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Original Article

Age and Physical Activity Levels in Companion Dogs: Results From the Dog Aging Project

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Abstract

While there has been an abundance of studies on the important relationship between physical activity and age in both dogs and humans, studies on dogs have primarily focused on how a dog's biological characteristics, such as their weight, affect the age–activity relationship. To date, there is little knowledge about how this relationship may be associated with contextual- and owner-level characteristics. We leveraged a large and novel data set from the Dog Aging Project (DAP) to investigate the extent to which the age–activity relationship is associated with certain dog and owner characteristics, namely dog size, owner age, and the environment in which they live. Dogs are a unique model for aging research as they are exposed to similar social and environmental elements as humans but have a shorter life span, allowing researchers to observe their entire life course. We find that older dogs are less active than younger dogs; rural dogs are more active than suburban and urban dogs, especially at younger ages; and larger dogs are more active than smaller dogs. These findings are generally consistent with previous studies. However, a surprising finding is that older owners have more active dogs than younger owners. As one of the first studies to utilize the large survey data from the DAP, this study lays the foundation for future investigations to further understand and identify the biological, social, and environmental causes, as well as consequences, of aging.

Keywords: Aging, Dogs, Environment, Physical activity

Age is the single greatest predictor of morbidity and mortality in humans (1,2). A rich literature in human populations describes age-related decline in activity levels (3,4) and increase in frailty (5,6). In recent years, researchers have found that activity levels in older people are powerfully associated with future risk of morbidity and mortality, suggesting that walking speed be considered the "sixth vital sign" (7).

Like humans, companion dogs exhibit age-related increases in many chronic conditions (8), many of which show dynamics similar to human patterns (9). Although an abundance of research exists on aging in human populations, relatively little is known about the effect of age on activity in dogs. Given the importance of human activity levels, both as an indicator of aging and as a potential marker of future risk, a clear understanding of the age–activity relationship among dogs could be of value to both veterinarians and pet owners. Moreover, dogs could provide a promising model to better understand the mechanisms linking activity levels and health in humans (10). Companion dogs experience many of the same environmental exposures as the humans they live with, and their phenotypic diversity makes them ideal "sentinels" for the effect of environmental risk

factors on human health (8,11). In addition, dogs' relatively short life span allows us to track age-related decline in ways that may not be feasible for human participants (12).

Previous studies in dogs have established that physical activity levels decline with age. For example, Head et al. (13) showed not only that dog activity decreases with age, but also that age effects depend on breed and whether or not humans are present. Actigraphy studies have shown that in addition to age, dog locomotor activity is related to housing conditions (14,15), owner schedule (16), feeding schedule (17,18), and presence of other dogs and/or people in the household (9).

Thus, as with humans, in addition to the effect of age, a host of other individual- and contextual-level factors influence activity and well-being (19,20). Here we consider the role of 3 characteristics on physical activity levels of dogs: dog size/weight, owner age, and residential place type, and in some cases, the interaction between these variables. These have all been explored previously, but not simultaneously, and not with the scope, breed diversity, and sample size made possible here by data from the Dog Aging Project (DAP) (10). Below, we briefly review the relevance of each of these 3 characteristics.

First, dog size and weight class appear to be strongly associated with physical activity. In studies relying on owner survey data, breed appears to influence owners' perception of how much exercise their dog needs (21), and is a predictor of owner-reported dog-walking frequency. In a survey of 241 dog owners in Canada, Degeling et al. (22) found that dogs believed by owners to require significant exercise are walked more frequently by their owners compared to dogs belonging to breed groups thought to require little exercise (ie, small and toy breeds). Other studies, however, find no association between perceived exercise requirements and reported dog walking after controlling for other confounding variables (23,24). Larger data sets are needed to help resolve these contradictory findings.

Second, numerous owner characteristics have been associated with dog-walking behavior, including owner health, motivation to walk the dog, gender, and socioeconomic status (22,25–27). While several studies have documented activity-related health benefits associated with dog walking for older adults (28–30), no study to our knowledge has assessed the role of owner age on age-related activity changes in companion dogs. This is surprising given the well-documented decline in physical activity among older humans (3). This study addresses this gap by focusing on owner age as another potential predictor of dog physical activity.

