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2 **Overweight dogs exercise less frequently and for shorter periods: results of a large online**  
3 **survey of dog owners from the United Kingdom**  
4

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24

25 **Abbreviations**        95%-CI: 95% confidence interval; OR: odds ratio  
26

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34 **Abstract**

35

36 Canine obesity is now the number one health concern in dogs worldwide. Regular physical activity  
37 can improve health, and owners are advised to exercise their dogs on a regular basis. However,  
38 limited information exists about associations between overweight status of dogs and walking  
39 activity.

40

41 An online survey was conducted between June and August in 2014, coinciding with the broadcast  
42 of a National UK television programme, exploring dog behaviour. Information gathered included  
43 signalment, overweight status, and owner reported information on duration and frequency of dog  
44 walking. The University of Liverpool Ethics Committee approved the project, and owners  
45 consented to data use. Simple and multiple logistic regression analysis were used to determine  
46 associations between overweight status and dog walking activity.

47

48 Data were available from 11,154 adult dogs, and 1,801 (16.1%) of these were reported as  
49 overweight by their owners. Dogs reported to be overweight dogs were more likely to be neutered  
50 ( $P<0.0001$ ) and older ( $P<0.0001$ ). Various breeds were over-represented including Beagle,  
51 Cavalier King Charles spaniel, Golden Retriever, Labrador retriever, and Pug ( $P<0.0001$  for all).  
52 Both frequency and duration of walking were negatively associated with overweight status  
53 ( $P<0.0001$  for both). On multiple regression analysis, duration and frequency were independently  
54 and negatively associated with the odds of being overweight, along with a range of other factors  
55 including age, neuter status, and breed.

56

57 This study has identified associations between overweight status and exercise. In the future, studies  
58 should determine the reason for this association, and whether changes in walking activity can  
59 influence on weight status.

60

61

62 **Introduction**

63

64 Overweight and obesity are common in dogs,<sup>(1,2)</sup> and recent evidence suggests that the prevalence is  
65 steadily increasing.<sup>(3)</sup> Known **comorbidities** include osteoarthritis, diabetes mellitus, respiratory  
66 disease, and neoplasia.<sup>(1,4)</sup> Dogs that are overweight also develop metabolic derangements,<sup>(5)</sup> and  
67 altered respiratory function.<sup>(6)</sup> Studies have also demonstrated that obese dogs have a poorer quality  
68 of life,<sup>(7)</sup> and that dogs that are overfed and are overweight long term, tend to have a shorter  
69 lifespan.<sup>(8)</sup> Numerous factors are known to predispose to obesity including breed, sex and being  
70 neutered.<sup>(1)</sup> Factors relating to the owner and environment are also known to be important,  
71 including their income, being middle aged, living in a single-dog household, and feeding  
72 snacks.<sup>(9,10)</sup>

73

74 Physical activity is also a possible risk factor for weight gain, not least given that research suggests  
75 obesity decreases physical activity in humans.<sup>(11,12)</sup> Conversely, other studies have suggested that  
76 low physical activity might predispose to weight gain, which then reduces physical activity.<sup>(13)</sup> To  
77 date, few studies have examined associations between activity and obesity in dogs. In two previous  
78 owner surveys of risk factors associated with obesity, the risk of being overweight declined steadily  
79 for each hour of exercise per week undertaken.<sup>(9,10)</sup> However, the relationship between duration and  
80 frequency was not considered. The aim of the current study was to examine patterns of exercise  
81 and their relationship to overweight status in dogs from a large online survey of owners.

82

83

## 84 **Methods and Materials**

85

### 86 *Study design and methodology*

87 A television documentary series called "Dogs - Their Secret Lives" was produced during early  
88 2014, and aired on Channel 4 television in the same year. It covered aspects of health and  
89 wellbeing in the UK canine population. The series featured 3 of the study authors (AJG, EB, ME),  
90 and **was broadcast** during the summer months. To accompany the series, an online survey was  
91 conducted between June and August in 2014, and this coincided with when the episodes aired. The  
92 University of Liverpool Ethics Committee approved the study, and all owner participation was  
93 voluntary, whereby owners who wished to complete the survey logged onto the Channel 4 website.  
94 Further, owners gave permission for their data to be used, in a fully anonymised form (i.e. any  
95 client-identifying data removed), and for the results to be publicised both on the TV shows and  
96 online. Further, they were not required to answer questions that they were unclear about, or did not  
97 wish to answer. To be eligible for inclusion in the data analysis part of the study, dogs had to be  
98 adult ( $\geq 2$  years of age) and questionnaire information needed to be complete i.e. **i.e. all questions**  
99 **used in the current study needed to be answered.**

