



# THE HEALTH CARE COST SAVINGS OF PET OWNERSHIP

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## Executive Summary

The academic and professional literature recognizing the link between pet ownership and improved health conditions continues to grow in depth and breadth. Combine this with the fact that pet ownership in the U.S. continues to grow, and the documented importance of pets in coping with the COVID-19 pandemic, now is the right time to update the analysis of the health care cost savings that pets bring to their owners. In our 2015 analysis, which broke new ground in tying observable health care improvements among pet owners to health care spending, we found strong evidence that pet ownership is linked to “lower stress, improved cardiovascular health, enhanced sense of well-being, reduced allergic sensitivities, and many other physical and mental health benefits” (Clower and Neaves, 2015). However, being able to explicitly quantify the value of these benefits through health care spending reductions was limited to savings related to reduced physician office visits and a reduction in pet owner obesity. Still, the conservative, preliminary analysis of cost savings in just these two spending categories totaled an estimated \$11.8 billion in the U.S. for 2015. Our aim is to update these calculations and add additional areas where the research allows us to do so.

Fortunately, research into how the human-animal bond impacts human health is expanding. Importantly, there is exceptional recent growth in the number and quality of studies seeking to understand, and in some cases value, the role of pet ownership towards mental health, including conditions like anxiety and Post-Traumatic Stress Disorder (PTSD). While the positive mental health impacts of pets is well documented, from an economic perspective much of this research does not yet provide all the data elements needed to link those impacts to specific health care cost savings. While we did find the ability to estimate costs savings in the treatment for two mental health maladies (See Table 1), it is likely that these impacts conservatively understate the total positive impact of pets on mental health.

Data, assumptions, and key findings associated with this analysis have found:

- The 2021-2022 National Pet Owners Survey conducted by the American Pet Products Association (APPA) found that:

- 70% of U.S. households own a pet.
  - Pet ownership has increased from an estimated 56% of households in 1988.
  - Millennials are the largest cohort of pet owners at 32%.
  - About a sixth, 14%, of pet owners and non-pet owners obtained a new pet during the COVID-19 pandemic.
- We used APPA's estimates of the rate of pet ownership combined with the most recent Census Bureau data for 2021 on households and the makeup of households to estimate:
  - There are 91.8 million U.S. households with pets, almost 227 million individuals.
  - Adult pet ownership in the U.S. is 180.9 million individuals.
- Based on studies in the U.S. and other developed nations, pet owners have fewer annual primary care physician office visits. Using the methodology employed in our 2015 analysis and adapted for more recent health care services consumption and cost information, pet ownership rates, and population increase, health care cost savings related to fewer primary care physician office visits in 2021 was almost \$15 billion.
- Dog ownership can be tied to higher levels of exercise (walking) that has been linked to reductions in obesity. In this analysis we were able to identify more comprehensive estimates of health care spending on obesity-related conditions. Dog owners who regularly walk their dogs, have lower levels of obesity that lead to a \$4.5 billion reduction in health care spending.
- *C. difficile* infection (CDI) is a bacterial infection and is a leading cause of health care facility related infections. Research has found that physical interactions with pets makes pet owners less susceptible to recurrences of *C. difficile* infection, with associated health care cost savings (avoided spending) for treatment of this infection calculated at \$90.47 million per year.
- Childhood anxiety is increasingly recognized as a widespread health care need in the U.S. Children who own a dog have a 9% lower probability of having clinical anxiety. Focused on a narrow demographic proportion within children aged 8 to 10 years old, dog ownership can be linked to about \$672 million in annual mental health care cost



savings. If further research holds these findings across all U.S. children, the estimated savings would be \$7.6 billion annually.

- Research on the mental health of seniors is calling much attention to challenges related to social isolation, which became especially prevalent during the COVID-19 pandemic. Based on pre-pandemic incident rates of social isolation among seniors (aged 65+) who own pets versus non-pet owners, and recent research on Medicare spending for health maladies related to social isolation, we estimate that pet ownership lowers annual Medicare spending by almost \$1.8 billion annually.
- In our previous report, we noted the importance of emerging research on the benefits of service animals in the treatment of PTSD. The focus of much of this research has been on military veterans. Additional research shows the benefits of emotional support animals for some veterans as well. New research is showing that overall spending on PTSD treatments is \$688 million lower for veterans with both emotional support and service animals. As the training and deployment of service animals as a complimentary treatment for PTSD continues to grow, these savings could increase dramatically in the coming years.
- There are several other health care conditions for which we are close to being able to include in our cost savings calculations, but for which we have not quite reached the level of certainly needed. These include:
  - Spending for sleep medication for veterans, which we consider to be included in the savings estimates for overall PTSD treatments.
  - Mental health improvements from having aquariums in memory care facilities.
  - Glycemic control-related medication savings for children with Type-1 diabetes who are active in caring for a family pet.
  - Influence of pet ownership on decisions to quit smoking.
- The total annual health care cost savings in the U.S. related to pet ownership is now at least \$22.7 billion per year.

**TABLE 1**  
**Annual Health Care Cost Savings Associated with Pet Ownership**

DESCRIPTION	SAVINGS
Physician Office Visits	\$14,986,493,000
Obesity	\$4,536,476,000
Treatment of <i>C. difficile</i> Infections	\$90,470,000
Mental Health Costs for Anxiety in Children 8-10 Years Old	\$671,711,000
Mental Health Care Costs of Socially Isolated Seniors	\$1,776,146,000
Veteran PTSD Treatments (Emotional Support & Service Animals)	\$688,017,000
<b>Total Identifiable Cost Savings</b>	<b>\$22,749,313,000</b>

Source: Authors estimates and supporting material.

As with any analysis, there are limitations to the findings presented above. The research used for estimating cost savings are based on the direct findings of published research or reasonable extrapolations of such research. While some reports on health outcomes may be related to general lifestyle changes incidental to, but not caused by, pet ownership, the number of studies showing statistically significant relationships between pet ownership and improved health conditions is growing. By using conservative estimates where quality data are available and supported by the preponderance of evidence, our estimates provide an "at least" estimate of health care cost savings. Moreover, the evidence of pet ownership health benefits is increasing. "According to the 2021 HABRI Benchmark Survey of U.S. Pet Owners, health care practitioners are increasingly embracing the benefits of pet ownership for patient health with 22% of pet owners in the U.S. saying that their doctor or therapist had recommended a pet for better health<sup>1</sup>. As with all research, our analyses are iterative and will expand and improve as more research is published on the health care benefits of pet ownership.

