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Behavioral Factors Influencing Dog-Owner Relationships: Differential Associations by Dog Size

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Abstract: To assess the influence of dog behavior, physical activity level, and size on dog-owner relationships in a large, representative sample of dogs from the continental United States. Dogs were drawn from the 2023 release of the Dog Aging Project's Annual Follow-up Survey. Dogs with complete data for all relevant variables (N = 18,416) were included in the present study. Owners reported perceptions of their dog's training, aggression, and food motivation displayed by their dog as well as perceived dog-owner interaction, costs of ownership, and emotional closeness to quantify dog-owner relationships. Dogs were also categorized as small (< 30 lbs), medium (> 30 to ≤ 60 lbs), or large (> 60 lbs), while demographic and environmental information was also collected (owner age, income, dog activity level, yard access). Mixed-effects linear regression models assessed the influence of dog behavior (training, aggression, food motivation), physical activity level, and size, including interaction terms for size and behavior, with dog-owner relationships. Simple slopes analyses were implemented to probe significant interactions. Higher levels of dog training and physical activity were associated with more positive dog-owner relationship outcomes, while aggression and food motivation were related to increased perceived costs and reduced dog-owner interaction. Notably, dog size moderated several associations such that aggression and poor training had stronger negative impacts on dog-owner relationships in medium and large dogs compared to small dogs. These data suggest that dog size and behavior interact to shape the quality of dog-owner relationships, warranting further exploration of owner perceptions that contribute to these patterns.

Keywords: Dog Size; Dog Owner Demographics; Dog Behavior

HIGHLIGHTS

- Dog behavior, activity level, and size were independently associated with dog-owner relationship quality.
- Aggression was more strongly associated with reduced interaction and higher perceived cost of ownership in medium and large dogs.
- Dog size moderated associations between behavioral traits and owner-reported relationship outcomes.

INTRODUCTION



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As of 2025, approximately 66% of U.S. households own a minimum of one pet, with 44.5% reporting ownership of at least one dog (Megna & Bailie, 2025). Since the 1980's, pet ownership has steadily increased with only 56% of U.S. households reporting ownership of any type of pet (Megna & Bailie, 2025). The concept of strong bonds between human and dogs is well-established, with data dating back to the 1980's demonstrating that many individuals regard their dogs as family and report meaningful emotional connections with them (Cain, 1985; McCune et al., 2014). Dog ownership has also been suggested to improve social wellbeing and physical health through facilitating social interaction, offering companionship and support, and promoting physical activity (Gillet et al., 2025; McConnell et al., 2011; McCune et al., 2014; Westgarth et al., 2019). However, dog owners have also reported various costs, including financial strain, time commitments, and difficulties related to dog behavior (Gillet et al., 2025). A thorough understanding of the factors influencing the strength and development of dog-owner relationships is crucial, given the complex interplay of benefits and drawbacks associated with dog ownership. Furthermore, behavioral challenges and weakened dog-owner bonds also contribute to relinquishment in severe cases (Applebaum et al., 2024; Eagan et al., 2022), further highlighting the importance of identifying factors that moderate the quality of these relationships.

The Monash Dog Owner Relationship Scale (MDORS) provides an integrative approach to capturing the holistic nature of dogs-owner relationships (Dwyer et al., 2006). Items on this scale pertain to owner perceptions regarding dog ownership, including dog-owner interaction, perceived costs, and perceived emotional closeness. Multiple studies have assessed the relationship between various dog and owner behavioral and demographic factors with dog-owner relationships (Calvo et al., 2016; Kujala et al., 2023; Meyer & Forkman, 2014; Somppi et al., 2022). Meyer and Forkman (2014) analyzed data from 426 Danish dog owners, demonstrating impacts of both owner demographics and dog behavioral traits on MDORS subscales. Specifically, owners that had children and older owners displayed reduced dog-owner interaction, while perceived cost was higher when dogs displayed fear-related behavioral issues. Emotional closeness was attenuated for companion-dogs and in single-dog households, and elevated when dogs displayed greater social fear (Meyer & Forkman, 2014). Expanding on these findings, Calvo et al. (2016) noted that males, university-educated individuals, and individuals with low life satisfaction scores, and those with miniature dogs (defined as weighing less than two



