebs, F.S., Gaugg, A., Meinert, A., Deschner, T. and Range, F., 2019. The role of oxytocin in the dog–owner relationship. Animals, 9(10), p.792.

Martin, K.E., Wood, L., Christian, H. and Trapp, G.S., 2015. Not just "a walking the dog": dog walking and pet play and their association with recommended physical activity among adolescents. *American Journal of Health Promotion*, *29*(6), pp.353-356.

Mathers, M., Canterford, L., Olds, T., Waters, E. and Wake, M., 2010. Pet ownership and adolescent health: Cross-sectional population study. Journal of paediatrics and child health, 46(12), pp.729-735.

Matte, A.R., Khosa, D.K., Coe, J.B., Meehan, M. and Niel, L., 2020. Exploring pet owners' experiences and self-reported satisfaction and grief following companion animal euthanasia. Veterinary Record.

McCullough, A., Ruehrdanz, A., Jenkins, M.A., Gilmer, M.J., Olson, J., Pawar, A., Holley, L., Sierra-Rivera, S., Linder, D.E., Pichette, D. and Grossman, N.J., 2018. Measuring the effects of an animal-assisted intervention for pediatric oncology patients and their parents: A multisite randomized controlled trial. Journal of Pediatric Oncology Nursing, 35(3), pp.159-177.

McCullough, A., Ruehrdanz, A., Garthe, R., Hellman, C. and O'Haire, M., (2019) Measuring the Social, Behavioral, and Academic Effects of Classroom Pets on Third and Fourth-Grade Students.

McNicholas, J. and Collis, G.M., 2000. Dogs as catalysts for social interactions: Robustness of the effect. British Journal of Psychology, 91(1), pp.61-70.

McNicholas, J., Gilbey, A., Rennie, A., Ahmedzai, S., Dono, J.A. and Ormerod, E., 2005. Pet ownership and human health: a brief review of evidence and issues. *Bmj, 331*(7527), pp.1252-1254.

McLeod, L.J., Driver, A.B., Bengsen, A.J. and Hine, D.W., 2017. Refining online communication strategies for domestic cat management. Anthrozoös, 30(4), pp.635-649.

Melco, A.L., Goldman, L., Fine, A.H. and Peralta, J.M., 2020. Investigation of physiological and behavioral responses in dogs participating in animal-assisted therapy with children diagnosed with attention-deficit hyperactivity disorder. Journal of Applied Animal Welfare Science, 23(1), pp.10-28.

Menna, L.F., Santaniello, A., Todisco, M., Amato, A., Borrelli, L., Scandurra, C. and Fioretti, A., 2019. The Human–Animal Relationship as the Focus of Animal-Assisted Interventions: A One Health Approach. International Journal of Environmental Research and Public Health, 16(19), p.3660.

Mendy, A., Wilkerson, J., Salo, P.M., Cohn, R.D., Zeldin, D.C. and Thorne, P.S., 2018. Exposure and sensitization to pets modify endotoxin association with asthma and wheeze. The Journal of Allergy and Clinical Immunology: In Practice, 6(6), pp.2006-2013.

Mičková, E., Machová, K., Daďová, K. and Svobodová, I., 2019. Does dog ownership affect physical activity, sleep, and self-reported health in older adults?. International journal of environmental research and public health, 16(18), p.3355.

Michelotto, A.L., Anater, A., Guebert, M.C., Borges, T.D., Michelotto Jr, P.V. and Pimpao, C.T., 2019. Animal-Assisted Activity for Children with Autism Spectrum Disorder: Parents' and Therapists' Perception. The Journal of Alternative and Complementary Medicine, 25(9), pp.928-929.

Min, K.D., Kim, W.H., Cho, S. and Cho, S.I., 2019. Owners' Attitudes toward Their Companion Dogs Are Associated with the Owners' Depression Symptoms—An Exploratory Study in South Korea. International journal of environmental research and public health, 16(19), p.3567.

