People and Animals: The International Journal of Research and Practice

Volume 3 | Issue 1 Article 7

2020

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Benedikt Hielscher
Institute of Health Promotion and Clinical Movement Science, German Sport University Cologne, benedikt.hielscher@gmx.de

Udo Ganslosser
Institute of Zoology and Evolutionary Research with Phyletic Museum, Friedrich Schiller University Jena, udo@ganslosser.de

Ingo Froboese
Institute of Health Promotion and Clinical Movement Science, German Sport University Cologne, froboese@dshs-koeln.de

People and Animals: The International Journal of Research and Practice

Volume 3 | Issue 1 | ISSN: 2575-9078 (2020)

More Than "Just" Walking: An Observational Study of Dog-Related Physical Activities

Benedikt Hielscher,[1,2] Udo Ganslosser,[2] and Ingo Froboese[1]

Keywords: dog ownership, physical activity, dog walking, heart rate, steps per minute, physical activity recommendations

Abstract: Dog ownership has been shown to correlate with physical activity (PA). However, knowledge about the intensities of dog-related PA (drPA) is still lacking. To investigate the duration and intensity of drPA in consideration of PA guidelines, an observational study of dog owners (DO) was conducted.

For this purpose, DO were recruited in metropolitan and nonmetropolitan regions of Cologne, Germany. A total of 44 male and female DO (18–64 years) without cardiovascular or cardiopulmonary diseases participated in the study. Validated questionnaires were used to determine the PA profile and relationship of DO to their dog. Participants reported their drPA in an activity diary. Steps were determined by a pedometer. A heart rate (HR) monitor was used to analyze HR and percentage of maximum HR (HR_{max}) during all drPA. Overall, drPA makes up a large part of the duration of the overall PA recorded. HR and percentage of HR_{max} were significantly lower during dog walking (DW) than during other drPA. Nearly 90% of DW time was performed at light or very light intensity. No correlation between objectively measured PA and attachment to the dog was found. Two single case analyses show that other drPA reach high intensity levels and thus can be rated as moderate to vigorous intensity activities. The current investigation demonstrates that DW alone is insufficient to reach PA guidelines. Consequently, other drPA might have more beneficial effects than DW. In future investigations, the role of other types of drPA on PA levels needs to be taken into consideration to improve PA status in healthy populations.

(1) Institute of Health Promotion and Clinical Movement Science, German Sport University Cologne; (2) Institute of Zoology and Evolutionary Research with Phyletic Museum, Friedrich Schiller University Jena

Background

The physical activity (PA) guidelines of the World Health Organization (WHO) recommend that individuals should be active at a moderate intensity for at least 150 minutes per week (Hanifi et al., 2010). An alternate way to reach this recommendation is to be active for 75 minutes per week at a vigorous intensity (Hanifi et al., 2010). A mix of both intensities that is comparable to these recommendations is also feasible (Hanifi et al., 2010). Considering step-based recommendations, Tudor-Locke et al. (2011) recommend that at least 7,000 to 8,000 steps per day should be performed, of which at least 3,000 steps should be taken at a brisk walking pace.

Current knowledge suggests that dog owners (DO) are more active than non-DO (nDO) (Brown & Rhodes, 2006; Cutt, Giles-Corti, Knuiman, et al., 2008; Dall et al., 2017; Ding et al., 2018; Feng et al., 2014; Mein & Grant, 2018; Oka & Shibata, 2009; Solomon et al., 2013; Westgarth et al., 2019) and that DO reach PA guidelines more frequently than nDO (Cutt, Giles-Corti, Knuiman, et al., 2008; Dall et al., 2017; Levine et al., 2013; Moudon et al., 2007; Oka & Shibata, 2009; Westgarth et al., 2019). Further, Gillum and Obisesan (2010) concluded that DO were commonly highly active. This leads to the conclusion that dog ownership could be recommended for achieving PA recommendations. Then again, there exists a considerable number of DO who do not engage in dog walking (DW) (Richards, 2016).

Most studies on dog-related PA (drPA) use questionnaires to measure PA. Only a few studies measure PA objectively. Usually, they focus either on total PA behavior or DW. Coleman et al. (2008) used accelerometers in their study and showed that DO are more active than nDO, but they attributed this statement to the explicit effect of DW. Dall et al. (2017) found that DO spend nearly two hours walking their dog per day, but only 32 minutes at moderate intensity. This study, however, included only an elderly population. Richards et al. (2014) confirmed Dall et al.'s (2017) results in a younger population. But in this study DW averaged only 22 minutes of moderate to vigorous activity per day. However, not only DW but also other drPA (e.g., agility, running or riding a bicycle with one's dog, general play, dog training, dog school, etc.) have to be taken into account to assess the PA level in DO because they might be performed at higher intensities than DW and thus have a major impact on human health.