<sup>1</sup> The HABRI Benchmark Survey of Pet Owners was conducted with a U.S. nationally representative sample of adults 18+ years old who own at least one pet regarding awareness, attitudes and behavior related to the human-animal bond. See: <https://habri.org/pet-owners-survey/>





## Health Care Costs and Pet Ownership

In our 2015 analysis, we found that pets contribute to general health and that interactions with pets can have a positive impact on some health conditions leading to health care cost savings. We found published research that directly examined the consumption of health care services, such as doctors' visits, among pet owners, lower incidence of obesity among dog owners who regularly walk their dogs, lower medication consumption for individuals in memory care facilities with aquariums, and improved life expectancy for pet owners who have had severe heart disease/events. Where there was sufficient data available by combining sources, we estimated the value of avoided medical costs associated with these identifiable health benefits of pet ownership.

In some instances, the literature provides evidence of a health benefit, but we do not have information allowing us to scale the impacts to the national level. For example, we can see that patients in memory care facilities with an aquarium require fewer mental health medications, and we know how much those medications cost, but we do not know how many memory care facilities have aquariums, so we cannot estimate the total cost savings. For other maladies, the medical literature showed that there are benefits of pet ownership, but the research does not provide sufficient clinical detail, such as specific reductions in medicines prescribed, to estimate a cost savings. In addition, some health benefits of the human-animal bond, while producing clearly positive benefits, may not produce monetary savings. For example, patients with pets who have improved long-term survival after a cardiac event derive a clear benefit, but this increased longevity may not produce economic benefit in the form of health care savings.

In this report, we update previous estimates, adjust our findings for new research, and report on types of cost savings that reflect the maturing field of study on the health benefits of pet ownership. This section is separated into three sections. The first reviews the literature and data sources that we bring together to offer estimates of health care cost savings associated with pet ownership. We have new data that allows us to expand our previous research into some areas of mental health. The second section looks at the literature that shows a positive health effect, but where there is insufficient information to "connect-the-dots" to a specific estimate of costs savings. The third section describes positive health impacts from pet ownership that are supported by research but are



not reported in a way that allows us to scale the impacts or identify economic benefits. The focus of this third section will be on research that has appeared in the professional and academic literature since our analysis in 2015.

### Quantifiable Health Care Cost Savings

As noted, our previous research found large health care cost savings of pet ownership related to fewer visits to physician offices and a lower incidence of obesity and its related health maladies among dog owners who regularly walk their pet. Fortunately, in this analysis we can add some new types of health care spending supported by an expanded number of research studies and publications reporting on health improvements tied to pet ownership.

### Physician Office Visits

One measure of general health is the number of primary care doctor visits that are necessary over a given year. A number of studies show that pet owners exhibit better overall health by having fewer physician office visits compared to non-pet owners. In Germany, pet owners visited a doctor's office 11.0 times per year versus 12.9 times per year for non-owners, a 15.8% reduction. Using multiple data analysis techniques to control for a wide range of demographic factors, the percentage reductions in physician visits between pet owners and non-owners ranges from 7.5% to 25% (Heady and Grabka, 2007). In Australia, pet owners visit a physician 4.9 times in a year versus 5.6 times for non-owners, a 12.5% reduction. The difference estimate for both Germany and Australia is about 10% after controlling for other variables affecting health (Heady and Grabka). Similarly, Siegel (1990) reported fewer annual doctor visits by pet owners (8.42 visits per year) and non-



owners (9.49 visits per year), a reduction of 11.3%. Siegel further observed that dog owners have a lower average rate of physician visits compared to other pet owners at 8.2 visits per year. Using these research findings, we have updated our estimates of health care cost savings to account for four factors: increase in U.S. population, the growth in percentage of U.S. households with a pet, the reduction in average number of physician office visits for all persons, and increasing costs associated with a physician visit.<sup>3</sup>

The APPA estimates that 70% of U.S. households own a pet. Data from the U.S. Census American Community Survey estimates about 131.2 million U.S. households, with an average of 2.47 persons per household. (Total U.S. population in 2021 exceeds 324 million). The average cost for a primary care physician office visit in the U.S. was \$186 in 2016 (AHRQ, 2020; Machlin and Mitchell, 2018). Using the health care cost inflation index provided by the U.S. Bureau of Economic Analysis and available from the Federal Reserve Bank of St. Louis "FRED" data portal, we estimate 2021 primary care physician office visits to cost \$296.41. In keeping with our previous analysis, applying the Heady and Grabka study findings to the U.S. population suggests a reduction of health care spending on office visits among pet owners at **\$15 billion**.

### Obesity

Several studies show the relationship between owners who walk their dogs and physical activity. The incidence of obesity (BMI > 30 kg/m<sup>2</sup>) is measured at 17% for dog walkers, 22% for non-owners, and 28% for dog owners who do not walk their dog. Cutt, et al (2008) reports that 23% of dog owners walk their dog 5 or more times per week. This research finding is broadly supported by other studies with similar findings linking pet ownership to higher levels of physical activity (Curl, et al, 2017; Egan, et al, 2013; Reeves, et al, 2011; Soares, et al, 2015, and Thorpe, et al, 2006; Levine, et al, 2013; Hoffman, 2021). About 54% of households have at least one dog. This implies that about 40 million individuals are measurably benefitting from walking their dog regularly. Given the demographic and behavioral shifts that have taken place since these studies were

conducted, our approach likely underestimates the total number of individuals who benefit from exercise taken with their dog.

Like all medical costs, the costs of treating the health maladies related to obesity are rising. A report published in 2021 (Cawley, et al), found the additional medical spending per obese person averaged \$2,781.60 in the period 2011-2016. Based on the Bureau of Economic Analysis medical cost inflation index, reported by FRED, medical costs rose by 12.9% from the average of 2011 through 2016 to 2021 resulting in an estimated annual cost of treating obesity of \$3,141. Allowing that 23% of adult dog owners walk their pets enough to achieve a 17% reduction in the rate of obesity suggests that about 1.44 million fewer people suffer from obesity. This lowers total medical expenditures in the U.S. by **\$4.5 billion**.

