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ORIGINAL ARTICLE

Pet ownership and adolescent health: Cross-sectional population study

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Objective: To determine whether adolescent health and well-being are associated with having a pet in the household (any pet, or specifically dogs, cats or horses/ponies) or average daily time spent caring for/playing with pet(s).

Methods: *Design, setting and participants* – Cross-sectional data from the third wave of the Health of Young Victorians Study (HOYVS), a school-based population study in Victoria, Australia. *Predictors* – Adolescent-reported pet ownership and average daily time spent caring for/playing with pet(s). *Outcomes* – Self-reported quality of life (KIDSCREEN); average 4-day daily physical activity level from a computerised diary; parent-proxy and self-reported physical and psychosocial health status (PedsQL); measured BMI status (not overweight, overweight, obese) and blood pressure. *Statistical Analysis* – Regression methods, adjusted for socio-demographic factors, and non-parametric methods.

Results: Household pet data were available for 928 adolescents (466 boys; mean age of 15.9 (SD 1.2) years). Most adolescents (88.7%) reported having a pet in their household. Of these, 75.1% reported no activity involving pets over the surveyed days. It appeared that neither owning a pet nor time spent caring for/playing with a pet was related, positively or negatively, to adolescent health or well-being.

Conclusions: Despite high rates of pet ownership, adolescents had little interaction with pets. It appears that owning a pet and time spent caring for/playing with a pet was not clearly associated with adolescents' health or well-being.

Key words: adolescent; animals; cross-sectional studies; domestic; health; physical activity.

What is already known on this topic

1 Sixty-three per cent of Australia's 7.5 million households own a pet. Evidence suggests that adult pet owners experience improved physical, mental and emotional health.
2 However, not all research has demonstrated positive effects of pet ownership on health and the cross-sectional nature of these studies precludes causal inferences.
3 In adolescents, little is known about relationships between health and pets. The few available studies comprise clinical or specialised samples.

What this paper adds

1 While a high number of adolescents owned a pet (more than 80%), only a small number actually reported caring for/playing with pet(s).
2 Neither owning a pet nor time spent caring for/playing with a pet appeared to be related to better adolescent health or well-being.
3 At the same time, there was little evidence to suggest that pet ownership contributed to negative outcomes for adolescents.

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Participant Consent: Informed consent was obtained from all participants. There is no chance that a patient (whether living, dead, or a child) may be identified from this paper.

Author Contribution: Megan Mathers acquired the data and has provided data analysis and interpretation along with Melissa Wake and Louise Canterford. Louise Canterford provided statistical expertise. Megan Mathers drafted the manuscript along with Louise Canterford. The conception and design of the study are attributed to Melissa Wake, Tim Olds and Elizabeth Waters. With the rest of the investigator team, these authors also secured funding for the study. Melissa Wake has provided a supervisory role, and, along with Tim Olds and Elizabeth Waters, has provided critical revision of the manuscript for important intellectual content.

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Introduction

Sixty-three per cent of Australia's 7.5 million households own a pet, with 38% owning a dog, 25% owning a cat, and 53% owning a dog and/or cat.[1] This high level of ownership reflects the value and importance placed on pets in society.[2] In the context of health-enhancing social environments, a key question is whether pet ownership is linked with better health and physical activity levels, and if so, what might be the range of causal pathways. Several are plausible: pet owners might be more active (i.e. they walk, bathe, play with their pets) than non-pet owners, or contact with pets might reduce stress. Each of these could result in a cascade or synergy of health outcomes. Alternatively, happy, organised, caring and healthy individuals or families may simply be more likely to acquire pets.[3]

Conversely, the presence of pets within a family can add to household commitments and add additional stress to often already stretched families (feeding, financial resources associated with health expenses, expectation to walk, bath or engage, and collection of refuse).

Evidence suggests that adult pet owners experience improved physical, mental and emotional health.[4] Cardiovascular benefits include lower systolic blood pressure,[5,6] plasma cholesterol in men and triglyceride levels.[5] This translates into fewer doctor visits; less medication for high blood pressure, sleeping difficulties, high cholesterol or a heart problem;[7] and better survival rates after a heart attack.[8,9] Emotional benefits include less mental stress,[10,11] less loneliness and depression[12,13] and higher self-esteem.[14] However, not all research has demonstrated positive associations between pet ownership and health,[15,16] and the cross-sectional nature of these studies precludes causal inferences. Furthermore, most samples were clinical or specialised, so that these findings might not generalise to the general community population.