Furthermore, some evidence suggests that attachment to one's dog is an important factor that could influence PA behavior positively (Oka & Shibata, 2012; Westgarth et al., 2014); while other investigations failed to confirm a beneficial effect (Hoerster et al., 2011). Another study by the authors found that attachment is associated with drPA, but not total PA (Hielscher et al., 2021). Little is known about the role of different drPA and attachment on reaching (health-concerning) guidelines for PA. In particular, studies that focus on the intensity of drPA are lacking.

Research Question

The purpose of this study was to gain a more detailed understanding of the impact of different drPA on health-related PA in a German setting. As a consequence, the goal was to compare other drPA with DW and other PA (PA without dogs) (oPA) in terms of their extent, duration, and intensity. Additionally, the influence of attachment on the PA behavior was part of the current investigation.

Materials and Methods

This observational study was conducted in the metropolitan and nonmetropolitan regions of Cologne, Germany. In total 53 DO were recruited via dog schools or social media groups for DO. Convenience sampling was used to recruit participants from these populations. Participants were included if they were between 18 and 64 years old and had a maximum of five dogs. Participants who reported any cardiovascular or cardiopulmonary disease were excluded from the study.

Participants filled out a self-report questionnaire containing questions on sociodemographics (age and

sex of participant, relationship and occupational status, smoking status, garden ownership, and whether or not participants grew up with animals), anthropometrics (weight in kg, height in m, disease), dog ownership particulars (number of dogs living at home, duration of dog ownership in total, whether the participant was the person mainly responsible for the dog), dog characteristics (age in months, sex of the dog, neutering status, how long the dog has lived in the household in months, body size in cm at the shoulder, weight and breed), participant's own exercise behavior, and attachment to one's dog. Garden ownership was surveyed in three categories: garden directly at the house, garden not directly at the house, and no garden. Some garden owners in Germany own a garden that is not directly adjacent to the house. These allotment gardens could be an important place to visit with dogs, especially for people who live in cities. Waist circumference (WC) was measured in light clothing by the first author.

Participants' self-reported PA was measured using the German Physical Activity, Exercise, and Sport Questionnaire (BSA-F), which was validated by Fuchs et al. (2015). The BSA-F uses the frequency and time of activities during the past four weeks to evaluate PA. PA was measured as hours per week (h/week). It differentiates between activities of daily living (ADL), exercise activities, and total PA (which is the sum of ADL and exercise activities). Most of these variables have been shown to correlate on a low to moderate, but significant level with maximum oxygen intake (VO_2max; Pearson $r = .35$, $p < .01$; Pearson $r = .24$, $p < .01$; Pearson $r = .34$, $p < .01$), power at the individual anaerobic threshold (p(IAT) Watt; Pearson $r = .35$, $p < .01$; Pearson $r = .27$, $p < .01$; Pearson $r = .34$, $p < .01$), and p(IAT) corrected for body weight (p(IAT/body weight) Watt/kg, Pearson $r = .24$, $p < .05$, Pearson $r = .18$, $p > .05$, Pearson $r = .23$, $p < .05$) (Fuchs et al., 2015). Additional questions for drPA contained DW, jogging, and riding a bicycle accompanied by one's dog. Further, questions about other drPA were included. The questions about other drPA were formulated openly. In this way, the participants were able to enter all the different types of activities they performed during the past four weeks. Since it was not yet known which activities were performed by DO, the open-ended question approach had an advantage over closed questions. The participants were thus completely free in the possibility of their statements and the likelihood that their activities were overlooked decreased. The additional dog-related questions were phrased to mirror the questions from the BSAF.

To measure attachment the German version of the Lexington Attachment to Pets Scale (LAPS) was applied. The LAPS is a widely used tool to measure attachment and was originally developed and validated by Johnson et al. (1992). It has been shown to be reliable in the German population (Cronbach's $\alpha = .89$, ICC = .95) (Hielscher et al., 2019).

The questions were provided in a paper and pencil questionnaire. The participants took the questionnaire home with them, filled it in there, and handed it back to the first author one week later after the observation period had ended.

Participants reported all drPA for six consecutive days in an activity diary. The diary consisted of a table and contained columns in which to record activity type, whether the heart rate (HR) monitor was worn, start and end time of the activity, and number of steps before and after the activity.

The contestants were instructed to use a pedometer (Omron HJ-113-E) during the daily waking hours, except during water-related activities (swimming, diving, etc.) or if there was a risk of injury from the technical equipment for the participants. Omron pedometers were proven valid for steps, but not for distance measurements (Giannakidou et al., 2012). Thus, no analyses were performed using distances.

Time and duration, as well as the steps the pedometer displayed before and after PA were registered by the participants. Only PA that lasted at least 10 minutes was included in the statistical analyses. This restriction is based on the WHO recommendations for PA that state that aerobic activities should last at least 10 minutes to be regarded as health-enhancing PA (Hanifi et al., 2010). Total steps per day (steps/day), steps during DW, during other drPA and oPA, as well as duration of DW, other drPA, and oPA were reported. Steps per minute (steps/min)

were calculated for each activity. The calculations were performed by the first author who is an exercise scientist with a master of science degree. Performed PA were classified based on the recommendations of Tudor-Locke et al. (2019):

- Light intensity (< 100 steps/min)
- Moderate intensity (100 - < 130 steps/min)
- Vigorous intensity (≥ 130 steps/min).

