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Quantifying youth dog-facilitated physical activity and potential associated factors

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Abstract: Currently, two in three American youth do not meet the National Physical Activity (PA) Guidelines. Dog-facilitated PA (e.g., dog walking and active play) is a promising target to promote youth PA. The study purposes were to 1) determine the quantity and intensity of dog-facilitated PA, 2) compare accelerometry and parent-report measurement methods, and 3) evaluate whether child-dog bond strength, child sex, yard size and/or dog size were associated with dog-facilitated youth PA. Children and their dog(s) wore ActiGraph accelerometers with a Bluetooth proximity feature for 7 days. Accelerometers are wearable devices that measure acceleration and are commonly used to estimate the intensity, duration, and patterns of physical activity. Additionally, parents logged child PA with the dog(s). Minutes of dog-facilitated moderate-to-vigorous PA (MVPA) were calculated from both measures. Twenty three children (mean age = 8.5 ± 1.4 years; 91.3% White) participated. Dog-facilitated mean daily minutes of MVPA assessed by accelerometer and parent-report were 16.6 (10.9) and 7.3 (7.4), respectively. There were no statistically significant differences between any of the associated factors and mean daily dog-facilitated MVPA. This study found nearly a quarter of average daily MVPA came from dog-facilitated PA. This is a potentially meaningful contribution to overall PA. Research in this field can be used to inform PA intervention development. Parent-reported PA vastly underestimated dog-facilitated PA when compared to device based measurement, and therefore future studies should consider using accelerometry to quantify dog-facilitated PA. Future studies should recruit larger, more diverse samples.

Keywords: human-animal interaction; movement; accelerometer; pediatric

HIGHLIGHTS

- Paired child-dog accelerometers provided an objective method for identifying dog-facilitated physical activity.
- Dog-facilitated physical activity contributed 22.0% of youths' mean daily moderate-to-vigorous physical activity.
- Parents reported nearly twice as much child-dog active play as dog walking.

INTRODUCTION

Currently, two in three children in the United States do not meet the National Physical Activity Guidelines of 60 minutes of moderate-to-



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vigorous physical activity (MVPA) each day (Friel et al., 2020). For youth, MVPA may include activities such as brisk walking, running, sports participation, or active games. These recommendations are higher than adult physical activity guidelines, reflecting the importance of regular activity in youth populations. However, a majority of youth in the United States do not meet these guidelines and therefore do not receive the many favorable health outcomes linked to youth physical activity, including improved cardiometabolic health, muscular and cardiorespiratory fitness, and bone health (Centers for Disease Control and Prevention, 2008). Novel, effective physical activity interventions for youth are urgently needed.

Dog-facilitated physical activity (e.g., dog walking, active play with the family dog) is a promising target for youth physical activity interventions. Research in the adult population has demonstrated that adult dog owners are more likely to meet physical activity guidelines than non-dog owners (Cutt et al., 2008; Soares, 2015; Potter & Sartore-Baldwin, 2019) and there is the potential for a similar relationship with the youth population. Additionally, one in two households in the United States already own a dog (Applebaum et al., 2020), suggesting the potential for high-reach physical activity interventions. Furthermore, human-animal interaction is known to provide numerous social-emotional health benefits for youth (Black, 2012; Mueller & Callina, 2014; Kertes et al., 2017; Flynn, 2020), adding to the health benefits of physical activity alone for improving overall quality of life.

As showed in [Figure 1](#), the rationale for this research is rooted in evidence that personal factors, including enjoyment, motivation, and social support, are associated with increased youth physical activity (Sterdt et al., 2014). Leveraging the human-animal bond between the child and family dog may lead to increased enjoyment of physical activity and social support for physical activity (through pet companionship), and thereby increase the likelihood of higher youth physical activity levels. Dog walking may also lend itself well to becoming a habitual behavior, which is increasingly recognized as an important factor for physical activity maintenance (Rebar, 2016).

