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Impacts of Dog Ownership and Attachment on Total and Dog-related Physical Activity in Germany

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

[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

Dog ownership is related to physical activity. There could, however, be variances in the strength of this relationship between different cultures. The objective of the present study was to investigate activity behavior in dog owners (DOs) in Germany. Further, the association between dog ownership, attachment and physical activity was examined. Total physical activity, dog walking, and other dog-related activities were investigated using an online survey that was promoted in several social media groups. A German physical activity questionnaire (BSA-F) and the Lexington Attachment to Pets Scale (LAPS) were used. DOs display higher levels of total physical activity, total walking, and other physical activities than non-dog owners (nDOs). Several other dog-related activities were reported by DOs. The most prominent were retrieve work, ball games and agility. Attachment to one's dogs was not related to total physical activity. However, attachment correlated with higher levels of time spent in dog-related physical activity and dog walking. It can be concluded that, in a German population, DOs are more physically active than nDOs. Attachment seems to correlate with type, but not quantity, of exercise in dog enthusiasts. Several dog-related activities were reported but information about them is still very limited. Therefore, future studies are needed to focus on the intensity and occurrence of these activities in a representative population of DOs in Germany.

Keywords: dog ownership, physical activity, dog walking, attachment

Correspondence: benedikt.hielscher@gmx.de

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Physical activity is associated with decreased levels of several severe diseases (Kyu et al., 2016; Waller et al., 2010). It has further been associated with a decreased risk of all-cause-mortality (Ekelund et al., 2015). The World Health Organization (WHO) recommends that healthy adults should accumulate 150 minutes of moderate to vigorous physical activity per week in order to maintain physical health (Hanifi et al., 2010).

In Australia (Cutt, Giles-Corti, Knuiman, et al., 2008), the UK (Dall et al., 2017; Ding et al., 2018; Feng et al., 2014; Solomon et al., 2013; Westgarth et al., 2019) and Japan (Oka & Shibata, 2009), dog owners (DOs) reach the recommendations of physical activity more often than non-dog owners (nDOs). However, dog keeping, dog walking behaviors (Christian et al., 2016), and the perception of dogs (Nagasawa et al., 2016) differ between countries. Two studies show that DOs in urban and rural areas of the same country differ in their dog walking behaviors (Baranyiová et al., 2005; Liao et al., 2018). Even street patterns and life-styles in the same country seem to be correlated with dog walking (Degeling et al., 2012; McCormack et al., 2011; Richards et al., 2013). Reports from several nations using different research methods show that the number of DOs walking their dogs varies widely (Cutt, Giles-Corti, & Knuiman, 2008; Hoerster et al., 2011; Reeves et al., 2011). Therefore, it is necessary to consider different countries and different regions and cultures in dog walking research. Further, since dog breed popularity changes over time (Ghirlanda et al., 2014), it is necessary to gather data on dog walking behaviors regularly, because different dog breeds might need different amounts of exercise. As new knowledge about the activity behavior of dogs emerges, DOs physical activity behavior might change, too. It is therefore important to carry out new studies on a regular basis so that a constant comparison can take place between the societal demands on dogs and the current state of knowledge about the needs of the animals.

Little is known about dog-related physical activities besides dog walking. Kerr et al. (2014) found that human handlers participating in canine agility are mainly overweight or obese and that the injury prevalence is comparable to that of marathon running. Westgarth et al. (2015) showed that people who play chase games with their dogs engage in less dog walking per day. To the best of the authors' knowledge, there are no other studies on adults that focus on other dog-related activities besides dog walking. This suggests that knowledge about human impact of activities, such as agility, mantrailing, or flyball, from the human perspective is scarce. Additionally, it is currently unclear whether dogs benefit from these activities. It is therefore very important to understand how many DOs engage in dog-related physical activities other than dog walking.

The correlation of attachment to one's dog and dog walking is also unclear. Attachment has been positively associated with dog walking in one study (Cutt, Giles-Corti, & Knuiman, 2008). However, another investigation with a comparable study design was not able to show an association between dog walking and attachment (Hoerster et al., 2011). Oka and Shibata (2012) show that greater attachment to one's dog is correlated with an increased likelihood of being a dog walker. Another study concluded that attachment to one's dog is associated with a longer duration of walking, but not with a higher walking frequency or distance (Curl et al., 2017).

Data from Germany about these topics is lacking. To the knowledge of the authors, no studies on dog-related human physical activity have been performed in Germany. Assuming that the perception of dogs, dog keeping behaviors and the activity behavior of DOs differ among international studies, it is unclear whether the previous research results can be transferred to Germany. Therefore, this study had three aims. First, it was designed to find differences between DOs and nDOs regarding their level of physical activity in a German population. The second goal was to explore dog-related physical activity behavior besides dog walking. Third, the study aimed to investigate the relationship between attachment to one's dog and the level of physical activity of DOs.

Method

Participants

Participants were DOs and nDOs who were asked to complete a German questionnaire about their physical activity behavior. Participants had to be 18 years or older and reside in Germany. DOs were restricted to owning a maximum of five dogs. This constraint was used because DOs had to give information about every dog. A former study in Germany with a similar design found that the mean number of dogs per owner was 2.06 ± 1.48 dogs (Hielscher et al., 2019). Adding two standard deviations (*SD*s) to the mean results in five dogs. The questionnaire was only provided in German, requiring participants to have basic knowledge of the language. No further exclusion criteria were defined that restricted people from participating.