100

### 101 *Survey design*

102 There were 43 questions in the survey, with 4 covering personal data not used in the project. The  
103 remaining questions covered signalment details of the dog (age, sex, neuter status, breed), current  
104 body weight, whether or not the dog was overweight, lifestyle, activity, and behaviour. **Owners**  
105 **gave their responses in free text boxes for age and bodyweight, and either checked boxes or used**  
106 **drop-down menus for the remaining questions. For overweight status, owners responded to the**  
107 **question "Is your dog overweight?", with their answer being based on their own subjective**  
108 **impression (i.e. no reference to a formal body condition scoring system). The main questions**  
109 **considered in the current study were those relating to activity, whereby two questions were**  
110 **considered.** For exercise frequency, the question asked was "How often do you exercise your dog  
111 outside of your home or garden?" and respondents could select: "more than once a day", "once a  
112 day", "4-6 times per week", "1-3 times per week", or "never". For exercise duration, the question  
113 asked was "Each time you exercise your dog how long is it for?" and respondents could select:  
114 "over an hour", "30 minutes to an hour", "11-30 minutes", and "0-10 minutes". The same data on  
115 exercise were also used for a separate study examining activity patterns amongst different dog  
116 breeds,<sup>(14)</sup> whilst the questions relating to behaviour are reported elsewhere.<sup>(15)</sup>

117

118 ***Data handling and statistical analysis***

119 All data were first entered into a computer spreadsheet (Excel version 14, Microsoft, Redmond,  
120 Washington, USA), to enable data checking and cleaning. Details of the data cleaning process are  
121 reported elsewhere.<sup>(15)</sup> Briefly, data were removed from all dogs under 2y age (to ensure no  
122 growing dogs were included), dogs with any missing data, and dogs with obvious errors in the  
123 dataset. Subsequently, age and bodyweight data inaccuracies were checked more closely given that  
124 these were free text boxes and more liable to errors. This involved using the "sort" function to  
125 check age and weight data within breed and sex, with expected ranges for the respective breed  
126 based upon information reported in an online encyclopaedia (<https://www.wikipedia.org>). Dogs  
127 with ages more than 20% outside the range reported for each breed (given uncertainties of the  
128 reported age ranges) were removed. Computer software (Stats Direct version 3.0.171; Stats Direct  
129 Ltd.) was used for all tests. Statistical significance was considered when  $P < 0.05$ , for two-sided  
130 analyses.

131  
132 Initially, associations between overweight status and activity levels were examined using Chi  
133 squared tests for trend; frequency and duration of exercise were examined separately, and the test  
134 was applied across the ordered categories (e.g. from least frequent exercise category to most  
135 frequent exercise category and from shortest duration of exercise to longest duration of exercise).  
136 Associations were further explored using logistic regression analysis to determine differences  
137 amongst exercise categories, and the possible influence of confounding variables (e.g. signalment).  
138 The outcome variable was overweight status, whilst variables considered were activity frequency,  
139 activity duration, and signalment (e.g. age, sex, neuter status, and breed). For activity frequency,  
140 "more than once a day" was used as the reference category and, for activity duration, "over an hour"  
141 was used as the reference category. Sex and neuter status were binary and age continuously as  
142 whole years. For breed, those that had previously been identified as significantly associated with  
143 overweight status (at  $P < 0.0017$ ) in a study using the same data<sup>(15)</sup> were initially included, each  
144 coded as a separate variable (whereby 1=from that breed and 0=not from that breed). An initial  
145 multiple regression model was constructed including all variables, and this was refined in a  
146 forwards and backwards stepwise fashion, so as to optimise the fit of the model and take account of  
147 covariance. During this procedure, exercise frequency and activity were retained *en bloc* even  
148 when single categories were not significant. When decisions were made regarding which breeds to  
149 retain and discard, priority was given to those breeds with the largest numbers. In the final model,  
150 only variables that were significant in their own right (at  $P < 0.05$ ) were retained.

