

Title: Exploring the impacts of social determinants of health and the human-animal bond on compliance and retention in Morris Animal Foundation's Golden Retriever Lifetime Study

Authors: Mary Corcoran, Liana R. Moss, Emilie Evans, Sloane M. Hawes, Jaci Gandenberger, Kevin N. Morris

Affiliation: Institute for Human-Animal Connection, Graduate School of Social Work, University of Denver

Acronyms

GRLS – Golden Retriever Lifetime Study

MAF – Morris Animal Foundation

IHAC – Institute for Human-Animal Connection

AKC – American Kennel Club

UKC – United Kennel Club

GRCA – Golden Retriever Club of America

SDOH – Social Determinants of Health

HAB – Human-Animal Bond

AVQ – Annual Veterinary Questionnaire

AOQ – Annual Owner Questionnaire

C-BARQ – Canine Behavioral Assessment & Research Questionnaire

HGMCT – High Grade Mast Cell Tumors

Introduction

Throughout the Golden Retriever Lifetime Study (GRLS) implementation, Morris Animal Foundation (MAF) has observed high rates of compliance ($\mu = 81.3\%$) and retention ($\mu = 86\%$) across more than 3,000 participating dog owners (Labadie et al., 2022). These rates are considerably higher than most longitudinal clinical trials focused on humans in which the average retention rate is 73.5% (Teague et al., 2018). Therefore, GRLS offers an opportunity to better understand factors that might affect study compliance and retention within longitudinal and clinical veterinary and human medical studies.

One potential set of factors influencing study compliance and retention rates is the social determinants of health (SDOH). These are an encompassing set of environmental and social conditions that influence individual human and community health that can be grouped into five domains, including economic stability, education access and quality, health care access and quality, neighborhood and built environment, and social and community context (U.S. Department of Health and Human Services [USDHHS], 2021). Several studies suggest compliance and retention rates in longitudinal studies may be informed by several of these environmental conditions, including socioeconomic status, education level (Rivera-Torres, Fahey, & Rivera, 2019), living arrangement, race, (Yang et al., 2016), access to healthcare, and policies (Lall et al., 2015).

Another potential factor affecting compliance and retention rates in veterinary medical studies is the human-animal bond. In particular, a stronger bond between an individual and their pet may predict higher rates of participation, compliance, and retention. For example, Lue, Pantenburg, and Crawford (2008) found that stronger owner-pet bonds are associated with higher levels of veterinary care, which included compliance with veterinary recommendations, regardless of cost. Anecdotal evidence demonstrates that GRLS participants likely represent a group of individuals who experience a particularly strong attachment to their pet dogs. As the veterinary field's interest in the human-animal bond continues to grow, it is essential to know the influence of the human-animal bond on compliance and retention for future study incorporation.

Another potential factor affecting compliance and retention rates in GRLS is collective-level motivations to participate in research that include increasing the representation of a group's interest,

political empowerment, or a desire to inform ‘change’ (Clark, 2010). Collective-level motivators may inform participation rates through a sense of social connection to other study participants that is achieved through the social media community cultivated by the MAF staff (Grieve et al., 2013). This online support system is particularly critical if a GRLS participant is grieving the loss of their pet dogs at any point during the study period (Robinson & Pond, 2019). An improved understanding of social and environmental factors on compliance and retention could also inform the study design of external veterinary or human health trials.

This study’s hypothesis is that social and environmental factors, defined by demographics, human-animal bond, and SDOH, influence rates of compliance and retention in the GRLS sample population. Individuals who are influenced by the highest number of positive social and environmental factors (e.g., higher than average income, lower levels of racial/ethnic diversity, higher access to healthcare services, higher measures of human-animal bond, etc.) will have lower rates of attrition than other individuals in the study who experience fewer positive social and environmental factors. By assessing compliance and retention through demographics, the SDOH framework, and the human-animal bond, this study, conducted by the University of Denver’s Institute for Human-Animal Connection (IHAC) in partnership with MAF, explores how these factors might inform the design of future veterinary and human longitudinal studies.

Background on the Golden Retriever Lifetime Study (GRLS)

The MAF GRLS is a longitudinal cohort study of 3,044 pure-breed golden retriever dogs designed to assess the incidence of and risk factors for four prevalent canine cancers - osteosarcoma, lymphoma, hemangiosarcoma, and mast cell tumors - the primary study endpoints (Simpson et al., 2017). Recruitment of golden retrievers for the GRLS began in September 2012 and ended in March 2015 (Ruple et al., 2021). To be eligible for inclusion in the GRLS as a study dog, golden retrievers were required to meet six criteria: (1) registration with the American Kennel Club, United Kennel Club, or another kennel club or service dog organization, (2) proof of three generations of pedigree documentation, (3) be less than two years of age, (4) the dog must be microchipped or have an alternate permanent identification, (5) there must be no prior diagnosis of a malignancy or life-threatening condition that may substantially shorten expected lifespan, and (6) the dog must reside within the contiguous United States (Guy et al., 2015; Ruple et al., 2021). MAF’s study dog recruitment efforts centered on sharing information via organizations such as the American Kennel Club (AKC), the United Kennel Club (UKC), the Golden Retriever Club of America (GRCA), as well as through golden retriever breeders (Guy et al., 2015). Members of these organizations were directed to the MAF website, where a brochure explained the expectations for study participation (Guy et al., 2015). Snowball sampling via a network of volunteers using Facebook and other social media platforms to share information about the GRLS was also utilized and became a main contributor to enrollment (Guy et al., 2015). Study recruitment ended after 3,000 dogs were enrolled in the study.

