



Excessive energy in dogs: The impact of caregiver-related variables and fear/anxiety

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ARTICLE INFO

Keywords:

Caregiver characteristics

Dogs

Excessive energy

Fear/anxiety

Human-dog bond

Training practices

ABSTRACT

Excessive energy (EE) and hyperactivity are frequent behavioral problems in dogs, with significant implications for canine welfare and caregiver well-being, yet they remain less studied than reactivity/aggression or separation-related problems. This study examined the influence of caregiver-related variables on EE in dogs, as well as the role of fear/anxiety. Data were collected through an online questionnaire from 730 caregivers, and multiple linear regression analyses were conducted. Younger dogs showed higher levels of EE. Among caregiver-related variables, stress, higher perceived caregiving costs, and more positive attitudes towards aversive training emerged as risk factors. In contrast, the ability to recognize chronic pain, knowledge of basic behaviors, and medication use were protective. The final regression model explained 21.3 % of the variance, with dog age, caregiver stress, and attitudes towards aversive training being the strongest predictors. When fear/anxiety was added, the explained variance rose to 29.5 %, underscoring its relevance as an emotional comorbidity. These findings highlight the central role of caregiver mental health, perceptions, and training practices in shaping EE, while also emphasizing the protective value of pain recognition, education, and medical support. Interventions should therefore integrate caregiver well-being, training strategies, pain assessment, and dogs' emotional states, in line with a One Welfare perspective.

1. Introduction

Behavioral problems in dogs compromise welfare and family well-being, and are linked to caregiver anxiety, depression, and reduced quality of life (Barcelos et al., 2023; Buller and Ballantyne, 2020; Lu o et al., 2015). Among these, excessive energy (EE²) or hyperactivity is particularly challenging, affecting nearly 39 % of dogs and often associated with destructiveness, fear, and aggression (Didehban et al., 2020; Shabelansky and Dowling-Guyer, 2016; Sulkama et al., 2021), yet it remains less studied than reactivity/aggression or separation-related problems. EE is generally situational and relieved by activity, while hyperactivity reflects persistent dysregulation of arousal (Overall,

2013). Here, EE is used as an umbrella term, as caregiver reports may conflate both phenomena.

This study examined the influence of caregiver-related factors (such as intrapersonal traits, the caregiver-dog bond, and management practices) on EE, while controlling for dog age and neuter status, and assessed whether fear and anxiety contributed to this problem. Physical activity, neuter status, caregiver mental health, and the caregiver-dog relationship have all been linked to energy-related behaviors (Gonz lez-Mart nez et al., 2024; Hoppe et al., 2017; Hunt et al., 2012; Lu o, 2015; Pirrone et al., 2015; Serpell, 1996; Siniscalchi et al., 2018; Sulkama et al., 2021; Zink et al., 2014). Fear, anxiety, and chronic pain may further exacerbate EE (Lindley, 2012; Mills et al., 2020; Salonen

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² EE - Excessive Energy.

R/Ams - Reactive/ aggressive manifestations.

MLRM - Multiple Linear Regression Models.

<https://doi.org/10.1016/j.applanim.2025.106900>

Received 15 September 2025; Received in revised form 9 December 2025; Accepted 11 December 2025

Available online 13 December 2025

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et al., 2020; Tiira et al., 2016). However, chronic pain may produce mixed behavioral outcomes: while it can increase hypervigilance, anxiety, restlessness, attention-seeking, irritability, and pacing (Mills et al., 2020), it often reduces spontaneous activity and mobility (Mills et al., 2020; Stevens et al., 2025). By integrating these variables, the present study aims to improve understanding of EE and inform prevention and intervention strategies, within a One Health/One Welfare framework, which emphasizes the interconnections between animal welfare, human wellbeing, and environmental contexts, and supports integrated approaches to behavioral and welfare challenges (Pinillos et al., 2016; World Health Organization, 2022).

2. Methods

The study was approved by the Ethics Committee of the University of Évora (Ref.: 22170). Informed consent was obtained from all participants.