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kilograms) were more likely to display higher dog-owner interaction and emotional closeness and lower perceived costs among 1,850 Spanish dog owners, suggesting that owner demographics and dog size may influence strength of dog-owner relationships. Importantly, these results (Calvo et al., 2016) also underscore the role of owner mental health in shaping pet relationships, a factor closely tied to relinquishment risk. Studies by Applebaum et al. (2024), Eagan et al. (2022), and Jensen et al. (2020) emphasize that compromised owner physical and mental well-being along with exposure to stressful personal and financial situations are often central drivers of pet relinquishment, particularly when paired with behavioral challenges or diminished relational quality. Moreover, Kujala et al. (Kujala et al., 2023) provided further context, reporting that owners of dogs with greater frequencies of physical activity reported lower dog-owner interaction and MDORS scores. Notably, this group (Kujala et al., 2023) did not demonstrate any significant association between dog performance on behavior tests (object choice, task solving) and MDORS scores. Lastly, Somppi et al. (2022) found that dogs whose owners reported greater emotional closeness displayed greater proximity-seeking and more fear behaviors, suggesting greater emotional reactivity in more closely bonded dogs. Conversely, greater perceived costs were demonstrated in dogs that were more independent less fearful, and less trainable, identifying specific behavioral traits that may negatively modulate the dog-owner relationship. Collectively, these studies provide a preliminary framework for understanding the multi-faceted factors that influence dog-owner bonding.

Further research has also examined the influence of dog behavior on other measures of dog-owner relationships (Arhant et al., 2010; Bennett & Rohlf, 2007; Herwijnen et al., 2018). Broadly, Herwijnen et al. (2018) noted that higher perceived costs and more frequent unwanted behaviors were associated with reduced owner satisfaction and weaker dog-owner relationships. However, Bennett and Rohlf (2007) reported that these negative outcomes could be partially mitigated through increased owner engagement and participation in training activities and play, suggesting that improved dog behavior or more attentive ownership can buffer the influence of behavioral challenges. Arhant et al. (2010) demonstrated that these dynamics may vary by dog size and training approach in their sample such that smaller dogs were rated as less obedient, more aggressive, and more anxious. Moreover, the use of punishment-based training methods was linked to heightened aggression and anxiety, while greater engagement in training and play predict improved obedience, regardless of dog size, emphasizing the potential for positive training to support dog-owner



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relationship quality across dog types (2010). These findings suggest that training, obedience, owner engagement, and dog size may influence the relationship between dog behavior and the dog-owner bond, highlighting potential areas for targeted interventions to enhance well-being for both dogs and their owners.

While multiple studies have established links between multiple subsets of dog behavior and dog-owner relationships (Bennett & Rohlf, 2007; Calvo et al., 2016; Meyer & Forkman, 2014; Somppi et al., 2022), no prior research has investigated potential for dog size to moderate this association, nor has any prior research simultaneously explored connections between aggression, training, and food motivation with dog-owner relationships. Therefore, the present study aimed to examine the influence of dog behavior, activity level, and size on dog-owner relationship quality, as measured by MDORS subscales, from a representative sample of dogs in the continental United States from the Dog Aging Project (DAP) (Sándor et al., 2022). We hypothesized that dogs who were more physically active, better trained, less aggressive, and less food motivated would display significantly increased levels of dog-owner interaction and emotional closeness, along with reduced perceived costs of ownership. We further hypothesized that differential associations would be observed by dog size such that these associations would be less impactful or eliminated altogether for small dogs and observed at a greater magnitude in medium and large dogs.

METHODS

Data Acquisition and Population

To assess the relationship between dog attributes and owner perceptions of dog-owner relationships, data from the DAP were utilized. Specifically, we accessed dog data from the annual follow-up survey (AFUS), released most recently on December 31st, 2023, including survey data from 26,847 dogs. Following exclusion of dogs with incomplete data for all base independent variables, covariates, and dependent variables, a final sample of 26,837 observations from 18,416 unique dogs (mean = 1.46 observations per dog) was utilized for analysis. Sample descriptives for unique dogs and owners can be observed below in Tables 1 and 2, respectively. The present investigation was determined to be exempt from review by the California State University of San Marcos Institutional Review Board.