Morgan, L., Protopopova, A., Birkler, R.I.D., Itin-Shwartz, B., Sutton, G.A., Yakobson, B. and Raz, T., 2020. Human-dog relationships during COVID-19 pandemic; booming dog adoption during social isolation.

Mubanga, M., Byberg, L., Egenvall, A., Ingelsson, E. and Fall, T., 2019. Dog ownership and survival after a major cardiovascular event: a register-based prospective study. Circulation: Cardiovascular Quality and Outcomes, 12(10), p.e005342.

Muela, A., Azpiroz, J., Calzada, N., Soroa, G. and Aritzeta, A., 2019. Leaving A Mark, An Animal-Assisted Intervention Programme for Children Who Have Been Exposed to Gender-Based Violence: A Pilot Study. International journal of environmental research and public health, 16(21), p.4084.

Mueller, M.K., Gee, N.R. and Bures, R.M., 2018. Human-animal interaction as a social determinant of health: descriptive findings from the health and retirement study. BMC public health, 18(1), pp.1-7.

Muñoz-Prieto, A., Nielsen, L.R., Martinez-Subiela, S., Mazeikiene, J., Lopez-Jornet, P., Savić, S. and Tvarijonaviciute, A., 2018. Application of the NEOH framework for self-evaluation of One Health elements of a case-study on obesity in European dogs and dog-owners. Frontiers in veterinary science, 5, p.163.

O'Haire, M.E., McKenzie, S.J., McCune, S. and Slaughter, V., 2014. Effects of classroom animal-assisted activities on social functioning in children with autism spectrum disorder. *The journal of alternative and complementary medicine*, *20*(3), pp.162-168.

Ogechi, I., Snook, K., Davis, B.M., Hansen, A.R., Liu, F. and Zhang, J., 2016. Pet ownership and the risk of dying from cardiovascular disease among adults without major chronic medical conditions. High Blood Pressure & Cardiovascular Prevention, 23(3), pp.245-253.

Ojwang, V., Nwaru, B.I., Takkinen, H.M., Kaila, M., Niemelä, O., Haapala, A.M., Ilonen, J., Toppari, J., Hyöty, H., Veijola, R. and Knip, M., 2020. Early exposure to cats, dogs and farm animals and the risk of childhood asthma and allergy. Pediatric Allergy and Immunology, 31(3), pp.265-272.

Olsen, C., Pedersen, I., Bergland, A., Enders-Slegers, M.J. and Ihlebæk, C., 2019. Engagement in elderly persons with dementia attending animal-assisted group activity. Dementia, 18(1), pp.245-261.

Olsen, C., Pedersen, I., Bergland, A., Enders-Slegers, M.J., Patil, G. and Ihlebæk, C., 2016. Effect of animal-assisted interventions on depression, agitation and quality of life in nursing home residents suffering from cognitive impairment or dementia: a cluster randomized controlled trial. International Journal of Geriatric Psychiatry, 31(12), pp.1312-1321.

Paul, E.S. and Serpell, J.A., 1996. Obtaining a new pet dog: Effects on middle childhood children and their families. Applied Animal Behaviour Science, 47(1-2), pp.17-29.

PDSA, P., 2011. PDSA Animal Wellbeing Report 2019.

Pendry, P., Kuzara, S. and Gee, N.R., 2019. Evaluation of Undergraduate Students' Responsiveness to a 4-Week University-Based Animal-Assisted Stress Prevention Program. International journal of environmental research and public health, 16(18), p.3331.

Perez, M., Cuscaden, C., Somers, J.F., Simms, N., Shaheed, S., Kehoe, L.A., Holowka, S.A., Aziza, A.A., Shroff, M.M. and Greer, M.L.C., 2019. Easing anxiety in preparation for pediatric magnetic resonance imaging: a pilot study using animal-assisted therapy. Pediatric radiology, 49(8), pp.1000-1009.