Overall, 635 participants participated in this study. One hundred and eighty-eight of these did not complete the last question and were therefore excluded. Seven participants were excluded because they reported that they did not reside in Germany at the time of the study. Finally, one participant was excluded because she stated that she had not completed the questionnaire truthfully. This left 369 DOs and 70 nDO for analyses.

Materials

After consent was provided, all participants completed an online questionnaire. The first part consisted of socioeconomic and anthropometric data. The questionnaire included the following items:

- Age in years
- Biological sex
- Height in meters
- Weight in kilograms
- BMI (calculated from self-reported height and weight, kg/m^2)
- Smoking status
- Family status (as being or not being in a relationship)
- Educational attainment
- Occupational status
- Household income in €
- State of residence
- Population of hometown
- Whether people above the age of 60 lived in the household
- Whether people below the age of 18 lived in the household
- Whether participants owned a garden
- Whether participants suffered from any chronic diseases
- Whether participants grew up owning at least one animal.
- Whether participants owned a dog

DOs were asked about the breed, height (measured at the withers) in centimeters, weight in kg, age in years, sex and neuter status of their dogs. Participants were asked for how long they have kept their dogs.

Physical activity was measured using the German Physical Activity, Exercise, and Sport Questionnaire (BSA-F) by Fuchs et al. (2015) which measures physical activity in minutes per week.

The BSA-F includes activity at work as an index value and several activities of daily living (ADL) including:

- Walking to work
- Walking to shops
- Riding a bicycle to work
- Riding a bicycle for other movement purposes
- Leisure time walking
- Gardening
- Physically demanding housework
- Physically demanding care taking
- Climbing stairs

The BSA-F also asks about engagement in sports and other exercise-related activities and uses open-ended questions to obtain information on the average time in minutes that participants engage in such activities. The ADL score is based on the frequency and duration with which the activity was performed within the past four weeks. Total physical activity in minutes per week can therefore be calculated by summing the ADL and the sport related activities. For this study, only the questions about the ADL and sport and exercise were used because dog keeping was seen mostly as leisure time activity and stair climbing might not reflect any of DOs typical activities.

The BSA-F is a well validated questionnaire. It has been shown that the activities of daily living, sport and exercise related activities, and the total physical activity level correlate with power at the anaerobic threshold (p (IAS) [W]), an increased power at the relative anaerobic threshold (p (IAS/KG) [W/kg]) and maximum oxygen consumption (VO_{2max}) (Fuchs et al., 2015).

DOs additionally were asked about dog-specific activities (e.g. walking, running or bicycle riding with their dogs). The wording of these questions was the same as that of the ADL in the BSA-F. They were also asked how often and how many minutes per session they engaged in other dog-related activities. The wording for these questions was the same as that of the sport related questions of the BSA-F.

A plausibility analysis for each group (DOs and nDOs) was performed on the values of the BSA-F. Activities that were obviously not suitable to increase participants' respiratory response were excluded (e.g. cuddling or feeding the dog). Then, all activities with less than 10 minutes per session or day were excluded, referring to the WHO recommendations that each physical activity should last at least 10 minutes or longer for health purposes (Hanifi et al., 2010).

Activities that were reported to have been performed 30 or 31 days in the past four weeks were interpreted as daily activities and therefore set to 28 days.

Values that were still considered implausible following this analysis were excluded (for single case decisions see Table 1). Finally, every value that exceeded or fell below three *SD*s of the mean value in each group was identified as an outlier and excluded. For the purpose of further analyses all values that were identified as implausible or as outliers were excluded. For total physical activity all cases that were identified as an outlier in at least one variable in the BSA-F were excluded.

The German version of the Lexington Attachment to Pets Scale (LAPS) was used to measure pet attachment (Hielscher et al., 2019). The LAPS was originally published by Johnson et al. (1992) for measuring the attachment of owner to pets. Due to its brevity and its use of the Likert scale, the questionnaire is suitable for an online survey. The LAPS can

be interpreted by summing all items. The score for total attachment ranges from 0 (no attachment at all) to 69 (highest measurable attachment by the LAPS). Ethical Approval was given by the ethics committee of the German Sport University Cologne (146/2017).

Table 1
Case wise decisions about the exclusion of cases and variables of individual cases

Affected variable	**Number of participants affected**	**Reason for casewise decision**	**Correction**
Entire Questionnaire	7	The participants did not reside in Germany at the time of the study.	These participants were excluded.
Leisure time walking	1	This participant reported walking on 56 days with 110 minutes each day.	The variable has been corrected to walking on 28 days for 220 minutes each day.
Other activity A	1	This participant reported in the open questions that he was riding the bicycle 60 times for 120 minutes each time. Further the participant reported that he rode the bicycle for other movement purposes on 30 days for 180 minutes each day.	The first variable has been corrected to 0 days and 0 minutes. The second variable has been corrected corrected to riding the bicycle on 28 days for 180 minutes each day.
Dog walking	1	This participant reported dog walking on 125 days for 60 minutes each day.	This value was excluded.
	5	The participants reported 120 days of dog walking.	This value was excluded.
	2	The participants reported 56 days of dog walking. One participant reported 45 minutes each day and one participant reported 60 minutes each day.	The number of days has been halved and the duration of dog walks doubled.
	1	This participant reported dog walking on 50 days.	This value was excluded.
	1	This participant reported dog walking on 40 days.	This value was excluded.
	1	This participant reported dog walking on 32 days with a duration of 30 minutes each day.	The variable has been corrected to walking the dog on 28 days for 30 minutes each day.
Dog-related activities (open field)	1	This participant reported “ball games” for 120 times on 28 days for 40 minutes each day.	This value was excluded.