151

152 **Results**

153 *Final dataset*

154 Details of the demographics of the final dataset are reported elsewhere.<sup>(15)</sup> Briefly, there were  
155 17,028 survey responses available and, after the data cleaning steps, responses for 11,154 dogs were  
156 used in the final analysis. A range of breeds were represented, with the most common being  
157 Labrador retriever (1,344), Jack Russell terrier (606), border collie (583), and cocker spaniel (512).  
158 The median age of the population was 5 years (range 2-19 years) and median bodyweight was 20 kg  
159 (range 1-107 kg). A total of 1801 owners (16.1%) reported that their dog was overweight, and these  
160 dogs were significantly heavier, more likely to be neutered, and of certain breeds (e.g. Beagle, Bull  
161 Terrier, Bulldog, Cavalier King Charles spaniel, Chihuahua, Golden Retriever, Labrador Retriever,  
162 and Pug) and older.<sup>(15)</sup>

163

164 *Association between overweight status and activity level*

165 Owner-reported exercise frequency and duration are shown in Table 1. With simple logistic  
166 regression analysis, dogs that were reported to be overweight exercised less frequently ( $P<0.0001$ )  
167 and for a shorter time ( $P<0.0001$ ) than those not reported to be overweight. On multiple logistic  
168 regression analysis, both exercise frequency and duration were independently and negatively  
169 associated with overweight status along with a range of other factors including age, neuter status,  
170 and breed (Table 2). Compared with dogs that were exercised more than once a day, the odds of  
171 being overweight steadily increased for dogs that were exercised 4-6 times per week (OR 1.297,  
172  $P=0.0165$ ), 1-3 times per week (OR 1.633,  $P<0.0001$ ) and not exercised at all (OR 1.975,  
173  $P=0.0087$ ). However, there was no difference between dogs exercised daily and more frequently  
174 ( $P=0.1270$ ). Further, compared with dogs exercised for over an hour, the odds of being overweight  
175 increased steadily for dogs exercised for 30 minutes to an hour (OR 1.266,  $P=0.0031$ ), 11-30  
176 minutes (OR 1.754,  $P<0.0001$ ), and 0-10 minutes (OR 2.241,  $P<0.0001$ ).

177

178 **Discussion**

179

180 The current study involved surveying the opinions of a large number of owners regarding patterns  
181 of exercise in their dogs. To our knowledge, it is the largest survey of its kind ever conducted that  
182 has explored associations between overweight status and activity. Independent associations were  
183 identified for both exercise frequency and exercise duration with overweight status, and these  
184 remained when possible confounding factors (such as breed, age, sex and neuter status) were taken  
185 into account. As a result, the findings of the study extend those of previous epidemiological  
186 surveys, which have only previously demonstrated an association with total weekly activity.<sup>(9,10)</sup>  
187 They also support the findings of a small study, which used objectively measured physical activity  
188 with accelerometers.<sup>(16)</sup> In that study, dogs that were obese had lower levels of vigorous intensity  
189 activity than dogs that were not obese. Of course, a limitation of both of these studies is that neither  
190 have investigated the reasons for the association. As a result, prospective studies are now required  
191 to investigate further the link between activity and overweight status.

192

193 Dogs that were reported to be overweight exercised less frequently, with the odds of being  
194 overweight steadily increasing when they were exercised less than once per day. Furthermore,  
195 duration of activity was negatively associated with being overweight, and the odds of being  
196 overweight steadily increasing the shorter the duration of exercise. As mentioned above, the given  
197 the nature of the study, it is not possible to determine the reason for the association, whether it is  
198 causal, and any direction to the causality. For example, it is possible dogs that are overweight are  
199 less able to exercise than those that are not, with the result that they take less frequent and shorter  
200 periods of exercise. Alternatively, it is possible that dogs exercising less are more prone to weight  
201 gain, and becoming overweight. If this is the case, the results of the current study suggest that a  
202 suitable target for dog owners should be to exercise their dog at least every day and for as long as  
203 possible.

204

205 There are a number of limitations to consider with this study. Firstly, the proportion of overweight  
206 dogs in the population examined was lower than expected (16.1%) based upon the expected  
207 prevalence of overweight dogs in the UK.<sup>(10)</sup> The possible reasons for this association have been  
208 discussed before,<sup>(15)</sup> and most likely be due either to participation bias, whereby the owners who  
209 took part were not representative of the UK population as a whole, or due to owners under-  
210 estimating actual body condition, meaning that many overweight dogs were incorrectly classified as  
211 normal. The resulting impact of this is that magnitude of the associations identified may well have  
212 appeared weaker than they actually were. A second limitation is the fact that activity was assessed