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	Small (n = 5,239)	Medium (n = 6,525)	Large (n = 6,652)
Aggression Score	7.05 (2.05)	7.80 (1.57)	7.78 (1.53)
Training Score	6.47 (4.79)	5.79 (4.22)	5.44 (4.16)
Food Motivation Score	55.70 (21.3)	57.50 (21.0)	58.20 (20.7)
Sex (Male, Female)	48.9%, 51.1%	39.8%, 60.2%	59.1%, 40.9%
Spay/Neuter Status (Yes, No)	92.8%, 7.2%	90.4%, 9.6%	87.2%, 12.8%
Very Good or Excellent Health	76.0%	81.2%	78.4%
Fair or Good Health	21.7%	17.0%	19.9%
Poor or Very Poor Health	1.6%	1.1%	1.0%
Not Active	20.0%	70.0%	10.0%
Moderately Active	11.9%	70.6%	17.5%
Very Active	13.8%	71.9%	14.3%
Companion Dog	98.9%	98.4%	98.1%
Not a Companion Dog	1.1%	1.6%	1.9%

Table 1. Sample Descriptives in all Unique Included Dogs by Size (N = 18,416)

	Frequency (n, %)	
Owner Age (Years)		
	18-34	1,952 (10.6%)
	35-54	5,746 (31.2%)
	54-65	4,586 (24.9%)
	65+	6,132 (33.3%)
Owner Income (USD/Year)		
	<60K	2,946 (16.0%)
	60-100K	4,384 (23.8%)
	100-160K	5,506 (29.9%)
	160K+	5,580 (30.3%)
Owner Education Level		
	Some College or Less	1,768 (9.6%)
	Undergraduate Degree or Technical Training	7,679 (41.7%)
	Masters or Professional Degree	7,127 (38.7%)
	Doctorate Degree	1,842 (10%)

Table 2. Categorical Owner Demographics (N = 18,416)

Independent Variables

Codebooks and variable information for all DAP data are publicly available through the project's GitHub repository (<https://github.com/dogagingproject/dataRelease>). The primary independent variables for the present study included subjective owner scores of dog training, aggression, and food motivation, each operationalized as a composite score. Training scores were derived by summing responses (0 = never to 4 = always) regarding frequency of immediately executing "sit" and "stay" commands and subtracting one item representative of dog distraction frequency on the same scale. Aggression scores were derived from responses to 10 items



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pertaining to aggression in various situations (e.g., interactions with other dogs, toy or food guarding, and behavior in different environments) on a zero (no aggression) to four (serious aggression) scale with higher scores indicating greater aggression. Lastly, dog food motivation was a formally defined subscale of the dog obesity risk assessment (DORA), with higher aggregated scores representing stronger food motivation tendencies. Moreover, dog activity level, and dog size also served as primary independent variables for all models. Dog activity level was categorically derived from owner-reported description of their dog as not active, moderately active, or very active, while dogs were categorized as small (< 30 lbs), medium (> 30 to ≤ 60 lbs), or large (> 60 lbs) based on owner-derived exact bodyweight.

To identify relevant covariates across a wide range of demographic and environmental candidate variables, stepwise regression analyses were conducted for each outcome. Prospective covariates included: dog insurance status, owner-perceived dog health, owner age, owner education, owner income, frequency of barking, access to dog parks, and perceived owner management. In adjusted hierarchical models, owner age, owner income, dog role, and access to on-property greenspace were retained in final adjusted models.

Owner age and income were treated categorically as continuous age and income values were not collected from owners. Owners were grouped as aged: 18-34, 35-54, 55-64, and 65+ and earning incomes of: < 60,000 (K)/year, 60-100K/year, 100-160K/year or > 160K/year in United States Dollars based on self-reported age and income ranges. Additionally, dog role was dichotomized as companion or non-companion (obedience, breeding, service, emotional support, etc.) roles. Lastly, yard access was categorized as 1) no yard, 2) yard < 1000 square feet (sqft), 2) yard between 1000sqft and one acre, or 3) a yard ≥ one acre.

Dependent Variables

The primary dependent variables in the present study were dog-owner interaction, perceived costs of dog ownership, and perceived emotional closeness. Each variable was treated as a continuous outcome and derived from subscales of MDORS and administered within the AFUS project. Dog-owner interaction represented a sum of nine items scored on one (never) to five (at least once per day) regarding the frequencies of shared play, activities, and affectionate behaviors with higher scores representing greater interaction. Next, perceived costs reflected negative emotions associated with dog ownership based on eight items scored between five (never or



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strongly disagree) and zero (at least once a day or strongly agree) with higher values representing fewer negative emotions or perceived costs. Lastly, perceived emotional closeness was reported as the sum of nine items also scored from one (strongly disagree) to five (strongly agree) with higher values reflecting more perceived emotional closeness.