Third, household location has been shown to be correlated with the health of both humans (19) and dogs (23). Studies focusing on the frequency and duration of dog-walking bouts by owners find that numerous built-environment-related characteristics are associated with owner dog-walking behavior, including neighborhood walkability, traffic conditions, greenspace availability, access to dog parks, and crime (23,25,31–37). While some studies have explored how owner dog-walking activity varies by residential place type (38), to our knowledge no studies have assessed the role of residential place type on the relationship between dog age and dog activity levels more broadly.

Taken together, these studies suggest that dog activity, much like human activity, both declines with age and is influenced by an array of individual and contextual factors. Yet existing studies focusing on dog activity rarely account for a full range of potential confounding variables (26). In addition, previous research tends to be limited by small sample sizes, short observation periods, or a narrow focus on particular breeds or physical activity types (ie, owner-accompanied dog walking).

With the recent launch of the DAP (10), we now have unprecedented power to shed new light on these questions. The DAP is a nationwide, long-term longitudinal study of the biological, environmental, and lifestyle determinants of healthy aging in companion dogs. Owners from all 50 U.S. states have enrolled tens of thousands of dogs in the DAP. Here we analyze the 2020 Curated Data Open Access Release (39) to investigate how the decline in age-related activity among companion dogs varies by contextual-, owner-level, and dog-level characteristics. As expected, we find that older dogs are less physically active than younger dogs. However, this relationship is significantly influenced by the dog's characteristics, the owner's characteristics, and the environment in which they live. Taking advantage of the first data release from the DAP, the intention of this article is to examine potential determinants of dog activity throughout the life course. As the DAP moves into its longitudinal phase, further analysis of these longitudinal data could shed light on the replicability and causal mechanisms of the associations explored here, and the consequences of activity levels on future health.

Data and Methods

DAP Survey Data

The DAP is primarily a long-term longitudinal observational study. The DAP collects survey data from participating owners and, for a subset of dogs, collects biospecimens, including cheek swabs for low-pass coverage whole-genome sequencing in 10 000 dogs, and for a subset of 1 000 of those dogs, other tissues for annual measures of routine clinical pathology, fecal microbiome, plasma metabolome, and white blood cell epigenome. As an open data project, the data collected each year are made available to interested researchers around the world. These data are available at https://dogagingproject.org/open_data_access.

Participants in the DAP begin by nominating their dogs through the project's public-facing website, https://www.dogagingproject.org. Each participant is then invited to create a private, password-protected portal, through which they can complete online surveys and upload documents related to their dog, such as veterinary electronic medical records. The first survey that participants are asked to complete is known as the Health and Life Experience Survey (HLES). The survey consists of 10 sections and uses branching logic to ask more than 200 questions about the dog's environment, behavior, lifestyle, diet, and health. Once a participant completes all 10 sections of HLES, their dog becomes a member of the DAP "Pack," and the owner will be asked to complete a follow-up survey each year for the life of the dog. The data used in this article represent first year data collected from 27 541 dog owners between December 2019 and December 2020. We focus on dogs aged between 1 and 17 years, inclusive. There are few dogs less than 1 year (2% of the sample) and few dogs older than 17 years (0.6% of the sample), so we remove the young puppies in our sample to reflect fully grown dogs and remove the extremely old dogs in order to reduce the amount of leverage and bias in our analysis. After removing these dogs and those with missing information on key variables, our effective sample size is 23 519. While the DAP is a longitudinal study, this first year of data analyzed here is limited to cross-sectional information.

Activity Measures and Predictor Variables

Our outcome variable, dog's physical activity, is measured in 3 ways. The first is the owner-reported physical activity "lifestyle" of the dog. In the HLES, owners were asked: "Please choose the best description

of your dog's lifestyle over the past year" and were given the following options to select: "Not active," "Moderately active," and "Very active." For the purpose of this analysis, we converted these responses into a continuous, linear scale ranging from 1 (corresponding to "Not active") to 3 (corresponding to "Very active"). The second physical activity measure is owner-reported physical activity intensity of the dog. Owners were asked: "Over the past year, when your dog is being active what is the average intensity level of that activity?" and were given the following options: "Low (walking)," "Moderate (jogging)," and "Vigorous (sprinting, such as fetching or playing Frisbee)." Again, we converted these responses into a continuous, linear scale ranging from 1 (corresponding to "Low") to 3 (corresponding to "Vigorous"). The final outcome variable we focus on is owner-reported duration of the dog's physical activity. Owners were asked: "Over the past year, on average how much time per day is your dog physically active?" and were asked to select the number of hours (ranging from 1 to 8+) and number of minutes (0, 10, 20, 30, 40, 50). We converted this into a single continuous measure indicating the number of hours and minutes their dog was active.