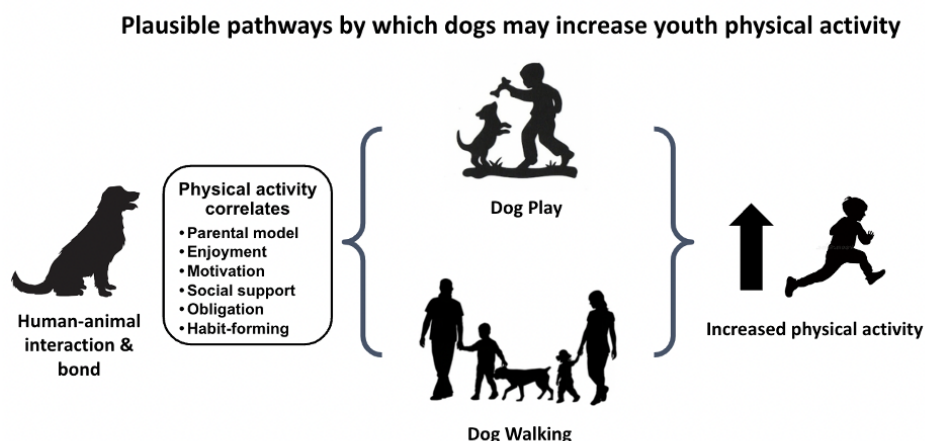


Figure 1. Conceptual model illustrating plausible pathways by which dogs may facilitate youth physical activity.



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Recent research shows a promising association between family dog ownership and youth physical activity levels (Chase et al., 2022); however, other factors may confound this association. These factors include differences in demographics between pet-owners and non-pet-owners (Marsa-Sambola, 2016; Saunders et al., 2017; Mueller et al., 2021), such as race/ethnicity or income, or that more active families may be more likely to own a dog, both of which could lead to a positive association that is unrelated to dog-facilitated physical activity. One of the contributing factors towards the lack of knowledge on the degree to which dog-facilitated physical activity contributes towards overall youth physical activity is the limited device-based physical activity research measurement tools utilized thus far in this field, which has primarily utilized self-report tools and few accelerometry measurement tools (Chase et al., 2022). In a recent review, only 55.6% of studies relied on self-report measures while only 38.8% included device-based measures (Chase et al., 2022). Self-report measures may be widely used because they are relatively low-cost, easy to administer, and feasible in larger samples; however, as wearable technologies become more accessible, device-based measures may increasingly be used to provide more objective estimates of PA.

Quantifying the volume and intensity of dog-facilitated physical activity for youth is important because if dog-owning children receive a significant amount of their daily physical activity through dog-facilitated physical activity, this would provide the rationale for increasing access to opportunities for dog walking and active play with dogs for non-dog owning youth. Socioeconomically disadvantaged youth populations are more likely to have poorer health outcomes and lower physical activity



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levels (Jackson et al., 2018), and therefore receive great benefits from increased physical activity; however, they may have less access to dog ownership due to rental restrictions or financial barriers. Interventions could reduce barriers to dog ownership for families, including rental restrictions on pets, or increase access to physical activity with non-owned dogs, such as through shelter dog walking programs or after-school programs involving therapy dogs, dog training or dog walking. If dog-owning children are not receiving a significant amount of their daily physical activity through dog-facilitated physical activity, future interventions may target increasing the amount of physical activity through home-based family interventions targeting dog walking education, dog-training and/or improving the human-animal bond. Furthermore, little is known about predictors of higher levels of dog-facilitated physical activity in youth.

The purposes of this study were to 1) determine the quantity and intensity of objectively-measured dog-facilitated physical activity among dog-owning youth ages 7 to 10 years old, 2) quantify youth dog-facilitated physical activity levels by comparing the Bluetooth proximity feature of paired child and dog accelerometers with parent-report measures, and 3) evaluate whether the strength of the child-dog bond, biological sex of the child, yard size and/or dog size are associated with higher amounts of dog-facilitated youth physical activity.

METHODS

Research study approval was received from both the lead author's Institutional Review Board (IRB) and Institutional Animal Care and Use Committee (IACUC) prior to beginning data collection.

Participants

Children aged 7-10 years old in grades 2 to 5 (i.e., elementary school aged) were recruited. To be eligible to participate, the family must have currently owned at least one dog and have owned all current dogs for at least 1 year. Participating family members must have been able to speak and read English, and participating children must have been ambulatory. The family dog(s) could not have any conditions that prohibited walking and must have been at least 1 year old at the time of the data collection. We made efforts to recruit a diverse population by recruiting in areas with higher populations of Black and Latino families through providing recruitment materials to community schools, libraries, and youth organizations to distribute through their virtual networks (i.e., Listservs, newsletters, school



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webpages), or hardcopy paper flyers to hang in their public areas. Internal recruitment (i.e., prior participant database, university newsletter) methods were also utilized, and flyers were hung by undergraduate research assistants in local community locations. Social media (i.e., Facebook) ads were utilized to reach a wider population. All family members were invited to participate; however, data from only one child was selected to be included by a random generator if multiple siblings participated in the study.