Statistical Analysis

All data were analyzed in R version 4.4.3 (R Foundation for Statistical Computing, Vienna, Austria). The lme4, lmerTest, performance, parameters, and interactions packages were utilized to assist in data modeling and post-hoc analysis. Prior to analysis, data were assessed for linearity, normality of residuals, and multicollinearity. Briefly, Q-Q plots were constructed and visually inspected to confirm normality of standardized residuals for each model. Residual vs. fitted plots were inspected to observe deviations from linearity or evidence of heteroscedasticity, neither of which were present. Absence of multicollinearity was verified through calculation of variance inflation factors (VIF) for all independent variables (Kim, 2019) with no independent variable displaying a VIF value greater than five.

As observations for each dog were not independent, a multilevel modeling approach was employed to assess the relationship between continuous measures of dog behavior and dog-owner relationships. Specifically, linear mixed-effects models were fit using restricted maximum likelihood to account for the nested structure of the data, with repeated observations nested within dog identification number. Each outcome was modeled in three hierarchical blocks, with predictors entered sequentially to reflect a logical flow of prediction. Block one was considered the base model and only included primary independent variables: dog training, aggression, food motivation scores, dog size (small as reference) and activity levels (not active as reference). Block two incorporated all aforementioned covariates, including further adjustment for owner age (18-35 as reference) and income (< 60K USD/year as reference), presence of other animals at home (no as reference), dog role (companion dog as reference), and access to yard space (no yard as reference). Model three built on the prior two models by incorporating interaction terms for dog size (small, medium, large) and continuous metrics of dog behavior (aggression, food motivation, training).

Model fit was evaluated using conditional and marginal R² values to denote the variance in dependent variables explained by random and fixed effects and Akaike Information Criterion (AIC). Likelihood ratio tests (LRTs) were utilized to compare fit of blocks two and three relative to the prior block with $\Delta\chi^2$ values evaluated for significance to demonstrate differences in

model fit from block to block. Individual contributions of independent variables to each regression model were denoted with unstandardized beta coefficients (B) at the 95% confidence interval (95% CI). Significant dog size $\times$ continuous dog behavior interactions for all continuous dependent variables were explored utilizing simple slopes analysis with Johnson-Neyman intervals computed to identify regions of significance (Bauer & Curran, 2005). Statistical significance for all analyses was set *a priori* at $p \leq 0.05$.

RESULTS

For each dependent variable, overall model fit and LRT results comparing fit of subsequent hierarchical models can be seen in [Table 3](#). Importantly, all three models significantly fit the data for all dependent variables. For Dog–Owner Interaction, Perceived Costs, and Emotional Closeness, the addition of covariates (Model 2) significantly improved model fit relative to the model 1 ($p < 0.001$) based on LRT results. Further addition of dog size $\times$ behavior interaction terms (Model 3) also significantly improved model fit over the adjusted models for all outcomes, including Dog–Owner Interaction ($p = 0.005$), Perceived Costs ($p < 0.001$), and Emotional Closeness ($p = 0.006$). Accordingly, all results of the present study are based on the fully adjusted Model 3. Individual contributions of independent variables to Model 3 for all outcomes can be seen in [Table 4](#).



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Model	Outcome	Model Summary				Likelihood Ratio Test	
		R^2_C	R^2_M	ΔR^2_M	AIC	$\Delta\chi^2$	p
1	Dog-Owner Interaction	0.791	0.061	-	146,168	-	-
2		0.789	0.073	0.012	145,935	291.72	<.001
3		0.789	0.073	<0.001	145,972	18.76	.005
1	Perceived Cost of Ownership	0.761	0.038	-	153,756	-	-
2		0.760	0.050	0.012	153,552	259.64	<.001
3		0.760	0.051	0.001	153,579	27.21	<.001
1	Perceived Emotional Closeness	0.755	0.008	-	165,156	-	-
2		0.750	0.037	0.029	164,550	657.17	<.001
3		0.750	0.038	0.001	164,583	17.98	.006

Table 3. Model Summary Statistics and Likelihood Ratio Test Results for all Models

Dog-Owner Interaction

In Model 3, several predictors were significantly associated with dog–owner interaction. Higher training scores were positively associated with greater interaction, while higher food motivation scores were modestly but significantly related to lower interaction. Aggression alone did not significantly influence dog–owner interaction, but its role varied by dog size.