Pérez-Camargo, G. and Creagan, E.T., 2018. The design of visitation facilities to engage patients with their own cats and dogs. Complementary therapies in clinical practice, 31, pp.193-199.

Pets at Home (2015) - http://petreport.petsathome.com/

Pikhartova, J., Bowling, A. and Victor, C., 2014. Does owning a pet protect older people against loneliness?. BMC geriatrics, 14(1), p.106.

Plitman, L., Černá, P., Farnworth, M.J., Packer, R. and Gunn-Moore, D.A., 2019. Motivation of owners to purchase pedigree cats, with specific focus on the acquisition of brachycephalic cats. Animals, 9(7), p.394.

Powell, L., Chia, D., McGreevy, P., Podberscek, A.L., Edwards, K.M., Neilly, B., Guastella, A.J., Lee, V. and Stamatakis, E., 2018. Expectations for dog ownership: Perceived physical, mental and psychosocial health consequences among prospective adopters. PLoS One, 13(7), p.e0200276.

Protopopova et al. (2020) Integration of AAI and Applied Behavior Analysis to Improve Academic Performance in Children with Intellectual and/or Developmental Disability

Raina, P., Waltner-Toews, D., Bonnett, B., Woodward, C. and Abernathy, T., 1999. Influence of companion animals on the physical and psychological health of older people: An analysis of a one-year longitudinal study. Journal of the American Geriatrics Society, 47(3), pp.323-329.

Randour, M.L., Smith-Blackmore, M., Blaney, N., DeSousa, D. and Guyony, A.A., 2019. Animal abuse as a type of trauma: lessons for human and animal service professionals. Trauma, Violence, & Abuse, p.1524838019843197.

Rehn, T., Beetz, A. and Keeling, L.J., 2017. Links between an owner's adult attachment style and the support-seeking behavior of their dog. Frontiers in psychology, 8, p.2059.

Reilly, K.M., Adesope, O.O. and Erdman, P., 2020. The Effects of Dogs on Learning: A Meta-Analysis. Anthrozoös, 33(3), pp.339-360.

Rhoades, H., Winetrobe, H. and Rice, E., 2015. Pet ownership among homeless youth: Associations with mental health, service utilization and housing status. Child Psychiatry & Human Development, 46(2), pp.237-244.

Richards, E.A., Ogata, N. and Cheng, C.W., 2017. Randomized controlled theory-based, e-mail-mediated walking intervention: differences between dog owners and non-dog owners. Clinical nursing research, 26(1), pp.47-67.

Sato, R., Fujiwara, T., Kino, S., Nawa, N. and Kawachi, I., 2019. Pet ownership and children's emotional expression: Propensity score-matched analysis of longitudinal data from Japan. *International journal of environmental research and public health, 16*(5), p.758.

Schreiner, P.J., 2016. Emerging cardiovascular risk research: impact of pets on cardiovascular risk prevention. Current cardiovascular risk reports, 10(2), p.8.

Schenk, G., Duindam, H.M., Creemers, H.E., Hoeve, M., Stams, G.J.J. and Asscher, J.J., 2018. The effectiveness of Dutch Cell Dogs in correctional facilities in the Netherlands: a study protocol of a quasi-experimental trial. BMC psychiatry, 18(1), p.218.

Scanlon, L., McBride, A. and Stavisky, J., 2020. Prevalence of pet provision and reasons for including or excluding animals by homelessness accommodation services. Journal of Social Distress and Homelessness, pp.1-7.

Schuurmans, L., Enders-Slegers, M.J., Verheggen, T. and Schols, J., 2016. Animal-assisted interventions in Dutch nursing homes: A survey. Journal of the American Medical Directors Association, 17(7), pp.647-653.

Simoneti, C.S., Ferraz, E., Menezes, M.B., Icuma, T.R. and Vianna, E.O., 2018. Cat ownership is associated with increased asthma prevalence and dog ownership with decreased spirometry values. Brazilian Journal of Medical and Biological Research, 51(12).