Procedures

Participating families were given the option of virtual or in-person study participation; the virtual option was offered to reduce additional burden that may discourage families from lower socioeconomic status from participating. All families elected to complete their study participation virtually. The participating family members completed a 30-minute virtual orientation on Zoom, and then electronically signed informed consent and informed assent forms. The family was then mailed the physical activity monitoring devices (ActiGraph GT3X accelerometers). Children then wore the device on their wrist 24 hours/day for 7 days, and the family dog(s) wore the device on their collar(s) for 7 days. This 7-day protocol has been previously successfully piloted with a small sample (n=12) of children ages 3 – 10 years old (Chase et al., 2022), and is a sufficient duration for collecting valid youth physical activity data in this field (Migueles, 2017). This week of physical activity measurement was scheduled while school was in-session for the child, and abnormal weeks (e.g., school testing, holidays, travel or school vacations) were avoided to ensure typical activity patterns were captured. Devices were mailed back in a provided prepaid padded envelope following the 7-day session of data collection. During the 7-day data collection window, children were asked to complete the Network of Relationships Inventory Pet, and parents were also asked to complete a daily survey reporting any child-dog physical activity, in addition to a one-time online questionnaire packet.

Measures

Physical Activity

Accelerometry: Child physical activity was measured using the ActiGraph GT3X (ActiGraph LLC, Pensacola, FL) accelerometer worn on the non-dominant wrist. This research-grade device contains a triaxial accelerometer which can provide measures of physical activity that are validated in this age group and used in large-scale youth physical activity measurement studies (Evenson & Wen, 2015). Accelerometers were initialized with a start



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time of 12:00AM on the first day of data collection, with a sample rate of 30Hz and idle sleep mode disabled. The devices were also set as receivers to track which minutes of physical activity were performed in proximity with the beacon device, which was zip tied on the dorsal side of the dog's collar, as described in previous literature validating the use of ActiGraph accelerometers for dogs (Yam, 2011). The accelerometer captured the child's physical activity during valid wear time, while the Bluetooth proximity feature was used to identify periods when the child was near their dog. Activity accumulated outside of the dog-proximity time frames was classified as activity without the dog and was not considered dog-facilitated physical activity.

The raw data provided by ActiGraph devices was downloaded using Actilife software (Version 7.2.0.0) and processed with GGIR (version 3.3-0) in R. A minimum of 16 hours of wear time per day was required for inclusion in analyses. Validated youth cutpoints (ENMO) (Hildebrand et al., 2014; Hildebrand et al., 2017) were used to determine minutes spent in light (< 201.00), moderate (201.00 – 707.00) and vigorous (707.00) physical activity intensities. Further, the minute-by-minute, time-stamped physical activity data were processed alongside the minute-by-minute, time-stamped proximity data to evaluate the physical activity performed in proximity with the dog. The time-stamped data was also aligned with the parent-reported physical activity behavior data (description below) to provide the physical activity quantity and intensity during parent-reported bouts of dog-facilitated physical activity via GGIR's activity log function.

Parent report: Parents were asked to complete a daily log on each of the 7 days of physical activity measurement. Each evening, parents received an automated text at their requested time (e.g., between 6:00pm to 9:00pm). This text provided a link to that day's brief online questionnaire facilitated via Qualtrics and formatted for a phone. This questionnaire asked parents to report their child's sleep and wake times for that day, any instances of device removal (and time and duration of device removal), as well as details of observed dog-facilitated physical activity that day, school times, and extracurricular activities. For the dog-facilitated physical activity, parents were asked to report bouts of active play or walks that they observed, in addition to time and duration, to the best of their knowledge. This information was compared with the accelerometer proximity data.

Questionnaires

The following study questionnaires were facilitated via Qualtrics. The Network of Relationships Inventory Pet was completed online by the



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participating child, and the Demographics Questionnaire was completed online by the participating parent.

