

Routledge
Taylor & Francis Group

Anthrozoös

A multidisciplinary journal of the interactions of people and animals

ISSN: 0892-7936 (Print) 1753-0377 (Online) Journal homepage: www.tandfonline.com/journals/rfan20

# A Systematic Review of Research on Pet Ownership and Animal Interactions among Older Adults

Nancy R. Gee & Megan K. Mueller

**To cite this article:** Nancy R. Gee & Megan K. Mueller (2019) A Systematic Review of Research on Pet Ownership and Animal Interactions among Older Adults, Anthrozoös, 32:2, 183-207, DOI: 10.1080/08927936.2019.1569903

**To link to this article:** https://doi.org/10.1080/08927936.2019.1569903

© 2019 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group

View supplementary material

Published online: 19 Mar 2019.

Submit your article to this journal

Article views: 11550

View related articles

View Crossmark data

Citing articles: 59 View citing articles

Full Terms & Conditions of access and use can be found at
https://www.tandfonline.com/action/journalInformation?journalCode=rfan20

ANTHROZOÖS VOLUME 32, ISSUE 2 PP. 183–207
REPRINTS AVAILABLE DIRECTLY FROM THE PUBLISHERS
PHOTOCOPYING PERMITTED BY LICENSE ONLY
© 2019 THE AUTHOR(S). PUBLISHED BY INFORMA UK LIMITED, TRADING AS TAYLOR & FRANCIS GROUP

# A Systematic Review of Research on Pet Ownership and Animal Interactions among Older Adults

**Nancy R. Gee*** **and Megan K. Mueller†**

**Nancy R. Gee, Department of Psychology, State University of New York, Fredonia, New York, USA, and WALTHAM Centre for Pet Nutrition, Leicestershire, UK*

*†Department of Clinical Sciences, Cummings School of Veterinary Medicine at Tufts University, USA; Tufts Institute for Human–Animal Interaction; Jonathan M. Tisch College of Civic Life at Tufts University, USA*

*Address for correspondence: Nancy R. Gee, Department of Psychology, State University of New York, Fredonia, NY 14603, USA. E-mail: nancy.gee@fredonia.edu*

*A supplemental file for this paper is available online*

A pdf of this paper can also be downloaded without charge. Gold Open Access sponsored by WALTHAM™.

*This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (http://creativecommons.org/licenses/by-nc-nd/4.0/), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way.*

**ABSTRACT** Research on the impact of companion animals in the lives of older adults is considered from two perspectives: pet ownership and in animal-assisted interventions (AAI). This paper first presents a discussion of potential theoretical explanations of the impact of animals on human health and wellbeing among older adults, and then provides a systematic review and evaluation of existing research on the topics of human–animal interaction (HAI) and physical health and exercise, depression and anxiety, and loneliness and social functioning. Each of the studies in this review ($n$ = 145) are rated according to modified Oxford Center for Evidence Based Medicine (OCEBM) levels and the role of theory, in conceptualizing the study or interpreting outcomes, is discussed. The quality of evidence for each topical area of HAI and aging research is summarized, and recommendations are made for future research directions that will increase our knowledge of the relationship between HAI and health outcomes for older adults in different settings.

**Keywords:** aging, animal-assisted interventions, human–animal interaction, older adults, pet ownership



The relationship between humans and animals is both enduring and important. Archeological evidence, some of which dates back as much as 32,000 years (Wang et al., 2013) provides a variety of examples of humans and animals living and working together. Ancient cave paintings show humans and animals working together to hunt, herd, or for mutual protection. A mosaic from Pompeii (79 AD) depicts a dog wearing a collar and leash. The longstanding nature of this relationship bears itself out in sheer numbers today, with pet ownership

Anthrozoös DOI: 10.1080/08927936.2019.1569903

(PO) extremely common throughout Western civilization. Dog ownership is estimated as 7.5 million in the UK, 60+ million in the European Union, and 6.4 million in Canada, and cat ownership is about 7.5 million, 60+ million, and 7 million, respectively (Pet Food Manufacturer's Association [PFMA], 2016). In the US, approximately two-thirds of homes include a pet (American Pet Products Association [APPA], 2017).

PO also is relatively common in the aging population; estimates range from over 50% of adults over the age of 50 (Mueller, Gee, & Bures, 2018) to 14% of individuals over the age of 65 (APPA, 2009). Thus, PO may be an important component of understanding aging, as older adults may experience an assortment of challenges related to ongoing PO (Anderson, Lord, Hill, & McCune, 2015). In addition, animals are often incorporated into therapeutic settings for older adults, as either animal-assisted activities (AAA; often informal or recreational activities) or therapy (AAT; goal-oriented, structured therapeutic activities delivered by trained professionals).

Given the potential importance of PO and both forms of therapeutic animal-assisted interaction (AAI) as contexts for human–animal interaction (HAI) in older adults, this paper assesses current research addressing the role of HAI in the lives of older adults. Specifically, we examine the theoretical underpinnings of human bonds to companion animals and systematically review the literature relevant to PO and AAI among older adults, evaluate the quality of that literature using the Oxford Center for Evidence Based Medicine (OCEBM) levels, and make specific recommendations for future research.

### *Theoretical Underpinnings of Human Attachment to Companion Animals*

The American Veterinary Medical Association (2007) defines the bond between humans and companion animals as a mutually beneficial and dynamic relationship influenced by behaviors essential to the health and wellbeing of both. A range of theories explain this bond, and a strong theoretical grounding is a critical component of high quality HAI research.

Perhaps the most commonly cited theoretical paradigm for understanding the human–animal bond is attachment theory. Originally proposed by Bowlby (1969), attachment theory suggests that maintaining close proximity to animals helps humans to better cope with the world. Attachment appears to be an important component of the relationship between people and their pets; research indicates that higher attachment to pets predicts a number of positive outcomes for older adults (e.g., Krause-Parello, 2008; Krause-Parello & Gulick, 2013). Similarly, the social support perspective focuses on not only the reality but also the extent to which a person perceives being cared for and is part of a social network providing supportive resources (Cohen & Wills, 1985). Animals presumably provide companionship and opportunities for nurturance and social support (e.g., Kurdek, 2009) which protects from the adverse effects of stressors, and enhances social capital (Wood, Giles-Corti, Bulsara, & Bosch, 2007).

Two alternate theoretical approaches provide more nuanced explanations for contributions of animals to human health and wellbeing: the BioPsychoSocial Model and the Social-Ecological Model. The BioPsychoSocial Model (Engel, 1997) explains health outcomes for individuals as a complex interaction of biological (e.g., biochemical, genetic), psychological (e.g., personality, behavior), and social factors (e.g., culture, family). Companion animals have the potential to influence any of these factors, which then impact the others to enhance or diminish health. In contrast, the Social-Ecological Model (Brofenbrenner, 1979) posits a community/policy-level understanding of human development in the context of the entire ecological system. This model proposes a network of interactions involving four different systems: 1) microsystem: immediate surroundings (e.g., family); 2) mesosystems: commu-

nity-level (e.g., church and neighborhood); 3) exosystems: social, political, and economic conditions; and 4) macrosystems: cultural values, customs, and laws. Companion animals may impact any of these. For example, many people consider their pets to be part of the family (microsystem; Herzog, 2010, p. 75) and dogs tend to increase social contacts with neighbors (mesosystem; Wood et al., 2007).

These (and other) theories provide frameworks for exploring HAI in various settings and are useful lenses for interpreting existing research on HAI and healthy aging. Given the complexity of human–animal relationships, understanding their theoretical basis is critical in framing research exploring the relationships between older adults and animals.

### *Research Evidence on HAI and Older Adults*

Although the evidence base on the role of PO and AAI in older adulthood is growing, it also has significant theoretical, conceptual, and methodological limitations (Gee, Mueller, & Curl, 2017). As the wider field of HAI grows in breadth and rigor of research, it is necessary to understand the quality of research within specific subfields such as healthy aging and to provide specific recommendations for future work. Therefore, our goal is to provide an overview and critical evaluation of existing work on PO and AAI in older adults, and discuss the risks and benefits associated with each. In so doing, we present the results of a systematic review of the literature following PRISMA guidelines (Moher et al., 2009) and evaluate the quality of that work using a modified version of the Oxford Center for Evidence Based Medicine (OCEBM) levels (Howick et al., 2011) following the approach taken by Hall et al. (2016).

## Method of Systematic Review

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were used (Moher et al., 2009). The inclusion criteria for article selection were that it had been 1) peer reviewed, 2) written in English, 3) published after 1965, and 4) included original research topically focused on HAI in older adults (defined as 50+ years) or provided information on HAI in a trajectory of aging that included older adults. Search terms used are provided in Table 1 and databases searched are provided in Table 2. The search included all articles available prior to February 2018.

**Table 1.** Search terms used to investigate the literature.

| | | |
|---|---|---|
| | | companion animals OR |
| | | pets OR |
| | | dogs OR |
| older adults OR | | canine OR |
| elderly OR | | feline OR |
| seniors OR | | cats OR |
| geriatrics OR | AND | fish OR |
| aging OR | | birds OR |
| age related OR | | pet ownership OR |
| aged | | animal interaction OR |
| | | animal assisted therapy OR |
| | | animal assisted activities OR |
| | | animal assisted interventions OR |
| | | animal assisted education |

**Table 2.** Databases searched.

| Combined Search | Separate Searches |
|---|---|
| Academic Search Complete, Alt Health Watch, CINAHL Plus with Full Text, Education Source, Environment Complete, ERIC, Health Source: Nursing/Academic Edition, LGBT Life with full text, MEDLINE with full text, PsychARTICLES, Psychology and Behavioral Sciences Collection, PsycINFO, Social Sciences Full Text, SocINDEX with Full Text | Google Scholar, Anthrozoös, Waltham.com, HABRI Central |