Participation in the GRLS for study dogs and their owners, referred to as participants, involves completing an Annual Owner Questionnaire (AOQ) and an annual veterinarian visit once per year (Guy et al., 2015). AOQs are online surveys that contain nine sections: dog information, conditions, reproductive information, dental and grooming, medications, diet, physical activity, the Canine Behavioral Assessment & Research Questionnaire (C-BARQ), and environmental and living conditions. Once a participant completes their AOQ, they are shipped an annual study kit containing materials for collecting clinical pathology samples - whole blood, serum, urine, stool, hair and nails (Guy et al., 2015). These samples are collected at the annual veterinary visit and sent to partner laboratories, which conduct the tests, including SuperChem, CBC, urinalysis, total T4, heartworm antigen, and fecal ova and parasite (Guy et al., 2015). Study veterinarians and owners each receive a copy of the lab reports and study veterinarians perform a full exam during the annual visit. After the visit is completed, study veterinarians are expected to complete an Annual Veterinarian Questionnaire (AVQ) with five sections: general information, disorders/conditions/diseases, general physical exam, superficial masses, and medications and vaccinations. To ensure that annual requirements are met, a series of reminders are sent out by the study

team for both AOQs and AVQs, which includes automatic emails, manual emails, and phone calls (Ruple et al., 2021). In addition to annual expectations, the GRLS also collects samples from biopsies of masses removed from study dogs (Guy et al., 2015). Upon request from a participant or study veterinarian, a biopsy kit containing formalin jars, RNALater, and clinical pathology materials is provided. The GRLS receives the results from the histopathology analysis of the biopsied tissues, enters them into the endpoint tracking system, and shares them with the study veterinarian and participant. At the end of a study dog's life, participants are encouraged, but not required, to have a necropsy performed, which allows the study to determine a cause of death and accurately track malignancies (Guy et al., 2015).

The GRLS has four enrollment statuses: enrolled, inactive, withdrawn, and enrolled deceased. Enrolled dogs are those who are actively participating in the study and fulfilling yearly study requirements. Inactive dogs are those who have not fulfilled any study requirements (AOQ, annual visit, AVQ) for more than three years. Withdrawn dogs those whose participants have notified MAF that they no longer wish to participate in the study. Enrolled deceased includes any dog for whom MAF has been informed of their death, regardless of previous status.

Materials and Methods

Recruitment

Recruitment for the study was carried out under a University of Denver Institutional Review Board-approved protocol (Protocol #1828459-1). To participate, interested participants must have participated in the Golden Retriever Lifetime Study for at least one year, been at least 18 years old, and been willing to give permission for the IHAC research team to access the limited set of data from the AOQs during their participation in the GRLS study. GRLS Operation staff and volunteers supported recruitment for the study by conducting phone calls, automated emails, personalized emails, postcards, and posts on the volunteer-run GRLS participant Facebook page. With input from the MAF Marketing team, the IHAC research team provided scripts for the phone calls and personalized emails to use for this recruitment. Recruitment occurred from March 2022 to May 2022 with a goal of recruiting 500 participants from the GRLS sample population. The recruitment material was sent to all enrolled (72.9% of GRLS participants) and inactive participants (10.8% of GRLS participants) ($n = 2931$). No incentives were offered for participation in the study.

Data Collection

Data collection took place online through a secure link and was hosted in the HIPPA-compliant REDCap database frequently used in human subjects research. This platform allowed individuals to complete the survey on their own computer or mobile device at their convenience. The electronic survey consisted of 42 multiple-choice 5-point Likert scale questions and 13 demographic questions and took approximately 20 minutes to complete. The survey included questions designed to assess the human-animal bond, social and environmental factors hypothesized to influence participation in a longitudinal research study, and a brief set of demographic questions (e.g., race/ethnicity, gender identity, annual household income, education, housing status, country of origin, and primary form of transportation). Two subscales (Love and Negative Impact) were included in the supplemental survey from The Pet Attachment and Life Impact Scale (PALS) due to its intention to measure attachment to pets instead of attitudes towards pets (Cromer & Barlow, 2013). Healthy People 2030 breaks SDOH into five domains: economic stability, education access and quality, healthcare access and quality, neighborhood and built environment, and social and community context. The current study's supplemental survey included questions from each of these domains within the context of Ecosocial theory (Barcelos Winchester, 2019). Individuals with exposure to more positive SDOH conditions (i.e., higher than average SES, lower levels of racial/ethnic diversity, high access to healthcare services, etc.) received a higher SDOH score. Compliance was defined as a continuous variable and conceptualized based on how many years the

participant has been “Enrolled” or “Enrolled Deceased” during the course of the study. This study utilized GRLS’ categorical variable of “study status” as the definition of retention. Study statuses include (1) Enrolled, (2) Enrolled Deceased, (3) Inactive, and (4) Withdrawn.

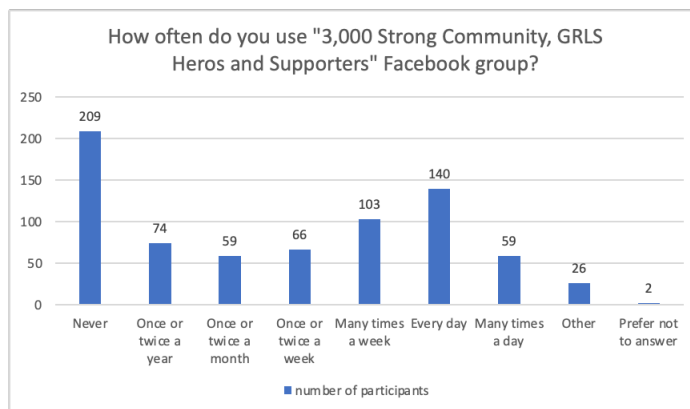
The data were cleaned by eliminating incomplete, unconsented, and duplicate responses. A total of 743 participants completed the survey and consented to participate in the study and have MAF securely transfer a limited set of data from their participation in the GRLS to the IHAC research team. Participants were also asked to provide their GRLS study ID (referred to as a CHLP/Hero ID) so that the limited set of data from GRLS could be securely transferred for the participating individuals. The GRLS study ID was not used for any other purposes within the study. The MAF team securely transferred the approved data (under a materials transfer agreement) from the GRLS database to the IHAC research team using a password-protected Excel spreadsheet. The data transferred by the MAF team did not contain any identifying information beyond the CLHP/Hero ID that was being used to match the GRLS records with the survey responses from the study participants. The data transferred from MAF were then imported into REDCap database and matched to participant responses to the survey where it was maintained and stored until the study was completed. The IHAC research team then exported all data for analysis, and the GRLS study ID was removed for analysis to ensure participants remained anonymous in the reporting of the findings. The MAF data included study dog diagnoses (including otitis externa, anaplasma, coccidia, giardia, Lyme disease, roundworms, tracheobronchitis, bladder infection cystitis, atopy, any dermatitis, hot spots, pododermatitis dermatitis, hypothyroidism, hemangiosarcoma, histiocytic sarcoma, lymphoma, mast cell tumor, osteosarcoma, and an aggregate of all tracked cancers), number of years participants were enrolled in the study, AOQ completion data, and AVQ completion data.