Continuation of Table 1

Affected variable	Number of participants affected	Reason for casewise decision	Correction
	1	This participant reported "playing" 100 times for 10 minutes on 28 days.	This value was excluded.
	1	This participant reported "playing" 62 times for 20 minutes on 28 days.	The variable has been corrected to "playing" for 56 times for 20 minutes within 28 days.
	1	This participant reported "ball games" for 60 times for 60 minutes within 28 days.	This value was excluded.
	1	This participant reported "dog education training" for 63 times for 15 minutes within 28 days.	This value has been corrected to 56 times for 15 minutes within 28 days.

Procedure

An online survey was administered through the website www.soscisurvey.de, a free online platform providing the ability to perform online questionnaires in Germany. This survey was supported by the German Kennel Association (VDH), who provided a link on their social media page. Additionally, several dog enthusiast social media pages shared the survey link. To ensure similar group numbers, DOs were encouraged to share the link with nDOs friends. The study period lasted from 15th November 2017 until 15th March 2018.

Statistical analysis

χ^2-tests were used for comparisons of categorical data between DOs and nDOs. For ordinal data, the Mann-Whitney-*U*-test was performed. Differences on a metric scale were tested using independent *t*-tests. For χ^2-tests effect sizes Phi-coefficient or Cramer's V were used, *t*-tests effect sizes were calculated with Cohen's *d* and for Mann-Whitney-*U*-tests *r* was calculated.

All statistical tests were performed using IBM SPSS Statistics 25 for Mac. If IBM SPSS did not support the calculation of effect sizes, Microsoft® Excel for Mac Version 16 was used. For all tests the level of statistical significance was set at $\alpha = 0.05$. A Bonferroni-correction was used for testing differences in physical activity behavior. Eleven *t*-tests were performed on physical activity related variables. Therefore, the adjusted α-value was set at $\alpha = 0.005$ for physical activity.

Planned stepwise linear regression analyses were used. In the analysis, two models were tested. In the first model socioeconomic variables and anthropometric variables were selected. The second model included either the variable dog ownership or the values of the LAPS. If attachment was used as a predictor in the second model, dog-related variables were added as predictors in the first model as well. The size and weight of the dog were used separately due to great variability in morphological shapes of dog breeds.

Cooks' distances and leverage values were calculated to check for outliers in the regression analyses. If both values identified a case as an outlier, this case was excluded from

further analysis. The Durbin-Watson-test was used to test for autocorrelation. To test for multicollinearity, the variance inflation factor (VIF) was examined.

Results

Participants were between 18 and 73 years old (M = 39.51 ± 12.61). nDOs and DOs did not differ in age (DO M = 39.37 ± 11.90, nDO M = 40.21 ± 15.93, t = .42, df = 84.20, p = .676, d = -.06) or BMI (DO M = 25.48 ± 5.64, nDO M = 26.14 ± 6.08, t = .88, df = 434, p = .381, d = -.11). More female than male DOs participated in the study. Furthermore, DOs had lower formal education, and were more likely to be employed and to own a garden. DOs grew up with animals more often than nDOs. No differences were observed in smoking or family status, people under 18 or over 60 years of age living in the household, monthly income or chronic diseases between DOs and nDOs (Table 2). In DOs, the mean LAPS value was 54.75 ± 8.41.

DOs (M = 20.46 ± 10.39 h/week) achieved higher total physical activity values than nDOs (M = 9.49 ± 8.72 h/week, t = -8.40, df = 90.16, p < .001, d = 1.14). All DOs reported at least 2 h/week of physical activity. DOs (M = 11.54, ± 6.40 h/week) reported more leisure time walking than nDOs (M = .86 ± .93 h/week, t = -29.97, df = 416.20, p < .001, d = 2.34) and higher values of other physical activities (DO M = 3.82 ± 3.78, nDO M = 1.74 ± 2.37, t = -5.98, df = 144.67, p < .001, d = .66). No other differences in physical activities were found (Table 2).

Mean time of dog-related activities was 13.38 ± 7.04 h/week. Running with a dog was reported by 18.1% and bicycle riding with one's dog was reported by 20.4%. Other activities (including running and bicycle riding) with one's dog were performed by 83.0% of the DOs. Average amount of dog walking was 10.93 ± 6.06 h/week, whereas other activities (including running and bicycle riding) were performed for a mean of 2.72 ± 2.93 h/week. The mean of running with dogs was .21 ± .61 h/week and the average value of bicycle riding with dogs was .19 ± .53 h/week.

The open-ended question pertaining to other dog-related activities was answered 567 times. The most frequently mentioned activities are depicted in Table 3. Five participants (1.36%) reported no dog walking at all and 18 participants (5.01%) reported a maximum of 2.5 h/week dog walking. After excluding dog-related activities, DOs (M = 6.99 ± 7.33 h/week) did not differ from nDOs in their total physical activity behavior (t = 2.28, df = 346, p = .023, d = -.31).

The hierarchical regression of total physical activity shows that dog ownership explains a significant amount of variance of total physical activity (Table 4). Further, the sex of the participant predicted total physical activity. In the second model the effect was smaller but still significant. The Durbin-Watson statistic is 2.06. Two cases show standardized residuals greater than 3. However, excluding these did not change the result. Therefore, the regression models were left unchanged.

Dog ownership correlated positively with leisure time walking after adjusting for confounding variables (Table 5). Additionally, both regression models showed that people who live without children under the age of 18 years engage in more leisure time walking. The Durbin-Watson statistic for this regression model is 1.94. No standardized residuals exceeded 3. Thus, no further case-by-case diagnostics were applied.