### Infection Prevention

*Clostridioides difficile* infection (CDI) is a bacterial infection and is a leading cause of health care associated infections (Finn, et al., 2021). This infection causes diarrhea and can eventually result in inflammation of the colon, a life-threatening condition. The bacterium that causes CDI is resistant to many disinfectants and is found in hospital and community settings with an incidence rate in the U.S. of 8.00 per 10,000 in health care settings and 2.0 per 10,000 in community settings (Finn, et al.) and has a notable recurrence rate among treated patients. Because the *C. difficile* bacterium is associated with animals and humans, Redding, et al. (2020) performed a study seeking to determine the risk factor that pet ownership contributes to the recurrence of CDI. Their research considered the intensity of owner-animal interaction using the following scale: non-pet owners (0 points); being primary care provider including feeding, grooming, exercise, and other activities (2 points); having the pet sleep in the owner's bed (3 points); allowing the pet to lick the owner's face or hands (4 points). The average interaction score in their study was 4.3 among pet owners and 2.076 among all study participants, including non-pet owners.<sup>4</sup> Their research not only failed to find a statistical link between pet ownership and this disease, but they

<sup>3</sup>Data from the U.S. Agency for Healthcare Research and Quality shows that in 2019 the U.S. population averaged 3.2 office visits for primary care services per year, the focus of our estimates here. In 2020, during the height of the COVID-19 pandemic, the average number of physician office visits for primary care fell to 2.8 per annum. We have chosen to use the 2019 figure as more representative of the consumption of health care services in 2021.

<sup>4</sup>The percentage of pet owners among the study group was 48.3%, which is substantially below the national average. Therefore, our approach likely underestimates the total number of avoided CDI cases.





also observed a statistically significant relationship that pet ownership appears to be a deterrent against the recurrence of CDI. For every point of interaction between owner and pet, the probability of recurrent CDI declined by 14%.

*Clostridioides difficile* infection requires an expensive treatment regimen that typically includes hospitalization costs, surgery, and medications totaling \$34,104 per patient (Rodriguez, et al., 2017). Combining this data with the results of the Redding (2020) study, we can offer an estimate of the health care cost savings related to the pet-owners lower incidence of recurring CDI. Since the Redding, et al. (2020) study was performed on a sample of patients from a Pennsylvania hospital, our population baseline is the number of patients spending at least one day in a hospital (hospitalizations) in 2019 according to the American Hospital Associations 2019 report. We chose 2019 to avoid hospitalizations caused by COVID-19.<sup>5</sup> Redding et al used an estimate of 20% to 30% recurrence rate for CDI. We use the midpoint of this range (25%) for our assumptions. There were a little over 36.5 million hospitalizations in 2017. Redding's analysis of the recurrence of CDI included both health care facility and community-based infections, so our disease infection rate is 10 per 10,000 hospital admissions (36,510 potential cases), times 25% recurrent rate for potential cases (9,127 cases). This infection rate is offset by Redding observed reduced risk due to pet ownership of 14% per point of pet interaction. The weighted average pet interaction score for the study group was 2.076, suggesting a reduction in CDI cases of 2,653. At \$34,104 costs per case, this totals a **\$90.47 million** reduction associated with pet ownership in the costs of treating CDI.

### Mental Health

Perhaps the broadest, and in many ways most important, findings in this updated report are the increase in the number of studies examining the benefits of pet ownership on mental health. According to Mental Health America (MHA), there are five key mental health advantages to owning a pet.

1) Alleviating Stress – “Owning a pet is linked to significantly lower heart rate and blood pressure in response to stress. In one study of cardiovascular

reactivity to stress, those with pets had significantly lower resting baseline heart rates and blood pressure and faster recovery of these parameters to baseline after cessation of stress...” (HABRI based on Allen, Blascovich and Mendes, 2002).

2) Fighting Depression – “Research has also demonstrated that pet owners laugh more – one study found that those with dogs or cats laughed more in their daily lives than people without pets. Pet owners reported laughing more on a daily basis, including reactions to their pet and spontaneous laughter, compared to non-pet owners...” (Valeri, 2006);



3) Reducing Loneliness – “Pets can provide people with the kind of social support that can help reduce feelings of loneliness and isolation... Research has also demonstrated that for those living alone, pet ownership can help reduce loneliness. Pet ownership is associated with increased morale and decreased loneliness in women living alone...” (Zasloff and Kidd, 1994);

4) Improving Wellbeing – “[P]et owners agreed that their pet has had a positive impact on their life... [Of] American adults, pet owners were more satisfied with their lives than non-pet owners but did not differ on other wellbeing measures. Dog owners scored higher on all aspects of wellbeing compared with cat owners...” (Bao and Schreer, 2016; McConnell et al, 2011); and

5) Supporting Long-Term Mental Health – “Research has found that pets can contribute, over time, to individuals developing routines that provide emotional and social support to those with a diagnosis of a long-term mental health problem... Pets also provided a distraction and disruption from distressing symptoms, such as hearing voices, rumination and facilitated routine and exercise for those who cared for them” (Brooks et all, 2016).

<sup>5</sup> The COVID-19 treatment protocols included isolating patients and much more intensive prophylactic measures such as surface cleaning. Therefore, it is possible that the effective incidence rate for CDI may have been lower. Moreover, we have taken the approach of not considering the exceptional health care issues during the pandemic for our analyses in this report.



While there are clear mental health benefits to millions of people in each of the areas outlined above, the economic benefit cannot always be calculated with available data. In this section, we will review this progress in human-animal bond research focusing on those issues for which we can draw specific health care cost savings estimates.

### Child Anxiety

Pediatric anxiety is a widely recognized health care challenge in the U.S. affecting almost one-third (32%) of the under-18 population (Pella, et al, 2020). There have been multiple studies showing that the presence of a dog can reduce stress and anxiety among children in hospital settings, clinical visits, and in the treatment of trauma-related disorders (Hinic, et al, 2019; Vagnoli, et al, 2015; O'Haire, et al, 2015). Gadomski, et al (2015) examined the impacts of dog ownership on the incidence of anxiety through formal testing of children aged 4 to 10 during routine annual visits to a pediatrician. The test for the presence of anxiety was the Screen for Child Anxiety Related Disorders (SCARED). The SCARED test, which is a self-report type test, is administered to children and parents. It is used to identify children who should be tested further for possible clinical treatment. SCARED rates as "excellent" in treatment sensitivity, which means that the test accurately predicts the need for treatment (Etkin, 2021). Gadomski and her colleagues found that children in families with a dog had a 9% lower probability of having clinical anxiety (20% probability for non-dog households versus 11% for dog owners).