The explanatory variables on which we focused are dog age, dog environment type, owner age, and dog size. Dog age is measured continuously in years. Dog size is measured as the owner-reported dog weight in kilograms. For the variable of owner age, owners were asked to select the age category they were in (eg, 18–24 years, 25–34 years, etc.). In this article, we transformed this age categorical variable into a continuous measure by taking the midpoint of each age bin. The dog environment type is the owner-reported place of residence, measured as "Urban (residing inside the city)," "Suburban (residing outside of the urban center, inside a neighborhood)," and "Rural (living outside of the city and suburbs, often on a sizable lot or acreage)."

We also control for a number of dog-, owner-, household-, and infrastructure-level variables. For dog-level characteristics, we include whether the dog is female or male, whether the dog is purebred or mixed breed, and whether the dog is spayed/castrated or intact. Prior studies suggest that these biological characteristics could influence the level of physical activity (13). Owner characteristics include whether the owner indicates their race is White (as opposed to non-White), whether the owner has a college degree or higher, income as a continuous measure, and region of residence, which is measured as Midwest, Northeast, South, and West as the reference category. We transform the owner income variable from a categorical variable into a continuous measure. In the DAP survey, owners were asked to select a category that their annual pretax household income falls under ("Less than $20 000"; "$20 000–$39 999"; "$40 000–$59 999"; and so forth up to the last category of "$180 000 or more"; respondents were also allowed to select "I'd prefer not to answer"). We transformed this variable into a continuous measure by assigning the midpoint of each income category. For example, respondents who selected "Less than $20 000" were assigned $10 000; those who selected "$20 000–$39 999" were assigned $30 000, while those who selected "$180 000 or more" were assigned $180 000. Owners who selected "I'd prefer not to answer" were removed from the analysis. These owner-level characteristics are included in the models as control variables because they could influence the amount of time and/or the geographic space that dogs can be physically active. For example, more affluent owners may live in areas that have a larger yard, which would influence the level and duration of physical activity for the dog. Similarly, the region of residence could affect the level of physical activity because of the differences in temperature, climate, and density, to name a few factors.

Household-level characteristics, including the number of people in the household and whether or not other dogs are present in the household, are also included as controls. Being around more people or more dogs could influence the level of physical activity for a dog, as indicated in previous studies (9). Finally, we control for dog-friendly infrastructure variables: whether there are parks or green spaces within half a mile of home; whether the dog is taken to parks or open spaces built specifically for dogs, including dog parks; and whether the dog has regular access to a yard or property at home. Having access to these dog-friendly infrastructures could influence the level of physical activity.

Statistical Methods

We performed exploratory visual data analysis with the DAP data and then ran regression models to determine the effect size and statistical significance of predictor variables. Because the physical activity outcome variables are continuous measures, we ran ordinary least squares (OLS) regression models to understand the relationship between dog physical activity and the key focal independent variables. We also explored the moderating effect of environment type, owner age, and dog size on the relationship between dog physical activity and dog age. That is, we were interested in understanding whether the association between dog physical activity and dog age varies depending on the environment the dog lives in, the age of the owner, and the size of the dog. Based on patterns apparent from visual inspection of the data (Supplementary Appendix), we also included squared terms for dog age, dog weight, and owner age in the models. The results in this study are based on the full model with all the covariates.

For the physical activity lifestyle and intensity outcome variables, we also ran multinomial logistic regression models, treating these variables as categorical rather than continuous. The results from the multinomial logistic regression models are substantively similar to the results presented in this study. We chose to use the continuous versions of these 2 outcome variables in this study for ease of interpretation of the results and visualizations.