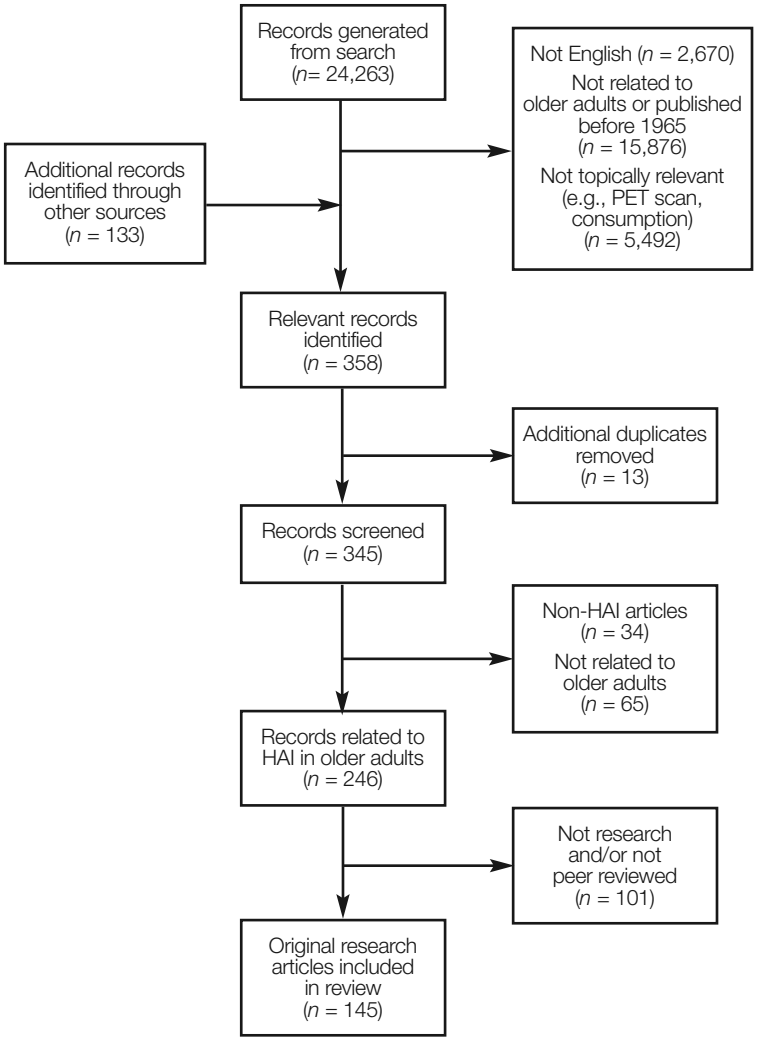



**Figure 1.** PRISMA (2009) search flow diagram.

## Results

The initial search returned 24,263 references. Additional filtering removed 24,038 references that did not meet our four criteria. An additional 133 records were identified through a direct Google Scholar search, a search of the journal *Anthrozoös*, Waltham.com, and via references from screened articles, returning a total of 358 relevant records. After removal of duplicates and articles added through the supplemental searches that failed to meet the four criteria, a total of 145 records remained that were included in the review (see Figure 1 for PRISMA diagram outlining search steps).

Each of the remaining articles was reviewed and ranked based on a modified version of the OCEBM level system (Howick et al., 2011; see Table 3 for rating definitions). The articles were divided by topic into two categories: PO and animal-assisted activities or therapy. Across both categories, few studies received high levels (1a = 0, 1b = 3, 1c = 0, 2a = 0, 2b = 12). Many (particularly those that were relatively high-quality outcomes research) were level 2c ($n$ = 60). In addition, 27 were level 4 and 39 level 5 (see Table 3 for breakdown by level). The studies were then organized by primary topic area (note: several studies involved more than one topic, e.g., anxiety and depression) for discussion. We also assessed studies for inclusion of a theoretical framework via searches within the articles (search terms: theory, theoretical, model, framework); results are presented by topic area in Table 4. The entire list of articles including the reference, design type, OCEBM rating, sample size, outcomes assessed, category (AAI or PO), and topic area of investigation is available in an online supplemental file. We briefly describe key findings and the quality of evidence supporting these findings within each of these topic areas below.

### *Physical Health & Exercise*

*PO Findings:* Some of the strongest research evidence to date regarding the impact of companion animals on human health and wellbeing comes from examinations of PO and cardiac health and physiological responses to stress in adults. Twenty-six studies focused on the relationship of PO, to physical health outcomes. The majority ($n$ = 24) were classified as level 2c (Aiba et al., 2012; Branson et al., 2016; Chowdhury et al., 2017; Crowley-Robinson & Blackshaw, 1998; Dall et al., 2017; Dembicki & Anderson, 1996; Enmarker, Hellzen, Ekker, & Berg, 2012; Feng et al., 2014; Friedmann et al., 2011; Friedmann et al., 2013; Garcia et al., 2015; Harris et al., 2009; Lago et al., 1989; Netting et al., 1988; Parker et al., 2010; Parslow et al., 2005; Pruchno et al., 2018; Raina et al., 1999; Richards, 2015; Shibata et al., 2012; Thorpe et al., 2006a, 2006b; Toohey et al., 2013; Winefield et al., 2008). These studies largely used standardized measures within longitudinal surveys, cross-sectional surveys with representative sampling techniques, and/or repeated measures designs with comparison groups. They mostly included comparisons of pet owners and non- owners, and did not involve random assignment to conditions, due to the nature of PO and the practical and ethical challenges with randomly assigning PO. Two additional studies classified as level 5 involved interviews of small groups of older adults regarding PO (Johansson et al., 2014), and a focus group of older adult dog walkers (Knight & Edwards, 2008).

A common outcome was the relationship between PO and cardiac health. For example, the presence of their pet was demonstrated to modulate cardiac autonomic imbalance in an analysis of 24-hour Holter monitor electrocardiogram results for 191 older adults with diabetes, hypertension, and/or hyperlipidemia (Aiba et al., 2012), and pet presence was associated with lower blood pressure in 32 older adult patients with hypertension (Friedmann,

**Table 3.** Modified OCEBM levels of eligible records ($n$ = 145).

| OCEBM Level | Level Definition | Study Types | Number of Articles | | Sample Size Range | |
|---|---|---|---|---|---|---|
| | | | Pet Ownership | AAI | Pet Ownership | AAI |
| 1a | Systematic reviews (with homogeneity of results) of RCTs | Systematic review of majority of evidence from 1b and 1c. | 0 | 0 | — | — |
| 1b | Individual RCT: with narrow confidence interval, includes effect size or power analysis | High quality RCT | 0 | 3 | — | 94 |
| 1c | All or none case series | Case series | 0 | 0 | — | — |
| 2a | Systematic reviews (with homogeneity of results) of cohort studies | Systematic review of majority of evidence from 2b or 2c. | 0 | 0 | — | 8 |
| 2b | Individual cohort studies including low quality RCTs | RCT with small sample size or no effect size/power analysis | 0 | 12 | — | 11–144 |
| 2c | Outcomes research, ecological studies | Longitudinal surveys, cross-sectional surveys with representative sampling, repeated measures with control groups | 44 | 17 | 26–39,995 | 10–233 |
| 3a | Systematic reviews (with homogeneity of results) of case-control studies | Systematic review of evidence from 3b, 4, 5. | 0 | 0 | — | — |
| 3b | Individual case-control studies | Case-control | 0 | 2 | — | 14 |
| 4 | Case series (and poor quality cohort and case control studies) | Repeated measures with no control group, cohort studies with small sample sizes or unstandardized measures | 1 | 26 | 32 | 3–91 |
| 5 | Expert opinion with explicit critical appraisal, or based on physiology, bench research or “first principles” | Case studies, focus groups, clinical records, non-representative cross-sectional surveys | 28 | 13 | 1–1,509 | 1–70 |
| **Total** | | | **73** | **73** | | |

Key: Oxford Center for Evidence-Based Medicine (OCEBM); randomized controlled trial (RCT), animal-assisted interventions (AAI).

Note: One reference in level 2c (Eshbaugh et al., 2011) included findings pertaining to both pet ownership and AAI, and is therefore included in the counts for both categories, but not added in twice for the total article count.

**Table 4.** Percentage of articles including theory, by topical category and OCEBM level.

| PET OWNERSHIP | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Physical Health | | Depression | | Anxiety | | Loneliness | | Cognitive | | Other | |
| Level | Total Articles | Includes Theory | Total Articles | Includes Theory | Total Articles | Includes Theory | Total Articles | Includes Theory | Total Articles | Includes Theory | Total Articles | Includes Theory |
| | *n* | *n* (%) | *n* | *n* (%) | *n* | *n* (%) | *n* | *n* (%) | *n* | *n* (%) | *n* | *n* (%) |
| 1b | | | | | | | | | | | | |
| 2b | | | | | | | | | | | | |
| 2c | 24 | 5 (21%) | 9 | 2 (22%) | 1 | 0 (0%) | 7 | 4 (57%) | | | 10 | 3 (30%) |
| 3b | | | | | | | | | | | | |
| 4 | | | | | | | | | | | 1 | 1 (100%) |
| 5 | 2 | 0 (0%) | 4 | 2 (50%) | 1 | 0 (0%) | 6 | 4 (67%) | | | 18 | 7 (39%) |
| **ANIMAL-ASSISTED INTERVENTIONS** | | | | | | | | | | | | |
| | Physical Health | | Depression | | Anxiety | | Loneliness | | Cognitive | | Other | |
| Level | Total Articles | Includes Theory | Total Articles | Includes Theory | Total Articles | Includes Theory | Total Articles | Includes Theory | Total Articles | Includes Theory | Total Articles | Includes Theory |
| | *n* | *n* (%) | *n* | *n* (%) | *n* | *n* (%) | *n* | *n* (%) | *n* | *n* (%) | *n* | *n* (%) |
| 1b | 1 | 0 (0%) | 1 | 0 (0%) | 1 | 0 (0%) | 1 | 0 (0%) | | | | |
| 2b | 3 | 2 (67%) | 5 | 1 (20%) | 2 | 1 (50%) | 5 | 0 (0%) | | | | |
| 2c | 4 | 1 (25%) | 7 | 3 (43%) | 1 | 0 (0%) | 8 | 0 (0%) | | | | |
| 3b | 1 | 0 (0%) | | | | | | | 1 | 0 (0%) | | |
| 4 | 5 | 2 (40%) | 4 | 0 (0%) | 4 | 0 (0%) | 13 | 5 (38%) | 1 | 0 (0%) | 3 | 1 (33%) |
| 5 | 3 | 0 (0%) | | | | | 5 | 2 (40%) | 1 | 1 (100%) | 2 | 1 (50%) |

Thomas, Son, Chapa, & McCune, 2013). In an analysis of 460 older individuals who had experienced a myocardial infarction, PO was the only factor significantly predicting survival (Friedmann, Thomas, & Son, 2011). Similarly, PO was associated with improved survival and lower risk of fatal cardiovascular events in a sample of hypertensive older adults (Chowhurdy et al., 2017). In an additional level 5 study with a small sample size (Johansson et al., 2014), older adults experienced companion animals as important physical and psychosocial contributors to recovery after a stroke.

PO was also associated with several other positive physical health and activity outcomes. Many studies focused on dog walking and patterns of dog-walking behaviors (e.g., Richards, 2015), and a number found that older adult dog owners engage in significantly more walking than non-pet owners (Dall et al., 2017; Dembicki & Anderson, 1996; Feng et al., 2014; Garcia et al., 2015; Harris et al., 2009; Shibata et al., 2012; Thorpe et al., 2006a, 2006b). Dog walking may also provide positive social outcomes that result from engaging in the community through dog walking. A random survey of adults 50 years of age or older ($n$ = 884) indicated that frequent dog walkers were more likely to experience higher levels of sense of community (OR = 1.94), in addition to increased time walking (OR = 10.68; Toohey, McCormack, Doyle-Baker, Adams, & Rock, 2013). Knight and Edwards (2008) conducted focus groups with older adult dog owners who reportedly perceived health and social benefits from dog walking.