During drPA participants were instructed to use a HR monitor (Polar RS400). HR was recorded in 1-second intervals. The validity and test-retest reliability of the Polar RS400 are very high (Engström et al., 2012). HR_{max} was calculated using the formula of Tanaka et al. (2001). A first visual scan of the HR was performed after data were transferred to the manufacturer's program: Polar ProTrainer 5. For further evaluation they were copied into an Excel file (Microsoft Excel for Mac ® 2013). Homogenous HR in a time interval of a minimum of 9 seconds or HR exceeding 200 beats per minute were classified as error in measurement and excluded from this activity. If more than 50% of the HR of an activity was classified as error, this activity measurement was excluded from all following analyses. HR were classified into different intensity levels by calculating percentage of HR_{max}, using the guidelines of the American College for Sport Medicine (ACSM). Very light intensity was defined as < 57% of HR_{max}, light intensity as 57–63%, moderate intensity as 64–76%, vigorous intensity as 77–95%, and nearly maximum HR as ≥ 96% (Riebe et al., 2018, p. 146). HR values that exceeded 100% of HR_{max} were classified as > 100%.

After participants received the pedometers and HR monitors, they went through the functionality together with the first author and demonstrated that they were able to operate the devices independently. They also received a manual. They were informed that at least one day of data collection had to take place on a weekend day so that the data could be used. However, due to the six-day observation phase, this was not a problem for any of the participants included. Finally, they were informed that they could contact the first author at any time via e-mail or telephone with any questions about the devices and the examination procedure.

Ethical approval was given by the ethics committee of the German Sport University Cologne (165/2017).

Statistical Analysis

Participants were excluded if they did not report data on three or more days. Moreover, at least one of the observation days had to be taken on the weekend.

Waist-to-height ratio (WHghtR) was calculated and dichotomized depending on participants' age using the cutoff values proposed by Schneider et al. (2010). This resulted in the categories "good WHghtR" and "poor WHghtR." For an age between 40 and 50 Schneider et al. (2010) assume the cutoff level to be between .50 and .60. Thus, for people between 40 and 50 years of age the cutoff level was set at .55. If participants exceeded the stated WHghtR cutoff levels, they were classified as participants with a poor WHghtR.

For questionnaire and diary data, outliers were identified in a two-step process. Following a visual scan using a histogram, outliers were calculated by adding and subtracting three standard deviations (*SD*s) from the mean in all metric variables. They were excluded from further analyses with the affected parameter. However, total PA by the BSA-F was only used in the statistical analysis if the individual scales of the BSA-F did not contain an outlier.

All data are presented as mean ± *SD* in tables. SPSS statistics (IBM SPSS Statistics, Version 26.0) was used for statistical analyses. All tests in the descriptive analysis were performed as two-sided tests and the significance level was set at $\alpha = 0.05$. Since the present investigation was conducted as an exploratory study, endpoints are regarded equivalently. As such, no correction for multiple testing was performed.

Differences in HR, steps, steps/min, and duration of PA were statistically compared between DW, other drPA, and oPA. The Kolmogorov-Smirnov test was performed to test for normal distribution. If there were at least 30 values, a normal distribution was assumed according to the central limit theorem (Field,

2014, p. 172). For HR and percentage of HR_{max} independent *t*-tests were used. To evaluate the magnitude of the effect of the *t*-tests, Cohen's *d* was calculated. Differences in steps, steps/min, and duration of activities were evaluated using the Kruskal-Wallis test with corrected pairwise comparisons, since data cannot be assumed to be distributed normally. χ^2-tests were used for nominal and ordinal data of demographic data. For correlations Spearman's *r* was used, due to missing normal distributions.

Results

A total of 53 male and female DO met the inclusion criteria and participated in the study. Six participants were excluded because either the questionnaire or the exercise diary had not been completed. Data of two participants were incomprehensible and one more participant reported a cardiovascular disease retrospectively. Thus, data of 44 participants were analyzed. The demographic, anthropometric, and dog-related data of the analysis population are summarized in Table 1. The most prominent dog breeds were Australian Shepherd (6 dogs), Border Collie (4 dogs), and Labrador Retriever (4 dogs).

In the questionnaire all participants reported DW: 28.6% reported jogging and 16.7% reported bicycle riding with their dog; 76.7% reported other drPA besides DW, jogging, or bicycle riding with one's dog. The results of the PA diary are shown in Table 2.

Analysis of duration of different types of activities did not reveal any statistically significant differences in the PA diary (Table 2). Tests for differences between steps per activity type indicated that compared with other drPA or oPA, DW provided the most steps per activity (Table 2). For DW, the average steps/min were significantly greater than for other drPA and oPA (Table 2). However, differences in intensity-level categories as measured by steps/min were not statistically significant (Table 3).