Results

We first discuss the descriptive statistics of the sample of both dogs and their owners (Table 1). On average, dogs in the sample are 7 years old and weigh approximately 23 kg. There is an even split between male and female dogs, as well as between purebred and mixed breed dogs, but the majority are spayed or neutered. Certain geographic regions, such as the Western region of the United States, and residential environment types, specifically suburban areas, are oversampled. The majority of owners of Pack participants have at least a Bachelor's degree (80%) and racially identify as White (95%). Owners also tend to be affluent, with an average household income of approximately $111 000. Dogs live in households with, on average, 2 persons. Slightly fewer than half of the dogs in this sample live in households where other dogs are present, though only 1 dog per household can be enrolled in the DAP. The majority of dogs live close to green spaces and yards (83%), but only 4 in 10 go to dog parks. Dogs in the sample are moderately active with an average physical activity lifestyle of 2.1 (slightly above the moderately active level) and average physical activity intensity of 1.7 (just below the moderately intense level). They are active for on average of 2.4 hours per day. We next turn to results from regression models to understand how physical activity varies with key focal variables.

Table 1. Descriptive Statistics of Sample, Dog Aging Project, 2019–2020 (*N* = 23 519)

	Mean (*SD*) or %
Key explanatory variables	
Dog age (years)	7.3 (4.0)
Urban environment	18%
Suburban environment	62%
Rural environment	20%
Owner age (years)	52.8 (14.4)
Dog weight (kg)	22.8 (13.1)
Covariates	
Male dog	50%
Female dog	50%
Pure breed	49%
Mixed breed	51%
Dog spay/neuter	93%
West	35%
Midwest	21%
Northeast	15%
South	29%
Dog owner White	95%
Dog owner bachelor's degree or higher	80%
Dog owner income	$111 024.7 ($51 225.1)
Number of people in household	2.2 (1.0)
Whether other dogs in house	46%
Whether park close to home	83%
Whether dog goes to dog parks	41%
Whether access to yard	83%
Physical activity outcome variables	
Lifestyle	2.1 (0.6)
Intensity	1.7 (0.8)
Duration	2.4 (1.7)

Note: *SD* = standard deviation.

Physical Activity and Dog Age

Controlling for dog-, owner-, and household-level confounders, we found that, all else equal, older dogs are reported to have less physical activity than younger dogs, on average (Figure 1). This relationship holds for all 3 physical activity outcomes—physical activity lifestyle, intensity, and duration. For example, at the age of 1, the average dog's physical activity lifestyle is approximately 2.5 (moderately to very active), physical activity intensity just slightly below 2.5 (between moderate and vigorous in intensity), and physical activity duration is slightly more than 3.5 hours. By the age of 17, the average dog's physical activity lifestyle has declined to 1.75, the intensity to 1.3, and the duration to 2.3 hours. Overall, dog age has the largest effect on each of the 3 physical activity outcomes, as the percentage variance explained by dog age is the largest compared to all the other covariates in the models (11.3%, 14.1% and 5.2% for lifestyle, intensity, and duration, respectively; Supplementary Table 1).

In addition to these general findings from Figure 1, an interesting pattern emerges for the physical activity duration variable, whereby the average duration rises slightly for very old dogs (aged 13+). This suggests that there might be a nonlinear relationship between physical activity duration and dog age, though these patterns could be due to the cross-sectional nature of the data. Overall, these findings are consistent with previous literature and what we generally know and understand about the relationship between physical activity and age in both dogs and humans.

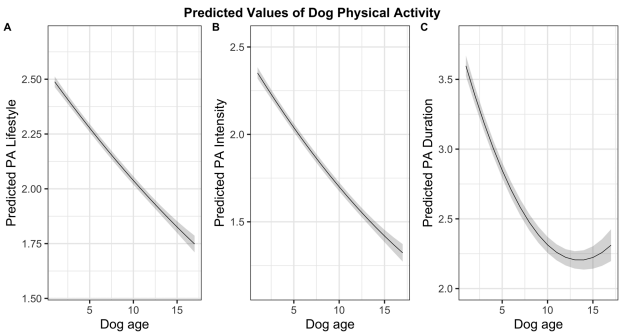

Figure 1. Predicted values of dog physical activity (PA) lifestyle (A), PA intensity (B), and PA duration (C) by dog age.