In contrast, several studies demonstrated negative, mixed, or null effects of PO on cardiovascular and physical health. Among patients admitted to hospital for acute cardiac symptoms ($n$ = 242), pet owners (especially cat owners) had higher rates of the composite outcome of mortality or hospital re-admission (Parker et al., 2010). In one survey of 2,551 older adults comparing sociodemographic attributes, mental and physical health measures, and personality traits of pet owners and non-owners, caring for a pet was associated with lower physical health (Parslow, Jorm, Christensen, Rodgers, & Jacomb, 2005). Similarly, several studies found no differences in various indictors of physical health in older adults (Crowley-Robinson, & Blackshaw, 1998; Winefield et al., 2008). The direction of findings also varied by species: Enmarker et al. (2012) and Pruchno et al. (2018) found positive associations between health outcomes and dog ownership, but negative associations between health outcomes and cat ownership. Some findings have been mixed across health domains: in one study of depression, salivary c-reactive protein (CRP), and executive function in 88 homebound older adults, pet owners had higher levels of executive functioning, but no differences in depression or systemic inflammation (Branson, Boss, Cron, & Kang, 2016).

In addition, health status predicted lower likelihood of PO for older adults, with poor or declining health associated with reduced likelihood of PO (Lago et al., 1989; Netting et al., 1988; Raina et al., 1999). These findings highlight the importance of understanding how health status may influence who chooses or is able to own a pet, and how this selection bias may impact findings related to PO and physical health.

Despite the mixed findings, the overall body of research on PO and physical health prompted the American Heart Association to issue a scientific statement in 2013 suggesting that PO (particularly dogs) may reduce risk for cardiovascular disease (Levine et al., 2013). However, the existing research noted above is somewhat limited with regard to large-scale, longitudinal health data within robust population-representative samples. These data would be useful for addressing issues such as selection effects in PO. Furthermore, study designs should include factors such as species and age of companion animal, length of ownership, availability of physical space, bonds, and relationship between the animal and other members of the

family, all potentially important components of understanding the complex relationship between PO and physical health for older adults.

*Findings from Intervention Studies:* Overall, the ability to randomly assign participants to conditions can distinguish animal interaction studies from those focusing on PO, because people are seldom amendable to the idea of having a researcher assign them a pet to own, but they are frequently willing to interact with different animals for the purposes of an AAI study. AAI with older adults can take place in a variety of settings (e.g., at home, in assisted-living environments) and for a variety of purposes.

Our review of the literature revealed 17 studies focused on how AAI might impact some aspect of physical health of older adults. One study (Cole, Gawlinski, Steers, & Kotlerman, 2007) was ranked 1b, the highest OCEBM level, three were level 2b (DeSchriver et al., 1990; Friedmann, Thomas, Cook, Tsai, & Picot, 2007; Friedmann, Galik, Thomas, Hall, Chung, & McCune, 2015), four were level 2c (Araujo, Silva, Costa, Pereira, & Safons, 2011; Krause-Parello & Kolassa, 2016; Sloane et al., 2002; Stasi et al., 2004), one was level 3b (Walsh et al., 1995), five were level 4 (Edwards & Beck, 2002, 2013; Harris et al., 1993; Luptak et al., 2004; Rondeau et al., 2010), and 3 were level 5 (Moffatt et al., 2014; Nordgren et al., 2012; Wehofer et al., 2013).

In the study providing the strongest evidence, Cole et al. (2007) employed a three-group randomized repeated-measures design, wherein 76 patients diagnosed with advanced heart failure participated in each of three 12-minute conditions: 1) visit from a volunteer and a dog, 2) visit from a volunteer, and 3) a usual care control. The volunteer plus dog group had significantly greater decreases, both during and after the visit, in systolic pulmonary artery pressure and capillary wedge pressure; significantly greater decreases, both during and after the visit, in epinephrine and norepinephrine levels; and the greatest decrease in state anxiety post-intervention. Despite its limitations (outcomes may vary with disease state or severity, interaction duration, and different medications), this study demonstrates that AAI can improve cardiopulmonary, neurohormone, and anxiety measures, but not BP, as reported in other studies.

Three other studies in this topic included random assignment to conditions. DeSchriver and colleagues (1990) report nonsignificant findings that aquarium observers tended to experience decreased heart rate, muscle tension, and skin temperature, despite the finding that the video recording of fish was just as effective. Friedmann et al. (2007) evaluated whether the presence of a dog could moderate cardiovascular stress response in independently living older adult hypertensives while they were speaking or sitting quietly. Participants ($n$ = 11) were asked to follow a Quiet-Talk-Quiet (QTQ) protocol where they sat quietly for two minutes, talking for two minutes, then sat quietly for two minutes, once in the presence of the dog and once without the dog. The dog was randomly assigned to either be present during the first or the second QTQ protocol. The blood pressure (BP) was significantly lower when they were speaking with the dog present compared with when they were speaking without the dog present, but there were no differences when sitting quietly. The authors conclude that the presence of the dog moderated the cardiovascular stress response (as measured by BP) and they point out that modest reductions in stress response repeatedly throughout a day can have a significant impact on morbidity. While compelling, these results must be interpreted with caution, as must all small sample studies. Limitations also include failure to assess participant lifestyle behaviors (e.g., diet, exercise), medications other than Coumadin, PO status, experience or history with dogs, or attachment/liking of dogs.

In the Pet Assisted Living (PAL) intervention study, assisted living (AL) residents with mild to moderate cognitive impairment were randomly assigned to the PAL intervention ($n$ = 22) or reminiscing control group ($n$ = 18) twice per week for 12 weeks (Friedmann et al., 2015). In the PAL condition, participants performed specific skills with a visiting dog; the reminiscing condition, intended as a social-interaction control included dog visits (e.g., in the presence of the handler) and encouraged the residents to reminisce. Physical activity (as recorded by 24-hour activity monitors and the Barthel Index) improved significantly more in the PAL condition than in the reminiscing condition. This small scale RCT includes information on participant demographics and health histories, and directly assessed physical, behavioral, and emotional functioning before the invention and monthly during the intervention. Generalizability of the study findings is limited by a lack of information on previous PO, experience or attachment, and the small number and type of facilities included (all were small with limited programs available to residents), all of which may impact the success of the intervention.

In four level 2c studies (Araujo, et al., 2011, Krause-Parello & Kolassa, 2016, Sloane et al., 2002, and Stasi et al., 2004) AAI positively impacted risk of falls, BP, and hospitalization rates, and tended to reduce other stress indicators such as heart rate, muscle tension, and skin temperature. None of these studies include or report random assignment, although one reported a random sample (Sloane et al., 2002). Further, these studies frequently included small or non-diverse samples, or lacked important controls such as appropriate comparison conditions or control over relevant aspects of the study (e.g., food quality when measuring nutritional intake or medications used by participants when assessing BP).

The single study ranked level 3b in this topical category was a case-control study without random assignment (Walsh et al., 1995), which reported significant reductions in BP decreased following AAI. The five level 4 studies, classified as case series or poor-quality cohort studies, all reported positive impacts of AAI via increased walking speed (Rondeau et al., 2010), decreases in BP (Harris et al., 1993; Luptak et al., 2004), or increases in nutritional intake (Edwards & Beck, 2002, 2013). Of the three single case studies at level 5, two reported the positive impact of AAI, including improvements in walking ability (Nordgren et al., 2012), and balance and stability (Wehofer et al., 2013), and one (Moffatt et al., 2014) reported a negative impact of AAI: the transmission of bacterial infection in a residential facility.

### *Depression*

*PO Findings:* Much of the existing research on PO in older adults addresses mental health outcomes. Depression has been an outcome of interest for both PO and AAI, with a hypothesized relationship between animal interaction effects on social support, stress-reduction, and depressive symptoms. However, research exploring the relationship between PO and depression in aging adults has produced mixed findings.

Our review identified 13 studies addressing PO and older adults, with some degree of overlap between studies addressing physical health outcomes and depression. The majority of these studies ($n$ = 8) assessed differences between pet owners and non-owners, (level 2c) (Antonacopoulos & Pychyl, 2010; Bennett et al., 2015; Branson et al., 2016; Enmarker et al., 2012; Garrity, Stallones, Marx, & Johnson, 1989; Mueller, Gee, & Bures, 2018; Parslow et al., 2005; Rajaram et al., 1993). Five additional level 5 studies were individual case studies (Likourezos et al., 2002) or non-representative cross-sectional surveys (Krause-Parello, 2012; Lund et al., 1984; Miller & Lago, 1990a; Miltiades & Shearer, 2011).

Overall, these studies indicate mixed findings with regard to the relationship between PO and depression. For example, one of the earliest studies on companion animals and older adults demonstrated that in bereaved older adults, PO and pet attachment were associated with less depression (i.e., multiple regression analysis of survey results from a probability sample of 1,232 Americans, 65 and older, by Garrity et al., 1989). By contrast, multiple studies have found no relationship between PO and depressive symptoms (Antonacopoulos & Pychyl, 2010; Branson et al., 2016; Miller & Lago, 1990a). Bennett et al. (2015) used an experience sampling method ($n$ = 68) and found that PO did not predict depression, but that frequency of the presence of the pet was moderately related to lower levels of depression. However, multiple studies found positive relationships between PO and/or pet attachment and higher levels of depression. For example, in a cross-sectional analysis of a subsample of 1,657 participants over the age of 50 from the Health and Retirement Study (a longitudinal cohort study based in the United States), Mueller et al. (2018) found that POs were 1.89 times more likely to have experienced depression than non-pet owners. Similarly, Parlslow et al. (2005) found higher rates of depressive symptoms among pet owners compared with non-pet owners in a sample of 2,551 older Australian adults. However, these studies are limited in that causal interpretations are not possible from such cross-sectional data; it may be that older adults who have less social support and are more depressed seek out PO as a means of ameliorating such symptoms.

The relationship between PO and depression varies in different groups of older adults. For example, in a cross-sectional population study of 12,093 rural residents over the age of 65, of whom 1,897 owned either a dog or cat, using self-rated depression symptoms, Enmarker et al. (2015) found that both human gender and species of pet mattered, with female cat owners demonstrating the highest levels of depression. The relationship between PO and depression appears to be complex, involving multiple factors related to both the humans and the animals. It is also possible that PO has no impact on depression in older adults. To better understand this issue, future research should implement rigorous research methodologies using sample sizes sufficient for detecting meaningful change, standardized measures, appropriate covariates, and longitudinal approaches.

*Findings from Intervention Studies:* Our search located a total of 17 studies on AAI in depression. Although the PO study results with respect to depression are mixed, the findings from animal interventions among older adults are clearer, and more consistently, though not universally, show a favorable impact of HAI on depression and quality of life.

One study merited an OCEBM rating of 1b. Ko, Youn, Kim, and Kim (2016) present the results of an 8-week RCT investigating the effect of pet insects on psychological health in community dwelling older Korean adults. The insect-caring group received five crickets in a cage and instructions about how to care for them The insect-caring group ($n$ = 46) and the control group ($n$ = 48) both received instructions about their own healthy lifestyle choices including information about exercise and diet. Participants were randomized into one of the two conditions, and both groups separately attended lectures and had telephone contact throughout the week with research assistants. All participants underwent a battery of psychometric and laboratory tests at baseline and again after the 8-week intervention. The statistical analysis revealed that the insect-care group, relative to the control group, had significantly improved depression scores as measured by the 15-item Geriatric Depression Scale. The insect-care group also had significantly improved cognition scores as measured

by the Mini Mental State Examination (MMSE), but none of the other measures (e.g., anxiety, stress, fatigue, insomnia, or inflammatory markers) showed a significant difference between the groups. The insect-care group was questioned about their compliance with the care of the insects as well as their subjective feelings about having pet insects. The majority of participants (87%) cared adequately for their insects while the remaining 13% did not. Subjectively, most of the insect-care group (73.9%) indicated that having a pet cricket had been beneficial for their psychological and physical health. Limitations of this study include failure to report participants' other PO status, history or experience, and possible culture-specific implications for the acceptance of insect therapy.