Network of Relationships Inventory Pet: The Network of Relationships Inventory Pet is a validated measure of the bond between the child and their companion dog (Cassels et al., 2017). It has four subsections with three questions each for a total of 12 questions. The subsections are Satisfaction (i.e., How happy are you with the way things are between you and your pet?), Companionship (i.e., How much you play around and have fun with your pet?), Disclosure (i.e., How much do you share secrets and private feelings with your pet?), and Conflict (i.e., How much do you and your pet argue with each other?). Scores range from 0 to 15, with higher scores indicating a stronger bond on the satisfaction, companionship and disclosure subscales, and lower scores indicating a stronger bond on the conflict subscale. The validity of this questionnaire has been supported in youth populations (Cassels et al., 2017).

Demographics Questionnaire: Parents were asked to report child demographic information including race and ethnicity, socioeconomic status (via household income), and whether they live in a rural, suburban, or urban area. Yard sizes were reported as either small, medium, or large/very large. Dog sizes were reported as either small, medium, or large/very large. Children with multiple dogs of varying sizes were excluded from this analysis (n=4).

Statistical approach

The normality of the data was evaluated to determine whether parametric or non-parametric statistics were utilized. Mean daily minutes of light, moderate and vigorous physical activity with and without the dog (assessed via both Bluetooth proximity and parent report) were calculated to determine the percent contribution of dog-facilitated physical activity to overall physical activity.

Paired sample t-tests were used to compare the two different measurement methods. SPSS Statistics software (version 29.0.2.0 (20)) was used to compare the mean daily parent-reported MVPA values to the mean daily device-reported MVPA values, with $\alpha = 0.05$.

Pearson correlations were used to determine whether the strength of the child-dog bond was associated with greater contributions of dog-facilitated MVPA (as measured by device and proximity data) to overall MVPA. Multiple regression analyses were used to determine whether the sex of the child predicted greater contributions of dog-facilitated MVPA (as measured by device and proximity data) to overall MVPA. One way ANOVA analyses

were used to determine whether yard size or dog size predicted greater contributions of dog-facilitated MVPA (as measured by device and proximity data) to overall MVPA.

RESULTS

Participant Demographics

Participant demographics are reported in [Table 1](#). Fourteen participants were recruited through social media (i.e., Facebook ads), 8 were recruited through University email recruitment database, and 1 was recruited through a friend. Twenty-eight participants were enrolled in the study; however, only 23 participants had valid data due to devices lost in the mail (n=1), not returned (n=1), damaged (n=1), battery dying prior to study completion (n=1), and participant dropping out early due to a family emergency (n=1).



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Age (years)	8.5 ± 1.4
Sex	9F (39.1%) 13M (56.5%)
	1 not reported (4.3%)
BMI (kg/m ²)	17.7 ± 3.1
BMI z-score	0.4 ± 1.1
Race	
Asian	0 (0.0%)
Black or African American	1 (4.3%)
Native American or American Indian	0 (0.0%)
Native Hawaiian or Pacific Islander	0 (0.0%)
White	21 (91.3%)
Multiple Races Reported	1 (4.3%)
Ethnicity	
Hispanic or Latino	1 (4.3%)
Non-Hispanic or Latino	22 (95.8%)
Parental Education Level [n (%)]	
2 Year College	2 (8.7%)
4 Year College	6 (26.1%)
Master's Degree	6 (26.1%)
Doctoral Degree	4 (17.4%)
Professional Degree	4 (17.4%)
Other	1 (4.3%)
Community Type [n (%)]	
Rural	6 (26.1%)
Suburban	13 (56.5%)
Urban	4 (17.4%)
Household Income [n (%)]	
Prefer not to answer	1 (4.3%)
< \$25,000 - \$49,999	2 (8.7%)
\$50,000 - \$99,999	4 (17.4%)
\$100,000 - \$149,999	5 (21.7%)
\$150,000 <	11 (47.8%)

Table 1. Participant Demographics (N = 23; mean ± SD or n (%)).