Evidence regarding physical activity is conflicting. Depending on the age and agility of the pet, owners (particularly dog owners) may be more likely to be physically active than non-pet owners.[5,16–18] Dog ownership was associated with a 58% increase in the odds of walking as recommended (180 min per week) in an Australian study.[19,20] Serpell[21] showed that acquisition of a dog was followed by a significant increase in the number and duration of recreational walks taken 10 months later. However, it is possible that walking merely replaces other types of physical activity, as other studies have reported that dog owners accumulate similar,[22] or only marginally increased,[23] accumulated weekly minutes of physical activity compared with non-dog-owners, and that benefits may relate to specific pet characteristics such as type and size of dog.

In adolescents, little is known about relationships between health and pets. The few available studies comprise clinical or specialised samples. Banman[24] reported that pets may serve various therapeutic functions in working with young people in a psychiatric environment. A qualitative study of 32 homeless youth found that 13 identified their pets as companions that provided unconditional love, reduced feelings of loneliness and improved their health.[25]

The potential benefits of pet ownership on health are of immense relevance to today's adolescents. The proportion of overweight and obese adolescents has reached epidemic levels,[26] and levels of sedentary behaviour exceed recommendations.[27] If pet ownership were shown to be beneficial, and the setting or context supportive, then this might help achieve healthful behaviour changes to address these issues, which has proven notoriously difficult in the standard health-care setting.

This paper draws on a large, established community-based study of adolescents aged 13.6–19.4 years. It aims to determine whether adolescent health and well-being are associated with (i) having any pet in the household; (ii) having a dog; (iii) having a cat; (iv) having a horse/pony and (v) average daily time spent caring for/playing with a pet(s).

Materials and Methods

Design and sample

The sample comprised adolescents in the third wave of a population-representative longitudinal study, the Health of Young Victorians Study (HOYVS 2005). Sampling and methods have been reported in detail previously.[28–30] Briefly, participants were selected for Wave 1 in 1997 from across Victoria, Australia (population 4.69 million in 1998), using a stratified 2-stage random sampling design based on school education sector (government, Catholic or independent) and school class level. For the primary school cohort, 24 schools were randomly selected with a probability proportional to size, and one class at each year level from each school was then randomly selected. The baseline response rate for prep (first school year in Victoria) through third grade students (ages 5–8 years) in 1997 was 83.2% (1943 of 2336 identified children), and these children were followed in Waves 2 (2000) and 3 (September 2005-December 2006). In Wave 3, 1662 students in years 8–11 were invited to participate. Of the 960 adolescents with parent consent in 2005 (57.8%), 928 had self-reported data on pets available, and form the sample for this paper (55.8%).

The study was approved by the Ethics in Human Research Committee of the Royal Children's Hospital and by the educational sector authorities (government, Catholic and independent). A parent-proxy provided prior written informed consent, and students also provided written informed consent on the survey day.

Procedures

One or two researchers visited each adolescent at school or home on two occasions wherever possible. At the first visit, adolescents completed a written questionnaire and 1–2 computerised activity diary days, and their height, weight and blood pressure were measured (see Box 1). At the second visit, the adolescent completed further days of the activity diary.

The Multimedia Activity Recall for Children and Adolescents (MARCA[35])

Contributed both predictor (time spent with pets) and outcome (physical activity) variables. The MARCA is a computerised 24-h activity recall, linked to a compendium of energy expenditure, which asks young people to recall everything they did on the previous day from the time they got up until the time they went

to bed, in blocks of at least 5 min duration. Using a point-and-click interface, young people choose from a list of about 250 activities grouped under seven main categories (Inactivity, Transport, Sport and Play, School, Self-Care, Chores and Other), and where appropriate, indicate whether the activity was of light, medium or hard intensity. The MARCA has a same-day test–retest reliability of r = 0.84–0.92 for major outcome variables (moderate to vigorous physical activity (MVPA); physical activity level (PAL) and screen time), and a convergent validity against accelerometry of r = 0.57 in a similar age range as the current sample.[35]

Adolescents were requested to complete four MARCA recalls (two full days at school and two full non-school days (weekend, holiday, or day-off)). Diaries were classified as 'unuseable' if they recorded fewer than 10 activities, or had very high (>3 metabolic equivalent totals (METs)) or very low (<1.1 METs) energy expenditures.