Silva, K., Lima, M., Fafiães, C., Sinval, J. and de Sousa, L., 2020. Preliminary test of the potential of contact with dogs to elicit spontaneous imitation in children and adults with severe autism spectrum disorder. American Journal of Occupational Therapy, 74(1), pp.7401205070p1-7401205070p8.

Smith, H.P. and Smith, H., 2019. A qualitative assessment of a dog program for youth offenders in an adult prison. Public Health Nursing, 36(4), pp.507-513.

Sørensen, I.K., Bidstrup, P.E., Rod, N.H., Rühling, T. and Johansen, C., 2018. Is dog ownership associated with mortality? A nationwide registry study. European Journal of Public Health, 28(6), pp.1169-1171.

Stanley, I.H., Conwell, Y., Bowen, C. and Van Orden, K.A., 2014. Pet ownership may attenuate loneliness among older adult primary care patients who live alone. Aging & Mental Health, 18(3), pp.394-399.

Strong, V., Brown, S.W. and Walker, R.O.B.I.N., 1999. Seizure-alert dogs—fact or fiction?. Seizure, 8(1), pp.62-65.

Swall, A., Ebbeskog, B., Lundh Hagelin, C. and Fagerberg, I., 2017. Stepping out of the shadows of Alzheimer's disease: a phenomenological hermeneutic study of older people with Alzheimer's disease caring for a therapy dog. International journal of qualitative studies on health and well-being, 12(1), p.1347013.

Syzmanski, T., Casey, R.J., Johnson, A., Cano, A., Albright, D. and Seivert, N.P., 2018. Dog training intervention shows social-cognitive change in the journals of incarcerated youth. Frontiers in veterinary science, 5, p.302.

Takashima, G.K. and Day, M.J., 2014. Setting the one health agenda and the human–companion animal bond. International journal of environmental research and public health, 11(11), pp.11110-11120.

Thelwell, E.L., 2019. Paws for Thought: A Controlled Study Investigating the Benefits of Interacting with a House-Trained Dog on University Students Mood and Anxiety. Animals, 9(10), p.846.

Thodberg, K., Sørensen, L.U., Christensen, J.W., Poulsen, P.H., Houbak, B., Damgaard, V., Keseler, I., Edwards, D. and Videbech, P.B., 2016. Therapeutic effects of dog visits in nursing homes for the elderly. *Psychogeriatrics*, *16*(5), pp.289-297.

Thomson, J.E., Hall, S.S. and Mills, D.S., 2018. Evaluation of the relationship between cats and dogs living in the same home. *Journal of Veterinary Behavior, 27*, pp.35-40.

Tkatch, R., Wu, L., MacLeod, S., Ungar, R., Albright, L., Russell, D., Murphy, J., Schaeffer, J. and Yeh, C.S., 2020. Reducing loneliness and improving well-being among older adults with animatronic pets. Aging & Mental Health, pp.1-7.

Toohey, A.M., Hewson, J.A., Adams, C.L. and Rock, M.J., 2018. Pets, social participation, and aging-in-place: Findings from the Canadian longitudinal study on aging. Canadian Journal on Aging/La Revue canadienne du vieillissement, 37(2), pp.200-217.

Turner, D.C., 2017. A review of over three decades of research on cat-human and human-cat interactions and relationships. *Behavioural Processes, 141*, pp.297-304.

Uccheddu, S., De Cataldo, L., Albertini, M., Coren, S., Da Graça Pereira, G., Haverbeke, A., Mills, D.S., Pierantoni, L., Riemer, S., Ronconi, L. and Testoni, I., 2019. Pet humanisation and related grief: Development and validation of a structured questionnaire instrument to evaluate grief in people who have lost a companion dog. Animals, 9(11), p.933.