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Dog size displayed significant associations with dog-owner interaction such that medium-sized dogs exhibited slightly lower interaction scores than small dogs. Dogs reported as moderately active or very active exhibited significantly greater dog-owner interaction compared to dogs rated as not active.

Regarding covariates, older owner age groups (ages 35–54, 55–64, and 65+) were each associated with lower dog-owner interaction scores relative to the reference group. Owner income had no influence on dog-owner interaction scores. Presence of other animals in the household was negatively associated with dog-owner interaction, whereas owning a dog not primarily identified as a companion was associated with greater dog-owner interaction. Greater yard access was linked to lower dog-owner interaction scores, while having access to a yard of any kind was negatively associated with dog-owner interaction with the largest negative association observed for dogs with access to a yard of one acre or more.

Significant interactions are visualized in [Figure 1](#). Significant dog size x aggression and food motivation interactions were noted for dog-owner interaction. Simple slopes analysis indicated that aggression was not significantly associated with dog-owner interaction among small dogs ($p = .530$) but displayed significant negative associations among medium ($B = -.05$, $p < .001$) and large dogs ($B = -.05$, $p < .001$). For food motivation (not pictured in [Figure 1](#)), a contrary pattern was noted for food motivation such that food motivation was negatively associated with dog-owner interaction among small dogs ($B = -.01$, $p < .001$), but not significantly related to dog-owner interaction for medium ($p = .090$) or large dogs ($p = .080$). However, even when statistically significant, these effects were trivial.

Perceived Costs

To reiterate, higher perceived costs scores represent lower perceived costs of dog ownership based on the coding structure employed by DAP researchers. In Model 3, multiple behavioral and demographic predictors were significantly associated with perceived costs of dog ownership. Higher training scores were associated with lower perceived costs, while greater aggression and food motivation were each associated with higher perceived costs. Medium and large dogs were associated with significantly higher perceived costs relative to small dogs, while dogs rated as moderately or very active were perceived as less costly compared to dogs classified as not active.

Regarding covariates in Model 3, older owner age groups (35–54, 55–64, and 65+) were also each associated with lower perceived costs, while higher



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income was associated with slightly higher perceived costs relative to owners earning < 60K USD of yearly income in some brackets (> 100K USD/year). Owners with other animals reported fewer perceived costs, and greater yard access was also associated with lower perceived costs, particularly for owners with more than one acre of yard space.

Two significant dog size x behavior interactions were present for perceived cost. First, the association between greater training scores and lower perceived costs was stronger for medium ($B = .35, p < .001$) and large dogs ($B = .37, p < .001$) compared to small dogs ($B = .24, p < 0.001$). Second, aggression was associated with higher perceived costs across all sizes but showed the steepest associations for medium ($B = -.13, p < .001$) and large dogs ($B = -.11, p < .001$), compared to small dogs ($B = -.08, p < .001$).

Perceived Emotional Closeness

Several predictors in Model 3 were significantly associated with perceived emotional closeness. Higher training and food motivation scores were each associated with greater emotional closeness. Conversely, aggression was not significantly associated with emotional closeness, while medium and large dogs were each associated with significantly lower emotional closeness relative to small dogs. Furthermore, dogs rated as very active displayed greater emotional closeness compared to the reference group (not active).

For covariates in Model 3, emotional closeness scores were significantly lower among owners in all older age groups (35–54, 55–64, and 65+) compared to those aged 18–34. Moreover, higher income levels were associated with lower emotional closeness while owners with other animals reported greater emotional closeness to their dogs, as did owners of dogs not identified primarily as companions. Greater yard access was also associated with slightly lower emotional closeness. A significant interaction was noted between large dog size and training such that training was positively associated with emotional closeness across all size groups, but this association was strongest among large dogs ($B = .27, p < .001$), followed by medium dogs ($B = .18$), with small dogs ($B = .11$) displaying the weakest positive association between training and emotional closeness. Importantly, the interaction between medium dogs (relative to small dogs) and emotional closeness for perceived cost was not significant ($p = .085$).