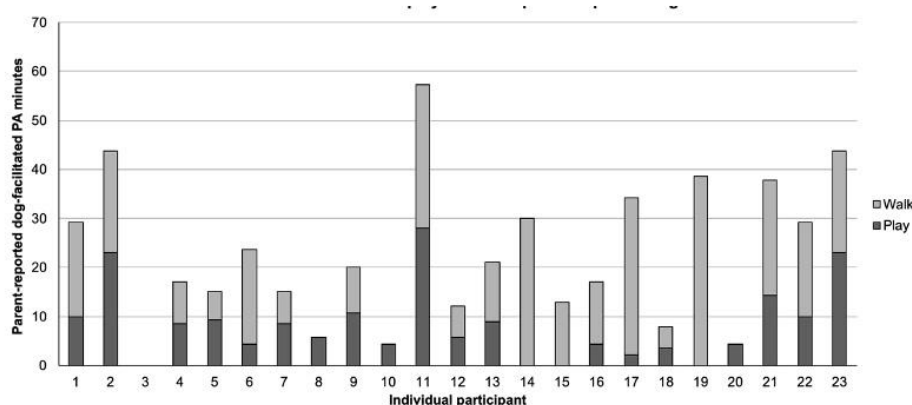
Physical Activity Results

Data were normally distributed. Of the overall parent-report data for participants with completed questionnaire data (n=23), 7.4±7.3 mean daily minutes were reported as dog walking, and 13.9±11.7 of mean daily minutes were reported as active play with the dog. [Figure 2](#) (panel A) shows the contribution of dog walking and active play to mean daily dog-facilitated physical activity minutes for each participant.

According to the accelerometer proximity data, dog-facilitated MVPA contributed an average of 16.6±10.9 minutes of daily MVPA for youth. This was 22.0% of mean daily overall MVPA. On average, parents (n=23)

reported 7.4 ± 7.3 mean daily minutes of dog walking and 13.9 ± 11.7 daily minutes of active play with the dog. [Figure 2](#) (panel B) shows the contributions of dog-facilitated MVPA minutes to overall MVPA minutes for each participant, based on accelerometry data.

Panel A: Individual contributions of walk versus play to overall parent-reported dog-facilitated PA



Panel B: Individual contributions of dog-facilitated MVPA to overall MVPA

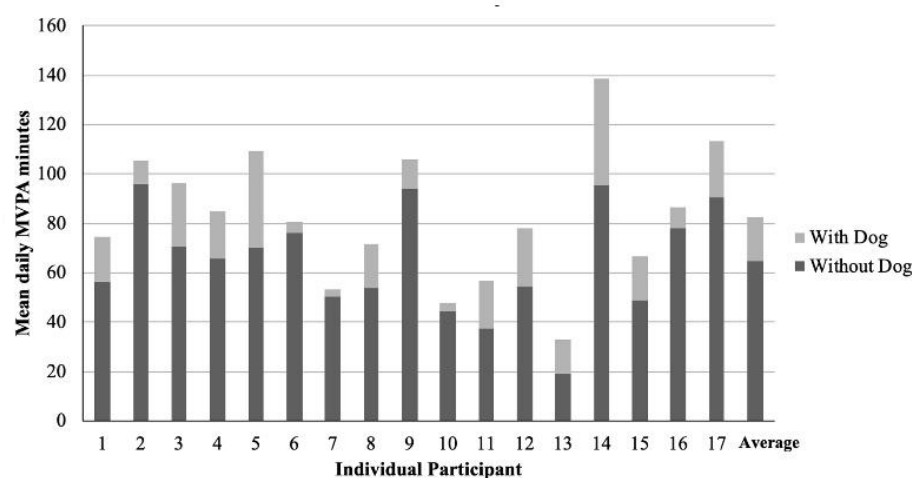


Figure 2. Panel A: Mean contributions of parent-reported dog-walking minutes and active-play minutes to overall parent-reported dog-facilitated MVPA minutes for participants with valid parent-report data ($n=23$). Panel B: Mean contributions of dog-facilitated MVPA minutes to overall MVPA minutes of individual participants with valid accelerometry data ($n=17$).

Predictors Results

There were no statistically significant associations between NRI-Pet subscale scores and mean daily dog-facilitated MVPA. There were no correlations between satisfaction and mean daily dog-facilitated MVPA ($r = 0.005$, $p = 0.985$), companionship and mean daily dog-facilitated MVPA ($r = -0.037$, $p = 0.884$), disclosure and mean daily dog-facilitated MVPA ($r = 0.072$, $p =$



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0.777), or conflict and mean daily dog-facilitated MVPA ($r = -0.112$, $p = 0.659$). There were no statistically significant associations between the biological sex of the child and mean daily dog-facilitated MVPA ($F = 0.017$, $p = 0.898$). There were no statistically significant associations between the size of the yard and mean daily dog-facilitated MVPA ($F = 0.240$, $p = 0.789$). There were no statistically significant associations between the size of the dog and mean daily dog-facilitated MVPA ($F = 0.963$, $p = 0.407$).