The remaining studies on this topic include five at level 2b (Colombo et al., 2006; Friedmann et al., 2015; LeRoux & Kemp, 2009, Travers et al., 2013; Zisselman et al., 1996), seven at 2c (Colby & Sherman, 2002; Francis et al., 1985; Holcomb et al., 1997; Lutwack-Bloom et al., 2005; Moretti et al., 2011; Mossello et al., 2011; Stasi et al., 2004), and four at 4 (Barker, Pandurangi, & Best, 2003; Kumasaka et al., 2012; Phelps et al., 2008; Prosser et al., 2008).

The majority of these remaining studies report results linking AAI to a decrease in depression in older adults. For example, in one study 144 cognitively intact older adults were randomly assigned to one of three experimental conditions for a period of three months: a canary, a plant, and nothing (Colombo et al., 2006). Pre- and post-intervention measures showed a significantly greater improvement in scores for the canary group than the plant group or the no-treatment group, for both depression and quality of life, with the largest impact on depression. There is also evidence that AAI is effective in reducing depression in older adults with cognitive impairments. In a randomized controlled trial, 55 assisted-living residents with mild to moderate dementia were assigned to dog-assisted therapy or human-therapist-only 11-week interventions (Travers et al., 2013). Participants in the dog-assisted therapy group had significantly improved depression and quality of life scores compared with those participants who received the human–therapist-only intervention.

While the results of these and similar studies (e.g., Kumasaka et al., 2012; Friedmann et al., 2015; LeRoux & Kemp, 2009; Mossello et al., 2011; Stasi et al., 2004) are promising, they should be interpreted with caution because they report a heterogeneous array of treatments and include inconsistent methodologies. Further, some studies report no significant effect of AAI on depression in older adults (e.g., Barker et al., 2003; Francis et al., 1985; Lutwack-Bloom et al., 2005; Zisselman et al., 1996).

### *Anxiety, Fear, Agitation, and Related Behaviors*

*PO Findings:* Only two articles were generated from the search addressing PO and anxiety, indicating that little is known about this relationship. In a single case study (level 5) an 89-year-old woman reported that obtaining pets reduced her anxiety (Likourezos et al., 2002). Bennett et al. (2015) used an experience sampling methodology (level 2c) in a sample of 68 adults, finding no differences between pet owners and non-pet owners on anxiety levels, and a moderate relationship between the frequency that a pet was present and lower anxiety.

*Findings from Intervention Studies:* Despite the relative lack of research on anxiety and PO, given the established connection between depression and anxiety (Gorman, 1996), measures of anxiety are frequently included when assessing psychological functioning in intervention studies. We found eight studies that specifically discuss anxiety, anxiety-related constructs (e.g., fear), or behaviors frequently associated with anxiety (e.g., agitation): one classified as level 1b (Cole et al., 2007), two as level 2b (Dabelko-Schoeny et al., 2014; LeRoux & Kemp,

2009), one as level 2c (Mossello et al., 2011), and four as level 4 (Barker et al., 2003; Edwards, Beck, & Lim, 2014; McCabe, Baun Speich, & Agrawal, 2002; Sellers, 2006).

A brief 12-minute AAI session significantly reduced anxiety in patients diagnosed with advanced heart failure (Cole et al. 2007; discussed in detail, in the Physical Health section). Dog AAI reduced anxiety in 10 Alzheimer's patients (Mossello et al., 2001), whereas another study reported it did not reduce anxiety in 16 residents of long-term care facilities (LeRoux & Kemp, 2009). In several studies, AAI is associated with a reduction in behavior problems that may be related to anxiety or agitation (Dabelko-Schoeny et al., 2014; Edwards et al., 2014; McCabe et al., 2002; Sellers, 2006). For example, Barker et al. (2003) assessed the impact of AAI on anxiety, fear, and depression in 35 adult inpatients with severe depression, bipolar disorder, or psychoses, all considered refractory to psychopharmacological intervention prior to electroconvulsive therapy (ECT). Patients were assigned on alternate dates to 15 minutes with magazines or 15 minutes with therapy dog. The AAT condition resulted in significantly lower fear; differences approached significance for anxiety and were not significant for depression.

Methodologies, intervention strategies, implementation durations, and approaches to measurement varied considerably in these studies, and sample sizes tended to be small (only two had sample sizes larger than 40 (Cole et al., 2007; Edwards et al., 2014). Generalizability of the results is extremely limited. In addition, most of these studies focus on short term effects; future work should determine if the effects are durable. Because of the diversity of participant characteristics, more research is needed to understand which populations may be most likely to benefit from AAI.

### *Loneliness and Social Functioning*

*PO Findings:* For older adults, positive social functioning and the prevention or reduction of loneliness are key outcomes. Given the potential for animals to function as companions and provide social support, it is important to consider the role of HAI in loneliness for older adults. Our review found 13 articles related to PO and loneliness and/or social functioning: seven articles rated as 2c (Antonacopoulos & Pychyl, 2010; Bennett et al., 2015; Eshbaugh et al., 2011; Hecht et al., 2001; Pikhartova et al., 2014; Stanley, Conwell, Bowen, & Van Orden, 2014; Winefield et al., 2008), and six rated as 5 (Connell et al., 2007; Knight & Edwards, 2008; Krause-Parello, 2008, 2012; Krause-Parello & Gulick, 2013; Stewart et al., 1985).

Several studies indicated that pet attachment was associated with lower loneliness in older adults (Krause-Parello & Gulick, 2013; level 5), mediated the relationship between loneliness and general health (Krause-Parello, 2008; level 5), and was viewed as a coping resource for loneliness (Krause-Parello, 2012; level 5). In a cross-sectional survey of 814 individuals over 60 who live alone, pets were particularly effective in attenuating loneliness (Stanley et al., 2014; level 2c). In a stratified probability sample of 298 rural residents aged 60+, PO was associated with both self-esteem and locus of control, although only for men, suggesting that further exploration of this phenomenon is necessary (Hecht, McMillin, & Silverman, 2001; level 2c). One study that relied on focus groups indicated that older adults believed that walking their dogs increased their social interactions (Knight & Edwards, 2008; level 5).

Conversely, several of the level 2c studies found no differences between pet owners and non-pet owners on loneliness and/or social support (Antonacopoulos & Pychyl, 2010; Bennett et al., 2015; Eshbaugh et al., 2011; Winefield et al., 2008). For example, a large study of English older adults ($n$ = 5,210) found that pet owners were significantly *more* likely to report loneliness, although the authors hypothesize that gender differences in PO and loneliness (women are

more likely to be pet owners and to have higher levels of loneliness) may explain these findings (Pikhartova et al., 2014). In a similar vein, Stewart et al. (1985) found that within a convenience sample of older adults, pet owners were more likely to have fewer friends, potentially indicating that older adults with less robust social networks may seek out companionship with pets. The research findings regarding loneliness and PO in older adults are limited by the relatively small number of studies that employ representative sampling techniques and rigorous study design that would allow for understanding any causal relationships between PO and loneliness and/or social support.

*Findings from Intervention Studies:* Clinical AAIs are suggested as a way of reducing loneliness and increasing social activity in older adults. Our review of the literature revealed 32 AAI papers relevant to this topic: one study was classified as level 1b (Banks & Banks, 2002), five as level 2b (Kongable, Buckwalter, & Stolley, 1989; Kramer, Friedmann, & Bernstein, 2009; Majic et al., 2013, Thodberg et al., 2016; Zisselman et al., 1996), eight as 2c (Bernstein et al., 2000; Churchill et al., 1999; Eshbaugh et al., 2011; Fick, 1993; Greer et al., 2002; Haughie, 1992; Martindale, 2008; Nordgren & Engstrom, 2014a), 13 as level 4 (Calvert, 1998; Chinner & Dalziel, 1991; Hinman & Heyl, 2001; Kaiser et al., 2002; Koda & Yanai, 2011; Marx et al., 2010; Phelps et al., 2008; Prosser et al., 2008; Richeson, 2003; Ruckdeschel & Van Haitsma, 2001; Sellers, 2006; Swall et al., 2015; Vrbanac et al., 2013), and five as level 5 (Curtright & Turner, 2002; Darrah, 1996; Fila, 1991; Kalfon, 1991; Roenke & Mulligan, 1998). Most studies reported positive effects of AAI on loneliness, social behaviors, or social interactions, but six studies reported no significant differences, and Kramer et al. (2009) reported that the presence of a robotic dog stimulated more social behaviors than interaction with a live dog.

In the level 1b 6-week study (Banks & Banks, 2002), 45 long-term care facility residents were randomly assigned into one of three groups: no AAT, or 30-min AAT sessions with a dog either weekly or three times per week. As measured by the UCLA Loneliness Scale, both AAT groups had similar significant reductions in loneliness compared with the no-AAT condition. Reduction in loneliness was strongly related to previous PO. The self-selected resident participants had a well-established life history of responsibility for, and emotional bonds to, pets. These results suggest that AAT is most effective, or potentially only effective, for people with experience or prior connections with pets. The AAT sessions were not scripted or detailed in discussion, so it is unclear what aspects of the interactions were likely to have been most relevant to the effects seen, and the potential for replication is limited. The study did not include a standard pet attachment scale so it is unclear how attachment to previous pets may have influenced the results. It is unknown if the same effects would hold true for individuals who had not previously owned pets, given this self-selected sample.

Two other level 4 studies in this category also report positive impacts of AAI on loneliness (Calvert, 1989; Vrbanac et al., 2013). The Vrbanac et al. study examined the impact of AAT on loneliness in 21 nursing home residents. Loneliness scores were significantly reduced after the six-month AAT program. Most participants had previously owned a pet, and the authors acknowledge the association between previous PO and efficacy of AAT. They also reported increased social behaviors, but correctly indicate that generalization is limited due to the small sample size. Nevertheless, the results of these two studies suggest the need to examine generalizability to other populations of older adults and whether previous PO, experience with companion animals, or connection to a pet is a pre-requisite to AAT efficacy in reducing loneliness.

Several observational studies (levels reported above) with relatively small sample sizes report an increase in social interactions associated with AAI. This result has been found in a group of older psychiatric patients (Haughie, 1992), older adults with dementia (Katsinas, 2000; Kongable, Buckwalter, & Stolley, 1989; Marx et al., 2010; Sellers, 2005), Japanese retirement home residents (Koda & Yanai, 2011), long-term care residents (Kramer, Friedmann, & Bernstein, 2009), nursing home residents (Fick, 1993), and community-dwelling older adults (Krause-Parello & Kolassa, 2016). These reported increases in socialization included interactions among the patients, as well as between the staff and the patients.