The study used an explanatory survey research design to test the hypothesis. Logistic regression and binomial logistic regression were employed to assess how a participant’s demographics, degree of human-animal bond (HAB), and SDOH influence their rates of compliance and retention. Logistic regression allowed the research team to assess the extent to which the social and environmental factors measured in the study predict an individual’s compliance and retention rates. Lastly, the relationship between the GRLS Barriers, HAB, and SDOH scores was assessed with Pearson's correlations coefficient.

Results

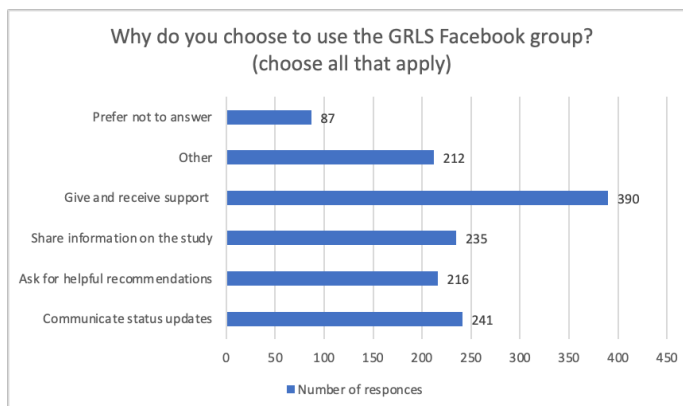
Of the 743 participants in this study, 209 (28%) reported never using the “3,000 Strong Community, GRLS Heros and Supporters” Facebook group, 74 (10%) reported using the group once or twice a year, 59 (8%) reported using it once or twice a month, 66 (9%) reported using it once or a week, 103 (14%) reported using it many times a week, 140 (19%) reported using it every day, 59 (8%) reported using it many times a day, 26 (3%) selected “other”, and 2 (0.3%) selected “prefer not to answer”. See Figure 1.

Figure 1:



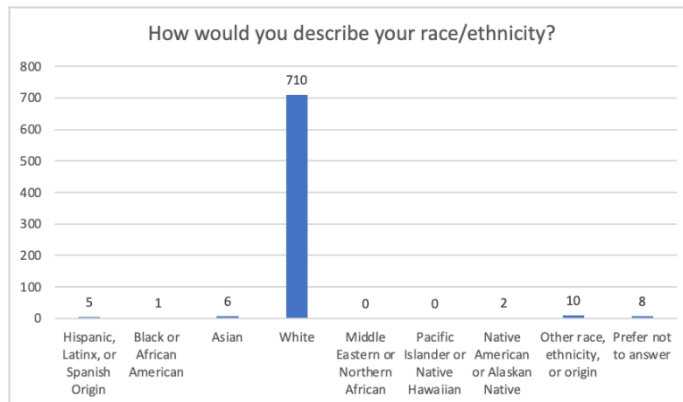
Of the 743 participants, 390 (52%) reported using the GRLS Facebook group to “give and receive support”, 235 (32%) reported using this group to “share information on the study”, 216 (29%) reported using it to “ask for helpful recommendations, and 241 (32%) reported using it to “communicate status updates. Additionally, 87 (12%) selected “prefer not to answer” and 212 (29%) selected “other”. See Figure 2.

Figure 2:



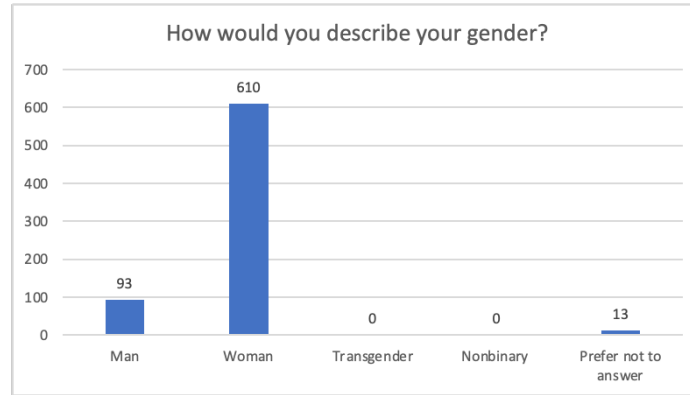
Of the 743 participants, 710 participants (96%) self-identified as White, 5 (0.7%) self-identified as Hispanic, Latinx, or Spanish Origin, 1 (0.1%) self-identified as Black or African American, 6 (0.8%) self-identified as Asian, 2 (0.2%) self-identified as Native American or Alaskan Native. Additionally, 10 (1.3%) participants selected “Other race, ethnicity, or origin” and 8 (1%) selected “prefer not to answer”. See Figure 3.

Figure 3:



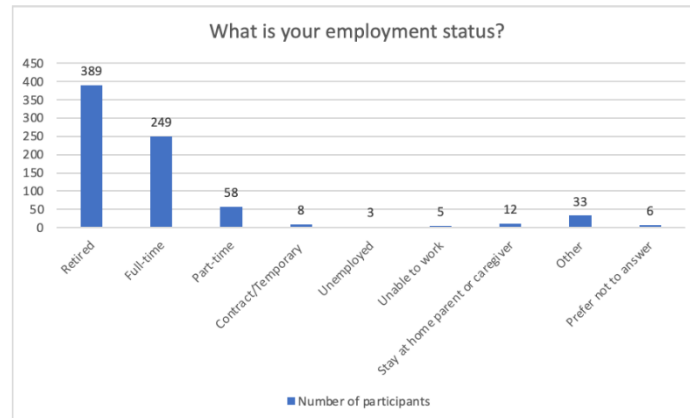
Of the 743 participants, 93 (13%) self-identified as a man, 610 (82%) self-identified as a woman, no participants (0%) self-identified as either nonbinary or transgender. Additionally, 13 (1.7%) selected “prefer not to answer”. See Figure 4.

Figure 4:



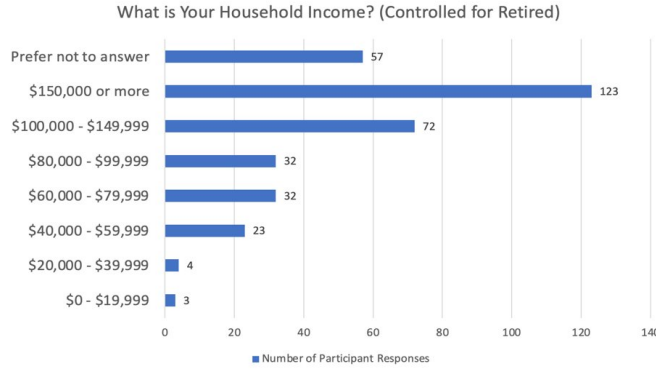
Of the 743 participants, 389 (52%) selected retired as their employment status, 249 (34%) selected full-time, 58 (8%) selected part-time, 8 (1%) selected contract/temporary work, 3 (0.4%) selected unemployed, 5 (0.7%) selected that they were unable to work, 12 (1.6%) reported being a stay-at-home parent or caregiver, 33 (4%) selected “other”, and 6 (0.8%) selected “prefer not to answer”. See Figure 5.