Mean HR during DW (M = 98.84 ± 14.11) was lower compared to other drPA (M = 105.52 ± 32.13, t = 57.57, df = 88670, p < .001, Cohen's d = -.27). Percentage of HR_{max} shows similar results (M_{DW} = 54.75 ± 7.43, $M_{other\ drPA}$ = 57.51 ± 17.27, t = 42.68, df = 81247, p < .001, Cohen's d = .21). The distribution of percentage of HR_{max} demonstrates that DW is performed at lower intensities compared with other drPA (Table 4).

Statistically significant correlations were observed between the duration of DW from the BSA-F and the PA diary (n = 43, $r_{Spearman}$ = .59, p < .001), the duration of DW from the BSA-F and the number of steps during DW per day (n = 44, $r_{Spearman}$ = .62, p < .001), the average duration of drPA in the PA diary and the average duration of drPA of the BSA-F (n = 38, $r_{Spearman}$ = .65, p < .001), and the average steps of all drPA per day and the duration of all drPA as reported in the BSA-F per week (n = 39, $r_{Spearman}$ = .63, p < .001).

Attachment scores did not correlate with DW steps per day ($r_{Spearman}$ = -.06) or steps at total drPA ($r_{Spearman}$ = -.06) or total steps ($r_{Spearman}$ = -.18).

Two drPA from different study participants are illustrated here as an example (Figures 1 and 2). Figure 1 shows the HR of a scooter tour of participant no. 6 (female, 35 years, height = 1.72 m, BMI = 21.97 kg/m^2, WHghtR = .42). The dog was a female, non-neutered Maltese (height at shoulder = 29 cm, weight = 5.8 kg, age = 89 months). The activity lasted 48 minutes; 1.4% of the time was at very light, 5.7% was at light, 26.3% at moderate, 46.3% at vigorous, and 12.6% at near maximum intensity; 6.2% of the time HR was higher than the calculated HR_{max}; and 1.6% of the HR time was defined as error. Average steps/min were 29.8.

Figure 2 shows the HR of a 40-year-old, 1.82 m tall male participant who reported fun-agility. Fun-agility is an activity that is comparable to normal agility, but does not have a competitive character. The dog has to cope with an obstacle course while the owner runs alongside the dog and gives it instructions about the course. The participant's BMI was calculated as 34.7 kg/m^2 and his WHghtR at the time of the study was .62. The dog was a female, neutered, medium German Spitz (height at shoulder = 31 cm, weight = 4.7 kg, age = 42 months). The activity lasted nearly 75 minutes. The percentage of HR_{max} reveals five peaks. Overall, 65.7% of the time

Table 1. Demographic, Anthropometric, and Dog-Related Data of LAPS and BSA-F

Variable		*n*	*M* ± *SD* or %
Age of participant in years		43	38.6 ± 11.3
Sex of participant	Male	6	13.6%
	Female	38	86.4%
Relationship status	In relationship	28	63.6%
	Single	16	36.4%
Occupational status	Occupied	38	88.4%
	Not occupied	5	11.6%
BMI in kg/m^2		41	25.5 ± 5.05
BMI in kg/m^2 categories	18.5–24.99	21	51.2%
	25.00–29.99	12	29.3%
	≥ 30.00	8	19.5%
WHghtR according to Schneider et al. (2010)	Good	33	78.6%
	Poor	9	21.4%
Smoking status	Yes	13	29.5%
	No	31	70.5%
Garden ownership	Adjacent to home	30	68.2%
	Not adjacent to home	2	4.5%
	No garden	12	27.3%
Grew up with animals	Yes	36	81.8%
	No	8	18.2%
LAPS		40	50.3 ± 9.34
Number of dogs		44	1.50 ± .76
Mainly responsible for dog	Yes	36	81.8%
	No	8	18.2%
Duration of total dog ownership in years		43	8.18 ± 9.82
Age of the dog in months[a]		66	60.4 ± 38.2
Size of the dog in cm[a]		56	49.3 ± 12.3
Weight of the dog in kg[a]		66	18.8 ± 9.0
Duration of ownership of this/these specific dog(s) in months[a]		66	46.9 ± 34.5
Dog breed[a]	Mongrel	33	50.0%
	Pedigree dog	33	50.0%
Sex of the dog[b]	Male	29	43.9%
	Female	37	56.1%
Neutering status[b]	Neutered	45	68.2%
	Not neutered	21	31.8%
Total PA (h/week)[b]		30	18.9 ± 9.52
Total drPA (h/week)[b]		39	11.6 ± 6.28
DW (h/week)[b]		44	10.3 ± 6.21
Running with dog (h/week)[b]		42	.13 ± .30
Bicycle riding with dog (h/week)[b]		42	.09 ± .32
Other drPA (h/week)[b]		43	1.98 ± 2.16

[a] *n* of these variables is bigger than 44 because several owners had multiple dogs; [b] BSA-F data; PA, physical activity; drPA, dog-related physical activity; LAPS, Lexington Attachment to Pets Scale; WHghtR, waist to height ratio.