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		Dog-Owner Interaction		Perceived Cost		Emotional Closeness	
		B [95% CI]	p	B [95% CI]	p	B [95% CI]	p
Base Predictors	Training	0.28 [0.24, 0.32]	< 0.001	0.24 [0.19, 0.29]	< 0.001	0.11 [0.05, 0.17]	< 0.001
	Aggression	-0.01 [-0.03, 0.01]	0.528	-0.08 [-0.10, -0.06]	< 0.001	0.02 [-0.01, 0.04]	0.288
	Food Motivation	-0.01 [-0.02, -0.01]	< 0.001	-0.00 [-0.01, 0.00]	0.001	0.01 [0.00, 0.02]	0.002
	Medium Dogs ^a	-0.21 [-0.36, -0.05]	0.008	-0.55 [-0.72, -0.37]	< 0.001	-0.78 [-0.99, -0.57]	< 0.001
	Large Dogs ^a	0.13 [-0.03, 0.28]	0.104	-0.39 [-0.56, -0.21]	< 0.001	-0.47 [-0.68, -0.26]	< 0.001
	Moderately Active ^b	10.80 [1.67, 1.93]	< 0.001	0.64 [0.49, 0.80]	< 0.001	0.04 [-0.15, 0.23]	0.694
	Very Active ^b	30.04 [2.86, 3.22]	< 0.001	0.82 [0.61, 1.03]	< 0.001	0.41 [0.16, 0.67]	0.002
	Owner Age 35-54 ^c	-0.43 [-0.63, -0.23]	< 0.001	0.53 [0.31, 0.76]	< 0.001	-0.90 [-1.18, -0.62]	< 0.001
	Owner Age 55-64 ^c	-0.67 [-0.88, -0.47]	< 0.001	0.14 [0.90, 1.38]	< 0.001	-10.95 [-2.24, -1.66]	< 0.001
	Owner Age 65+ ^c	-0.97 [-1.17, -0.77]	< 0.001	0.32 [1.09, 1.56]	< 0.001	-20.16 [-2.44, -1.87]	< 0.001
Covariates	Owner Income 60-100K ^d	0.05 [-0.11, 0.21]	0.553	-0.14 [-0.32, 0.05]	0.154	-0.71 [-0.93, -0.48]	< 0.001
	Owner Income 100-160K ^d	-0.04 [-0.20, 0.13]	0.651	-0.29 [-0.48, -0.10]	0.003	-10.40 [-1.63, -1.16]	< 0.001
	Owner Income 160K+ ^d	-0.06 [-0.23, 0.12]	0.524	-0.24 [-0.43, -0.04]	0.019	-10.82 [-2.07, -1.58]	< 0.001
	Other Animals Present ^e	-0.55 [-0.66, -0.43]	< 0.001	0.35 [0.22, 0.48]	< 0.001	0.51 [0.35, 0.67]	< 0.001
	Not a Companion Dog ^f	0.67 [0.29, 1.04]	< 0.001	0.01 [-0.42, 0.45]	0.956	10.19 [0.66, 10.73]	< 0.001
	≤ 1000 sqft yard ^g	-0.28 [-0.48, -0.09]	0.005	0.34 [0.11, 0.57]	0.003	-0.29 [-0.57, -0.01]	0.042
	≤ 1000 sqft to 1 acre yard ^g	-0.42 [-0.61, -0.22]	< 0.001	0.44 [0.21, 0.66]	< 0.001	-0.57 [-0.85, -0.29]	< 0.001
	≥ 1 acre yard ^g	-0.74 [-0.96, -0.52]	< 0.001	0.64 [0.38, 0.90]	< 0.001	-0.75 [-10.06, -0.43]	< 0.001
	Medium Dog x Training	0.01 [-0.05, 0.07]	0.761	0.11 [0.04, 0.18]	0.002	0.07 [-0.01, 0.16]	0.085
	Large Dog x Training	0.02 [-0.04, 0.08]	0.589	0.13 [0.06, 0.20]	< 0.001	0.16 [0.07, 0.24]	< 0.001
Interactions	Medium Dog x Aggression	-0.04 [-0.07, -0.01]	0.008	-0.05 [-0.08, -0.01]	0.007	-0.03 [-0.07, 0.01]	0.144
	Large Dog x Aggression	-0.05 [-0.08, -0.02]	0.001	-0.03 [-0.07, 0.00]	0.042	-0.02 [-0.06, 0.02]	0.384
	Medium Dog x Food Motivation	0.01 [0.00, 0.01]	0.013	-0.00 [-0.01, 0.00]	0.398	0.01 [0.00, 0.01]	0.224
	Large Dog x Food Motivation	0.01 [0.00, 0.01]	0.016	-0.00 [-0.01, 0.00]	0.432	-0.00 [-0.01, 0.01]	0.810