Attachment to one's dog did not correlate with total physical activity after adjustment for confounding variables. Dog-related variables did not impact total physical activity. Statistically significant predictors in the fully adjusted model were: sex of the participant (B = 5.71, β = .16, SE = 2.56, p = .027) and the presence of any chronic diseases (B = 3.29, β = .15, SE = 1.51, p = .030).

Total dog-related physical activities correlated, after adjustment for confounding variables, to level of attachment (Table 6). Furthermore, age of the participant was a significant

predictor of total dog-related physical activity. The Durbin-Watson-statistics for this regression model was 1.87. One case exceeds a standardized residual of 3, but exclusion of this case did not alter the results. Hence, the results shown include this case. Some multicollinearity was detected in maximum dog weight and size. However, since the VIF did not exceed 10, there was no concern. Neither of the dog-related variables had an impact on dog-related physical activities.

Dog walking was positively associated with dog attachment and age of the participant but neither of the dog-related variables (Table 7). No cases exceed a standardized residual of 3; thus, no further case-by-case analyses were applied.

Table 2
Sociodemographic variables between DO and nDO

Variable	Manifestation	nDO n (%)	DO n (%)	*Test statistics* (*df*)	*p*	Effect size
Sex	Male 0	23 (32.9)	35 (9.5)	27.78[a] (1)	< **.001**	.25[c]
	Female 1	47 (67.1)	332 (90.5)			
Chronic disease	Yes 0	18 (25.7)	112 (31.4)	.89[a] (1)	.396	-.05[c]
	No 1	52 (74.3)	245 (68.6)			
Smoking Status	Smoker 0	11 (15.9)	83 (22.6)	1.51[a] (1)	.265	-.06[c]
	Non-smoker 1	58 (84.1)	285 (77.4)			
Family status	Not in relationship 0	14 (20.0)	107 (29.0)	2.39[a] (1)	.145	-.07[c]
	In relationship 1	56 (80.0)	262 (71.0)			
Formal education	No graduation	1 (1.4)	0	10747.00[b] (-2.30)	**.021**	-.11[d]
	Secondary modern school qualification	2 (2.9)	18 (4.9)			
	Intermediate high school certificate	11 (15.7)	117 (31.8)			
	University of applied science qualification or high school diploma	28 (40.0)	122 (33.2)			
	College or university degree	27 (38.6)	101 (27.4)			
	Dissertation	1 (1.4)	10 (2.7)			
Occupational status	Employed 0	48 (68.6)	306 (83.2)	8.07[a] (1)	**.007**	-.14[c]
	Not employed 1	22 (31.4)	62 (16.8)			

Continuation of Table 2

Variable	Manifestation	nDO n (%)	DO n (%)	*Test statistics* (*df*)	*p*	Effect size
People > 60 years living in household	Yes 0	16 (22.9)	50 (13.6)	3.91[a] (1)	.067	.10[c]
	No 1	54 (77.1)	317 (86.4)			
People < 18 years living in household	Yes 0	20 (28.6)	71 (19.3)	3.08[a] (1)	.107	.08[c]
	No 1	50 (71.4)	297 (80.7)			
Income in € per month	< 1.000	16 (26.2)	47 (14.9)	10 088.00[b] (.64)	.524	.03[d]
	1.000 - 1.999	17 (27.9)	113 (35.9)			
	2.000 - 2.999	9 (14.8)	74 (23.5)			
	3.000 - 3.999	9 (14.8)	39 (12.4)			
	4.000 - 5.999	7 (11.5)	30 (9.5)			
	6.000 - 7.999	3 (4.9)	8 (2.5)			
	8.000 - 9.999	0	2 (.6)			
	≥ 10.000	0	2 (.6)			
Garden ownership	Yes 0	45 (64.3)	293 (79.4)	7.59[a] (1)	**.008**	-.13[c]
	No 1	25 (35.7)	76 (20.6)			
Grew up with animals	Yes 0	45 (64.3)	290 (78.6)	6.66[a] (1)	**.014**	-.12[c]
	No 1	25 (35.7)	79 (21.4)			
Physical activities as measured by the BSA-F in h/week	Walking to work	.42 (.98)[e]	.18 (.61)[e]	2.03 (78.30)[f]	.046	-.29[g]
	Walking to shop	.41 (.86)[e]	.14 (.32)[e]	2.49 [f] (70.59)	.015	-.42[g]
	Riding a bicycle to work	.21 (.53)[e]	.04 (.21)[e]	2.50 [f] (69.69)	.015	-.42[g]
	Riding a bicycle for other movement purposes	.61 (1.24)[e]	.29 (.68)[e]	2.02 [f] (74.79)	.047	-.32[g]
	Gardening	.46 (.76)[e]	.50 (.92)[e]	-.32 [f] (420)	.751	.05[g]

Continuation of Table 2

Variable	Manifestation	nDO n (%)	DO n (%)	*Test statistics* (*df*)	*p*	Effect size
	Housework	2.98 (4.22)[e]	3.00 (3.32)[e]	-.04 [f] (428)	.969	.01[g]
	Care taking	2.15 (6.38)[e]	1.21 (4.76)[e]	1.15 [f] (80.48)	.255	-.17[g]

Note. The number behind dichotomous variable categories describes the coding used in the data set. [a]c^2 statistics, [b]Mann Whitney *U* statistics, [c]Phi-coefficient, [d]Cramer's V, [e]*mean* (*standard deviation*), [f]*t*-test (*df*), [g]Cohen's d