Pella, et al (2020) performed research on the cost of treating childhood anxiety. They performed surveys of parents of children with one or more anxiety conditions including generalized anxiety disorder, social phobia, separation anxiety, as well as co-morbidity among these conditions. The research was performed in a central Connecticut (rural) and an urban Maryland community. These researchers used insurer records, public health data, and previous studies to calculate total direct and indirect costs of treating childhood anxiety. The direct costs include general medical costs, specialty mental health services (in-patient and out-patient), and substance abuse treatment, including in-facility, at home, and hotline-style services. Importantly, the direct costs did not include school-based services such as

counseling. Indirect costs included the cost of missing school, lost earnings for parents, and other related costs. This analysis does not consider the indirect costs since we are focused on health care cost savings. The study data covered 2015 and 2016, though it did not specify which data items came from which years or if the data are corrected for inflation. Therefore, we assume that all reported expenses are in 2016 dollars, which we adjust for 2021 spending using a health care cost index available from the Federal Reserve Bank of St. Louis. Adjusting for families that reported no direct spending, the mean health care costs for treating children diagnosed with anxiety is \$2,134 per year. There is a wide range of values represented by this average cost with some families experiencing a few calls to a hotline, while others spent more than \$100,000 on specialized in-patient services.

Combining the findings of the Pella, et al (2020) and Gadomski, et al (2015) research projects, we estimate the total health care cost savings related to avoided anxiety conditions in children. However, because of research study limitations, we are taking a very conservative approach for our estimates. As noted, Gadomski and colleagues used the SCARED test for childhood and adolescent anxiety in a testing population that ranged from 4 to 10 years old. However, Etkin (2021) reports that the SCARED protocol is designed for subjects aged 8 to 18 years old.<sup>6</sup> We therefore estimated the potential cost savings to children aged 8 to 10 years of age in the population.<sup>7</sup> The second adjustment, which may be overly conservative in nature, addresses a limitation of the study population in the Gadomski research, which was performed in upstate New York. Gadomski notes that the demographics of the study sample matched reasonably well with area demographics. However, the demographic distribution of subjects is very different from the U.S. population. Therefore, to avoid possibly overstating the mental health care cost savings for children with dogs, our projections are matched approximately to the study population. Even using this very conservative approach, the annual mental health cost savings associated with dog ownership lowering the incidence of childhood anxiety is almost **\$672 million**.

If further research confirms these findings to all cohorts of U.S. children, the projected annual mental

<sup>6</sup>We are not suggesting that the Gadomski team's findings are not correct, but we are not assuming the findings for students outside of the testing instrument's range in adjusting disease prevalence.

<sup>7</sup>Our estimates of the population of children in this age group is based on extrapolations of Census estimates for 2021 by age cohorts.



health care cost savings would exceed **\$7.6 billion**. This does not include indirect costs associated with missed school or parents having to miss work.

### **Social Isolation and Loneliness Among Seniors**

As observed by Serpell (1991:717) "pet ownership may help to ameliorate the effects of negative life events, such as bereavement, and have a positive impact on certain anxiety and depression indices." As our population ages, we have increased incidence of seniors becoming socially isolated due to death or health-related separation from a spouse or domestic partner, families and friends becoming geographically isolated for family or employment reasons, and other factors. Flowers, et al (2017) reports that 14% of seniors aged 65 and above are socially isolated. This is a separate, more intense condition than loneliness. Mosen, et al, (2021) finds that social isolation among seniors is associated with a 17% increase in hospital admissions and a 21% increase in the risk of a senior requiring an emergency department visit. Meisters, et al (2021) in a broader study of all adults in the Netherlands finds the related mental health care challenge of loneliness has a direct effect on higher spending for general practitioner care (0.5%) and mental health care expenditures (11%). Flowers and team estimated that socially isolated seniors in the U.S. have \$1,608 in additional Medicare spending. This same team of researchers writing as Shaw, et al (2017), reported that objectively isolated seniors increased Medicare spending an average of \$1,644 per year.

Several studies published over the past few years show that pet ownership improves owners' sense of loneliness and reduces social isolation. While some of these focus on specific animals (dogs), others focus on overall pet ownership. Pets provide companionship and increase social interactions among owners ((Hui Gan, et al, 2020; Wood, et al, 2015; Ikeuchi, et al, 2021). Using data from the APPA Survey, 27% of Baby Boomers and 3% of the Silent Generation<sup>8</sup> own a pet. Using population data from the U.S. Census Bureau, we estimated the weighted average of the population aged 65+ with pets is 14.1% or almost 7.9 million.<sup>9</sup> If we assume that Flower's

reported incidence rate is the upper end of social isolation avoidance among seniors with pets and using Flower's slightly lower cost estimate for Medicare funded health services among socially isolated seniors, then senior pet owners are consuming almost **\$1.8 billion** less in Medicare spending related to social isolation.<sup>10</sup>

These findings suggest that the role of pet ownership may benefit community-dwelling older adults by providing companionship, giving a sense of purpose and meaning, reducing loneliness and increasing socialization. These benefits may also increase resilience in older adults against mental health disorders, which may positively influence their mental health outcomes (Gan et al, 2020).

### **Post-Traumatic Stress Disorder Among Veterans**

In 2015, we observed an important, emerging area of research focused on the role of pets and service animals in the treatment of PTSD among U.S. veterans. This research has now documented significant benefits to veterans.<sup>11</sup> Post-Traumatic Stress Disorder can be caused by many different events. Among the civilian population, natural and man-made disasters, criminal actions, domestic violence, and other factors can trigger long-running PTSD. In active duty and veteran populations, the trauma of war-related injuries, persistent threats, social stress, and other causes can leave damage as lasting as any physical wound. The economic costs of treating PTSD, among those who seek treatment, has become a major obligation for society. Davis, et al (2022) estimate that in 2018 the total excess economic burden from PTSD in the U.S. totaled



<sup>8</sup> APPA references the group as "Builders". We have assumed it refers to individuals 75 and above.

<sup>9</sup> There is a steep fall off in pet ownership as folks reach advanced years. We scaled estimates to reflect that relative more Baby Boomers who are under 65 have pets versus older members of that cohort. When combined with the relatively few owners who are among the Silent Generation, our estimate is that 14.093% of 65+ persons are pet owners.

<sup>10</sup> Given that the reported incidence of social isolation among seniors is 14%, which includes both pet owners and non-pet owners, using this as the presumed avoidance of social isolation among pet owners is reasonably conservative.

<sup>11</sup> HABRI funded a proof-of-concept study with results that suggest the addition of trained psychiatric service dogs to usual care may improve PTSD symptomology, but not below the level of clinical diagnosis, and contribute to better quality of life and improved social functioning in military members and veterans. See: <https://habri.org/pressroom/20150416>.