Table 4. Linear Mixed Effects Regression Results for All Models



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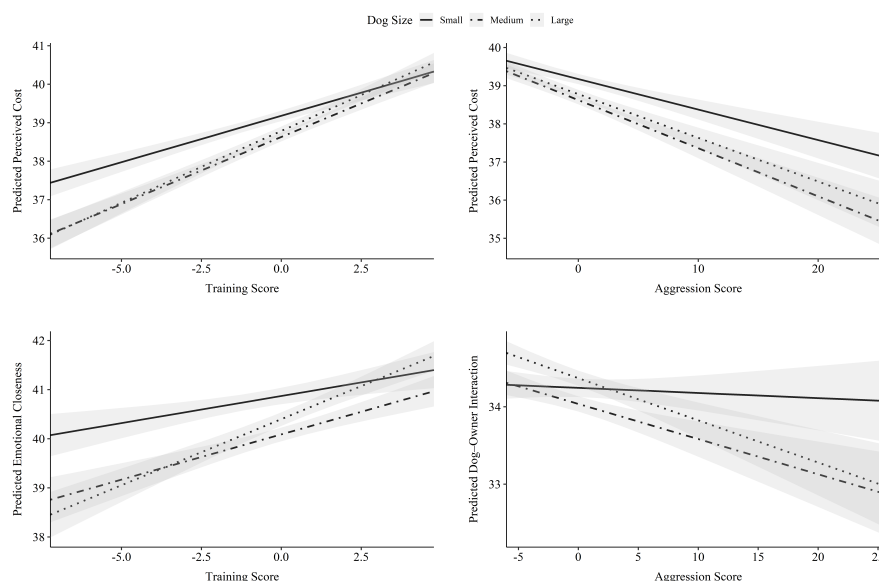


Figure 1. Predicted Dog-Owner Interaction, Perceived Emotional Closeness, and Perceived Cost values derived from model 3, including interactions between training, aggression, and dog size (small, medium large). Higher perceived costs scores reflect lower owner-reported perceived costs. Shaded ribbons surrounding regression lines represent 95% confidence intervals for predicted values.

DISCUSSION

The primary aim of the present study was to assess the influence of dog aggression, training, and food motivation on dog-owner interaction, emotional closeness, and perceived costs, and whether these associations vary by dog size. As hypothesized, higher levels of dog physical activity and training were generally associated with dog-owner interaction, emotional closeness, and lower perceived costs. Aggression and food motivation were associated with higher perceived costs and reduced dog-owner interaction. Moderation analyses supported the hypothesized moderating influence of dog size on associations between aggression and reduced dog-owner interaction or increased perceived costs, as these associations were stronger in medium and large dogs, but negligible in small dogs. Furthermore, the positive association between training and emotional closeness was strongest among large dogs. Contrary to our hypotheses, food motivation was negatively associated with dog-owner interaction solely in small dogs. Owner demographics showed consistent associations with MDORS subscales such that older owners reported less dog-owner interaction and emotional closeness, but lower perceived costs, while higher income was associated with reduced emotional closeness, but not dog-owner interaction or perceived costs. Additionally, environmental factors played a role in shaping dog-owner relationships as owners of non-



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companion dogs and those with other pets in the household reported greater emotional closeness, while greater yard access was consistently associated with lower interaction, closeness, and perceived costs.

Regarding main effects from the present study, our findings both reinforce and extend patterns reported in prior research studies (Calvo et al., 2016; Kujala et al., 2023; Meyer & Forkman, 2014). Our work aligns particularly with Meyer and Forkman (2014), as we also observed that older dog owners report reduced dog-owner interaction and that non-companion dogs were associated with increased emotional closeness compared to companion dogs. We expanded on their findings linking fear-related behavior to perceived cost by further demonstrating that lower training scores and higher levels of aggression were associated with increased perceived costs and reduced emotional closeness. Notably, food motivation was negatively associated with dog-owner interaction, but associated with increased emotional closeness and perceived cost, indicating that food-motivated dogs may elicit stronger bonds while demanding more from their owners. We also provided further context relating to the influence of owner demographics on dog-owner relationships, identifying that owners earning more income reported reduced perceived emotional closeness and increased perceived costs, complementing the positive link between emotional closeness and education reported by Calvo et al. (2016). These patterns suggest that while older and higher-income owners may experience a more practical, less emotionally involved relationship with their dogs, they also perceive ownership as less burdensome. In contrast to Kujala et al. (2023), we observed that greater levels of dog physical activity were positively associated with, dog-owner interaction, reduced perceived cost, and, in very active dogs, increased emotional closeness.