Figure 5:



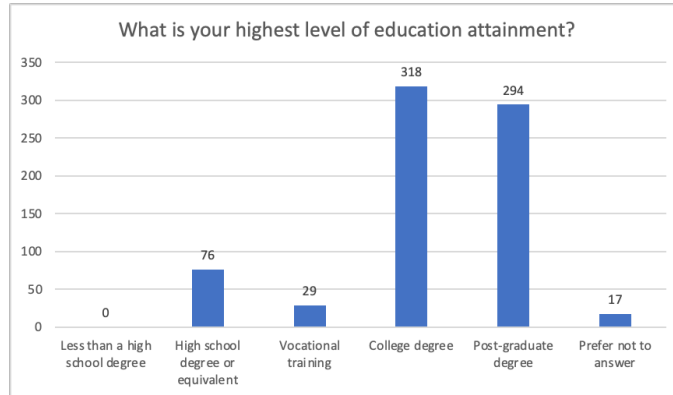
When controlled for retirement (389 participants [52%]), 123 (16.76%) selected that their household income in American dollars is 150,000 or more, 72 (9.8%) selected 100,000-149,999 dollars, 32 (4.40%) selected 80,000-99,999 dollars, 32 (4.40%) selected 60,000-79,999 dollars, 23 (3.13%) selected 40,000-59,999 dollars, 4 (0.54%) selected 20,000-39,999 dollars, and 3 (0.41%) selected 0-19,999 dollars. See Figure 6.

Figure 6:



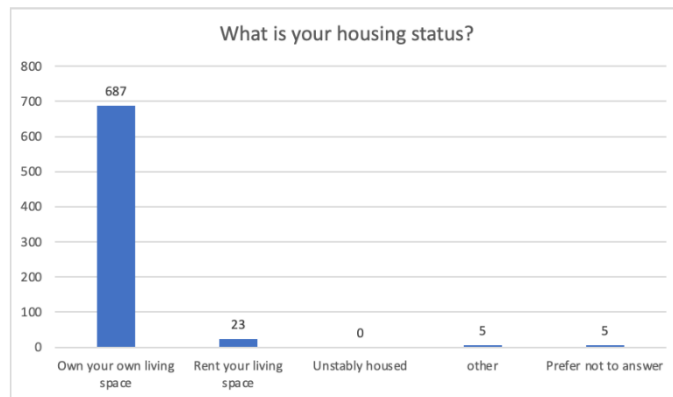
Of the 734 participants, no participants reported that their highest level of education attainment was less than a high school degree, 76 (10%) reported that their highest level of education attainment was a high school degree or equivalent, 29 (4%) reported that their highest level of education attainment was vocational training, 318 (43%) reported that their highest level of education was a college degree, 294 (40%) reported that their highest level of education attainment was a post-graduate degree, and 17 (2%) selected “prefer not to answer”. See Figure 7.

Figure 7:



Of the 734 participants, 687 (92%) reported that they own their own living space, 23 (3%) reported that they rent their living space, no participants (0%) reported that they are unstably housed, 5 (0.7%) participants reported “other”, and 5 (0.7%) selected “prefer not to answer”. See Figure 8.

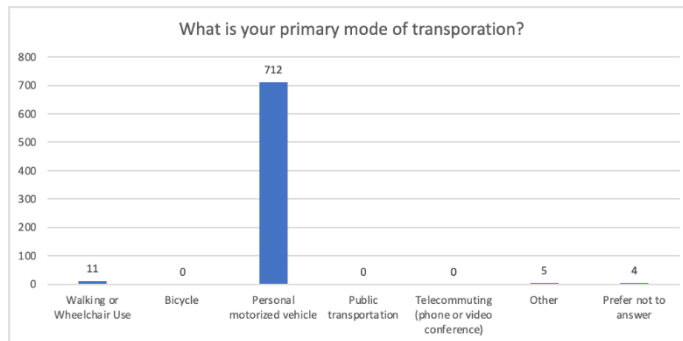
Figure 8:



Of the 734 participants, 712 (96%) reported that a personal motorized vehicle was their primary mode of transportation, 11 (1.5%) reported that walking or wheelchair use was their primary mode of transportation, no participants (0%) reported bicycle, public transportation, or telecommuting as a primary

mode of transportation. Additionally, 5 (0.7%) participants selected “other”, and 4 (0.5%) participants selected “prefer not to answer”. See Figure 9.

Figure 9:



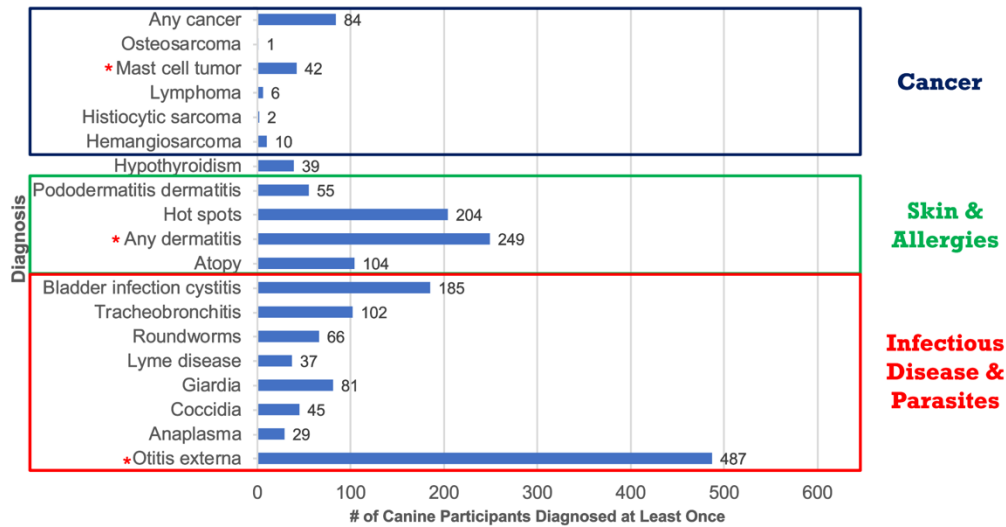
When asked how they heard about the GRLS, 36 (5%) reported that they heard through community outreach from study researchers/volunteers, 145 (20%) reported that they heard through their veterinarian, 100 (13%) participants reported that they heard through a participating friend, 134 (18%) reported that they heard via the Golden Retriever Club of America, 48 (6%) reported that they heard via American Kennel Club or United Kennel Club, 33 (4%) reported that they heard from an online or in-person announcement, 22 (3%) reported that they heard from advertisements in pet magazines, 48(6%) reported that they heard from using Facebook or other social media, and 267 (36%) selected “other”, and 5 (0.7%) selected “prefer not to answer”.