Table 3.
Frequency of other dog-related activities from the participants

Activity	n (%) of participants mentioning this particular activity
Retrieving	61 (16.5)
Ball games	55 (14.9)
Agility	39 (10.6)
General Play	38 (10.3)
Dummy Work	29 (7.9)
Search Work	26 (7.0)
Subordination	24 (6.5)
Mantrailing	23 (6.2)
Tug-of-war	22 (6.0)
Scent work	21 (5.7)
Dog Sport	12 (3.3)
Rally Obedience	11 (3.0)
Competition Dog Sports	10 (2.7)
Obedience	9 (2.4)
Catch Games	8 (2.2)
IPO	8 (2.2)
General Training	8 (2.2)
Dog Training Field	6 (1.6)
Dog School	6 (1.6)
Hunting	6 (1.6)
Horseback Riding	6 (1.6)
Search Games	6 (1.6)
Frisbee	5 (1.4)
Nosework	5 (1.4)
Rescue Dog Work	5 (1.4)
Guard Dog Work	5 (1.4)
Hiking	5 (1.4)

Note. Only activities that were mentioned at least five times are shown. Respondents were allowed to name a maximum of five categories. Thus, the percentage do not add up to 100%.

Table 4.
Hierarchical regression of total physical activity and dog ownership

Variable	Model 1				Model 2			
	B (β)	**SE**	***p***	**VIF**	**B (β)**	**SE**	***p***	**VIF**
Constant	10.88	6.26	.084		5.88	5.93	.323	
Family status	.01 (.00)	1.39	.997	1.09	.49 (.02)	1.31	.706	1.09
Smoking status	-2.63 (-.11)	1.45	.072	1.05	-2.27 (-.09)	1.37	.097	1.05
Formal education	-.34 (-.03)	.74	.644	1.24	-.11 (-.01)	.70	.879	1.25
Occupational status	2.06 (.07)	1.79	.250	1.08	2.90 (.10)	1.68	.086	1.08
Income in € per month	.10 (.01)	.50	.846	1.34	-.17 (-.02)	.47	.725	1.35
Garden ownership	.87 (.04)	1.60	.586	1.36	2.17 (.09)	1.51	.152	1.39
People > 60 living in household	-.67 (-.02)	1.92	.726	1.12	-2.08 (-.07)	1.82	.254	1.14
People <18 living in household	.98 (.04)	1.66	.557	1.07	-.71 (-.03)	1.58	.656	1.10
Size of hometown	-.08 (-.01)	.54	.887	1.37	.23 (.03)	.51	.647	1.38
Age of participant	.01 (.01)	.06	.830	1.34	.02 (.02)	.06	.779	1.34
Sex of participant	7.70 (.25)	1.88	**< .001**	1.09	3.77 (.12)	1.87	**.045**	1.23
BMI	.05 (.03)	.11	.655	1.10	.04 (.02)	.11	.773	1.10
Any chronic diseases	2.37 (.10)	1.40	.092	1.09	2.67 (.12)	1.32	**.043**	1.10
Dog Ownership					10.68 (.38)	1.72	**< .001**	1.27

Note. R^2 for Model 1 = .08 (p = .050), ΔR^2 = .11 for Model 2 (p_{change} < .001)

Table 5.
Hierarchical regression of leisure time walking and dog ownership

Variable	Model 1				Model 2			
	B (β)	**SE**	***p***	**VIF**	**B (β)**	**SE**	***p***	**VIF**
Constant	4.41	3.63	.225		-2.79	3.15	.377	
Family status	-1.61 (-.10)	.84	.057	1.10	-1.22 (-.08)	.72	.090	1.10
Smoking status	-1.90 (-.11)	.88	**.031**	1.04	-1.40 (-.08)	.75	.062	1.05
Formal education	-.54 (-.07)	.43	.216	1.23	-.05 (-.01)	.37	.888	1.25
Occupational status	-.34 (-.02)	1.03	.742	1.11	.43 (.02)	.88	.628	1.12
Income in € per month	.10 (.02)	.29	.734	1.30	-.20 (-.04)	.25	.426	1.31
Garden ownership	-.15 (-.01)	.97	.882	1.36	1.24 (.08)	.84	.141	1.39
People > 60 living in household	1.72 (.08)	1.10	.118	1.11	.63 (.03)	.94	.505	1.12
People <18 living in household	3.35 (.19)	.95	**< .001**	1.08	1.84 (.10)	.82	**.026**	1.11
Size of hometown	.13 (.03)	.31	.671	1.29	.40 (.08)	.26	.123	1.30
Age of participant	.02 (.04)	.03	.478	1.27	.04 (.06)	.03	.199	1.28
Sex of participant	4.98 (.23)	1.14	**< .001**	1.07	1.39 (.07)	1.02	.174	1.19
BMI	-.01 (-.00)	.07	.934	1.10	-.01 (-.01)	.06	.850	1.10
Any chronic diseases	.60 (.04)	.83	.470	1.13	.83 (.05)	.71	.245	1.13
Dog Ownership					10.67 (.55)	.94	**< .001**	1.24

Note. R^2 for Model 1 = .13 ($p < .001$), ΔR^2 = .24 for Model 2 ($p_{change} < .001$)

Table 6.
Hierarchical regression of total dog-related physical activity and attachment