Physical Activity and Size

We find that activity levels are positively associated with dog size, with larger dogs being more active than smaller dogs (Figure 2). However, this only holds for lifestyle and intensity. In comparison, for a given age, dogs of all sizes are active for about the same amount of time (Figure 2C). There is a slight moderating effect of dog size on the activity–age relationship, specifically for lifestyle and intensity. Larger dogs are more active than smaller ones especially at a younger age, whereas there is little differentiation in activity levels across dog size for older dogs. This is indicated by the modest variation in the slope gradient across dog sizes in Figure 2A and B, and by the significant interaction terms in the regression models (see Model 4 in Supplementary Tables 2 and 3). Adding an interaction term between dog age and dog weight to the regression models for these 2 outcomes also slightly improves model fit based on the Akaike information criterion (AIC) (see Supplementary Tables 2 and 3).

Physical Activity and Owner Age

Dogs with older owners are more active than dogs with younger owners, after controlling for dog-, owner-, and household-level characteristics in OLS regression models (Figure 3). However, this is only the case for the physical activity lifestyle and duration outcome variables. For these 2 outcomes, the youngest owner age class is less active than the next oldest groups, all else equal, as shown in Figure 3. The actual data (Supplementary Figure 2) show a similar pattern. For physical activity intensity, in comparison, there is little differentiation in activity levels across owner age (Figure 3B). These findings are in marked contrast to our initial expectation that, for a given dog age and size, older owners would rate their dogs as active at a lower intensity and for a shorter duration compared to younger owners. Moreover, we observe a minor effect of owner age category on the activity–dog age relationship, as indicated by the significant, albeit small, interaction terms in the regression models ($\beta = 0.0001$ for physical activity lifestyle in Model 3 Supplementary Table 2, and $\beta = -0.0004$ for physical activity duration in Model 3 Supplementary Table 4) and the negligible variation in the slope gradient across owner ages in Figure 3.

Physical Activity and Environment

Finally, we were interested in understanding not only the role of dog and owner characteristics, but also how the environment where a dog lives influences activity and the association between activity and age. Across all 3 physical activity outcomes, owners of dogs that live in rural areas report a higher level of activity than dogs living in urban or suburban places, all else equal, thereby supporting our

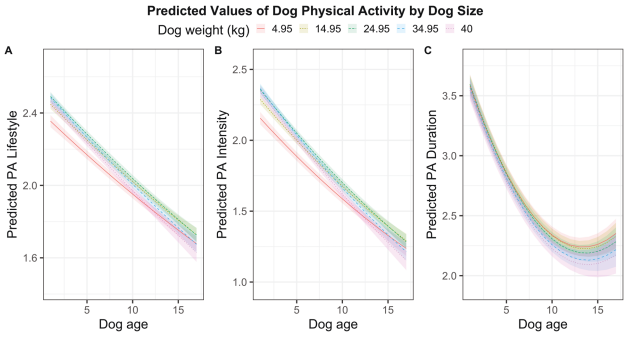

Figure 2. Predicted values of dog physical activity (PA) lifestyle (A), PA intensity (B), and PA duration (C) by dog size. Dog size is presented as the midpoint of the following 6 categories: 0–9.9 kg, 10–19.9 kg, 20–29.9 kg, 30–39.9 kg, and >40 kg.

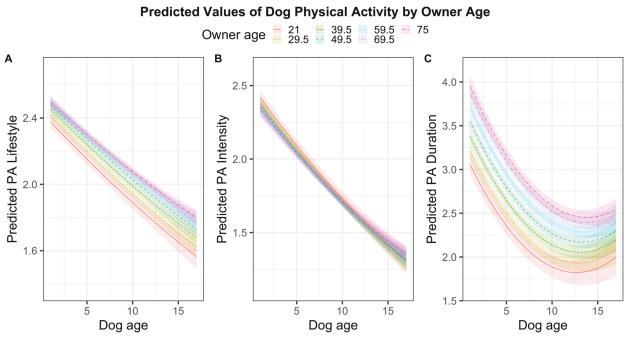

Figure 3. Predicted values of dog physical activity (PA) lifestyle (A), PA intensity (B), and PA duration (C) by owner age.