The average number of years that participants were enrolled in the GRLS was 9.08 years. The average number of years that participants completed the AOQ was 8.69 years. On average, participants completed 95.64% of AOQs that they were requested to complete. The average number of years that participants completed the AVQ was 8.34 years. On average, participants completed 91.76% of AVQs that they were requested to complete. The average participant HAB score was 4.62 out of 5, the minimum was 2.75 and the maximum was 5. The average participant SDOH score was 4.34 out of 5, the minimum was 1.75 and the maximum was 5. The average participant barriers to GRLS participation score was 4.63 out of 5, the minimum was 2.43 and the maximum was 5. Higher SDOH scores and barriers to GRLS participation scores indicate that the participant(s) experienced fewer SDOH challenges and fewer barriers to participation in the study respectively. Higher HAB scores indicate that the participant(s) had a stronger bond with their dog.

The frequency of various canine health diagnoses among the 743 human participants’ canine companions over the course of their participation in the GRLS was determined. Of these 743 dogs, 487 (65.55%) were diagnosed with otitis externa (ear infection), 29 (3.9%) were diagnosed with anaplasma (anaplasmosis), 45 (6.06%) were diagnosed with coccidia, 81 (10.9%) were diagnosed with giardia, 37 (4.98%) were diagnosed with Lyme disease, 66 (8.88%) were diagnosed with roundworms, 102 (13.73%) were diagnosed with tracheobronchitis (kennel cough), 185 (24.9%) were diagnosed with bladder infection cystitis, 104 (14%) were diagnosed with atopy, 249, (33.51%) were diagnosed with “any dermatitis” (this included bacterial dermatitis, contact dermatitis, and dermatitis), 204 (27.46%) were diagnosed with hot spots, 55 (7.40%) were diagnosed with pododermatitis dermatitis, 39 (5.25%) were diagnosed with hypothyroidism, 10 (1.35%) were diagnosed with hemangiosarcoma, 2 (0.27%) were diagnosed with histiocytic sarcoma, 6 (0.81%) were diagnosed with lymphoma, 42 (5.65%) were diagnosed with a mast cell tumor, 1 (0.13%) was diagnosed with osteosarcoma, and 84 (11.31%) were diagnosed with “any cancer” (this included an aggregate of all tracked cancers). See Figure 10.

Figure 10:

Frequency of Canine Diagnoses



A binomial logistic regression was performed to determine the effects of the SDOH score, GRLS Barriers score, and the HAB score based on the assumption that participants' dogs experienced a variety of conditions. These conditions included otitis externa, anaplasma, coccidia, giardia, Lyme disease, roundworms, tracheobronchitis, bladder infection cystitis, atopy, any dermatitis, hot spots, pododermatitis dermatitis, hypothyroidism, hemangiosarcoma, histiocytic sarcoma, lymphoma, mast cell tumor, osteosarcoma, and an aggregate of all tracked cancers. It was found that, holding all other predictor variables constant, the SDOH score was significantly positively correlated with a diagnosis of otitis externa ($p = .038$), significantly negatively correlated with a diagnosis of anaplasma ($p = .006$), and significantly positively correlated with a diagnosis of dermatitis ($p = .014$). In addition, the binomial logistic regression found that the GRLS Barriers score was significantly positively correlated with otitis externa ($p = .016$), approaching significantly negatively correlated with anaplasma ($p = .059$), approaching significantly positively correlated with dermatitis ($p = .089$), and approaching significantly positively correlated with mast cell tumors ($p = .074$). The binomial logistic regression analysis found no significant correlations between the HAB score and the likelihood that participants' dogs experienced any of the conditions. For the purposes of this study, bacterial dermatitis, contact dermatitis, and general dermatitis diagnoses were aggregated into one "dermatitis" variable. For coccidia, giardia, Lyme disease, roundworms, tracheobronchitis, bladder infection cystitis, atopy, hot spots, pododermatitis dermatitis, hypothyroidism, hemangiosarcoma, histiocytic sarcoma, lymphoma, osteosarcoma, and an aggregate of all tracked cancers, no interactions were found to be statistically significant.

A linear regression analysis was performed to determine the relationship between AVQ and AOQ completion rates and HAB, SDOH, and GRLS Barriers scores. It found no statistically significant relationship between AVQ and AOQ response rates and HAB score, SDOH score, or GRLS score. In addition, a linear regression was performed to determine the relationship between AVQ and AOQ completion rate and the analyzed dog health conditions. It found that AVQ response rates were approaching significantly positively correlated to otitis externa ($p = .08$). No other interactions between the dog health conditions and AOQ or AVQ response rates were found to be statistically significant nor approaching statistical significance.

Furthermore, a binomial logistic regression was performed to determine the effects of the participants race and ethnicity on their GRLS Barriers score, HAB score, SDOH score, and the likelihood that participants' dogs experienced a variety of conditions. It found that GRLS barriers scores ($p = .04$), HAB scores ($p = .07$), and SDOH ($p = .02$) scores were all higher among white participants. These

findings were statistically significant for GRLS barriers ($p = .04$) and SDOH ($p = .02$) scores, while the finding for HAB was approaching statistical significance ($p = .07$). However, there were no statistically significant correlations between the race/ethnicity of the GRLS study participants and the dog health conditions analyzed for this report.

Lastly, the relationship between the GRLS Barriers, HAB, and SDOH scores was assessed with Pearson's correlation coefficient. This found a small ($r = .29$) positive correlation ($p < .001$) between HAB scores and GRLS barriers scores. In addition, it found a moderate ($r = .32$) positive correlation ($p < .001$) between HAB scores and SDOH scores. And finally, the analysis found a strong ($r = .53$) positive correlation ($p < .001$) between SDOH scores and GRLS barriers scores.