These main effects help clarify our interaction findings, which indicate that the relationship between dog behavior and dog-owner dynamics can differ depending on dog size. Numerous studies have identified significant behavioral differences based on size, with smaller dogs often seen as more anxious, less obedient, and more aggressive than larger dogs (Arhant et al., 2010; Bennett & Rohlf, 2007), despite equivocal evidence regarding size-driven differences in empirically-observed aggression (Ayrosa et al., 2022). These behavioral traits may influence owner perceptions and dynamics of dog-owner relationships, yet research is limited regarding whether the impact of this behavior varies by size. Addressing this gap in knowledge, we demonstrated that associations of increased dog aggression with reduced dog-owner interaction and increased perceived cost were significantly stronger among medium and large dogs compared to small



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dogs. Similarly, higher training scores were more strongly associated with emotional closeness and reduced perceived costs in medium and large dogs as well. While it is understood that destructive or aggressive behavior are broadly recognized as serious issues, presenting risks to dog owners and the general public (Pirrone et al., 2015; Williams & Blackwell, 2019), our findings raise the possibility that the challenges attributed to larger dogs may stem more from owner perceptions than actual behavioral severity. These perceptions may stem from beliefs regarding greater physical strength or safety concerns; however, there is a paucity of peer-reviewed evidence either supporting or contradicting this notion.

These data suggest that the impact of dog behavior on dog-owner relationship quality is not uniform across dog sizes, with future research warranted to investigate the role of perceived owner safety, dog strength, and dog manageability in shaping these associations. Behavioral problems are among the leading causes of dog relinquishment with behaviors such as aggression, social conflict, and poor management cited as common behavioral traits that lead to this outcome (Applebaum et al., 2024; Eagan et al., 2022; Jensen et al., 2020). Furthermore, larger, young adult, or healthy dogs are more likely to be relinquished for behavioral reasons (Eagan et al., 2022). Owners have also been reported to underestimate or fail to recognize dog behavioral problems (Powell et al., 2021), suggesting limited awareness or understanding of dog behavior in owners. As dog behavior can vary by size and breed (Ayrosa et al., 2022; Pirrone et al., 2015; Salonen et al., 2020), it is key to understand varying owner perceptions regarding lack of training and aggression in dogs vary by breed and size as well in order to improve dog and owner quality of life and improve relinquishment outcomes. Further research in this area should also aim to identify owner motivations for MDORS responses, specifically relating to dog size or breed.

Multiple limitations exist in the present study. Frequency of dog breeds in the included sample were not uniform, and common breeds such as Labradors and Golden Retrievers and German Shepherd Dogs were notably over-represented. As specific behavioral tendencies vary by breed (Salonen et al., 2020), this sampling bias makes the generalization of these findings to less common breeds challenging. Dogs were also sampled exclusively from the US, limiting the applicability of our results to other areas with cultural or geographic contexts that shape dog-owner relationships and perceptions of dog behavior. Lastly, the cross-sectional nature of our design, limits our ability to make inferences regarding longitudinal influences of dog behavior on dog-owner relationships over time.



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CONCLUSIONS

The present study reveals potential for the relationship between dog behavior and dog-owner relationships to vary by dog size, with behavior traits such as aggression and poor training exerting a stronger negative influence in larger dogs. Large dogs in the included sample required higher training standards to achieve the same emotional closeness as smaller dogs, suggesting that owners may have stricter expectations or more challenges forming bonds with bigger dogs. These findings underscore the importance of examining how owner perceptions of safety, control, and manageability differ by dog size or breed. Future research should investigate these perceptual differences to inform targeted interventions that strengthen the dog-owner bond, promote positive mental health outcomes for both owners and pets, and ultimately reduce behavior-related relinquishment. As the dog-owner relationship is complex, recognizing the nuanced roles of perception, environment, and life stage may lead to better outcomes for both dogs and owner wellbeing, and reduce relinquishment occurrence.

CONFLICTS OF INTEREST

Neither author has any conflicts of interest to declare.

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AUTHOR CONTRIBUTIONS

M.J.S. was the primary contributor to the research design and conceptualization, manuscript writing, and analytical planning. A.G.P. was responsible for data analysis, results presentation, and contributed to manuscript writing and research design. All authors reviewed and approved the final version of the manuscript prior to submission.

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