expectation about the relationship between physical activity and living environment (Figure 4). While there is a significant association between the environment and physical activity (see Model 1 in Supplementary Tables 2–4), it is a smaller effect than the association between age and activity. Specifically, the variance explained by environment is 1.8% and 1.2% for the intensity and duration outcomes, respectively (see Supplementary Table 1), while that explained by age for those variables is 14.1% and 5.2%, respectively. We also observe that environment alters the effect of age on activity level (Figure 4), though the effect is small relative to the main effect of age on activity (see Model 2 in Supplementary Tables 2–4). Younger dogs in rural areas are notably more active than those in suburban and urban areas, but older dogs in rural areas are about as active as those in suburban and urban places. Adding an interaction term between dog age and environment to the regression models for all 3 physical activity measures also slightly improves model fit based on AIC (see Supplementary Tables 2–4).

Discussion

An extensive body of literature has documented the important relationship between physical activity and age in both dogs and humans (3,4,13). However, studies on dogs have focused primarily on how dog biological characteristics, such as breed or size, affect the age–activity relationship (13,22). As such, there is little knowledge about how age-related decline in activity among dogs may vary by contextual- and owner-level characteristics. Understanding these associations is important for veterinarians wanting to assess whether a

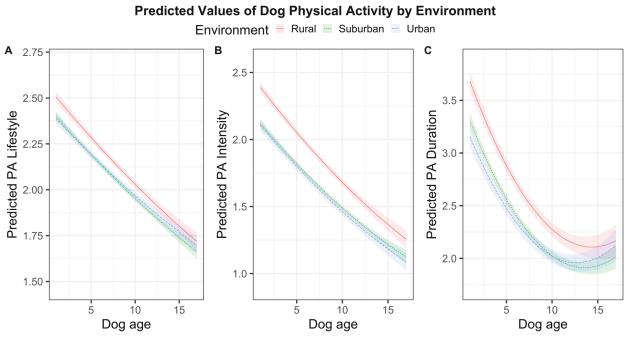

Figure 4. Predicted values of dog physical activity (PA) lifestyle (A), PA intensity (B), and PA duration (C) by environment type.

dog's activity levels are typical, given certain characteristics, and for identifying the basic biological causes and consequences of aging. This study thus makes strides in addressing this gap by using a large and novel data set from the DAP, which allows us to explore a variety of dog and owner characteristics in a much larger sample of dogs than has hitherto been possible, while accounting for a wide range of confounding and moderating variables.

While we expected a monotonic decline in activity with dog age, we noticed a slight increase in activity duration among the oldest dogs. This nonlinear relationship may be due to older dogs moving more slowly when walking the same distance or the same route around a neighborhood as their gait slows with age. Alternatively, this pattern could be due in part to the phenomenon of demographic heterogeneity (also known as survivorship bias) (40). If frailty increases risk of mortality in dogs, as it does in humans (6), then we might expect that population-level mean fitness in dogs could actually increase with age, if the frailest dogs in an age group die first. In humans, this pattern can lead to age-related declines in mortality rate (40). As the DAP begins to collect longitudinal data, we will be able to quantify the degree to which demographic heterogeneity shapes these patterns.

Overall, our results are consistent with our expectations, especially regarding the relationship between dog physical activity and dog age, size, and environment. Specifically, our findings suggest that as dogs age, they are less physically active. Our findings also suggest that rural dogs are more active than suburban and urban dogs, especially at younger ages, and that larger dogs are more active than smaller dogs, which is consistent with previous work (22). However, more investigations are needed to disentangle the complex relationships between variables that we see here, and to understand the implications for dog and owner health. For example, although we find that rural dogs are more active, does that activity level translate to owners also being more active? In fact, in rural areas, many dogs are likely able to run freely on the property without the owners present. In the case of size, further work is needed to separate the effects of size and body condition (eg, overweight, underweight), and how these 2 elements of size affect physical activity. Future studies should thus consider what it means to live in a rural environment for physical activity levels and consider the degree to which dog condition, including obesity, might affect physical activity.