This study's original hypothesis stated that social and environmental factors, defined by demographics, human-animal bond, and SDOH, influence rates of compliance and retention in the GRLS sample population. Individuals who are influenced by the highest number of positive social and environmental factors (e.g., higher than average income, lower levels of racial/ethnic diversity, higher access to healthcare services, higher measures of human-animal bond, etc.) will have lower rates of attrition than other individuals in the study who experience fewer positive social and environmental factors. Unfortunately, this study could not execute testing the retention component of the hypothesis due to an extremely low response rate (8 participants) from individuals who had withdrawn from/ became inactive from/dropped out of the GRLS, which would have produced insufficient statistical power for data analysis (see Limitations).

Discussion

The goal of this study was twofold: 1) investigate the influence of social and environmental factors, including demographics, the HAB, and SDOH on compliance and retention in GRLS participants; and 2) investigate the influence of owners' demographic characteristics, including SDOH, on the health outcomes of their dogs. Participants in GRLS who engaged in this study have not only been enrolled in the study for almost a decade on average but also have contributed to a high response rate to the research protocol, which far exceeds what is typically expected in other human or veterinary clinical research trials (Robiner, 2005).

In this study, higher SDOH scores and barriers to GRLS participation scores (obtained via the survey instrument) indicate that the participant(s) experienced fewer SDOH challenges and fewer barriers to participation in the GRLS study, respectively. Higher HAB scores indicate that the participant(s) had a stronger bond with their dog. The study found extremely high average SDOH, HAB, and GRLS participation scores for the participants. This suggests, that in general, GRLS participants experience a low degree of SDOH challenges and barriers to participation and maintain strong bonds with their dogs. The demographics of the GRLS participants likely influence the low levels of barriers to GRLS participation (assessed through the GRLS participation score) and SDOH challenges faced by participants. This study found that both GRLS participation scores and SDOH scores were significantly higher among white participants. Multiple studies suggest that the demographic characteristics of participants play a significant role in research participation (Asare et al., 2017; Janson et al., 2001; Rachlis et al., 2017). Historically, individuals with demographic characteristics, including low socioeconomic status, younger chronological age, lower education, and being from racial or ethnic minority groups, have been underrepresented in public health and medical studies. Underrepresentation in these studies is primarily due to researchers deeming individuals in these communities difficult to access, engage, and retain (Bonevski et al., 2014; Janson et al., 2001). More recent research has identified that socially disadvantaged and minority groups tend to decline participation for other reasons. The most common reasons are a mistrust of researchers, fear of authority, or not understanding the purpose of the research due to poorly designed informed consent procedures (Bonevski et al., 2014). Barriers to participating in longitudinal studies might also include scheduling conflicts, implicit costs of participation, and lack of study accessibility. These same barriers may also interfere with study procedure

compliance (Asare et al., 2017; Janson et al., 2001). Participant retention is achieved most effectively through compensation for participation, a participant's commitment to finish, and a participant's belief in the importance of the study (Janson et al., 2001).

Notably, a strong positive correlation between SDOH scores and GRLS barriers scores was identified. This relationship likely arises as the same SDOH challenges that may impact a participant are also considered barriers to participating in the GRLS study (healthcare access and quality, economic stability, and neighborhood and built environment). Moreover, researchers found that the HAB scores in this study were positively correlated with both the barriers to GRLS participation scores and SDOH scores. This result is in accordance with earlier findings from Lue, Pantenburg, and Crawford (2008), who found that stronger human-animal bonds are associated with higher levels of veterinary care regardless of cost. Therefore, it is likely that the high SDOH scores (participants experiencing fewer social determinants of health challenges such as low socioeconomic status) of the participants in this study are driving the high HAB score. In addition, one might reasonably anticipate that GRLS participants would be more likely to score highly on a HAB measurement than the general population due to the long-term nature of GRLS participants' pet ownership, self-selected participation, and subsequent time investment in the GRLS. It is possible that the positive correlation between HAB scores and SDOH and GRLS barriers scores could be attributed to the limited variation in HAB scores (scoring 4.6 out of 5 on average) and the homogeneity of the sample.

Some statistically significant correlations obtained through data analysis were contradictory to the study hypotheses. One of these at first seemingly contradictory results is the positive correlation between participants' SDOH score and otitis externa (commonly known as an ear infection). One possible explanation for this finding is that a person with a higher SDOH score may have more financial and logistical (transportation, veterinarians in close proximity, etc.) resources to visit a veterinarian (Card et al., 2018), making it more likely that they receive an ear infection diagnosis for their pet dog than a person who is unable to visit the veterinarian as frequently. This is especially relevant to this population, considering otitis externa/ear infections are very common in golden retrievers, a breed of dog with large, droopy ears and an inclination to swim (Lehner et al., 2010; Hayes et al., 1987; Sharma & Rhoades, 1975). This assumption is further supported by the researchers finding a positive correlation between the AVQ response rate and a diagnosis of otitis externa/ear infections. Those participants who complete more AVQs (visit the veterinarian annually at least) are more likely to receive a diagnosis of a highly common condition in golden retrievers. A similar explanation can be applied to other counterintuitive results, such as the positive correlation between SDOH scores and dermatitis, barriers to GRLS participation scores and otitis externa/ear infections, as well as barriers to GRLS participation scores and mast cell tumors. Having fewer barriers to GRLS participation implies that veterinary visits (including for the completion of the AVQ) may be more accessible to the participant than a participant with more barriers to GRLS participation. These variables may be positively correlated in this context because a participant who is more likely to visit a veterinarian will thus increase their likelihood of receiving an otitis externa/ear infection diagnosis, dermatitis diagnosis, and/or mast cell tumor diagnosis (HGMCT). Similar in nature to the high incidence of otitis externa/ear infections, golden retrievers have a predisposition to dermatitis, and therefore, there were a high number of dermatitis diagnoses present in this study (Zur et al., 2002). Additionally, having barriers to accessing veterinary care may also make it difficult to obtain a tumor biopsy for a pet, potentially leaving malignancy undetected and, therefore unreported to the MAF GRLS. While GRLS provides a limited stipend for veterinary expenses, this stipend may not cover the cost of all care. Therefore, participants with higher SDOH scores (experience fewer SDOH challenges) may be more likely to have a dog diagnosed with HGMCT because they have increased financial and logistical access to veterinary care (including tumor biopsy).