Table 2. Statistical Analysis of Different PA Types from the Diary

Variable	*n*	Number of observed days *M* ± *SD*	*M* ± *SD*	H-value (*df*)	Kruskal-Wallis *p*
Steps DW/day	44[a]	5.61 ± .62	5,099 ± 3,803	Not calculated	
Steps total drPA/day	44[a]	5.52 ± .63	5,571 ± 3,773		
Total steps/day	41[a]	5.59 ± .67	10,448 ± 3,808		
Steps/DW	352[b]		3,652 ± 2,663	11.5 (2)	.003
Steps/other drPAs	41[b]		2,801 ± 2,958		
Steps/oPA	17[b]		2,547 ± 2,274		
Steps/min DW	346[b]		68.5 ± 24.9	38.1 (2)	< .001
Steps/min odrPA	41[b]		42.1 ± 33.3		
Steps/min oPA	17[b]		46.4 ± 30.4		
Duration DW (h/day)	43[a]	5.79 ± .51	1.28 ± .93	Not calculated	
Duration total drPA (h/day)	43[a]	5.79 ± .51	1.53 ± .91		
Duration total PA (h/day)	42[a]	5.81 ± .51	1.56 ± .86		
Duration DW (min/DW)	362[b]		56.0 ± 41.0	5.68 (2)	.058
Duration other drPA (min/other drPA)	51[b]		74.6 ± 56.2		
Duration oPA (min/oPA)	21[b]		74.0 ± 62.6		

[a], *n* = number of participants; [b], *n* = number of activities; DW, dog walking; other drPA, dog-related physical activity except DW; oPA, other physical activities (physical activity without dogs)

Table 3. Intensity of PAs Categorized Due to Steps/Min According to Tudor-Locke et al. (2019)

Intensity Level	DW *n* (%)	Other drPA *n* (%)	oPA *n* (%)	χ^2-value (*df*)	*p*	Cramer's V
Light (< 100 steps/min)	316 (91.3)	38 (92.7)	17 100.0	2.13 (4)	.712	.05
Moderate (100 – < 130 steps/min)	25 (7.2)	2 (4.9)	0			
Vigorous (≥ 130 steps/min)	5 (1.4)	1 (2.4)	0			

DW, dog walking; other drPA, dog-related physical activity except DW; oPA, other physical activities (physical activity without dogs).

of intensity were at very light, 7.0% at light, 15.2% at moderate, and 2.9% at vigorous intensity; 9.1% of the HR time was missing. Average steps/min were not calculated due to noncompliance with wearing the pedometer in this activity.

Discussion

The results of this research support previous studies showing that DW is an important source of PA for DO. Other drPA were performed by a smaller number

Table 4. Differences in Categories of % of HR_{max} between DW and Other drPA According to Riebe et al. (2018)

Intensity Level	DW % of time	odrPA % of time	χ^2-value (df)	p	Cramer's V
Very light*	63.1	57.7	51626 (5)	< .001	.37
Light*	26.5	11.2			
Moderate*	10.1	15.1			
Vigorous*	.30	14.1			
Near maximum*	.00	1.54			
> 100 %*	.00	.41			

odrPA, dog-related physical activity except DW.
Note: Intensity levels are based on calculated HR_{max}, thus HR_{max} is a hypothetical value; *, difference between DW and odrPA is significant after Bonferroni-correction on a level $p \leq .05$.

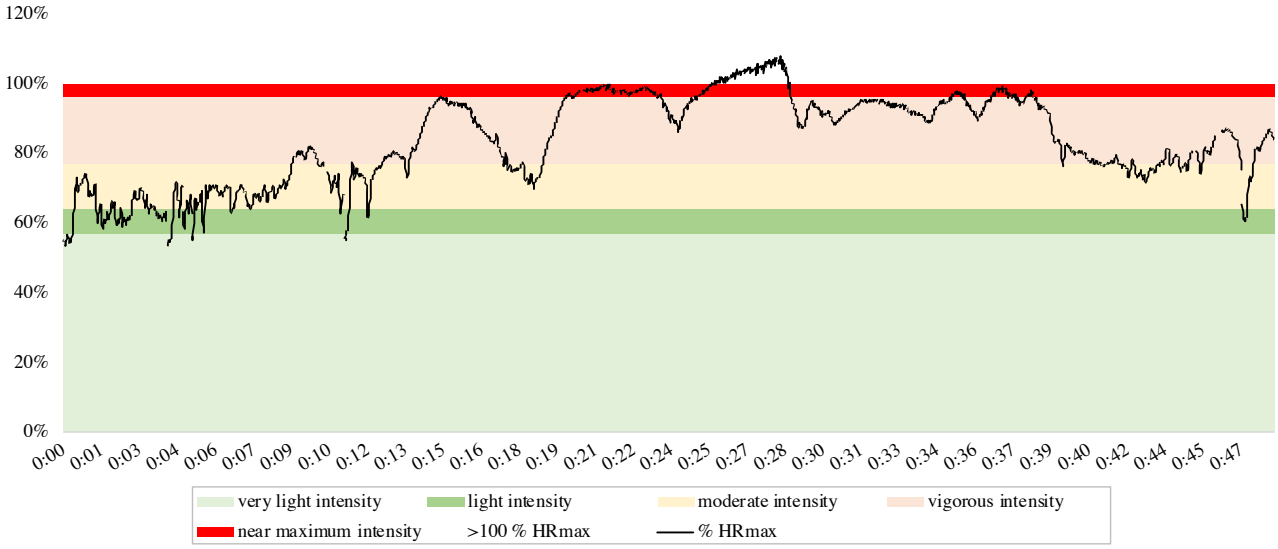

Figure 1. Scooter tour performed by participant no. 6.
Note: Errors are not presented.

of participants. However, more than three quarters of the sample engaged in some other drPA than DW.