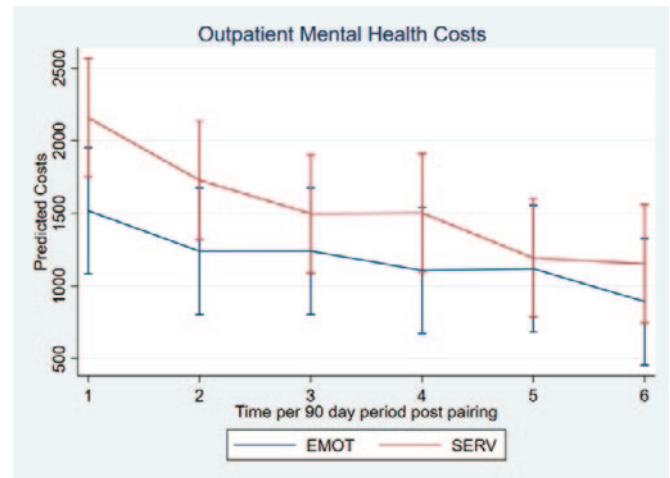
\$232.2 billion. Of that total, \$42.7 billion is related to veterans and active duty military personnel including \$17.8 billion in disability payments and \$10.1 billion in direct health costs.

The Veterans Health Administration (VHA) (2021) published a two-monograph report examining the costs and benefits of service dogs in the treatment of veteran PTSD. The purpose of the study included comparing the effectiveness of service dogs versus emotional support dogs. Service dogs are defined as dogs that are individually trained to do work or perform tasks for people with disabilities. They are protected under the Americans with Disabilities Act (ADA). Any business or facility that serves the public generally must allow service animals to accompany people with disabilities in all areas of the facility where the public is normally permitted to go. Emotional Support Animals are defined as animals that provide "emotional support that alleviates one or more symptoms or effects of a person's disability." ESAs can be any companion animal species, and they have no special rights to access other businesses or public facilities that have "no pets" policies.

This represents some level of departure from our usual focus on pets, but the implications and the insights of this research have application for the broader population. Moreover, the estimates provided in these studies are real and should be included in any assessment of health care cost savings associated with pets and service animals. The studies included a broad set of medical expenditures including inpatient and outpatient medical/surgical services, medicines, mental health services, and substance abuse treatments. Figure 4 is from the VHA report and clearly shows decreasing health care cost profiles for treatments including service dogs (SERV) and emotional support dogs (EMOT). See Figure 4.

The authors of the VHA report caution that they are not claiming "causation" between the use of service and emotional support dogs and lower health care spending among veterans with PTSD. Their caution is reportedly because of typical regressions towards the mean in any experimental group. However, given the average age of study participants, about 50

**FIGURE 4**  
**EMOT versus SERV Outpatient Mental Health Costs**



Source: Veterans Health Administration (2021)

years, it seems unlikely that this group of veterans is new to treatment, which would lower the likelihood that regression towards the mean is a threat to research validity. We appreciate the researcher's caution, but there is an increasingly robust body of literature that supports the practice of incorporating animals, especially service dogs, in treating PTSD (see for example Bergen-Cico, et al, 2018; Jensen, et al, 2021; O'Haire and Rodriguez, 2018; Stern, et al, 2013; Rodriguez, et al, 2021).

Based on Davis et al (2022), there are 1.66 million veterans in the U.S. with PTSD. Assuming that the proportion of vets with dogs is no more than the overall population, that would suggest 1.164 million veterans with PTSD have a dog. To be clear, these dogs may be considered as just pets, emotional support animals or trained service animals. Importantly, given the effectiveness is shown across service dogs and emotional support dogs (Nieforth, et al, 2012), we do not have to limit our assessment to those veterans who have received a service dog from the Veterans Administration or one of many charities who have been providing such animals for several years. In fact, there is evidence that all companion dogs "may help relieve some of the psychological distress associated with PTSD" (Stern, 2013). Adjusting to estimates provided in the VHA report to an annual cost figure, the annual average medical care cost savings we used for our estimates is about \$591 per dog owner or **\$688 million per year**.<sup>12</sup>

<sup>12</sup> We do note some caution in generalizing the findings of the research reviewed in this section. The emotional support dogs used in the study may not be representative of the overall pet dog population in terms of breed, temperament, obedience training and other characteristics. The Veterans Administration required that emotional support dogs used in the programs described be obedience trained, well socialized, and meet the same high health and soundness standards required of service dogs (Leighton et al, 2022). Also, our assumption that pet ownership among veterans with PTSD is approximate to the broader population of pet owners may not be precise.



## Health Care Costs that are Partially Quantifiable

This section of the report covers some old and some new ground where we have data that allows us to quantify some elements of health care cost savings associated with pet ownership, but we are missing important data elements. In certain instances, we report findings here that are likely subsets of costs covered in the previous section. We include them here to avoid double counting any economic benefits reported.

### Infections

Similar to the discussion of CDI above, Gandolfi-Decristophoris, et al (2012) found that exposure to pets lowered the risk of nursing home patients contracting multi-drug resistant staphylococci among nursing home residents with pet contact. While we can note that multi-drug resistant infections are difficult and costly to treat, we do not have estimates of pet ownership among this institutionalized population.

### Alzheimer's/Dementia

Multiple studies have shown that placing an aquarium in facilities for Alzheimer's patients preceded an improvement in food consumption behavior that resulting in fewer nutritional supplements (Lakdawalla, 2003; Edwards and Beck, 2002). Placing an aquarium in the facility boosted patient food intake resulting in a decreased need for food supplements and lowering total care costs. Edwards, Beck, and Lim (2014) in a more recent paper, concluded that dementia patients demonstrated less uncooperative behavior, better sleep, fewer incidences of irrationality, and less frequent instances of inappropriate behaviors after an aquarium was introduced in patient spaces. Importantly, they linked these improved patient behaviors to staff job satisfaction, which could lower staff turnover and replacement costs. A key challenge here is being able to quantify the number of facilities with aquariums.

Related to these other aquarium studies, Clements, et al (2019) reviewed several studies finding that individuals in non-institutional settings enjoyed mental health and nutritional benefits when exposed to fish in home or public aquariums.

## Type 1 Diabetes

A systematic review by Flör et al. (2018) concluded that social capital was positively associated with diabetes control among different populations, independent of the quality or quantity of social capital. However, the few studies available and variations among populations and measures limit the ability to draw firm conclusions related to dimensions of social capital and whether the association is the same at the individual or neighborhood level. Gebreab et al. (2017), using data from the Jackson Heart Study, examined social cohesion, measured as trust in neighbors, shared values with neighbors, willingness to help neighbors, and extent to which neighbors get along. The study revealed higher neighborhood social cohesion was associated with a 22% lower incidence of T2DM. Studies demonstrating the relationship between social support and diabetes have associated increased social support with better glycemic control and improved quality of life, while lack of social support has been associated with increased mortality and diabetes-related complications. We know that social capital increases in neighborhoods with more pets, suggesting that increases in pet ownership may contribute to lower incidence of T2DM (Wood, et al, 2005).