While still in need of further investigation, the “hygiene hypothesis”, often applied within human health, may provide a partial explanation for the positive correlation between SDOH scores, GRLS participation scores, and dermatitis: “The hygiene hypothesis of atopic disease suggests that environmental changes in the industrialized world have led to reduced microbial contact at an early age and thus resulted in the growing epidemic of atopic eczema, allergic rhinoconjunctivitis, and asthma” (Rautava et al., 2004). When applied to the present study’s sample, it’s possible that higher SDOH scores and barriers to GRLS participation scores of the participants suggests that the dog may have had less exposure to allergens and microbes as a puppy, leading to a limited immune response in adulthood and an increased likelihood of experiencing dermatitis later in their life. However, it is essential to note that recent examinations of the hygiene hypothesis suggest that the rise in allergic conditions in humans may not be entirely due to this limited exposure to allergens/pathogens/microbes in early life and “a more general version of the hygiene hypothesis is still valid, but the aetiologic mechanisms involved are currently unclear” (Brooks et al., 2013).

Other results from this study supported the study hypotheses. There was a negative correlation between SDOH scores and anaplasma as well as barriers to GRLS participation scores and anaplasma. *Anaplasma phagocytophilum* is the bacterium that causes the disease, anaplasmosis, and is tick-borne (Centers for Disease Control and Prevention, 2015). This correlation may be explained by the inherent cost of preventative medicine for tick-borne illnesses, which may be more accessible to those with higher SDOH scores and barriers to GRLS participation scores. In this study, participants with less detrimental environmental variables/exposures, which would impact canine health outcomes, are likely to have higher SDOH and GRLS participation scores. For example, these participants may experience lower levels of pollution and less exposure to parasites (ticks), while having exposure to less vacant lots/properties and a higher degree of landscaping and other protective factors.

Limitations

While the current study has contributed to a better understanding of the influence of social and environmental factors, including demographics, the HAB, and SDOH, on compliance in GRLS participants, as well as the impact of owner’s demographic characteristics on dog health outcomes, it has several limitations. The sample provided in this study ($n=743$) consists of a largely homogeneous group (mostly white [96.7%], women [82.1%], who own their own living space [93.6%], utilize a personal motorized vehicle as their primary mode of transportation [97%], have a college degree [43.3%] or a post-graduate degree [40%], and are employed full-time [33.5%] or retired [52.4%]), which limits the external validity of the findings. Future longitudinal studies of canine health should include more robust efforts at recruiting and including a more diverse population of human owners to increase the diversity of demographics and SDOH. These efforts could include reducing barriers to participation and widening eligibility/inclusion criteria such as removing the requirement to register with the AKC, UKC, or another kennel club or service dog organization, not requiring proof of three generations of pedigree documentation, providing comprehensive funding for required veterinary visits, tests, and procedures, providing vouchers or funding for transportation to required veterinary visits, providing incentives for participation in the research, reducing language barriers to participation in the research, and employing targeted recruitment strategies.

Originally, this study was intended to investigate the compliance and retention of GRLS participants. Particularly, this study intended to explore if SDOH had any relation with participation in research. Unfortunately, this study could not execute testing the retention component of the hypothesis due to an extremely low response rate (8 participants) from individuals who had withdrawn from/ became inactive from/dropped out of the GRLS, which would have produced insufficient statistical power for data

analysis. This group's data was a crucial component to analyzing and comparing the compliance and retention of active versus inactive GRLS participants.

Conclusions and Future Directions

The function by which pet ownership may be associated with human health benefits is still understudied. Therefore, causal research designs, such as those employed in this study, are helpful to understand the direction of this association. Furthermore, compliance and retention in clinical research studies are difficult concepts to research. However, having a further understanding of barriers to participation in research can provide researchers with the knowledge to make research more accessible. This study assessed which factors contribute to the high rates of compliance in the MAF GRLS. Better understanding the factors influencing the high rates of compliance can be used to inform interpretation of the findings from the GRLS and help improve the designs of future veterinary and human health clinical trials.

Acknowledgments

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I do not have transportation to vet appointments	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can not find affordable vet care for the required appointments	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can not find a veterinarian that provides services in my preferred language for the required appointments	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can not find veterinarians willing to report the required veterinary information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I do not have enough time to bring my pet to the vet for the required appointments	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can not find available appointments at the vet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can not find a quality veterinary care provider for my pet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I do not trust and/or feel discriminated against by the GRLS research team	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

1. If you would like, please further describe your experiences when facing barriers to participating in the GRLS.

For the following questions, please choose one response unless otherwise noted:

2. How often do you use the “3,000 Strong Community, GRLS Heroes and Supporters” Facebook group?
 - a. Never
 - b. Once or twice a year
 - c. Once or twice a month
 - d. Once or twice a week
 - e. Many times a week
 - f. Every day
 - g. Many times a day
 - h. Prefer not to answer
 - i. Other, please explain _____
3. Why do you choose to use the GRLS Facebook group (choose all that apply)?
 - a. Communicate status updates
 - b. Ask for helpful recommendations
 - c. Share information on the study
 - d. Give and receive support
 - e. Prefer not to answer
 - f. Other, please explain _____
4. How did you hear about the Golden Retriever Lifetime Study(choose all that apply)?
 - a. By community outreach from GRLS researchers/volunteers
 - b. Through my vet
 - c. Through a participating friend
 - d. Via Golden Retriever Club of America
 - e. Via American Kennel Club (AKC) or United Kennel Club (UKC)

- f. Using online/in-person announcement
 - g. Using advertisements in pet magazines
 - h. Using Facebook or other social media posts
 - i. Prefer not to answer
 - j. Other, please explain _____
5. How would you describe your gender (choose all that apply)?
- a. Cisgender Woman
 - b. Cisgender Man
 - c. Trans or Transgender
 - d. Nonbinary
 - e. A gender identity not listed here: _____
 - f. Prefer not to answer
6. What is your age in years?
- a. _____
 - b. Prefer not to answer
7. How would you describe your race/ethnicity? (choose all that apply)
- a. Hispanic, Latinx, or Spanish Origin
 - b. Black or African American
 - c. Asian
 - d. White
 - e. Middle Eastern or North African
 - f. Pacific Islander or Native Hawaiian
 - g. Native American or Alaskan Native
 - h. Biracial or multiracial
 - i. Some other race, ethnicity, or origin _____
 - j. Prefer not to answer
8. What is your employment status (choose all that apply)?
- a. Retired
 - b. Full-time
 - c. Part-time
 - d. Contract/Temporary
 - e. Unemployed
 - f. Unable to work
 - g. Stay at home parent or caregiver
 - h. Other _____
 - i. Prefer not to answer
9. What is your household income in American dollars?
- a. 0-19,999
 - b. 20,000-39,999
 - c. 40,000-59,999
 - d. 60,000-79,999
 - e. 80,000-99,999
 - f. 100,000-149,999
 - g. 150,000 or more
 - h. Prefer not to answer
10. What is your highest level of educational attainment?
- a. Less than a high school degree