The results reported in this category are mixed, with some studies reporting no significant differences between AAI groups and no-AAI groups (e.g., Bernstein, Friedmann, & Malaspina, 2000; Zisselman et al., 1996). A common theme among the studies is the variability in methodologies, intervention strategies, implementation durations, and approaches to measurement. Again, the studies in this section tended to have small sample sizes (only nine of the 30 studies reported sample sizes larger than 40) with the potential for generalizing of results extremely limited. Most of these studies focus on short term effects, gather very little information on PO history or experience, and frequently do not use standardized or validated measures.

### *Other*

*PO Findings:* In addition to the domains noted above, a number of studies addressed other outcomes. Five studies focused on the demographics of PO and what factors predicted likelihood of PO in older adults. In three studies, age predicted PO and older adults were less likely to own pets (Marx et al., 1988; Müllersdorf et al., 2010; Tower & Nokota, 2006; level 2c). In a longitudinal study of 7,952 older women, those who lived in family situations and/or a house were more likely to own a pet compared with those who lived in a residential facility (Pachana et al., 2005; level 2c). Finally, in a qualitative study exploring reasons that older adults do not own a pet, participants reported convenience and demands on time and energy as important factors (Chur-Hansen et al., 2008; level 5).

Eight additional studies addressed zoonoses or injury related to animals. One study using matched controls (level 2c) found that dog owners were more likely to have Paget's disease compared with non-owners (O'Driscoll & Anderson, 1985). The remainder of the studies were classified as level 5; five were individual case reports and described instances of older adults who obtained infections or injuries from contact with pets (Abood & Kang, 2006; Capellan & Fong, 1993; Hoffman & Donovan, 2013; Paton et al., 1988, Paul & Rostand, 1987). Similarly, Shields et al. (2009) described a series of case studies on dog bite fatalities, including older adults (level 5). One additional study was a description of clinical records (level 5) and describe the prevalence of dog bites and cat scratches, indicating that injuries from cats were more common in older individuals (Ostanello et al., 2005).

Six studies focused specifically on pet attachment. Bagley and Gonsman (2005; level 2c) found that attachment to pets decreased with age from middle adulthood through late adulthood. Watt and Pachana (2007; level 4) explored pet attachment and quality of life and found no significant relationship. Chur-Hansen et al. (2009; level 5) qualitatively assessed the effects of attachment to pets and indicated that the benefits of pet attachment may be optimal at moderate levels of attachment, with detrimental effects at both extremes. Similarly, Barnard-Nguyen et al. (2016; level 5) found that attachment to a pet was a strong predictor of grief and anger at the death of the pet, and McCutcheon and Fleming (2002; level 5) indicated age differences in grief, where young owners experienced greater anger, hostility, and despair

compared with older pet owners. Finally, one article (Stallones et al., 1988; level 2c) represented an attachment measure development study.

The remaining studies addressed a range of different factors, including moderate positive relationships between PO and general life satisfaction (Himsworth & Rock, 2013; Norris et al., 1999; level 2c), morale (Robb & Stegman, 1983; level 2c), caregiving behaviors (Putney, 2014; level 5), general attitudes about interacting with animals (Gage & Magnuson-Martinson, 1988; Miller & Lago, 1990b; Verderber, 1991; level 5), fear of dogs (Boyd et al., 2004; level 5), animal hoarding (Ockenden et al., 2014; level 5), and engagement with pet-related stimuli (Cohen-Mansfield et al., 2010; level 2c). Many of these studies experienced similar limitations as previously cited PO research, such as non-representative sampling techniques, small sample sizes, and cross-sectional data.

*Findings from Intervention Studies: 1) Cognition:* Three AAI studies were found that focus on some aspect of cognition. Kanamori et al. (2001), level 3b, report the results from a small sample ($n$ = 7) of dementia patients compared with a control group ($n$ = 20). Improvements in Activities of Daily Living (ADL), Mini Mental State Exam (MMSE), and salivary chromogranin A (CgA), as a measure of mental stress, were noted in conjunction with a six-week AAT program. Macauley (2006), level 4, examined AAI in a group of aphasia patients who reported greater satisfaction following the intervention, but without a comparison group. Falk and Wijk (2008), level 5, performed an observational study involving 35 hospital rehabilitation patients and found that AAI had a positive effect on both involuntary attention and mental restoration. The quality of evidence on the topic of cognition is weak and is limited to research that lacks appropriate comparison groups and standardized measures, thus interpretation of results must be treated with extreme caution.

*2) Other:* Finally, six studies do not fit into any of the previous categories and are rated in the lowest two OCEBM levels. Three of these, OCEBM level 4 (Cassidy, Webb, McKeown, & Stiles, 1995; Nordgren & Engstrom, 2014b; Shalev & Ben-Mordehai, 1996) address staff perceptions of AAI, quality of life, and acceptance of a snake as an AAI animal. The remaining three studies, level 5 (Kendziorski, & Treacy, 1999; Strickland & Davidson, 2016; Yates, 1987), examine feelings toward resident pets, factors predicting interest in AAI, and perceptions of benefits from AAI. As with cognition, the evidence is weak and lacks appropriate comparison groups and standardized measures; the results should be interpreted with extreme caution.

## Discussion

This review shows that, as with other subfields of HAI, within the existing research focusing on HAI and aging there is a wide range of methodological approaches and rigor. Even allowing for that, the findings from this review suggest some important future directions for the field. Many of the results presented are promising in terms of the potential for animals to positively impact the health and wellbeing of older adults, but the mixed findings also reflect the reality that the relationship between humans and animals is complicated and at times conflicted. We suggest that future researchers embrace this complexity and explore theoretical frameworks and methodological approaches that can account for the uniqueness of the relationships between pets and people.

The existing evidence suggests physical and mental health benefits of PO and AAI for older adults. The nature of PO provides for increased exposure to the animal, relative to the more sporadic nature of AAI; this is likely to enhance bonding that is probably linked to increased

emotional and social support for older adults. PO may provide an opportunity to nurture and care for another living being, which may explain research findings of decreased loneliness in pet owners. Furthermore, there are relatively robust findings regarding physical and cardiovascular health for pet owners (dog owners in particular). Maintaining mobility and physical activity is critical for older adults, and pets may be a way of motivating this activity in a sustained way. On the other hand, AAI may be more appropriate for older adults who are no longer able to care for a pet. It may allow them to accrue the psychosocial benefits related to interacting with an animal (e.g., decreased depression) without the burden of caring for the animal on a day-to-day basis.

Despite the potential benefits, it is also important to recognize potential ethical considerations, including risks for both the humans and the animals of pet owners that may disproportionately impact older adults. Bereavement and grief from the loss of a pet can be a significant stressor for many individuals (Hunt & Padilla, 2006). For older adults already at risk of increased loneliness (Perlman & Peplau, 1982), the loss of a pet could be particularly traumatizing. Similarly, an individual transitioning from a home environment to a residential facility may find limited resources for caring for the pet, or suffer emotional distress related to enforced separation. It appears that AAI may be particularly effective for former pet owners, many of whom may find themselves deprived of the daily companionship of their animals.

In addition to emotional health challenges, there may also be physical risks for older adults, as documented in research on falls and pets. Additional risks include bites/scratches, zoonotic diseases, and allergies. These risks also apply to AAI settings. Ideally, a trained therapy animal with up-to-date vaccinations and health care is present with a human handler, and thereby these risks are reduced. There are additional ethical concerns associated with PO for older adults, for example, how well an individual can responsibly care for an animal's welfare and wellbeing as the human ages. These concerns do not apply to AAI situations where the handler and animal team have been tested by, and registered with, a reputable AAI organization. These registered teams also bring with them an insurance policy that covers accidents or injuries that happen during an activity or intervention, thus alleviating liability concerns. However, not all AAI organizations have robust safety policies, and therefore it is necessary for individuals and facilities to be aware of best practices for AAI teams visiting older adults.

In sum, the evidence indicates that there is real potential for companion animals to beneficially impact the health and wellbeing of older adults, but the evidence base is not strong. Further, as with all research in the field of HAI, it is challenging to separate out causation. Do pets positively impact health status or do healthy people opt to have pets? We do not know if many of the relationships between PO and positive health outcomes are due to PO itself or other selection factors. Overall, findings from intervention studies provide stronger evidence of the impact of animals on psychological and behavioral outcomes, because the intervention can be experimentally compared with a control condition. However, a common concern in this type of research is the appropriateness of the control condition. This area of research is in critical need of methodologically rigorous research to fully explore the mutually influential relationships between older adults and pets.

To address these limitations, we suggest implementing a wide variety of high quality research methodologies to provide a solid evidence base. Ideally, such future research will be predicated upon a theory of HAI, perhaps one of the several described above or other field-specific appropriate theoretical frameworks. In general, the studies included in this review tended to be applied in nature (particularly with regard to the research focusing on physical

health outcomes) or focused primarily on addressing previous limitations in HAI research, and as a result seldom relied on theory to frame the study design or the interpretation of the results. Those that did include theory did so with varying levels of detail and integration. It may be that the interdisciplinary nature of research that combines HAI with gerontology presents challenges in the development of a comprehensive theory. To provide some assessment of the inclusion of theory in the studies reviewed herein, we have indicated in Table 4 those studies where the words "theory, theoretical, or framework" were included in the text of the manuscripts. As you can see from that table the percentages of studies that mention theory (regardless of the complexity of that discussion) is lower than one would expect in the scientific examination of any of the topical areas. Using theory to guide research is a critical component of the scientific pursuit of knowledge and we encourage researchers to add this important conceptualization to their investigations.

To address methodological limitations, incorporating HAI measures into large-scale national datasets is one strategy for assessing both selection factors for, and outcomes associated with, PO for older adults. Intervention studies must include appropriate control conditions, standardized measurement tools, assurance of treatment fidelity, and long-term follow up. Research should focus on understanding not only the outcomes associated with HAI, but also the quality of the relationship between older adults and pets or therapy animals, as a means of better understanding how HAI can moderate or predict health outcomes. Furthermore, collaboration between experts in gerontology and in HAI is needed to conduct the nuanced, contextually sensitive research that can establish a stronger evidence base.

Researchers and practitioners need to work together to establish a translational pipeline to help guide older adults, caregivers, and professionals to make the best decisions for individuals and establish best practice guidelines for intervention research and programs. Research results should inform support for older adults in successful PO, determine the most effective types of interventions, promote human and animal welfare, and avoid risks from PO and animal interaction.

## Conflicts of Interest

The authors state there are no conflicts of interest.

## References

Note: * indicates references included in the systematic review.

Abood, A., & Kang, N. (2006). Trigger thumb in a fish-owner. *Journal of the Royal Society of Medicine, 99(*7), 370.*

Aiba, N., Hotta, K., Yokoyama, M., Wang, G., Tabata, M., Kamiya, K., … Masuda, T. (2012). Usefulness of pet ownership as a modulator of cardiac autonomic imbalance in patients with diabetes mellitus, hypertension, and/or hyperlipidemia. *American Journal of Cardiology, 109*, 1164–1170.*

American Pet Products Association. (2009). 2010 pet owners survey. Greenwich, CT: American Pet Products Association.

American Pet Products Association. (2018). 2017–2018 APPA National pet owners survey. Greenwich, CT: American Pet Products Association.

American Veterinary Medical Association. (2007). *U.S. pet ownership & demographics sourcebook.* Schaumburg, IL: Author.