In an article that was released shortly after our previous report, Maranda and Gupta (2016) reported on research that looked at the relationship between pet care and the incidence of childhood diabetes. The study included children between 9 and 19 years of age and compared the likelihood of glycemic control for those who a) had one or more pets in their household, and b) were actively engaged in the pet's care. The children who were actively involved in pet care were 2.5 times more likely to have control of their glycemic levels. In the study sample, this represented about 37% of the children.

According to the American Diabetes Association 244,000 children in the U.S. have Type 1 Diabetes with data from the University of Michigan's Institute for Healthcare Policy and Innovation, the cost of care for this disease is about \$2,500 per person each year. Therefore, the results of Maranda and Gupta's (2016) research suggests that potential medical cost savings could be as much as **\$91.5 million** per year for families whose diabetic child actively cares for a pet. However, the research article does not make clear that these children were able to cease



medications, just that they had better outcomes (glycemic control). This would certainly suggest other cost savings related to health maladies consequential to diabetes, but we do not have research that allows us to quantify those impacts and related savings.

### Loneliness and Mental Health

There are several studies linking pet ownership to lower levels of loneliness overall (Antonacopoulos, 2017; Carr, et al, 2020; McConnell, et al, and Stanley, et al (2014). Gerst-Emerson and Jayawardhana (2015) observed that loneliness is a consistent predictor of doctor visits in community dwelling adults. However, research specifically examining health care costs related to loneliness produce mixed results (Shaw, et al, 2017; Meisters, et al, 2021). Therefore, in keeping with our conservative approach, this analysis does not include any potential health care cost savings from pet ownership on the specific condition of loneliness for the general population. This issue can be addressed as the literature matures on health care costs and loneliness; an issue that has gained much attention related to the COVID-19 pandemic. Moreover, it is possible that the reduction in loneliness among pet owners is reflected in the overall reduction in physician office visits discussed above. We suspect that there are also links to the connections between loneliness and labor productivity that could expand our understanding of broader positive economic effects of pet ownership in the future.

Additionally, Wang et. al (2018) found 34 studies that reported quantitatively on the longitudinal relationship between perceived social support/loneliness at baseline and various outcomes of mental illness at follow-up. Although substantial



heterogeneity exists in the identified articles, some generalizations can be made. There is substantial evidence that less perceived social support at baseline tends to predict greater symptom severity, poorer recovery/remission, and worse functional outcomes at follow-up among people with depression, and preliminary evidence of a similar relationship for people with bipolar disorder, or anxiety disorders. There is also some evidence that greater loneliness is associated with more severe depression and anxiety symptoms and poorer remission from depression.

### Smoking

The discussion about the impacts of second-hand smoke on smokers' decisions to quit has been tied to concerns about household pets. Millberger, Davis, and Holm (2009) found smokers willing to quit to avoid exposing their pets to secondhand smoke. The Centers for Disease Control reports data suggesting that additional health care cost spending by smokers in the U.S. is about \$6,350, which does not include productivity loss, income loss, and other factors associated with the impacts of smoking related diseases. If studies emerge that allow us to estimate the number of smokers who quit because of their pets, we could show a potential large number of health care cost savings. If Millberger and colleagues are correct and intention to quit leads to quitting, and the incidence of pet ownership holds for smokers, the potential health care cost savings would approach **\$48 billion** annually.

### PTSD/Trauma – Not Military Service Related

In the previous section we utilized the emerging literature on the benefits of service and companion animals in treating veterans with PTSD, but health care spending on PTSD is much larger outside of the veteran population. Davis, et al (2022) estimates that non-veteran related PTSD health care costs in the U.S. at \$189.5 billion per year. The sources of that trauma are varied, but increasingly we can tie such trauma to disaster events.

The relationship between humans and pets can be amplified during times of crises. According to the American Veterinary Medical Association (AVMA), "human and animal health and welfare are inextricably intertwined" (2006). Disasters, whether natural or human-induced, are deadly, destructive, and disruptive events, otherwise punctuating, that occur when a hazard interacts with human risk and



vulnerability. Disasters are, thus, a result of interaction between a historical-cultural system, in which the resultant damage and loss suffered and the degree of disruption of the system is a product of this interaction. Prior research has demonstrated that the consequences of disasters are often broad-based, long-term, and unanticipated (Thornton, Murphy-Greene, and Simon, 2021).

There are “tremendous emotional, economic, and practical challenges that individuals face in the wake of disasters, and as we better understand the role companion animals play in family units, the human-animal bond has emerged as an important consideration in [emergency] management” (AVMA, 2006). The human-animal bond has intense emotional dependencies and attachments that exist between people and animals. When broken, fractured, strained, or even separated during times of crises, it can result in significantly reduced psychological and physical health benefits for children, the elderly, the disabled, the mentally and physically ill, and the incarcerated. Any disaster plan for pet owners and communities alike, should, therefore, include preparedness and response protocols for the evacuation and sheltering for both people and their companion animals. Moreover, research into the specific benefits that pet ownership and companionship could play in avoiding or alleviating PTSD among disaster victims could easily show billions in avoided health care costs.

### Health Care Benefits/Costs that are Not Quantifiable

In this final section we review topics that have not seen literature develop that can serve as a reasonable basis for estimating health care cost savings. For some topics this is because the efficacy of pet interactions remains uncertain. Other health benefits are both recognized and significant but not economically quantifiable.

#### All-Cause Mortality

Kramer, et al (2019) performed a meta-analysis of ten studies with an average time follow up time span of a little more than 10 years. Their findings showed that dog ownership is associated with a 24% reduction in risk of death from any (health) cause. This may be driven in part by their findings that for dog owners with a prior coronary event, the mortality risk for all causes drops by 65%.

### Allergies

There are numerous studies examining the relationship of exposure to pets and the likelihood of developing allergies or asthma. Exposure to dogs and cats in very early years reduces the risk of allergies (Wegienka, et al, 2011), with the protective effect rising as the number of pets increase (Hesselmar, et al, 2018). Perinatal exposure, to dogs and cats, likely reduces the risk of developing allergic disease including asthma (Lodge, et al, 2012; Dharmage, et al, 2012). However, Carlsen, et al (2012), find neither benefit nor harm from pet exposure on the risk of childhood asthma or allergies.