Data were collected online (October 2023–March 2024) from 730 caregivers (95.2 % women; M age = 35.5 years, range 18–82). The procedures were identical to those described in our previous study on reactive/aggressive manifestations (R/AMs) (Batista et al., 2025a), with the following differences.

EE was assessed with six caregiver-reported items describing restlessness, agitation, attention-seeking, and excitement during walks (see Appendix 1 in [supplementary material](#)). Fear/anxiety (F/A) was assessed with four caregiver-reported items reflecting fearful behavior, anxious arousal, and heightened vigilance in everyday contexts (Appendix 2). For both EE and F/A, responses were provided on a 0–10 scale. Predictor variables included dog characteristics, caregiver mental health, attachment style, personality, caregiving perceptions, training practices, and management routines (Batista et al., 2025a).

Multiple linear regression models were estimated in blocks (dog, sociodemographic, intrapersonal, interpersonal, and management variables), including all variables that showed significant correlations with EE. A final model tested fear/anxiety as an additional predictor, excluding variables known to also influence fear/anxiety in this dataset (dog's age, caregiver stress, perceived caregiving costs, attitudes towards aversive training, number of basic behaviors, veterinary consultations, and medication) to avoid endogeneity.

3. Results

Table S1 ([supplementary material](#)) presents the correlations between the variables under study and EE, as well as the internal consistency (Cronbach's alpha) of each scale. Osteoarthritis and general health problems correlated negatively with EE. As most of these dogs were under medication, the effect was likely due to treatment rather than the condition itself, and both variables were excluded from further analyses.

3.1. Correlations

The results confirm that younger dogs present higher levels of EE. Intact females showed more EE than intact males, while spayed females were reported with higher EE than intact females, a pattern not observed in males. Dogs who had lived with their caregivers for a shorter period also displayed more EE.

Intrapersonal variables such as stress, depression, anxiety, insecure attachment styles, lower emotional stability, and lower openness to experience were all associated with higher EE in dogs.

At the interpersonal level, higher perceived costs, weaker caregiver–dog bonds, more positive attitudes towards aversive training, and greater difficulty in recognizing chronic pain were linked to higher EE.

Regarding caregiving and management, dogs under medication were evaluated as having fewer EE. Those walked once a day were reported with more EE, while those walked three times a day with fewer. Dogs that had received professional training, were corrected with

punishment, or knew fewer basic behaviors were also assessed as showing more EE.

3.2. Regressions

In the multiple regression linear models (Marôco, 2021), all predictors were significant, and the explained variance increased as more variables were added (see Table 1).

In Model 1, only the dog's age was included, explaining 7.6 % of the variance in the criterion variable. In Model 3, among intrapersonal variables, only stress predicted this behavioral problem, increasing the explained variance to 12.2 %. However, dog age remained the variable with the greatest explanatory power. In Model 4, among the interpersonal variables, perceived costs of owning a dog, attitudes towards aversive training, and the ability to recognize chronic pain in the dog predicted EE, raising the explained variance to 19.8 %. Finally, in Model 5, the medication dummy variable and the four basic behaviors dummy variable also significantly affected EE, increasing the explained variance to 21.3 %. In this model, dog age (β std = .163) was the variable with the greatest explanatory power, followed by attitudes towards aversive training (β std = .192) and caregiver stress (β std = .166). The most important set of variables was the interpersonal variables (R^2 change = .079).

To include fear/anxiety in the regression, we excluded all predictors that also influence fear/anxiety. Thus, only the Chronic Pain Perception Scale was retained. The estimated model was significant and explained 29.5 % of the variability in EE problems (Table 2).

4. Discussion

This study adds insight into factors associated with EE in dogs, supporting previous findings while also highlighting some divergences. Younger dogs showed more EE, consistent with their naturally higher energy levels and lower self-regulation capacity (Sulkama et al., 2021). Dogs that had lived with caregivers for a shorter period also showed more EE, possibly reflecting younger age or difficulties adjusting to household routines. Contrary to Sulkama et al. (2021), females tended to present higher EE, with intact females showing more problems than spayed females, in line with evidence that intact dogs may be more prone to Attention-Deficit/Hyperactivity Disorder (ADHD-like behaviors; González-Martínez et al., 2024).