Anderson, K. A., Lord, L. K., Hill, L. N., & McCune, S. (2015). Fostering the human–animal bond for older adults: Challenges and opportunities. *Activities, Adaptation, & Aging, 39*, 32–42.

Antonacopoulos, N. M. D., & Pychyl, T. A. (2010). An examination of the potential role of pet ownership, human social support and pet attachment in the psychological health of individuals living alone. *Anthrozoös, 23*, 37–54.*

Araujo, T. B., Silva, N. A., Costa, J. N., Pereira, M. M., & Safons, M. P. (2011). Effect of equine-assisted therapy on the postural balance of the elderly. *Brazilian Journal of Physical Therapy, 15*, 414–419.*

Bagley, D. K., & Gonsman, V. L. (2005). Pet attachment and personality type. *Anthrozoös, 18,* 28–42.*

Banks, M. R., & Banks, W. A. (2002). The effects of animal-assisted therapy on loneliness in an elderly population in long-term care facilities. *Journal of Gerontology, 57A,* M428–M432.*

Barker, S. B., Pandurangi, A., & Best, A. M. (2003). Effects of animal-assisted therapy on patients' anxiety, fear, and depression before EDT. *The Journal of ECT, 19,* 38–44.*

Barnard-Nguyen, S., Breit, M., Anderson, K. A., & Nielsen, J. (2016). Pet loss and grief: Identifying at-risk pet owners during the euthanasia process. *Anthrozoös, 29*, 421–430.*

Bennett, P. C., Trigg, J. L., Godber, T., & Brown, C. (2015). An experience sampling approach to investigating associations between pet presence and indicators of psychological wellbeing and mood in older Australians. *Anthrozoös, 28*, 403–420.*

Bernstein, P., Friedmann, E., & Malaspina, A. (2000). Animal-assisted therapy enhances resident social interaction and initiation in long-term care facilities. *Anthrozoös, 13*, 213–224.*

Bowlby, J. (1969). Disruption of affectional bonds and its effects on behavior. *Canada's Mental Health Supplement, 69*, 1–17.

Boyd, C. M., Fotheringham, B., Litchfield, C., McBryde, I., Metzer, J. C., Scanlon, P., . . . Winefield, A. H. (2004). Fear of dogs in a community sample: Effects of age, gender and prior experience of canine aggression. *Anthrozoös, 17,* 146–166.*

Branson, S., Boss, L., Cron, S., & Kang, D-H. (2016). Examining differences between homebound older adult pet owners and non-pet owners in depression, systemic inflammation, and executive function. *Anthrozoös, 29*, 323–334.*

Brofenbrenner, U. (1979). *The ecology of human development.* Cambridge, MA: Harvard University Press.

Calvert, M. M. (1989). Human–pet interaction and loneliness: A test of concepts from Roy's adaptation model. *Nursing Science Quarterly, 2,* 194–202.*

Capellan, J., & Fong, I. (1993). Tularemia from a cat bite: Case report and review of feline-associated tularemia. *Clinical Infectious Diseases, 16,* 472–475.*

Cassidy, K., Webb, L., McKeown, D., & Stiles, T. (1995). Evaluation of a companion animal program on a continuing care psychiatric unit. Perspectives, *Gerontological Nursing Association, 19*, 15–20.*

Chinner, T. L., & Dalziel, F. R. (1991). An exploratory study on the viability and efficacy of a pet-facilitated therapy project within a hospice. *Journal of Palliative Care, 7*,13–20.*

Chowdhury, E. K., Nelson, M. R., Jennings, G. L., Wing, L. M., Reid, C. M., & ANBP2 Management Committee. (2017). Pet ownership and survival in the elderly hypertensive population. *Journal of Hypertension, 35*, 769–775.*

Churchill, M., Safaoui, J., McCabe, B. W., & Baun, M. M. (1999). Using a therapy dog to alleviate the agitation and desocialization of people with Alzheimer's disease. *Journal of Psychosocial Nursing and Mental Health Services, 37*, 16–22.*

Chur-Hansen, A., Winefield, H., & Beckwith, M. (2008). Reasons given by elderly men and women for not owning a pet, and the implications for clinical practice and research. *Journal of Health Psychology, 13*, 988–995.*

Chur-Hansen, A., Winefield, H. R., & Beckwith, M. (2009). Companion animals for elderly women: The importance of attachment. *Qualitative Research in Psychology, 6*, 281–293.*

Cohen, S., & Wills, T. A. (1985). Stress, social support, and the buffering hypothesis. *Psychological Bulletin, 98,* 310–357.

Cohen-Mansfield, J., Marx, M. S., Thein, K., & Dakheel-Ali, M. (2010). The impact of past and present preferences on stimulus engagement in nursing home residents with dementia. *Aging and Mental Health, 14,* 67–73.*

Colby, P. M., & Sherman, A. (2002). Attachment styles impact on pet visitation effectiveness. *Anthrozoös, 15,* 150–165.*

Cole, K. M., Gawlinski, A., Steers, N., & Kotlerman, J. (2007). Animal-assisted therapy in patients hospitalized with heart failure. *American Journal of Critical Care, 16,* 575–588.*

Colombo, G., Buono, M. D., Smania, K., Raviola, R., & DeLeo, D. (2006). Pet therapy and institutionalized elderly: A study on 144 cognitive unimpaired subjects. *Archives of Gerontology and Geriatrics, 42*, 207–216.*

Connell, C. M., Janevic, M. R., Solway, E., & McLaughlin, S. J. (2007). Are pets a source of support or added burden for married couples facing dementia? *Journal of Applied Gerontology, 26*, 472–485.*

Crowley-Robinson, P., & Blackshaw, J. K. (1998). Pet ownership and health status of elderly in the community. *Anthrozoös, 11*, 168–171.*

Curtright, A., & Turner, G. S. (2002). The influence of a stuffed and live animal on communication in a female with Alzheimer's dementia. *Journal of Medical Speech-Language Pathology, 10*, 61–72.*

Dabelko-Schoeny, H., Phillips, G., Darrough, E., DeAnna, S., Jarden, M., Johnson, D., & Lorch, G. (2014). Equine-assisted intervention for people with dementia. *Anthrozoös, 27,* 141–155.*

Dall, P. M., Ellis, S. L. H., Ellis, B. M., Grant, P. M., Colyer, A., Gee, N. R., . . . Mills, D. S. (2017). The influence of dog ownership on objective measures of free-living physical activity and sedentary behaviour in community-dwelling older adults: A longitudinal case-controlled study. *BMC Public Health, 17,* 496. doi:10.1186/s12889-017-4422-5.*

Darrah, J. P. (1996). A pilot survey of animal-facilitated therapy in southern California and South Dakota nursing homes. *Occupational Therapy International, 3*, 105–121.*

Dembicki, D., & Anderson, J. (1996). Pet ownership may be a factor in improved health of the elderly. *Journal of Nutrition for the Elderly, 15,* 15–31.*

DeSchriver, M. M., & Riddick, C. C. (1990). Effects of watching aquariums on elders' stress. *Anthrozoös, 4,* 44–48.*

Edwards, N. E., & Beck, A. M. (2002). Animal-assisted therapy and nutrition in Alzheimer's disease. *Western Journal of Nursing Research, 24*, 697–712.*

Edwards, N. E., & Beck, A. M. (2013). The influence of aquariums on weight in individuals with dementia. *Alzheimer Disease and Associated Disorders, 27*, 379–383.*

Edwards, N. E., Beck, A. M., & Lim, E. (2014). Influence of aquariums on resident behavior and staff satisfaction in dementia units. *Western Journal of Nursing Research, 36,* 1309–1322.*

Engel, G. L. (1997). From biomedical to biopsychosocial: Being scientific in the human domain. *Psychosomatics, 38*, 521–528.

Enmarker, I., Hellzen, O., Ekker, K., & Berg, A-G. T. (2015). Depression in older cat and dog owners: The Nord-Trøndelag Health Study (HUNT)-3. *Aging & Mental Health, 19,* 347–352.*

Eshbaugh E. M., Somervill, J. W., Kotek, J. H., Perez, E., Nalan, K. R., & Wilson, C. E. (2011). Presence of a dog, pet attachment, and loneliness among elders. *North American Journal of Psychology, 13*(1).*

Falk, H., & Wijk, H. (2008). Natural activity: An explorative study of the interplay between cage-birds and older people in a Swedish hospital setting. *International Journal of Older People Nursing, 3,* 22–28.*

Feng, Z., Dibben, C., Witham, M. D., Donnan, P. T., Vadiveloo, T., Sniehotta, F., . . . McMurdo, M. E. (2014). Dog ownership and physical activity in later life: A cross-sectional observational study. *Preventive Medicine, 66,* 101–106.*

Fick, K. M. (1993). The influence of an animal on social interactions of nursing home residents in a group setting. *American Journal of Occupational Therapy, 47*, 529–534.*

Fila, D. (1991). The significance of companion animals to a geriatric vascular patient: A case study. *Holistic Nursing Practice, 5,* 11–15.*

Francis, G., Turner, J. T., & Johnson, S. B. (1985). Domestic animal visitation as therapy with adult home residents. *International Journal of Nursing Studies, 22,* 201–206.*

Friedmann, E., Galik, E., Thomas, S. A., Hall, P. S., Chung, S. Y., & McCune, S. (2015). Evaluation of a pet-assisted living intervention for improving functional status in assisted living residents with mild to moderate cognitive impairment: A pilot study. *American Journal of Alzheimer's Disease & Other Dementias, 30*, 276–289.*

Friedmann, E., Thomas, S. A., Cook, L. K., Tsai, C., & Picot, S. J. (2007). A friendly dog as potential moderator of cardiovascular response to speech in older hypertensives. *Anthrozoös, 20,* 51–63.*

Friedmann, E., Thomas, S. A., & Son, H. (2011). Pets, depression and long-term survival in community living patients following myocardial infarction. *Anthrozoös, 24*, 273–285.*

Friedmann, E., Thomas, S. A., Son, H., Chapa, D., & McCune, S. (2013). Pet's presence and owner's blood pressures during the daily lives of pet owners with pre- to mild hypertension. *Anthrozoös, 26,* 535–550.*

Gage, G. M., & Magnuson-Martinson, S. (1988). Intergenerational continuity of attitudes and values about dogs. *Anthrozoös, 1,* 232–239.*

Garcia, D. O., Wertheim, B. C., Manson, J. E., Chlebowski, R. T., Volpe, S. L., Howard, B. V., . . . Thomson, C. A. (2015). Relationships between dog ownership and physical activity in postmenopausal women. *Preventive Medicine, 70,* 33–38.*

Garrity, T. F., Stallones, L., Marx, M. B., & Johnson, T. P. (1989). Pet ownership and attachment as supportive factors in the health of the elderly. *Anthrozoös, 3*, 35–44.*

Gee, N. R., Mueller, M. K., & Curl, A. L. (2017). Human–animal interaction and older adults: An overview. *Frontiers in Psychology.* https://doi.org/10.3389/fpsyg.2017.01416.

Gorman, J. M. (1996). Comorbid depression and anxiety spectrum disorders. *Depression and Anxiety, 4,* 160–168.