Although DW was performed significantly longer per week than other drPA, the latter could have a bigger impact on human health. This could be concluded from the higher percentage of HR_{max} and higher percentage of HR categories for other drPA compared to DW.

Considering only PA duration, the results highlight that DW is the most important PA in DO. However, DW is predominantly performed at light or very light intensities. This was confirmed in two different measurements in the current study: steps/min and time in HR categories. However, steps/min and percentage of HR_{max} showed contrasting results when comparing DW and other drPA. Average steps/min were higher for DW than for other drPA. While step/min categories did not differ significantly, the mean percentage of HR_{max} was significantly higher in the other drPA as compared with DW. The small effect sizes of these

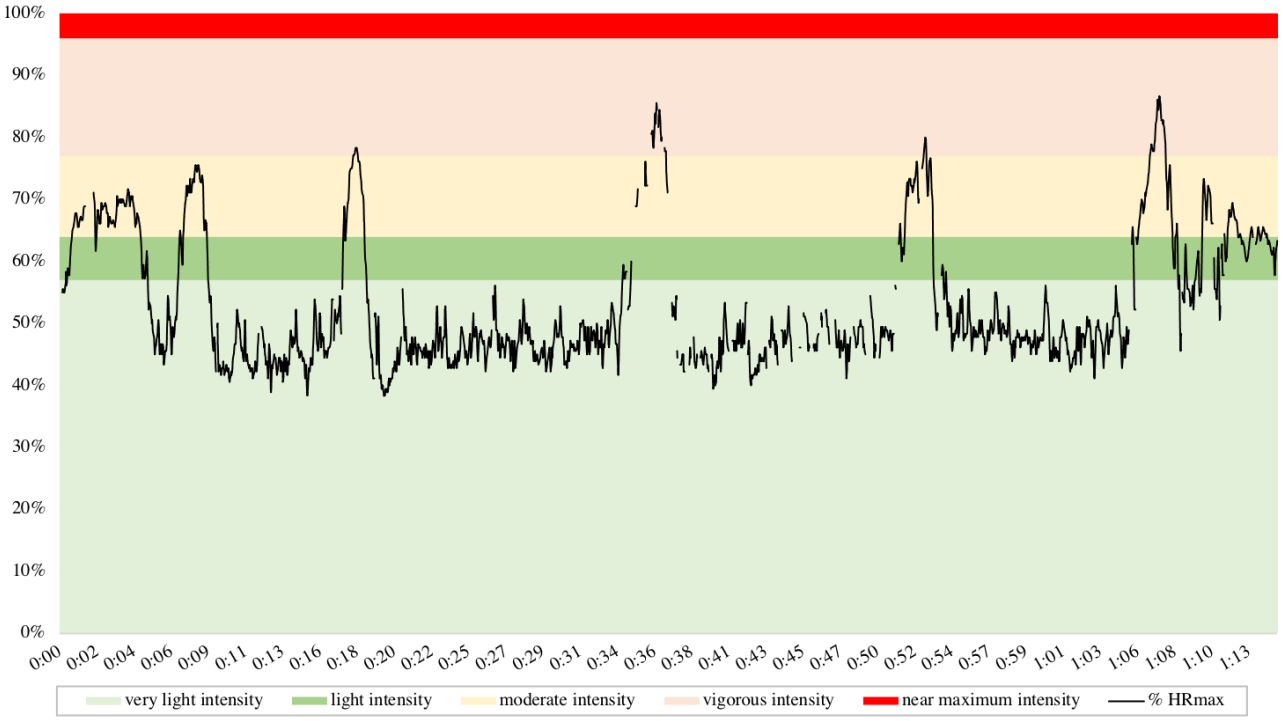

Figure 2. Fun-agility performed by participant no. 19.
Note: Errors are not presented.

comparisons may be attributed to high variations in intensities, especially in other drPA. Activities like "letting the dog run," "fun-agility," or "jogging with the dog" are all categorized as "other drPA," but may vary widely in regard to their intensity levels. The variation of intensity of the different activities aggravates the interpretation and analysis of these activity data. This way, the assessment of the result could be more conservative than it would be if activity types were analyzed individually in comparison to DW.