### Mental Health

There is a rapidly expanding body of literature on the mental health benefits of pets. Some of these studies have been touched on in previous sections of this report. The preponderance of evidence suggests that having pets in our lives results in lower stress and anxiety (Janevic, et al, 2019; Xie, et al, 2017), reduces the likelihood of depression (Friedman, et al, 2011), and response to trauma (O’Haire, et al, 2015). Brooks and colleagues (2016 and 2018) address the ways that pets help their owners manage long-term mental health conditions so they can remain productive and deal with daily life and crisis events. Interestingly, the settings of these studies include not only institutions (medical and nursing care facilities) and residences, to now include pets that are brought to their owners’ workplaces (see Barker, 2005; Barker, et al, 2012; Wagner & Pine e Cunha, 2021; Wells and Perrine, 2001; Wilkin, et al, 2016). Many of these studies take qualitative approaches that do not lend themselves to numerical case counts or assessments of health care related cost avoidance. However, in future research, considering how pets can enhance worker productivity through improved mental health could illuminate a new approach to assessing the economic benefits of pet ownership.

### COVID-19

The COVID-19 pandemic is, hopefully, a once in a lifetime global health catastrophe and we assume that there will be an abundance of journal articles and research reports in the coming years on the role that pets played in key health issues directly and indirectly related to the pandemic. Beken, et al, (2021) posit that benefits of pet ownership, such as exercise, reductions in severity of allergies and asthma, and improved mental health (less loneliness) may have lowered the severity of COVID-19 among some pet



owners. One study (Bennetts, et al, 2022), on the other hand, found that companion animal owners in Australian households with children exhibited higher levels of anxiety (children) and increased psychological distress (adults) during the pandemic. This counterintuitive finding calls for further analysis in understanding how perceptions of stress are altered during unusual health crises.

### Heart Disease

The earliest formal research we uncovered connecting pet ownership with health benefits addressed improvements in survivability among those suffering a heart attack. While it is important to note that this research project does not include addressing issues of reduced mortality among pet owners, which requires the socially and economically awkward task of valuing human life, pet ownership, including dog (Mubanga, 2017) and cat (Qureshi, 2009) ownership, has been shown to be associated with reduced risk for death due to cardiovascular disease.

Our focus is on reducing health care costs for the living. Levine, et al, (2013) writing for the American Heart Association, noted some positive relationships between pet ownership and heart related health measures including hypertension, cholesterol counts, physical activity, stress, and obesity (see for example Friedmann, et al, 2015; Yeh, et al, 2019). In one interesting study that crosses over with mental health, Herrald, Tomaka, and Medina (2002) found that pet owners were more likely to complete cardiac rehabilitation programs (96.5% versus 79.2%, respectively). Importantly, the body of research on linkages between pet ownership and cardiac health continues to develop and will likely lead to future assessments of cost savings. In a broad study using ten years of data from the Swedish National Patient Register, Mubanga et. al (2019) found that dog ownership was associated with a reduced risk of hospitalization for recurrent myocardial infarctions in patients aged 45-80. Outside of pandemics, heart disease remains the number one health challenge among Americans. The research on the impacts of pets on heart health will continue.

Furthermore, a recent National Health and Nutrition Examination Survey demonstrated that even after considering potential confounding factors, having a pet (cat or dog) was an independent predictor of lower hypertension risk (Krittanawong, et al, 2020). Surma, et al (2022), in a broad review of previous

studies, reports that pet owners experienced a 1.7 mmHg lower systolic BP (SBP), a non-statistically significant reduction in diastolic blood pressure (DBP), and a statistically significant reduction in heart rate of 2.3 beats-per-minute. The lowering of blood pressure was especially prevalent during direct contact with the pet and was influenced by the intensity of the owner-pet relationship and varied across species of the pet and breed of dog. Another meta-analysis of 26 studies found that pet owners have lower heart rates but found no difference in pet ownership regarding the presence of hypertension (El-Qushayri, et al, 2020). These findings are promising. While not showing consistency in results, which is not unusual for emerging areas of research, these studies are building a base of knowledge that will help us understand the complex, interactive effects that pets have on these measures of cardiac health. While we may not fully understand the mechanisms or magnitude of effect, the preponderance of evidence is increasingly pointing in a positive direction.



### Healthy Aging

Owning a pet is common for many individuals later in life, though the rate of ownership is substantially lower for older adults and declines with advancing age (Bolstad, et al., 2021). Even so, many companion animal interactions with older adults involve animal-assisted activities (AAA) and animal-assisted therapy (AAT). In most cases, traditional "[p]et ownership comes with additional responsibilities that the brief interactions" of AAA do not. This research crosses with several of the topics previously covered including heart health, obesity, and mental health. While the literature regarding the benefits of the human-animal bond for late-life population groups





have found some mixed results (Gee and Mueller, 2019; Raina, et al, 1999), owning a pet was related to having fewer symptoms of anxiety, better pain management, and reduced frailty (Bolstad, et al., 2021; Janevic, 2019; Kojima, Aoyama, and Taniguchi, 2020). Older adults experience a multitude of worsening cognitive and physical functions, notably associated with increased mortality risk, as well as greater psychological symptoms. "Interaction with animals is a non-pharmacological intervention that is posited to support health and may promote healthy aging" (Friedmann, et al., 2020: 294). Research has linked better health outcomes in older adults with pet ownership, especially those with chronic ailments, such as heart disease (Friedmann, et al., 2020).

### Animal-Assisted Therapy in Clinical Settings

The focus of this research is on pet ownership, though with the previously noted allowance for the benefits of service animals for veterans with PTSD. It is worth noting the research on the incorporation of companion animals in clinical settings that do not imply the patients are owners of the animals. This can include Animal Assisted Interventions (AAI), such as Animal Assisted Therapy (AAT), Animal Assisted Activities (AAA) and other interventions for achieving improved human health.<sup>13</sup> The health care cost associations, not yet quantifiable, manifest in the role these animals play in promoting better direct or

indirect clinical outcomes for human patients. Orlandi, et al (2007) noted psychological and physical benefits for patients undergoing chemotherapy treatments who have hour-long sessions with a therapy dog. Therapy dog interactions have been linked to lower medication use by patients in care facilities (Lust, et al, 2007), improvements in post-operative recovery among children (Calcaterra, et al, 2015), and better outcomes for children suffering mental health disorders (Stefanini, et al, 2015).