Variable	Model 1				Model 2			
	B (*β*)	**SE**	***p***	**VIF**	**B (*β*)**	**SE**	***p***	**VIF**
Constant	7.61	5.32	.153		-5.13	6.42	.425	
Family status	-1.86 (-.12)	.98	.059	1.14	-1.41 (-.09)	.97	.147	1.14
Smoking status	-.93 (-.06)	1.02	.363	1.09	-.83 (-.05)	1.00	.411	1.09
Formal education	-.25 (-.03)	.51	.632	1.31	-.01 (-.00)	.51	.992	1.34
Occupational status	.09 (.00)	1.25	.946	1.09	-.01 (.00)	1.23	.993	1.09
Income in € per month	-.10 (-.02)	.34	.764	1.30	-.18 (-.04)	.34	.585	1.31
Garden ownership	2.06 (.12)	1.15	.074	1.35	2.09 (.12)	1.13	.065	1.35
People > 60 living in household	-.29 (-.01)	1.29	.823	1.09	-.55 (-.03)	1.26	.667	1.10
People <18 living in household	2.52 (.14)	1.15	**.029**	1.10	1.84 (.10)	1.14	.109	1.13
Size of hometown	.08 (.02)	.36	.827	1.38	.21 (.04)	.35	.555	1.39
Age of participant	.06 (.09)	.04	.163	1.26	.11 (.17)	.04	**.012**	1.44
Sex of participant	2.44 (.09)	1.73	.158	1.14	2.31 (.08)	1.69	.173	1.14
BMI	-.06 (-.05)	.08	.456	1.14	-.07 (-.06)	.08	.349	1.14
Any chronic diseases	1.27 (.08)	.96	.189	1.13	1.48 (.10)	.95	.118	1.13
Number of dogs	.02 (.00)	.42	.959	1.33	-.06 (-.01)	.42	.884	1.34
At least one dog between the age 2 and 10 years	.82 (.04)	1.18	.488	1.18	.87 (.05)	1.16	.451	1.18
Maximum size of dog	.08 (.15)	.06	.190	3.56	.08 (.14)	.06	.186	3.56
Maximum weight of dog	-.07 (-.12)	.06	.265	3.50	-.06 (-.11)	.06	.298	3.50
Attachment					.19 (.22)	.06	**.001**	1.25

Note. R^2 for Model 1 = .09 (p = .072), ΔR^2 = .04 for Model 2 (p_{change} = .001)

Table 7.
Hierarchical regression of dog walking and attachment

Variable	Model 1				Model 2			
	B (*β*)	**SE**	***p***	**VIF**	**B (*β*)**	**SE**	***p***	**VIF**
Constant	4.19	4.45	.348		-6.18	5.40	.254	
Family status	-1.39 (-.10)	.83	.095	1.15	-1.06 (-.08)	.82	.198	1.16
Smoking status	-.90 (-.06)	.85	.292	1.07	-.74 (-.05)	.84	.375	1.08
Formal education	-.01 (-.00)	.43	.990	1.32	.18 (.03)	.43	.674	1.34
Occupational status	.13 (.01)	1.05	.898	1.09	.02 (.00)	1.03	.985	1.09
Income in € per month	-.14 (-.03)	.29	.633	1.31	-.19 (-.04)	.28	.510	1.32
Garden ownership	1.44 (.10)	.98	.141	1.35	1.44 (.10)	.96	.136	1.35
People > 60 living in household	.33 (.02)	1.06	.758	1.09	.24 (.01)	1.04	.819	1.09
People <18 living in household	2.15 (.13)	.96	**.026**	1.09	1.66 (.10)	.95	.083	1.12
Size of hometown	.07 (.02)	.30	.811	1.39	.19 (.04)	.30	.535	1.40
Age of participant	.08 (.14)	.03	**.028**	1.28	.12 (.22)	.04	**.001**	1.44
Sex of participant	1.67 (.07)	1.37	.225	1.12	1.51 (.07)	1.35	.265	1.13
BMI	-.06 (-.06)	.06	.369	1.13	-.07 (-.07)	.06	.281	1.13
Any chronic diseases	1.09 (.08)	.80	.175	1.14	1.29 (.10)	.79	.102	1.15
Number of dogs	-.23 (-.04)	.36	.526	1.35	-.29 (-.06)	.35	.405	1.35
At least one dog between the age 2 and 10 years	1.37 (.09)	1.00	.169	1.18	1.42 (.09)	.98	.149	1.18
Maximum size of dog	.08 (.16)	.05	.135	3.49	.08 (.16)	.05	.123	3.49
Maximum weight of dog	-.05 (-.11)	.05	.324	3.45	-.05 (-.10)	.05	.336	3.45
Attachment					.15 (.21)	.05	**.001**	1.24

Note. R^2 for Model 1 = .10 (p = .022), ΔR^2 = .03 for Model 2 (p_{change} = .001)

Discussion

The results of this study show that in a German population, dog owners are more physically active than non-dog owners, with much of DOs' physical activity associated with their dog. Dog walking was the most prominent activity for DOs, but DOs mentioned many other dog-related activities.

Attachment does not seem to be correlated to total physical activity in DOs, but it is associated with dog-related physical activities. Thus, attachment seems to alter the type but not duration of physical activities performed. However, causality remains unclear. On the one hand, it is plausible that more attached DOs engage in different types of dog-related physical activity. However, it is also possible that engaging in different types of dog-related physical activity strengthens the attachment of the owner to the dog.