Considering steps/day, the current study found similar results to those of previous studies (see Dall et al., 2017; Rhodes et al., 2012). The results of the current trial demonstrate that DO mostly reached the minimum recommendations of 7,000 to 8,000 steps/day as described by Tudor-Locke et al. (2011). Additionally, Tudor-Locke et al. (2011) state that at least 3,000 of the recommended steps/day need to be accumulated in a brisk walking pace. Similarly, the WHO guidelines declare that moderate to vigorous intensities are necessary to reach PA recommendations (Hanifi et al., 2010). In all drPA types more than 90% of the activities were performed at light intensity levels as measured in steps/min. But since only mean values per activity were assessed, it is not possible to give information about activities altering in intensity levels. Therefore, there is a risk that the steps/minute will classify interval-like activities as mild intensity, even though they reach a medium or vigorous intensity in reality.

When the number of steps per activity is compared, however, it can be seen that other drPA differ statistically significantly in the number of steps to DW. But this could also be due to the statistical power that follows from the high number of of documented dog walks.

The current state of evidence suggests that DO reach PA guidelines more often if they walk their dog and if they perform DW frequently (Coleman et al., 2008; Hoerster et al., 2011; Oka & Shibata, 2012; Shibata et al., 2012; Soares et al., 2015; Thorpe et al., 2006; Toohey et al., 2013). Furthermore, some studies found that DW is at least partially a moderate-intensity activity (Dall et al., 2017; Richards et al., 2014). The

results from the current study indicate that—in a healthy population—the intensity of DW is mostly not sufficient to reach PA guidelines. At the same time, the two individually reported exemplary cases discussed earlier show that other drPA have the potential to achieve moderate to vigorous intensities and thus might provide an increased benefit to human health.

Overall, little increases in the amount of PA lower the risk of several severe diseases and all-cause mortality, especially if subjects were inactive before (Kyu et al., 2016). Thus, DW might be better for human health than a completely sedentary lifestyle. But the current results reveal that other drPA might be a better approach to tackle the problem of inactivity in a healthy population than just DW.

Moderate to high correlations between the self-reported duration and the objectively measured duration, as well as the steps of the participants and the objective duration were observed both during DW and other drPA. However, correlation does not equal validity and it can be deduced from the data that the objectively measured duration is distinctly lower than the results of the self-reported questionnaire data. Overreporting is a well-known phenomenon in exercise science when surveying PA through questionnaires, especially with moderate to vigorous intensity (Hartley et al., 2014; Nicolaou et al., 2016). The size of this effect seems to be related to the extent of the PA actually performed (Cleland et al., 2014). As a result, it could be that people with different levels of PA overreport their activity to different amounts. This in turn could lead to a reduced correlation between the two elicitation methods: BSA-F and PA diary. Taking this into account, studies that only used questionnaires to measure the PA of DO are not sufficient for a realistic validation of PA. Furthermore, investigations that use only surveys could be biased in two ways. First, overreporting could lead to an overestimation of the number of people who are sufficiently active. Second, people may overestimate the intensity of their activity and consequently report activities that are insufficient to reach the intensities necessary to meet PA recommendations.

In the current study no correlations between steps during DW and values of the LAPS (attachment scores) were determined, which is surprising because attachment is mentioned as having an impact on DW in several studies (Cutt, Giles-Corti, & Knuiman, 2008; Oka & Shibata, 2012; Westgarth et al., 2014). However, another study published a finding similar to the current results. Hoerster et al. (2011) reported that DO who walked their dogs and DO who did not showed no differences in attachment to their dog. DW obligation (in a sense that DO feel that it is their responsibility to walk their dog), however, was higher in dog walkers than non–dog walkers (Hoerster et al., 2011). This might offer an explanation for the current results. DO who believe that it is socially desirable to walk their dogs engage in more DW (Cutt, Giles-Corti, Wood, et al., 2008), and they might therefore exercise their dogs regardless of whether they are attached to their dogs or not. Another explanation could be that the recruiting method via social media and dog schools might lead to an oversampling of dog enthusiasts who are generally highly attached. This could lead to a higher knowledge of dog behavior. Several studies suggest that free-roaming dogs do not engage in a lot of activity during the day (Boitani et al., 2017; Majumder et al., 2014; Sparkes et al., 2014). If DO knew that free-living and free-roaming dogs do not engage in a lot of PA, they might refrain from engaging in drPA as they want to keep their dogs in a species-appropriate way. Another explanation could be that if DO have similar levels of attachment but differ on knowledge about dog activity behavior, this could lead to differing PA behavior of DO. This could explain why this study failed to find a correlation between attachment and PA behavior.