Regarding intrapersonal variables, caregivers who were more neurotic, less open to experiences, and had insecure attachment styles reported higher EE in their dogs. Although novel for EE, these associations are consistent with findings for R/AMs (Batista et al., 2025a). Poorer caregiver mental health (anxiety, depression, and stress), was also linked to higher EE (Hunt et al., 2012; Luño et al., 2015; Siniscalchi et al., 2018), suggesting that unstable emotional states may create tense environments that contribute to EE (Hoppe et al., 2017).

From an interpersonal perspective, higher perceived costs and weaker caregiver–dog bonds were linked to EE, supporting evidence that unbalanced relationships increase the likelihood of behavioral problems (Pirrone et al., 2015; Serpell, 1996). Positive attitudes towards aversive training (Dodman et al., 2018) also predicted higher EE, consistent with studies linking such methods to elevated cortisol and impulsive behaviors (González-Martínez et al., 2024; Ziv, 2017). Finally, the caregiver's ability to recognize chronic pain acted as a protective factor (Batista et al., 2025b), as restlessness from pain can otherwise be misinterpreted as EE (Mills et al., 2020; Morey and Grau, 2013). These findings emphasize the importance of caregiver awareness for early pain detection to reduce EE associated with discomfort.

Regarding management, dogs walked once a day were evaluated by caregivers as having more EE than those not walked, while three daily walks were linked to fewer problems, suggesting that insufficient exercise may generate frustration whereas adequate activity reduces difficulties (González-Martínez et al., 2024; Hoppe et al., 2017). Dogs that

Table 1
Predictors of excess energy behaviors.

		Model 1 Dog characteristics	Model 2 Sociodemo-graphic variables	Model 3 Intrapersonal Variables	Model 4 Interpersonal variables	Model 5 Caregiving and management
Dog's age	β_{std} (β_i)	-0.278*** (-0.125)	-	-0.275*** (-0.124)	-0.243*** (-0.110)	-0.214*** (-0.097)
DASS: Stress	β_{std} (β_i)		-	0.218*** (0.600)	0.170*** (0.470)	0.166*** (0.458)
MDORS: Perceived Costs	β_{std} (β_i)		-		0.153*** (0.447)	0.163*** (0.447)
Attitudes Toward Aversive Training	β_{std} (β_i)		-		0.187*** (0.486)	0.192*** (0.498)
Chronic Pain Perception Scale	β_{std} (β_i)		-		-0.117*** (-0.071)	-0.106*** (-0.064)
Dummy variable: two basic behaviors	β_{std} (β_i)					-0.027 (-0.119)
Dummy variable: three basic behaviors	β_{std} (β_i)		-			-0.069 (-0.285)
Dummy variable: four basic behaviors	β_{std} (β_i)		-			-0.132** (-0.515)
Dummy variable: medication	β_{std} (β_i)		-			-0.085* (-0.327)
Intercept β_o		2.880	-	1.768	0.448	0.601
Explained variance (R_a^2)		0.076	-	0.122	0.198	0.213
Increment (R_{change}^2)		0.077	-	0.047	0.079	0.019
Model significance		$F(1, 728) = 60.931$ $p < 0.001$	-	$F(3, 727) = 51.716$ $p < 0.001$	$F(5, 724) = 37.077$ $p < 0.001$	$F(9, 720) = 22.973$ $p < 0.001$

Note. * $p < .05$, ** $p < .01$, *** $p < .001$. The criterion variable corresponds to problems of excess energy (minimum = 0; maximum = 10). Medication was coded as a dummy variable (does not take = 0; takes = 1). Training of three basic behaviors was also coded as a dummy variable (one behavior = 0; three behaviors = 1), as well as the training of four basic behaviors (one behavior = 0; four behaviors = 1).