These findings are in line with earlier studies that have suggested that DOs are more physically active than nDOs from Australia (Cutt, Giles-Corti, Knuiman, et al., 2008), Canada (Brown & Rhodes, 2006), Japan (Oka & Shibata, 2009), the UK (Dall et al., 2017; Ding et al., 2018; Feng et al., 2014; Mein & Grant, 2018; Solomon et al., 2013; Westgarth et al., 2019) and the Czech Republic (Mičková et al., 2019). However, the percentage of people who reported that they did not walk their dogs was relatively small in the current study (1.36%) compared to other studies. Hoerster et al. (2011) reported that 31% of DOs do not walk their dog, while Cutt, Giles-Corti and Knuiman (2008) reported that 23% do not. This might be a consequence of a possible sampling effect in the present study. It is plausible that members of social media groups that focus on dogs are comprised of highly motivated and attached DOs. Additionally, DOs who participated in this study might be more motivated and attached than the average DOs in these social media groups. Therefore, the first hypothesis, that DOs are more physically active than nDOs, could only partially be answered because the results might not be representative of the entire dog-keeping population in Germany. Thus, the results of the current study need to be interpreted with caution and further studies are needed.

Another possible explanation for these results is the impact of cultural or sociodemographic factors and their association with different attachment styles or animal welfare beliefs. Nagasawa et al. (2016) found that DOs in the USA and Japan differ in their perceptions of dogs and their behavior. Further, Oka and Shibata (2012) state that DOs in Japan have to walk their dogs more frequently than DO in the US or Australia because of smaller yards and different leash laws. These factors may apply in Germany as well. Gardens (also called yards) in Germany might be smaller than in the US but bigger than in Japan. Since most DOs in this study stated that they have a garden, the duration of physical activity of DOs in Germany should be somewhere between that of DOs in the US and in Japan. However, this statement is difficult to evaluate due to the different study designs. Other aspects might also explain the result. If the belief that dogs need a lot of physical exercise is stronger among German DOs, this too, could explain their higher levels of physical activity, but this hypothesis requires further investigation.

In this study, all DOs obtained the recommended 150 minutes of physical activity per week. This highlights the idea that in this population interventions to improve physical activity behavior and health status should focus on intensity rather than duration of physical activity. The duration of physical activity is most likely sufficient.

Biological sex was found to be a significant predictor of total physical activity and total leisure time walking. This could be because more than 90% of this sample was female. Since the standard error, which is needed to calculate significance levels, depends on the sample size, this finding might be coincidental. The addition of dog ownership to the model decreases the parameter estimate of the independent variable sex on total physical activity significantly, which supports this hypothesis.

People who reported not having a child under the age of 18 years living in the household also reported more leisure time walking. This could be because people with children under 18 tend to be middle-aged. Finger et al. (2017) found that females in Germany aged between 30 and 44 years are least likely to meet physical activity recommendations. For males, the authors found that those under the age of 30 were most likely to meet the physical activity guidelines. Since it is plausible that middle-aged adults are most likely to live with children under the age of 18 years and the population in this study was mostly female, which is the population less likely to meet physical activity guideline according to Finger et al. (2017), this could explain the statistical difference.

Age is a statistically significant predictor in the models of total dog-related physical activity and dog walking. In the model of total physical activity that includes nDOs, age was not statistically significant. Several studies, however, report contrary results - that dog walking is mostly performed by younger people (Reeves et al., 2011; Richards et al., 2013). A Japanese study, however, found that people above the age of 49 were more likely to walk with their dog than the reference group of people below the age of 30 (Oka & Shibata, 2012). Similar to this, results from the US and the UK show that dog walking is especially popular in middle-aged adults (Richards, 2016; Westgarth et al., 2019). An Australian study found that people replace non-dog-related activities with dog walking when they acquire a dog (Cutt, Knuiman, & Giles-Corti, 2008). As in the Australian investigation, it is conceivable that dog walking, as the age of DOs increases, could replace other physical activities without a dog. This would mean that the duration of the overall activity behavior would remain the same, while the duration of dog walks would increase. Therefore, there could be an interaction effect between the percentage of activities with dogs within total activity and the age of dog owners.

This investigation explores dog activities other than dog walking. Surprisingly, running or bicycle riding with one's dog were performed by very few DOs and only for a short time per week. Both activities are nonetheless reported by a considerably larger percentage of participants than in a previous study from the UK (Westgarth et al., 2019). This could again be due to differences in the study design. The study in the UK recruited their sample from different households, which might be less prone to bias than a self-selected sample. Differing cultural views on physical activity or dog keeping could explain these differences as well. However, this is only a hypothesis and needs further investigation. Overall, other dog-related activities in total were performed for a considerable amount of time in this study. Thus, they need further attention by researchers because they might be another way to increase physical activity in DOs.

Most of the existing studies used questionnaires to determine whether DOs achieved the recommended levels of physical activity. The WHO recommends 150 minutes of moderate physical activity, 75 minutes of vigorous physical activity or an adequate mixture of both each week (Hanifi et al., 2010). Furthermore, muscle-strengthening activities should be performed at least two times per week (Hanifi et al., 2010). Previous studies suggest that DOs are more likely to reach these goals than nDOs (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). However, most of these studies only focused on dog walking and the goal of 150 minutes of physical activity. Neither intensity nor strength-training were considered. This is problematic because dog walks only just reach the threshold that is necessary to be considered moderate intensity (Ainsworth et al., 2000). Further, dog walks seem to be slower than walks without dogs (Messent, 1983). This effect appears to be even greater with older dogs, perhaps because old dogs walk slower and sniff more (Belshaw et al., 2020). Additionally, it was shown that higher attachment correlates with a longer duration of walks but also a shorter distance in comparison to walks without dogs (Curl et al., 2017). This leads to the conclusions

that dog walking might be slower than walking without a dog and that the positive impacts on health might vanish due to failure to reach the necessary physical intensity.