DISCUSSION

Currently, 2 in 3 children in the United States do not meet the National Physical Activity Guidelines of 60 minutes of moderate-to-vigorous physical activity each day (Friel et al., 2020). Dog-facilitated physical activity is a promising target for increasing youth physical activity. This study aimed to quantify the volume and intensity of dog-facilitated physical activity for youth, compare measurement methods, and advance knowledge of factors (i.e., sex of the child, strength of the human-animal bond, yard size, and dog size) that are associated with dog-facilitated physical activity in youth.

This study found that nearly a quarter (22%) of average daily MVPA came from active play with the dog or dog walking. This is a potentially meaningful contribution to overall physical activity. This aligns with prior research indicating a positive relationship between dog ownership and youth physical activity, with multiple studies directly linking dog-ownership with higher youth physical activity levels (Salmon et al., 2010; Sirard et al., 2011; Christian et al., 2013; Martin et al., 2015; Engelberg, 2016). However, future studies should explore whether dog-owning children are engaging in more physical activity than a control group of non-dog-owning children utilizing these more precise objective physical activity measurement methods. Additionally, future studies should compare children who are not meeting the physical activity guidelines to children who are meeting the physical activity guidelines to see whether dog ownership is a predictive factor. Finally, a recent study (Adams et al., 2024) found that dog acquisition positively impacted youth physical activity, and dog loss negatively impacted youth physical activity, and therefore research should continue to explore the impact of dog acquisition on the physical activity levels of the children within the household, to see whether there are any significant changes.

Furthermore, according to parent-report data, about twice as much mean daily child-dog activity was active play time (13.9 minutes) as compared to dog-walking time (7.4 minutes). Unlike adults, children may engage more



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with dogs through playful activities, such as fetch, chase, or other interactive games, rather than structured walks. Play-based interactions may align better with the physical activity choices of children, and could provide more varied opportunities for MVPA. This may make dog-facilitated play a valuable focus for interventions aimed at youth populations. By prioritizing dog play, future research could more effectively tap into youth physical activity correlates and the ways in which children interact with their dogs to encourage increased physical activity. However, family and/or youth dog-walking also remains a valuable intervention target as there is more room for a greater contribution to daily dog-facilitated physical activity. Of the two known dog-facilitated physical activity interventions in youth populations (Morrison, 2013; Ng et al., 2022) thus far, both reported neutral findings. Future studies could also examine whether dog-facilitated physical activity (both active play and walking behaviors) occurs in discrete bouts or is distributed throughout the day, and whether certain times of day increased likelihood of increased dog-facilitated physical activity.

This research study also compared the novel measurement method of accelerometry proximity device measurement to the traditional measurement method of self-reporting. The results supported the hypothesis that parents reported fewer daily dog-facilitated MVPA minutes (-11.7) than the devices. The small study sample size should be taken into consideration when interpreting these results. Furthermore, the Bluetooth methods of the accelerometry have not been validated via direct observation for this method and use. Therefore, future studies should consider direct observation in conjunction with these methods to determine any misclassification of proximity that would be of importance prior to scaling up this measurement method. This would ensure that the development of future studies in this area use the measurement methods that are the most accurate, or that the over- or under-estimation of dog-facilitated physical activity by parent-report or accelerometry is better understood.

Several potential predictive factors were explored in this study. No significant associations were found, likely due to the small, underpowered sample size. The first factor was the strength of the human-animal bond. Considerations for future research are consistency of measurement methods utilized for the human-animal bond, and recruiting participants with a variety of human-dog bond strength. The two prior studies (Westgarth, 2013; Gadomski et al., 2017) examining family dog ownership and youth physical activity, which both found positive associations between a child's pet attachment and their levels of physical activity with the dog, utilized



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two different questionnaires than the questionnaire utilized in this study. Consistency in human-animal bond measurement in youth physical activity studies could contribute to the repeatability of methods and comparability of outcomes.