Table 2
Predictors of excess energy behaviors, including fear/anxiety as a predictor.

		Model Including Fear/Anxiety
Chronic Pain Perception Scale	β_{std} (β_i)	-0.090** (-0.055)
Fear/anxiety	β_{std} (β_i)	0.533 (0.392)
Intercept β_o		0.844
Explained variance (R_a^2)		0.295
Model significance		$F(2, 727) = 153.354$, $p < 0.001$

Note. ** $p < .01$, *** $p < .001$. The criterion variable was excess energy problems (minimum = 0; maximum = 10).

knew more basic behaviors were evaluated as having lower EE, reinforcing the protective role of training and mental stimulation (Pirrone, 2015). In contrast, dogs that had received professional training were often evaluated as having higher EE, possibly because caregivers seek help when problems are already severe and because unregulated training may still rely on aversive methods. Consistently, dogs corrected with the word “no” were evaluated as having less EE than those punished. Anthropomorphism was not associated with EE, possibly because when dogs' needs are met through exercise and education, treating them as “children” does not translate into problematic behavior (Pirrone et al., 2015). Finally, dogs under medication were evaluated as having fewer EE, suggesting that treatment, whether behavioral or medical, can support management of these behaviors.

Regression analysis identified the main predictors of EE. Dog age was the most consistent variable, but caregiver-related factors such as stress and attitudes towards aversive training showed comparable weight, underscoring the role of the caregiver–dog relationship. Perceived costs and pain recognition also contributed, as did knowing more basic behaviors and medication use, highlighting the importance of both interpersonal and management variables. The final model explained 21.3 % of the variance. Adding fear/anxiety raised this to 29.5 %, confirming its strong influence on EE (González-Martínez et al., 2023; Tiira et al.,

2016).

However, chronic pain is known to produce mixed behavioral outcomes: although it can increase restlessness, hypervigilance, and pacing (Mills et al., 2020), it frequently reduces spontaneous activity and mobility (Stevens et al., 2025). This dual pattern may help explain why pain perception remained a predictor of EE in our sample, as caregivers may interpret pain-related agitation or discomfort as excessive energy. Furthermore, dogs receiving medication showed lower EE, consistent with the expectation that treatment reduces pain-linked arousal, whereas untreated dogs may display more behaviors that caregivers interpret as EE.

This study has some limitations. Its cross-sectional design prevents causal inferences, and the use of an online self-report questionnaire may have introduced reporting bias. The predominance of women in the sample may also limit generalizability. Moreover, no definition of EE was provided to participants, which may have increased variability in interpretation. Finally, relying on caregiver-reported measures of EE and fear/anxiety may have led to subjective assessment of behaviors.

Future research should use longitudinal designs to clarify causal pathways between caregiver characteristics, fear/anxiety, and EE. Broader recruitment, particularly of male caregivers, would strengthen generalizability. Intervention studies targeting caregiver stress, training practices, and pain recognition represent promising strategies to reduce EE in dogs.

5. Conclusion

These results highlight the need for an integrated approach to managing EE in dogs. Caregiver factors such as mental health, bond quality, training attitudes, pain recognition, and basic education were central. Dogs under medication were evaluated by caregivers as having fewer EE, suggesting that appropriate care improves welfare. Fear and anxiety also emerged as key comorbidities. Interventions should therefore combine caregiver education, basic training, attention to pain, medication when needed, and assessment of emotional states to improve

outcomes for dogs and caregivers, in line with a One Health/One Welfare perspective.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CRediT authorship contribution statement

Batista Maria da Conceição Espírito Santo Toscano: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Catarina Lavrador:** Writing – review & editing, Supervision. **Gonçalo da Graça-Pereira:** Writing – review & editing, Supervision, Resources, Conceptualization.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) used DeepL Translate to improve the clarity and readability of the English language. After using this tool, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

Declaration of Competing Interest

The authors declare no conflicts of interest.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.applanim.2025.106900](https://doi.org/10.1016/j.applanim.2025.106900).

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