- b. High school degree or equivalent
 - c. Vocational training
 - d. College degree
 - e. Post-graduate degree
 - f. Prefer not to answer
11. What is your housing status?
- a. Own your living space
 - b. Rent your living space
 - c. Rent or own more than one living space
 - d. Unstably housed
 - e. Other
 - f. Prefer not to answer
12. What country were you born in?
- g. Please describe: _____
 - h. Prefer not to answer
12. What is your primary mode of transportation?
- a. Drive alone
 - b. Public transit
 - c. Ride with others in a carpool or vanpool
 - d. Bicycle
 - e. Walk
 - f. It depends on the day as to what is available
 - g. Prefer not to answer

Appendix B

Consent to Participate in Research

Project Title: Exploring the impacts of social determinants of health and the human-animal bond on compliance and retention in Morris Animal Foundation's Golden Retriever Lifetime Study

IRBNet Protocol #: 182459-1

Principal Investigator: Kevin Morris, PhD

You are being asked to participate in a research study. Your participation in this research study is voluntary and you do not have to participate. This document contains important information about this study and what to expect if you decide to participate. Please consider the information carefully and ask any questions you might have before deciding whether to give your permission to take part in this study. If you decide to be involved in this study, this form will be used to record your permission.

Purpose

This study will assess how social and environmental factors, including demographics, the human-animal bond, and Social Determinants of Health (SDOH), influence compliance and retention rates in the Golden Retriever Lifetime Study.

Procedures

You will be asked to complete an online survey questionnaire that will ask you questions about your relationship with your study pet, social and environmental influences in your life, your zip code, and other demographic information. You may take the questionnaire wherever you choose on your own device (e.g., mobile phone, personal computer). The questionnaire will take you approximately 15 minutes to complete. We will then ask for your permission to access information collected by Morris Animal Foundation regarding your compliance and retention within the Golden Retriever Lifetime Study. If you consent to sharing this information, Morris Animal Foundation will securely transfer a limited set of data from your participation in the Golden Retriever Lifetime Study to the Institute for Human-Animal Connection research team. The research team will then use your responses to the questionnaire and the data obtained from your participation in the Golden Retriever Lifetime Study to assess how social and environmental factors influence compliance and retention of participants in the Golden Retriever Lifetime Study.

Risks or Discomforts

The potential risks from taking part in this study are minimal. You may experience mental or emotional stress or fatigue. You may find some questions about your financial situation sensitive. If either of these are the case, you may choose not to answer survey a question for any reason, and without penalty. If at any time you feel uncomfortable, you may stop the survey. If you decide to withdraw early, your information will be deleted from the study. If you have any questions or concerns about the survey process or questions, please contact the research team using the information provided at the end of this form.

Benefits

Your decision whether or not to participate in this study will not affect you or your participation in the Golden Retriever Lifetime Study. We cannot and do not guarantee or promise that you will receive any direct benefits from this study. However, it is possible the findings may be used to improve inclusion and retention in future research studies.

Incentive for Participation

There is no compensation for participating in this study.

Source of Funding

This study is not funded.

Confidentiality of Information

The data for this study will be kept confidential (private). The Institute for Human-Animal Connect will not ask you to provide any identifying information about yourself in order to participate. Your questionnaire will only be identified to the Institute for Human-Animal Connection by your study animal's ID number (CHLP/HERO) and your zip code. If you give permission for the research team to access data from your participation in the Golden Retriever Lifetime Study, none of the data securely transferred by Morris Animal Foundation will contain any of your identifying information. All research data will be stored in a secure and password protected University server that is accessible only to key research personnel. All research personnel are required to complete training in the ethical conduct of research.

Limits to confidentiality

If any information contained in this study is the subject of a court order or lawful subpoena, the University of Denver might not be able to avoid compliance with the order or subpoena. The research information may be shared with federal agencies or local committees who are responsible for protecting research participants.

Use of your information for future research

The information collected for this project will not be used or shared for future research.

Use of your previous information given in the Golden Retriever Lifetime Study

Participation in this study will require providing permission for the Institute for Human-Animal Connection to access a limited amount of data from the Annual Owner Questionnaire (AOQ) about your neighborhood, your study dog, and other questions from the AOQ that are related to the health of your study dog (e.g., Does your neighbor(s) use wood as a frequent/primary heating source?). The Institute for Human-Animal Connection will request these data from the Golden Retriever Lifetime Study only on the study dog ID you provide for the research team in the survey questionnaire. None of the data transferred by Morris Animal Foundation will contain any of your identifying information.

Do you give permission to the Institute for Human-Animal Connection to access your compliance and retention data from the Golden Retriever Lifetime Study?

Yes _____

No _____

Questions

If you have any questions about this project or your participation, please feel free to ask questions now or contact the Principal Investigator for the study, Kevin Morris, at 303-871-2235 or email him at ihacresearch@du.edu at any time.

The Morris Animal Foundation is also available to answer your questions about this study. Their call center can be reached at 855-447-3647 or your questions can be sent by email to grdogs@caninelifetimehealth.org.

If you are not satisfied with how this study is being conducted, or if you have any concerns, complaints, or general questions about the research or your rights as a participant, please contact the University of Denver (DU) Institutional Review Board to speak to someone independent of the research team at 303-871-2121 or email at IRBAdmin@du.edu.

Signing the consent form

YES **NO** I confirm that I have read this form (or someone has read to me)

YES **NO** I am aware that I am being asked to participate in a research study

YES **NO** I have had the opportunity to ask questions and they have been answered to my satisfaction

YES **NO** I understand that my participation is voluntary, and I can discontinue participation at any time.

My consent also indicates that I am at least 18 years of age and I voluntarily agree to participate in this study. I am not giving up any legal rights by signing this form.

[Please feel free to print a copy of this consent form.]

Printed name of subject	Signature of subject	Date