Greer, K. L., Pustay, K. A., Zaun, T. C., & Coppens, P. (2002). A comparison of the effects of toys versus live animals on the communication of patients with dementia of the Alzheimer's type. *Clinical Gerontologist, 24,* 157–182.*

Hall, S. S., Gee, N. R., & Mills, D. S. (2016). Children reading to dogs: A systematic review of the literature. *PLoS ONE 11*(2): e0149759.

Harris, M. D., Rinehart, J. M., & Gerstman, J. (1993). Animal-assisted therapy for the homebound elderly. *Holistic Nursing Practice, 8,* 27–37.*

Harris, T. J., Owen, C. G., Victor, C. R., Adams, R., & Cook, D. G. (2009). What factors are associated with physical activity in older people, assessed objectively by accelerometry? *British Journal of Sports Medicine, 43*, 442–450. http://dx.doi.org/10.1136/bjsm.2008.048033.*

Haughie, E. (1992). An evaluation of companion pets with elderly psychiatric patients. *Behavioural Psychotherapy, 20*, 367–371.*

Hecht, L., McMillin, D., & Silverman, P. (2001). Pets, networks, and wellbeing. *Anthrozoös, 14,* 95–108.*

Herzog, H. (2010). Some we love, some we hate, some we eat: Why it's so hard to think straight about animals. New York, NY: Harper Collins.

Himsworth, C. G., & Rock, M. (2013). Pet ownership, other domestic relationships, and satisfaction with life among seniors: Results from a Canadian national survey. *Anthrozoös, 26,* 295–305.*

Hinman, M. R., & Heyl, D. M. (2001). Influence of the Eden alternative™ on the functional status of nursing home residents. *Physical & Occupational Therapy in Geriatrics, 20,* 1–20.*

Hoffman, W., & Donovan, K. (2013). Traumatic digital amputations of the foot inflicted by pet cat upon individual with diabetic peripheral neuropathy. *Journal of the American Podiatric Medical Association, 103*, 441–444.*

Holcomb, R., Jendro, C., Weber, B., & Nahan, U. (1997). Use of an aviary to relieve depression in elderly males. *Anthrozoös, 10,* 32–36.*

Howick, J., Chalmers, I., Glasziou, P., Greenhalgh, T., Heneghan, C., Liberati, A., Moschetti, I., Phillips, B., & Throrton, H. (2011). *The Oxford Levels of Evidence 2*. Oxford Centre for Evidence-Based Medicine. https://www.cebm.net/index.aspx?o=5653

Hunt, M., & Padilla, Y. (2006). Development of the Pet Bereavement Questionnaire. *Anthrozoös, 19,* 308–324.

Jegatheesan, B., Beetz, A., Ormerod, E., Johnson, E., Fine, A. H., Yamazaki, K., Dudzik, C., Garcia, R. M., Winkle, M., & Choi, G. (2015). The IAHAIO definitions for animal-assisted interventions and guidelines for wellness of animals involved. In A. H. Fine (Ed.), *Handbook on Animal-Assisted Therapy* (4th ed., pp. 415–418). New York, NY: Elsevier Press.

Johansson, M., Ahlström, G., & Jönsson, A. (2014). Living with companion animals after stroke: Experiences of older people in community and primary care nursing. *British Journal of Community Nursing, 19,* 578–584.*

Kaiser, L., Spence, L. J., McGavin, L., Struble, L., & Keilman, L. (2002). A dog and a "happy person" visit nursing home residents. *Western Journal of Nursing Research, 24,* 671–683.*

Kalfon, E. (1991). Pets make a difference in long term care. *Perspectives, Gerontological Nursing Association, 15*, 3–6.*

Kanamori, M., Suzuki, M., Yamamoto, K., Kanda, M., Matsui, Y., Kojima, E., . . . Oshiro, H. (2001). A day care program and evaluation of animal-assisted therapy (AAT) for the elderly with senile dementia. *American Journal of Alzheimer's Disease & Other Dementias, 16*, 234–239.*

Katsinas, R. P. (2000). The use and implications of a canine companion in a therapeutic day program for nursing home residents with dementia. *Activities, Adaptation & Aging, 25*, 13–30.

Kendziorski, S., & Treacy, C. (1999). The effects of animal-assisted therapy at a long term care facility. Masters Thesis 457. Retrieved from https://scholarworks.gvsu.edu/theses/457.*

Knight, S., & Edwards, V. (2008). In the company of wolves: The physical, social, and psychological benefits of dog ownership. *Journal of Aging and Health, 20*, 437–455.*

Ko, H. J., Youn, C. H., Kim, S. H., & Kim, S. Y. (2016). Effect of pet insects on the psychological health of community-dwelling elderly people: A single-blinded, randomized, controlled trial. *Gerontology, 62*, 200–209.*

Koda, N., & Yanai, J. (2011). Dog–resident interactions in a Japanese retirement home. *Anthrozo s, 24,* 155–165.*

Kongable, L. G., Buckwalter, K. C., & Stolley, J. M. (1989). The effects of pet therapy on the social behavior of institutionalized Alzheimer's clients. *Archives of Psychiatric Nursing, 3,* 191–198.*

Kramer, S. C., Friedmann, E., & Bernstein, P. L. (2009). Comparison of the effect of human interaction, animal-assisted therapy, and AIBO-assisted therapy on long-term care residents with dementia. *Anthrozoös, 22,* 43–57.*

Krause-Parello, C. A. (2008). The mediating effect of pet attachment support between loneliness and general health in older females living in the community. *Journal of Community Health Nursing, 25,* 1–14.*

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*, 194–203.*

Krause-Parello, C. A., & Gulick, E. E. (2013). Situational factors related to loneliness and loss over time among older pet owners. *Western Journal of Nursing Research, 35,* 905–919.*

Krause-Parello, C. A., & Kolassa, J. (2016). Pet therapy: Enhancing social and cardiovascular wellness in community dwelling older adults. *Journal of Community Health Nursing, 33*, 1–10.*

Kumasaka, T., Masu, H., Kataoka, M., & Numao, A. (2012). Changes in patient mood through animal-assisted activities in a palliative care unit. *International Medical Journal, 19*, 373–377.*

Kurdek, L. A. (2009). Pet dogs as attachment figures for adult owners. *Journal of Family Psychology, 23,* 439–446.

Lago, D., Delaney, M., Miller, M., & Grill, C. (1989). Companion animals, attitudes toward pets, and health outcomes among the elderly: A long-term follow-up. *Anthrozoös, 3,* 25–34.*

LeRoux, M. & Kemp, R. (2009). Effect of a companion dog on depression and anxiety levels of elderly residents in a long-term care facility. *Psychogeriatrics, 9,* 23–26.*

Levine, G., Allen, K., Braun, L. T., Christian, H. E., Friedmann, E., Taubert, K. A., … Lange, R. A. (2013). Pet ownership and cardiovascular risk: A scientific statement from the American Heart Association. *Circulation, 127*, 2353–2363.

Likourezos, A., Burack, O., & Lanlz, M. (2002). The therapeutic use of companion animals. *Clinical Geriatrics, 10,* 31–35.*

Lund, D. A., Johnson, R., Baraki, H. N., & Dimond, M. F. (1984). Can pets help the bereaved? *Journal of Gerontological Nursing, 10,* 8–9.*

Luptak, J. E., & Nuzzo, N. A. (2004). The effects of small dogs on vital signs in elderly women: A pilot study. *Cardiopulmonary Physical Therapy Journal, 15*, 9–12.*

Lutwack-Bloom, P., Wijewickrama, R., & Smith, B. (2005). Effects of pets versus people visits with nursing home residents. *Journal of Gerontological Social Work, 44*, 137–159.*

Macauley, B. L. (2006). Animal-assisted therapy for persons with aphasia: A pilot study. *Journal of Rehabilitation Research and Development, 43*, 357–366.*

Majić, T., Gutzmann, H., Heinz, A., Lang, U. E., & Rapp, M. A. (2013). Animal-assisted therapy and agitation and depression in nursing home residents with dementia: A matched case–control trial. *The American Journal of Geriatric Psychiatry, 21,* 1052–1059.*

Martindale, B. (2008). Effect of animal-assisted therapy on engagement of rural nursing home residents. *American Journal of Recreation Therapy, 7*, 45–53.*

Marx, M. B., Stallones, L. B., Garrity, T. F., & Johnson, T. P. (1988). Demographics of pet ownership among US adults 21 to 64 years of age. *Anthrozoös, 2,* 33–37.*

Marx, M. S., Cohen-Mansfield, J., Regier, N. G., Dakheel-Ali, M., Srihari, A., & Thein, K. (2010). The impact of different dog-related stimuli on engagement of persons with dementia. *American Journal of Alzheimer's Disease & Other Dementias, 25*, 37–45.*

McCabe, B. W., Baun, M. M., Speich, D., & Agrawal, S. (2002). Resident dog in the Alzheimer's special care unit. *Western Journal of Nursing Research, 24,* 684–696.*

McCutcheon, K. A., & Fleming, S. J. (2002). Grief resulting from euthanasia and natural death of companion animals. *OMEGA: Journal of Death and Dying, 44,* 169–188.*

Miller, M., & Lago, D. (1990a). The wellbeing of older women: The importance of pet and human relations. *Anthrozoös, 3*, 245–252.*

Miller, M., & Lago, D. (1990b). Observed pet-owner in-home interactions: Species differences and association with the pet relationship scale. *Anthrozoös, 4,* 49–54.*

Miltiades, H., & Shearer, J. (2011). Attachment to pet dogs and depression in rural older adults. *Anthrozoös, 24,* 147–154.*

Moffatt, C., Appuhamy, R., Andrew, W., Wynn, S., Roberts, J., & Kennedy, K. (2014). An assessment of risk posed by a campylobacter-positive puppy living in an Australian residential aged-care facility. *Western Pacific Surveillance and Response Journal, 5*, 1–6.*

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & Prisma Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine, 6*(7), e1000097.