Another factor explored was the biological sex of the child. This was not statistically significant, possibly due to the relatively small sample size. As research has demonstrated a sex disparity in youth physical activity levels (Telford et al., 2016), with boys engaging in higher physical activity levels than girls, identifying potential intervention directions that promote increased physical activity for girls is essential. Several prior studies have also found that dog-owning girls engage in higher levels of dog-facilitated physical activity when compared to dog-owning boys in the same samples (Salmon et al., 2010; Christian et al., 2013; Christian et al., 2014); therefore, future studies should continue to explore the sex of the child as a potential associated factor of increased physical activity among dog-owning youth.

Furthermore, the adult literature has previously found an association of medium-to-large sized dogs contributing to higher portions of dog-facilitated physical activity to overall physical activity (Schofield et al., 2005; Westgarth et al., 2015); however, no prior research had explored this relationship in youth. The findings from this study, while not significant, suggest that small dogs may be just as beneficial for youth populations. This may be due to the smaller stature of children, and/or the approachability and reduced intimidation factor of smaller dogs. Future studies should consider expanding this dog-size predictor component to account for breed or breed types within dog sizes. While this study did not plan to recruit a sufficient sample size to examine breed-specific differences, future, larger studies should consider examining dog breed.

Finally, no significant associations were found in relationship to yard size and dog-facilitated physical activity; however the characteristics of the yard remain a plausible predictor of dog-facilitated physical activity. Prior research (Engelberg, 2016) reported that adolescents living in single-family homes walked their dogs about one day per week less than adolescents living in multi-family homes or apartments, and the authors hypothesized that this may be due to yard size differences. This study found that potentially greater contributions of youth dog-facilitated physical activity may come from play rather than walking, as discussed above; therefore, this predictor should continue to be explored with taking into consideration dog play.



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Strengths and Limitations

One strength of this study is the accelerometry methods. The novel methods and 24-hour protocol for accelerometry data were needed advancements in the data collection methods used within this field. Furthermore, all data were collected during the same season (meteorological spring); while day-to-day weather variations may still impact dog-facilitated PA, this controls for changes that may occur due to changes in seasons (e.g., winter versus summer weather, school year vs summer routines).

The small, homogenous sample is a limitation for the generalizability and interpretation of the results from this study. Intentional efforts were made to recruit a larger, more diverse population, by specifically sending recruitment materials to a wide range of schools and libraries and through the use of social media as a recruitment tool. However, the population was a majority White, high-income and highly educated households. This may be influenced by the field of study, as research has found that Black/non-Hispanic, Hispanic and Multiracial participants are less likely to own pets than White/non-Hispanic participants (Mueller et al., 2021). Future studies should recruit larger, more diverse samples to evaluate whether these findings hold in more diverse and generalizable populations.

CONCLUSION

This research contributed to the knowledge base on dog-facilitated physical activity for youth, in order to inform the development of future measurement methods and eventual interventions leveraging human-animal interactions in the long-term. The results of this study found that dog-facilitated MVPA contributed 22.0% of mean daily overall MVPA and that, according to parent-report data, about twice as much mean daily child-dog activity was active play time (13.9 minutes) as compared to dog-walking time (7.4 minutes). Furthermore, parents reported 11.7 fewer daily dog-facilitated MVPA minutes than the devices. Finally, no significant associations were found between any of the potential predictors (i.e., sex of the child, strength of the human-animal bond, yard size, and dog size) and dog-facilitated MVPA. Future studies with larger sample sizes should continue to explore whether and how dogs support physical activity in youth.

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COMPETING INTERESTS

The authors declare that they have no financial or non-financial competing interests to report.

ETHICS APPROVAL

All study procedures involving human participants were reviewed and approved by The University of Massachusetts Amherst Institutional Review Board, and all study procedures involving animals were reviewed and approved by The University of Massachusetts Amherst Institutional Animal Care and Use Committee.

CONSENT TO PARTICIPATE

Informed consent was obtained electronically from parents/guardians, and informed assent was obtained from participating children prior to data collection.

ANIMAL WELFARE

All procedures involving companion animals were non-invasive and were conducted in accordance with the approved IACUC protocol and relevant institutional guidelines for animal welfare.

AUTHOR CONTRIBUTIONS

CS, SB, MM and KP conceptualized the study. CS collected the data. CS and SB analyzed the data. CS drafted the manuscript. All authors contributed to manuscript revision and approved the final version.

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