At the outset of this study, based on previous literature (3), we predicted that younger owners would be more likely to have more active dogs than older owners. Instead, we found that older owners have more active dogs than younger owners. One potential explanation for this unexpected finding is that as people age, they gain

greater flexibility in their work schedules, have fewer commitments tied to school-aged children, and eventually retire, leaving more time to spend walking and exercising their dog compared to younger age groups. Our results could also be shaped by owner bias. The measures of dog activity we use here represent subjective reports, and might be influenced not only by the actual activity of the dog but also by the relative activity levels of the owner. Research has found that agreement between subjective, self-reported physical activity estimates and accelerometer measures among adults is surprisingly low (41). More research is thus needed to further investigate this relationship, especially by collecting objective measures of physical activity using activity monitors. This work has important implications for understanding not only dog aging but also human physical activity levels and general health.

We found substantive differences in age-related activity patterns depending on how physical activity was measured. For example, for most ages, there is little differentiation between a small and large dog in terms of the amount of time it is physically active, but larger dogs tend to show greater *intensity* of activity. Meanwhile, the intensity of a dog's physical activity does not vary dramatically across the owner's age. Given this, these 3 different measures (lifestyle, intensity, and duration) may signal different aspects of physical activity that are partially independent. It is also possible that different levels of owner subjectivity influence these variables. In the future, actigraphy monitors will collect valuable objective data on physical activity for a subset of dogs in the DAP. These data will enable future research to assess the associations between physical activity and key covariates, as well as examine trends compared to owner-reported data. In addition to collecting objective measures of physical activity, future research should consider alternative definitions of physical activity. For example, studies should consider whether dogs are walked by their owners, whether dogs are taken to active sports events and shows or participate in "dog sports", and/or whether dogs are simply running around in a yard by themselves without the dog owners present (42). These are important avenues for future research that would have important implications for broadening our understanding of dog activity and the implications for both dogs' and owners' physical activity levels and general health.

Dogs serve as a unique model for aging research as they are exposed to similar social and environmental factors as humans but have a shorter life span, making it possible for researchers to observe their entire life course. As we continue to track the dogs studied in the DAP, we will be uniquely placed to identify how environmental factors can shape the long-term trajectory of activity and health. Until now, surprisingly little work has been done to understand the intrinsic and extrinsic factors that shape these age-related changes in behavior. Future data from the DAP, which will include whole-genome sequencing, and annual metabolome, microbiome, epigenome, and activity level data from a subset of dogs, will help us identify putative biological mechanisms that underlie age-related variation in activity. This work also lays the foundation for a deeper understanding of how activity, cognition, and general measures of health are associated, if and how activity influences future morbidity and mortality, and how and why dog ownership might affect owner health (43). As we noted in our introduction, one of the most interesting and repeatable findings in literature on humans is that walking speed is associated with residual life expectancy (7). As the DAP moves into its longitudinal phase, it will be exciting to learn if this pattern is recapitulated in dogs.

While this study offers significant and novel findings, there are limitations worth noting. First, our variables are owner-reported, including the physical activity characteristics, so these measures might suffer from greater bias and lack of precision than objective measures. Future research should thus consider more rigorous, objective, and quantitative measures of physical activity through the use of actigraphy monitors (44). Second, the DAP Pack (45) represents dogs and dog owners who are self-nominated, and are a nonrandom sample of American dogs and owners. For example, among all dog owners, the DAP Pack sample likely captures a subsection of dog owners who are particularly passionate about their dogs and/or have the time and capacity to answer hundreds of survey questions relating to their pet. Moreover, owners of Pack participants tend to be more affluent and well-educated than average, and minority populations are currently underrepresented in the Pack. Third, the analysis we have presented here is based on cross-sectional data, leading to potential cohort effects and bias due to demographic heterogeneity (40). Finally, there was substantial overlap between the data collection period and the initial rollout of coronavirus disease 2019 (COVID-19) quarantine restrictions, which may have had significant implications for dog activity levels, owners' own activity levels (46), and owners' interpretation of dog activity (47). Future waves of DAP data will allow greater insights into COVID-19-related impacts on dog activity and processes related to aging over time.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* online.

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Conflict of Interest

Daniel Promislow is a paid as a member of the Research Advisory Board of the Waltham Petcare Science Institute.

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