Vidović, V.V., Štetić, V.V. and Bratko, D., 1999. Pet ownership, type of pet and socio-emotional development of school children. Anthrozoös, 12(4), pp.211-217.

Vitale, K.R. and Udell, M.A., 2019. The quality of being sociable: The influence of human attentional state, population, and human familiarity on domestic cat sociability. Behavioural processes, 158, pp.11-17.

Wall, M., Cave, N.J. and Vallee, E., 2019. Owner and cat-related risk factors for feline overweight or obesity. *Frontiers in veterinary science, 6*, p.266.

Walker, J.K., Waran, N.K. and Phillips, C.J., 2016. Owners' perceptions of their animal's behavioural response to the loss of an animal companion. Animals, 6(11), p.68.

Wallis, L.J., Szabó, D., Erdélyi-Belle, B. and Kubinyi, E., 2018. Demographic change across the lifespan of pet dogs and their impact on health status. Frontiers in Veterinary Science, 5, p.200.

Ward-Griffin, E., Klaiber, P., Collins, H.K., Owens, R.L., Coren, S. and Chen, F.S., 2018. Petting away pre-exam stress: The effect of therapy dog sessions on student well-being. Stress and Health, 34(3), pp.468-473.

Wenden, E.J., Lester, L., Zubrick, S.R., Ng, M. and Christian, H.E., 2020. The relationship between dog ownership, dog play, family dog walking, and pre-schooler social–emotional development: findings from the PLAYCE observational study. Pediatric Research, pp.1-7.

Westgarth, C., Boddy, L.M., Stratton, G., German, A.J., Gaskell, R.M., Coyne, K.P., Bundred, P., McCune, S. and Dawson, S., 2013. Pet ownership, dog types and attachment to pets in 9–10 year old children in Liverpool, UK. BMC Veterinary Research, 9(1), p.102.

Westgarth, C., Ness, A.R., Mattocks, C. and Christley, R.M., 2017. A birth cohort analysis to study dog walking in adolescence shows no relationship with objectively measured physical activity. Frontiers in veterinary science, 4, p.62.

Wijker, C., Leontjevas, R., Spek, A. and Enders-Slegers, M.J., 2020. Effects of dog assisted therapy for adults with autism spectrum disorder: an exploratory randomized controlled trial. Journal of autism and developmental disorders, 50(6), pp.2153-2163.

Williams, E.J. and Blackwell, E., 2019. Managing the risk of aggressive dog behavior: investigating the influence of owner threat and efficacy perceptions. Risk analysis, 39(11), pp.2528-2542.

Wong, P.W., Yu, R.W. and Ngai, J.T., 2019. Companion animal ownership and human well-being in a metropolis—The case of Hong Kong. International journal of environmental research and public health, 16(10), p.1729.

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

Wu, Y.T., Luben, R. and Jones, A., 2017. Dog ownership supports the maintenance of physical activity during poor weather in older English adults: cross-sectional results from the EPIC Norfolk cohort. J Epidemiol Community Health, 71(9), pp.905-911.

Zijlema, W.L., Christian, H., Triguero-Mas, M., Cirach, M., Van Den Berg, M., Maas, J., Gidlow, C.J., Kruize, H., Wendel-Vos, W., Andrušaitytė, S. and Grazuleviciene, R., 2019. Dog ownership, the natural outdoor environment and health: a cross-sectional study. *BMJ open*, *9*(5), p.e023000.

Xu, S.L., Trevathan, E., Qian, Z., Vivian, E., Yang, B.Y., Hu, L.W., Zeng, X.W., Li, M., Zhou, Y., Qin, X.D. and Bao, W.W., 2017. Prenatal and postnatal exposure to pet ownership, blood pressure, and hypertension in children: the Seven Northeastern Cities study. *Journal of hypertension*, *35*(2), pp.259-265.

NESTLÉ PURINA PETCARE EMENA
CORPORATE COMMUNICATIONS
www.purina.eu
greta.drumstaite@purina.nestle.com