To our best knowledge, no studies of this kind have been performed in Germany yet. The mentioned studies were conducted mostly in North America (e.g., Brown & Rhodes, 2006; Coleman et al., 2008; Gillum & Obisesan, 2010; Hoerster et al., 2011; Lim & Rhodes, 2016; Moudon et al., 2007; Rhodes et al., 2012; Richards et al., 2014; Thorpe et al., 2006; Toohey et al., 2013), and partly in the United Kingdom (e.g., Dall et al., 2017; Feng et al., 2014; Mein & Grant, 2018; Solomon et al., 2013; Westgarth et al., 2019), Australia (e.g., Cutt,

Giles-Corti, & Knuiman, 2008; Cutt, Giles-Corti, Knuiman, et al., 2008; Schofield et al., 2005), and Japan (e.g., Oka & Shibata, 2009, 2012; Shibata et al., 2012). One study concluded that LAPS scores did not differ between different countries. However, it mentioned anecdotally misunderstandings in attachment questions (Schoenfeld-Tacher et al., 2010). This could lead to the conclusion that attachment scores might be the same between different countries but attachment style might differ. Given this hypothesis and because animal keeping can be perceived as a cultural construct (Blouin, 2013), it is plausible that the bond between people and their dogs might influence PA behavior in varying countries differently.

The current study has some limitations. First, the calculated HR_{max} usually deviates in a certain range from the true HR_{max} of a person (see the results of Tanaka et al., 2001). Thus, exercise testing for a maximum HR could have improved the results. It has to be mentioned that the study was observational without comparison to a physically inactive reference group. However, future studies should include some form of exercise testing in order to better assess and manage participants' performance in activities. Second, due to recruitment via social media and dog schools, self-selection bias and social desirability could be an issue. This might lead to a study population that is more strongly attached to their dogs, which might influence drPA behavior. Third, due to the small sample size none of the sociodemographic variables were included in the statistical analyses. Therefore, the effects found were only described in a very general way. Future studies should try to recruit larger samples so that sociodemographic variables can be included in the analyses. Another possibility would be for future studies to initially only deal with certain subsamples and thus deliver more valid results even with small samples.

Conclusion

In conclusion, the current observational study states that the intensity of DW does not add to PA guidelines in a healthy population, but that other drPA might help DO reach PA guidelines frequently. This implies that future research needs to focus on other drPA. However, DW could still be considered as an intervention for vulnerable, impaired, or sedentary populations.

Summary for Practitioners

It has been shown that physical activity (PA) can prevent several severe diseases (Kyu et al., 2016). Further, it has been shown that dog owners (DO) engage in more PA than non–dog owners (nDO) (Brown & Rhodes, 2006; Cutt, Giles-Corti, Knuiman, et al., 2008; Dall et al., 2017; Ding et al., 2018; Feng et al., 2014; Mein & Grant, 2018; Oka & Shibata, 2009; Solomon et al., 2013; Westgarth et al., 2019). Most of these studies focused either on total PA or dog walking (DW). However, most of them did not evaluate the intensity of dog-related physical activity (drPA).

The WHO emphasizes that PA must be at least at moderate intensity in order to be considered a health-promoting activity (Hanifi et al., 2010). Some studies show that dog walks can be categorized as moderate activity (Dall et al., 2017; Richards et al., 2014). One of these studies has been conducted in an older population (Dall et al., 2017), so a generalization to healthy, young to middle-aged DO might not be adequate. However, Richards et al. (2014) have shown that in a mostly middle-aged population at least part of the dog walks can be considered moderate to vigorous PA.

The PA questionnaire, the duration in the PA diary, and the number of steps per day showed that the duration of PA was most likely sufficient to achieve the WHO recommendations. Within the overall PA and drPA, DW took up most of the time. Other drPA were performed on average for only a short time per week and day. However, most participants engaged in at least some type of drPA besides DW. Furthermore, the number of steps per minute was higher in DW than in other drPA. Nevertheless, this was not enough to allow DW to

be classified as moderate activity more often than other drPA.

Other results of this study show that the average HR and the average percentage of HR_{max} were higher during other drPA than during DW. Furthermore, the percentage of HR_{max} showed that other drPA could be categorized more often in the range of moderate to vigorous PA than DW. This showed that other drPA might provide a better health effect to humans than DW.

No association was found between human-dog attachment and objectively measured PA in any form. According to these results, human-dog attachment does not appear to be relevant in human PA.

The results of this study could lead DO to believe that they need to be more active with their dog. And indeed, Pickup et al. (2017) state that many family dogs do not get enough exercise. However, dogs in free-living or free-roaming conditions are inactive most of the day (Boitani et al., 2017; Majumder et al., 2014; Sparkes et al., 2014). This could lead to a conflict of interest in regard to the PA behavior of dogs and their owners.

Overall, the results state that the PA of DO is more complex than previously assumed. The physical intensity of DW might not be sufficient to trigger positive health effects in a healthy and young to middle-aged population of DO. However, other drPA than DW must be considered in order to improve the physical fitness and health of DO. Due to the study design, no different drPA could be distinguished. Therefore, different drPA could have different effects on human (and dog) health. It is conceivable, for example, that dogs perform the main part of the movement in some activities, while the DO themselves hardly move at all. Other activities, however, could be very demanding for the owner.

In conclusion, DW might pose a beneficial intervention to sedentary, frail, or impaired adults. Further benefits could be achieved by adding or substituting other drPA to the PA routine of DO. In order to be able to make further recommendations for practitioners, further research in this field is needed on both the dog and the human side.

Declaration of Interest Statement

The authors declare that there is no conflict of interest.

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