213 on the basis of owner reports, rather than more objective measures for example using  
214 accelerometers. This may have led to inaccuracies in that they are based upon what owners think  
215 and say they do, rather than what they actually do. This may well have been compounded by the  
216 fact that response options were limited, and owners were required to choose from a defined number  
217 of categories. Some owners might have found it difficult to select an appropriate category, for  
218 example, if their dog undertook a pattern of exercise that varied from day to day in terms of  
219 frequency and duration. A final limitation was the fact that, whilst a number of confounding  
220 variables were examined, others were not considered including owner factors (e.g. ability to take  
221 their dog for a walk), local environment, local weather patterns, and concurrent illness (e.g.  
222 orthopaedic disease). Size of dog has previously been associated with motivation to take dogs for  
223 walks,<sup>(17)</sup> but this was not included in the model due to collinearity with breed. Further studies  
224 should consider acquiring more detail on owners and their dogs, further explore further different  
225 activity patterns, and consider assessing physical activity in different ways concurrent, perhaps by  
226 using owner reports in conjunction with objective measurements of physical activity. Ultimately,  
227 intervention studies will likely be required to determine reasons for the association between  
228 overweight status and both the duration and frequency of exercise.

229

230

## 231 **Conclusions**

232 The findings of the current study have identified associations between dogs that are overweight and  
233 both their frequency and duration of exercise. **The odds of being overweight was greater both for**  
234 **dogs that exercised less than once a day and those that exercised for less than an hour each time.**  
235 Future studies should determine the reason or this association, and whether changes in exercise  
236 pattern can influence the likelihood of dogs becoming overweight.

237

238

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241 for its assistance hosting and promoting the survey.

242

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247

248

249 **Conflict of Interest**

250 Royal Canin financially supports the post of AJG at the University of Liverpool, whilst Dogs Trust

251 Financially supports the post of EB at the University of Bristol.

252

253 **Authorship**

254 AJG, EB, and ME proposed the research questions and designed the questionnaire. AJG conducted

255 the statistical analyses and CW advised. AJG, EB and CW interpreted the results. AJG produced

256 the first draft of the manuscript, which was subsequently reviewed and edited by the other authors.

257 All authors approved the final manuscript.

258

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- 299

300 **Table 1. Exercise frequency and duration in the study dogs**

301

Exercise	<u>Owner-reported weight status</u>		P-value <sup>1</sup>
	Overweight (n=1801)	Not overweight (n=9353)	
<u>Frequency</u>			<0.0001
More than once a day	948 (52.6%)	5347 (57.2%)	
Once a day	538 (29.9%)	2823(30.2%)	
4-6 times per week	124 (6.9%)	556 (5.9%)	
1-3 times per week	163 (9.1%)	565 (6.0%)	
Never	28 (1.6%)	62 (0.7%)	
<u>Duration</u>			<0.0001
Over an hour	236 (13.1%)	1735 (18.5%)	
30 minutes to an hour	903 (50.1%)	5084 (54.4%)	
11-30 minutes	608 (33.8%)	2395 (25.6%)	
0-10 minutes	54 (3.0%)	140 (1.5%)	

302 <sup>1</sup>Chi squared test for linear trend applied across ordered categories.

303

304

305 **Table 2. Multiple logistic regression analysis on associations between overweight status and**  
 306 **both signalment factors and activity**

Variable	Odds Ratio	95%-CI	Probability
Sex			
Female (reference)	1.000	---	---
Male	0.854	0.770-0.948	0.0029
Neuter status			
Intact (reference)	1.000	---	---
Neutered	2.212	1.870-3.426	<0.0001
Age (per year)	1.063	1.046-1.079	<0.0001
Breed			
Beagle	8.100	5.485-11.961	<0.0001
Cavalier King Charles Spaniel	2.254	1.883-3.426	<0.0001
Golden Retriever	1.893	1.409-2.542	<0.0001
Labrador Retriever	1.736	1.500-2.009	<0.0001
Pug	4.878	2.508-9.369	<0.0001
Exercise frequency			
More than once a day (reference)	1.000	---	---
Once a day	1.097	0.974-1.235	0.1270
4-6 times per week	1.297	1.049-1.603	0.0165
1-3 times per week	1.633	1.344-1.984	<0.0001
Never	1.975	1.188-3.283	0.0087
Exercise duration			
Over an hour (reference)	1.000	---	---
30 minutes to an hour	1.266	1.083-1.481	0.0031
11-30 minutes	1.754	1.482-2.076	<0.0001
0-10 minutes	2.241	1.531-3.281	<0.0001

307 95%-CI, 95% confidence interval.