### Service Animals

As with the previous section, our research focus does not explicitly look at the health care cost savings associated with service animals, though that may be a needed expansion in future studies. Service animals have a clear and compelling impact on their owners' ability to physically function, more effectively and more safely, which has implications for lowering medical and assistance costs. There is also research supporting the connection between service animals, who are specifically trained to assist their owner with a physical disability, including a physical, sensory, psychiatric, intellectual or other mental disability, and improvements in owners' mental wellbeing (Allen and Blascovich, 1996). From a broader economic perspective, service animals also promote work participation and productivity (Allen and Blascovich; Rodriguez, Bibbo, and O'Haire, 2020; Hall, et al, 2017), which is a key area for further research.



<sup>13</sup> Some of the animals in Animal Assisted Intervention could be considered pets, but this varies based on the procedure/program.



### Direct and Indirect Effects

As noted in a previous paragraph, some of the beneficial health effects of pet ownership may not manifest as direct benefits. Having a pet in the home reduces anxiety, which may lower the costs of treating individuals with more extreme cases of this disorder. In turn, anxiety has been shown to worsen many other conditions like cardiovascular disease and can impede recovery from a wide range of maladies and impairments. For an economic perspective, pets have a direct effect on the costs of anxiety and an indirect effect on hypertension, surgical recovery, and other health matters, which is a multiplier effect. We are still struggling to quantify all of the beneficial direct effects pet ownership has on health care costs, much less understanding second-order effects. But those second-order effects are real. Therefore, it is reasonable to conclude that the estimates of health care cost savings we have calculated in this research is very conservative and

substantially undervalues the economic benefits of pet ownership.

### Findings

In sum, for those categories of health care spending where we have sufficient data and information to make reasonable estimations of costs savings associated with pet ownership, we find that pet ownership is associated with annual health care cost savings of **\$22.7 billion** (see Table 3). As will be shown below, even with the expansion of topics in this analysis compared to our 2015 effort, our ability to show quantifiable health care cost savings is still only scratching the surface of this increasingly important issue. In the following sections, we briefly discuss these areas for future potential research to illustrate, at least qualitatively, the breadth of the positive impacts on human health resulting from pet ownership.

**TABLE 3**  
**Annual Health Care Cost Savings Associated with Pet Ownership**

DESCRIPTION	SAVINGS
Physician Office Visits	\$14,986,493,000
Obesity	\$4,536,476,000
Treatment of <i>C. difficile</i> Infections	\$90,470,000
Mental Health Costs for Anxiety in Children 8-10 Years Old	\$671,711,000
Mental Health Care Costs of Socially Isolated Seniors	\$1,776,146,000
Veteran PTSD Treatments (Emotional Support & Service Animals)	\$688,017,000
<b>Total Identifiable Cost Savings</b>	<b>\$22,749,313,000</b>

Source: Authors estimates and supporting material.



## Future Considerations

In this analysis we have been able to expand on our 2015 research that showed important health care cost savings through a small number of health indicators (physician office visits and obesity). Our analysis updated previous estimates to account for the growing percentage of U.S. households with pets and the increase in health care costs that continue to rise faster than general inflation rates. Three new health topics are added to our list of cost savings: health spending related to seniors who suffer from social isolation, treatment cost savings related to lower recurrences of *C. difficile* infections, and the deployment of service and companion animals for veterans living with PTSD. In total, these health care cost savings exceed **\$22.6 billion** in current year dollars.

Just as exciting is the continued progress researchers are making that will allow future studies to expand the list of health care cost savings topics further. Most promising are studies focused on:

- PTSD treatment in the general population;
- Confirming the benefits of dog ownership in alleviating childhood anxiety across all age and demographic groups;
- The impact of pets on smoking cessation;

- Being able to specify cost reductions for impacts on Type 1 Diabetes;
- Roles of pets in lowering the incidence of loneliness in the general population; and
- Better care for individuals with memory disorders.

Work continues through the scientific process of test-question-retest for several other health topics related to the impacts of pets:

- Gaining certainty on the benefits of early exposure to pets on allergies;
- Deeper understanding of pet ownership's relationship with heart health;
- How pets improve physical and mental wellbeing as we age;
- Pets' roles in mitigating the impacts of a pandemic; and
- New areas of research on mental health benefits of companion animals.

What is clear, even though we have been able to show dramatically higher health care cost savings in this analysis, compared to our previous analysis, we are still just scratching the surface in our ability to assess the economic benefits, direct and indirect, of pet ownership.





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## Author Biographies

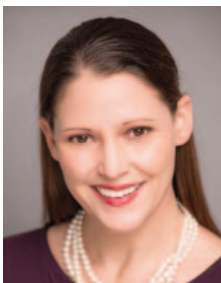


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Dr. Terry L. Clower is Northern Virginia Chair and professor of public policy in the Schar School of Policy and Government at George Mason University. He is also director of Mason's Center for Regional Analysis. The Center provides economic and public policy research services to sponsors in the private, nonprofit, and public sectors. Prior to joining Mason, Clower was director for the Center for Economic Development and Research at the University of North Texas. He also spent 10 years employed in private industry in logistics and transportation management positions.

Dr. Clower has authored or co-authored more than 150 articles, book chapters, and research reports reflecting experience in economic and community development, economic and fiscal impact analysis, transportation, land use planning, housing, and economic forecasting. His scholarly articles have appeared in *Economic Development Quarterly*; *Urban Studies*; *Economic Development Review*; *Regional Studies*, *Regional Science*; the *Australasian Journal of Regional Studies*; *Regional Studies* *Regional Science*, *Sustaining Regions*; and *Applied Research in Economic Development*. He recently completed a term as regional (Americas) editor for the journal *Regional Science Policy and Practice*.

Dr. Clower received a BS in marine transportation from Texas A&M University in 1982, a MS in applied economics from the University of North Texas in 1992, and a PhD in information sciences from the University of North Texas in 1997, specializing in information policy issues and the use of information resources.



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Prior to establishing Delta Point Solutions, LLC, Dr. Thornton was the Director of Grants at George Mason University's Schar School of Policy and Government. In this role, she worked closely with faculty in developing proposals and securing contracts while also securing her own. She was also a Research Assistant Professor in the Master of Public Administration program and Coordinator for its Emergency Management and Homeland Security graduate certificate.

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Dr. Thornton has a Doctor of Philosophy in Public Policy and Administration from Mississippi State University, where she also earned a Master of Public Policy and Administration and a Bachelor of Arts in Political Science with an emphasis in the Geosciences. She has been recognized by the U.S. Department of Defense as a subject matter expert in critical infrastructure protection and social capital.