One study with elderly participants used accelerometers and found that at least some dog walking falls within the category of moderate intensity (Dall et al., 2017). But elderly patients cannot be compared to a healthy young or middle-aged population. For this reason, the comparison of this study with the current results would be inappropriate. However, another study found that dog walking is at least partly in the moderate intensity range in a comparable population (Richards et al., 2014). This would suggest that recommended exercise can be achieved by walking a dog.

Although many DOs engage in dog-related activities besides dog walking, the results of this study do not provide information about the intensity of these activities. Further, it is unclear whether all DOs reported all activities, or whether the assessed intensity of the dog-related activities was valid. Some people might have experienced some dog-related activities as a form of physical exercise and therefore reported them in this study, while others may have deemed the same activities to be relaxing and not necessary to report. This could lead to the conclusion that certain activities are not beneficial for one's health when they in fact are beneficial and vice versa. Consequently, activities that are potentially effective in improving health need to be included in future research. The results of the current study highlight the need to focus on dog-related activities besides dog walking for health-related outcomes in DOs.

The level of attachment of DO is comparable to results of a previous investigation (Hielscher et al., 2019). Since earlier findings on the influences of attachment on physical activities in DOs are inconsistent, the current study provides new insights. The review by Westgarth et al. (2014) states that the dog-owner relationship seems to be the most important predictor of dog walking. Other studies failed to find associations between attachment to dogs and physical activity behavior of DOs (Hoerster et al., 2011; Curl et al., 2017). They support the idea that higher attachment to one's dog shifts the activity behavior of the DOs towards dog-related physical activity. But it does not seem to increase physical activity in general. Thus, non-dog-related physical activities might be substituted if DOs are more attached to their dog.

Dog-related activities might raise animal welfare concerns. Earlier studies in free living or free ranging dogs show that most dogs do not travel long distances and are only active for short time periods each day (Boitani et al., 2017; Pérez et al., 2018; Sparkes et al., 2014). Moreover, similar results were found earlier in kenneled dogs (Hubrecht et al., 1992). There are findings that postulate that canine attention deficit hyperactivity disorder (ADHD) symptoms correlate with frequency and duration of dog walking (Hoppe et al., 2017). Consequently, DOs who engage in more activities might not act in the best interest of their dogs. On the other side, a study from the UK shows that many dogs do not receive enough activity per day (Pickup et al., 2017). In addition, Pérez et al. (2018) found that some individuals of free roaming dogs travel long distances per day, which would also suggest that long and frequent activities with a dog could be harmless.

The present study has some limitations. Questionnaires tend to overreport physical activity patterns (see e.g. Cleland et al., 2014; Hartley et al., 2014; Nicolaou et al., 2016). Not only time but also intensity of physical activity can be overestimated. Further, the questions about other dog-related activities might be prone to bias because DOs could report activities that are strenuous for their dogs but not for themselves. It is conceivable that the same dog-related activities are very different in their intensity levels for different DOs. For example, ball games could be highly intense if DOs chase their dogs who have the ball. On the other hand, if the handler only throws the ball and the dog only retrieves it, it might not raise heart rate of the DO at all. Thus, whether DOs reach physical activity recommendations needs to be interpreted with caution.

Furthermore, DOs answered more questions about their physical activity behavior than nDOs. This might lead to a greater amount of overreporting in DOs than nDOs. Consequently, the differences need to be interpreted carefully.

Lastly, the level of significance was Bonferroni-corrected in all physical activity variables. But if the chances of making a Type I error decrease, the chances of making a Type II error increase. Thus, it is possible that nDOs might engage in more walking to work, walking to shop, riding bicycles to work or riding bicycles for transportation purposes. The effect sizes are small to average. The mean values, however, are very small. So, even if there is a statistically significant effect in the population, the practical significance of this effect is vanishingly small.

This study has several strengths. First, to the knowledge of the authors, this is the first study of its kind in a German population and therefore extends knowledge to a new cultural background. Earlier studies mainly focused on English-speaking populations (see e.g. Christian et al., 2016; Ding et al., 2018; Westgarth et al., 2017), the Czech Republic (see e.g. Baranyiová et al., 2005; Maugeri et al., 2019; Mičková et al., 2019) or Japan (see e.g. Oka & Shibata, 2012; Shibata et al., 2012). In order to see whether the results of this investigation can be transferred to the entire German dog-keeping population further investigations are needed. These studies should either be carried out as replication studies, or better, with a recruitment method that allows randomization.

The second strength of this study is that it gives more detailed information about dog-related activities than previous publications. Earlier studies often used the International Physical Activity Questionnaire (IPAQ), which asks for light, moderate or vigorous physical activity as well as walking behavior (The IPAQ group, n.d.). The BSA-F extends beyond this instrument in regard to the mentioned activities, offering more detailed insights into exercise types. Although dog walking is the most important dog-related physical activity in regard to duration, the frequency, duration and intensity of other dog-related physical activities need to be further examined in various settings. The authors see the highest potential to improve Dos' health in activities like agility, canicross, hiking, general play, and catch and chasing games.

Conclusion

In conclusion, the results suggest that DOs in Germany are more active than nDOs. However, the results should be interpreted cautiously and future research is needed to verify these results. Second, the results show that many DOs engage in other dog-related activities beyond dog walking. Dog ownership is a lifestyle choice and there might be a wish to share other activities with one's dog. Third, the study found that attachment is a predictor of dog-related physical activity but not total physical activity. This stresses the importance of further investigation in other activities for human health.

The question of whether these activities have beneficial effects on human health remains unanswered and needs further investigation. The intensity of dog-related physical activities other than dog walking especially need to be addressed in future studies. Lastly, interventions that aim for human health benefits through dog-related physical activities should target intensity of activities rather than duration.

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