Moretti, F., De Ronchi, D., Bernabei, V., Marchetti, L., Ferrari, B., Forlani, C., . . . Atti, A. R. (2011). Pet therapy in elderly patients with mental illness. *Psychogeriatrics, 11*, 125–129.*

Mossello, E., Ridolfi, A., Mello, A. M., Lorenzini, G., Mugnai, F., Piccini, C., Barone, D., Perzzi, A., Masotti, G., & Marchionni, N. (2011). Animal–assisted activity and emotional status of patients with Alzheimer's disease in day care. *International Psychogeriatrics, 23,* 899–905.*

Mueller, M. K., Gee, N. R., & 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,* 305. https://doi.org/10.1186/s12889-018-5188-0.*

Müllersdorf, M., Granström, F., Sahlqvist, L., & Tillgren, P. (2010). Aspects of health, physical/leisure activities, work and socio-demographics associated with pet ownership in Sweden. *Scandinavian Journal of Social Medicine, 38*, 53–63.*

Netting, E. F., Wilson, C. C., & Fruge, C. (1988). Pet ownership and nonownership among elderly in Arizona. *Anthrozoös, 2*, 125–132.*

Nordgren, L., & Engström, G. (2012). Effects of animal-assisted therapy on behavioral and/or psychological symptoms in dementia: A case report. *American Journal of Alzheimer's Disease & Other Dementias, 27,* 625–632.*

Nordgren, L., & Engström, G. (2014a). Effects of dog-assisted intervention on behavioural and psychological symptoms of dementia. *Nursing Older People, 26*, 31–38.*

Nordgren, L., & Engström, G. (2014b). Animal-assisted intervention in dementia: Effects on quality of life. *Clinical Nursing Research, 23*, 7–19.*

Norris, P. A., Shinew, K. J., Chick, G., & Beck, A. M. (1999). Retirement, life satisfaction, and leisure services: The pet connection. *Journal of Park & Recreation Administration, 17,* 65–83.*

Ockenden, E. M., De Groef, B., & Marston, L. (2014). Animal hoarding in Victoria, Australia: An exploratory study. *Anthrozoös, 27*, 33–47.*

O'Driscoll, J., & Anderson, D. (1985). Past pets and paget's disease. *The Lancet, 326*(8461), 919–921.*

Ostanello, F., Gherardi, A., Caprioli, A., La Placa, L., Passini, A., & Prosperi, S. (2005). Incidence of injuries caused by dogs and cats treated in emergency departments in a major Italian city. *Emergency Medicine Journal, 22*, 260–262.*

Pachana, N. A., Ford, J. H., Andrew, B., & Dobson, A. J. (2005). Relations between companion animals and self-reported health in older women: Cause, effect or artifact? *International Journal of Behavioral Medicine, 12*, 103–110.*

Parker, G. B., Gayed, A., Owen, C. A., Hyett, M. P., Hilton, T. M., & Heruc, G. A. (2010). Survival following an acute coronary syndrome: A pet theory put to the test. *ACTA Psychiatrica Scandinavica, 121*, 65–70.*

Parslow, R. A., Jorm, A. F., Christensen, H., Rodgers, B., & Jacomb, P. (2005). Pet ownership and health in older adults: Findings from a survey of 2,551 community-based Australians aged 60–64. *Geronotology, 51*, 40–47.*

Paton, B. G., Ormerod, L. D., Peppe, J., & Kenyon, K. R. (1988). Evidence for a feline reservoir for dysgonic fermenter 2 keratitis. *Journal of Clinical Microbiology, 26*, 2439–2440.*

Paul, R. V., & Rostand, S. G. (1987). Cat-bite peritonitis: Pasteurella multocida peritonitis following feline contamination of peritoneal dialysis tubing. *American Journal of Kidney Diseases, 10*, 318–319.*

Perlman, R., & Peplau, L. A. (1982). Theoretical approaches to loneliness. In L. A. Peplau & D. Perlman (Eds.), *Loneliness: A sourcebook of current theory, research and therapy* (pp. 123–134). New York, NY: Wiley.

Pet Food Manufacturer's Association. (2016). Pet population 2016. Retrieved from http://www.pfma.org.uk/pet-population-2016.

Phelps, K. A., Miltenberger, R. G., Jens, T., & Wadeson, H. (2008). An investigation of the effects of dog visits on depression, mood, and social interaction in elderly individuals living in a nursing home. *Behavioral Interventions, 23,* 181–200.*

Pikhartova, J., Bowling, A., & Victor, C. (2014). Does owning a pet protect older people against loneliness? *BMC Geriatrics, 14,* 106. https://doi.org/10.1186/1471-2318-14-106.*

Prosser, L., Townsend, M., & Staiger, P. (2008). Older people's relationships with companion animals: A pilot study. *Nursing Older People, 20*, 29–32.*

Pruchno, R., Heid, A. R., & Wilson-Genderson, M. (2018). Successful aging, social support, and ownership of a companion animal. *Anthrozoös, 31*, 23–39.*

Putney, J. M. (2014). Older lesbian adults' psychological well-being: The significance of pets. *Journal of Gay & Lesbian Social Services, 26*, 1–17.*

Raina, P., Waltner-Toews, D., Bonnett, B., Woodward, C., & 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,* 323–329.*

Rajaram, S. S., Garrity, T. F., Stallones, L. F., & Marx, M. B. (1993). Bereavement—Loss of a pet and loss of a human. *Anthrozoös, 6,* 8–16.*

Richards, E. A. (2015). Prevalence of dog walking and sociodemographic characteristics of dog walkers in the US: An update from 2001. *American Journal of Health Behavior, 39,* 500–506.*

Richeson, N. E. (2003). Effects of animal-assisted therapy on agitated behaviors and social interactions of older adults with dementia. *American Journal of Alzheimer's Disease & Other Dementias, 18,* 353–358.*

Robb, S. S., & Stegman, C. E. (1983). Companion animals and elderly people: A challenge for evaluators of social support. *The Gerontologist, 23*, 277–282.*

Roenke, L., & Mulligan, S. (1998). The therapeutic value of the human–animal connection. *Occupational Therapy in Health Care, 11*, 27–43.*

Rondeau, L., Corriveau, H., Bier, N., Camden, C., Champagne, N., & Dion, C. (2010). Effectiveness of a rehabilitation dog in fostering gait retraining for adults with a recent stroke: A multiple single-case study. *NeuroRehabilitation, 27*, 155–163.*

Ruckdeschel, K., & Van Haitsma, K. (2001). The impact of live-in animals and plants on nursing home residents. *Alzheimer's Care Quarterly, 2*, 17–27.*

Sellers, D. M. (2005). The evaluation of an animal assisted therapy intervention for elders with dementia in long-term care. *Activities, Adaptation, & Aging, 30*, 61–77.*

Shalev, A., & Ben-Mordehai, D. (1996). Snakes: Interactions with children with disabilities and the elderly—some psychological considerations. *Anthrozoös, 9,* 182–187.*

Shibata, A., Oka, K., Inoue, S., Christian, H., Kitabatake, Y., & Shimomitsu, T. (2012). Physical activity of Japanese older adults who own and walk dogs. *American Journal of Preventive Medicine, 43*, 429–433.*

Shields, L. B., Bernstein, M. L., Hunsaker, J. C. 3rd., & Stewart, D. M. (2009). Dog bite-related fatalities: A 15-year review of Kentucky medical examiner cases. *The American Journal of Forensic Medicine and Pathology, 30*, 223–230.*

Sloane, P. D., Zimmerman, S., Gruber-Baldini, A. L., & Barba, B. E. (2002). Plants, animals, and children in long-term care: How common are they? Do they affect clinical outcomes? *Alzheimer's Care Today, 3*, 12–18.*

Stallones, L., Marx, M. B., Garrity, T. F., & Johnson, T. P. (1988). Attachment to companion animals among older pet owners. *Anthrozoös, 2,* 118–124.*

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

Stasi, M., Amati, D., Costa, C., Resta, D., Senepa, G., Scarafioiti, C., . . . Molaschi, M. (2004). Pet-therapy: A trial for institutionalized frail elderly patients. *Archives of Gerontology and Geriatrics, 38,* 407–412.*

Stewart, C. S., Thrush, J. C., Paulus, G. S., & Hafner, P. (1985). The elderly's adjustment to the loss of a companion animal: People–pet dependency. *Death Studies, 9,* 383–393.*

Strickland, O. J., & Davidson, S. (2016). Predictors of interest in participation in an animal-assisted activity program among elderly citizens. *Society & Animals, 24,* 213–229.*

Swall, A., Ebbeskog, B., Lundh Hagelin, C., & Fagerberg, I. (2015). Can therapy dogs evoke awareness of one's past and present life in persons with Alzheimer's disease? *International Journal of Older People Nursing, 10,* 84–93.*

Thodberg, K., Sørensen, L. U., Videbech, P. B., Poulsen, P. H., Houbak, B., Damgaard, V., . . . Christensen, J. W. (2016). Behavioral responses of nursing home residents to visits from a person with a dog, a robot seal or a toy cat. *Anthrozoös, 29,* 107–121.*

Thorpe, R. J., Kreisle, R. A., Glickman, L. T., Simonsick, E. M., Newman, A. B., & Kritchevsky, S. (2006a). Physical activity and pet ownership in year 3 of the health ABC study. *Journal of Aging and Physical Activity, 14,*154–168.*

Thorpe, R. J., Simonsick, E. M., Brach, J. S., Ayonayon, H., Satterfield, S., Harris, T. B., . . . Kritchevsky, S. B. (2006b). Dog ownership, walking behavior, and maintained mobility in late life. *Journal of the American Geriatrics Society, 54,* 1419–1424.*

Toohey, A. M., McCormack, G. R., Doyle-Baker, P. K., Adams, C. L., & Rock, M. J. (2013). Dog-walking and sense of community in neighborhoods: Implications for promoting regular physical activity in adults 50 years and older. *Health & Place, 22*, 75–81.*

Tower, R. B., & Nokota, M. (2006). Pet companionship and depression: Results from a United States internet sample. *Anthrozoös, 19,* 50–64.*

Travers, C., Perkins, J., Rand, J., Bartlett, H., & Morton, J. (2013). An evaluation of dog-assisted therapy for residents of aged care facilities with dementia. *Anthrozoös, 26*, 213–225.*

Verderber, S. (1991). Elderly persons' appraisal of animals in the residential environment. *Anthrozoös, 4,* 164–173.*

Vrbanac, Z., Zecevic, I., Ljubic, M., Belic, M., Stanin, D., Bottegaro, N. B., Jurkic, G., Skrlin, B., Bedrica, L., & Zubcic, D. (2013). Animal assisted therapy and perception of loneliness in geriatric nursing home residents. *Collegium Antropologicum, 37,* 973–976.*

Walsh, P. G., Mertin, P. G., Verlander, D. F., & Pollard, C. F. (1995). The effects of a 'pets as therapy' dog on persons with dementia in a psychiatric ward. *Australian Occupational Therapy Journal, 42,* 161–166.*

Wang., G., Zhai, W., Yang, H., Fan, R., Cao, X, Zhong, L., … Zhang, Y. (2013). The genomics of selection in dogs and the parallel evolution between dogs and humans. *Nature Communications, 4,* 1860. https://www.nature.com/articles/ncomms2814.

Watt, D., & Pachana, N. A. (2007). The role of pet ownership and attachment in older adults. *The Australian Journal of Rehabilitation Counselling, 13,* 32–43.*

Wehofer, L., Goodson, N., & Shurtleff, T. L. (2013). Equine assisted activities and therapies: A case study of an older adult. *Physical & Occupational Therapy in Geriatrics, 31*, 71–87.*

Winefield, H. R., Black, A., & Chur-Hansen, A. (2008). Health effects of ownership of and attachment to companion animals in an older population. *International Journal of Behavioral Medicine, 15*, 303–310.*

Wood, L. J., Giles-Corti, B., Bulsara, M. K., & Bosch, D. A. (2007). More than a furry companion: The ripple effect of companion animals on neighborhood interactions and sense of community. *Society & Animals, 15,* 43–56.

Yates, J. (1987). Project PUP: The perceived benefits to nursing home residents. *Anthrozoös, 1,* 188–192.*

Zisselman, M. H., Rovner, B. W., Shmuely, Y., & Ferrie, P. (1996). A pet therapy intervention with geriatric psychiatry inpatients. *American Journal of Occupational Therapy, 50,* 47–51.*