Predictor variables

Adolescents reported whether they had in their household any (i) pet(s), (ii) cat(s), (iii) dog(s) and (iv) any other pet(s) (if applicable), and the number of each (if applicable). The MARCA analytical module was used to determine minutes (per diary) devoted to feeding pets/farm animals, playing with animals (sitting), playing with animals (walking/running; light, medium, hard) or bathing dog. Average daily time devoted to these activities was calculated for each adolescent, by taking the average across each 'useable' diary; thus, a number of estimates (11.6%) were based solely upon school day information or non-school day information. The distribution of average daily time spent caring for/playing with pets was highly skewed to the right, with 77.6% of respondents having a daily average of 0 min. Hence, this continuous variable was categorised into three groups (zero, >0 to < 15, and ≥15 min) in accordance with the distribution of the data.

Outcome measures are summarised in Box 1.

Socioeconomic and demographic variables (covariates)

These comprised the adolescent's sex, age, and the Socio-Economic Indexes for Areas (SEIFA) disadvantage index at the postcode of residence level. SEIFA values are standardised scores by geographic area compiled from 2001 census data to numerically summarise the social and economic conditions of Australia (national mean 1000, SD 100; higher values represent greater advantage).[36] SEIFA values were analysed using categories

Box 1 Measures of potential outcomes of pet ownership

Construct	Measure	Additional information
Body Mass Index (BMI), weight (kg)/height (m)^2	Measured by a trained researcher.	Weight was measured in light clothing to the nearest 100 g using digital scales (Tanita, THD-646) and height (measured twice) to the nearest 0.1 cm using a portable rigid stadiometer (Invicta (Leichester, UK) , Model IPO955). The average of the height measurements were used in analyses; where the two differed by more than 0.5 cm, a third measurement was taken and the median used in analyses. Participants were classified as non-overweight, overweight or obese according to the IOTF age- and sex-specific criteria for BMI.[31] Adolescents >18 years of age were classified as non-overweight (<25 kg/m^2), overweight (≥25 and <30 kg/m^2) or obese (≥30 kg/m^2).
Average daily physical activity level	MARCA, adolescent self-report.	Refer to the methods (predictor variables) section for information about MARCA. The MARCA's analytical module, a software engine that decodes and analyses daily diaries, was used to determine an overall daily physical activity level (PAL, in METs (Standard Metabolic Equivalent)).
Blood pressure	Digital blood pressure monitor (A & D Medical (San Jose, USA), Model UA-787); measured by a trained researcher.	3 measurements were taken, 1 min apart. A mean score of the 2nd and 3rd readings was calculated. Systolic and diastolic blood pressure percentiles were calculated according to gender, age and height.[32] Systolic and diastolic hypertension are defined as blood pressures ≥ their respective 95th percentiles; systolic and diastolic 'prehypertension' as blood pressures ≥90th and <95th respective percentiles.[32]
Health status	Pediatric Quality of Life Inventory 4.0 (PedsQL 4.0)[33] 13–18 year old self-report and parent-proxy versions.	23 items, Cronbach's alpha = 0.89 adolescent; 0.92 parent.[33] Assesses physical, emotional, social, and school functioning, from which Physical and Psychosocial health summary scores were derived. The possible range of scores is 0–100, with 100 representing best possible health.
Quality of Life	KIDSCREEN,[34] adolescent self-report.	10 items, Cronbach's alpha = 0.82.[34] Assesses the health-related quality of life of healthy and chronically ill children and adolescents aged 8–18 years. Ten domains are measured: physical well-being, psychological well-being, moods and emotions, self perception, autonomy, parents' relations and home life, peers and social support relations, school environment, bullying, and financial resources. Higher scores indicate higher quality of life.

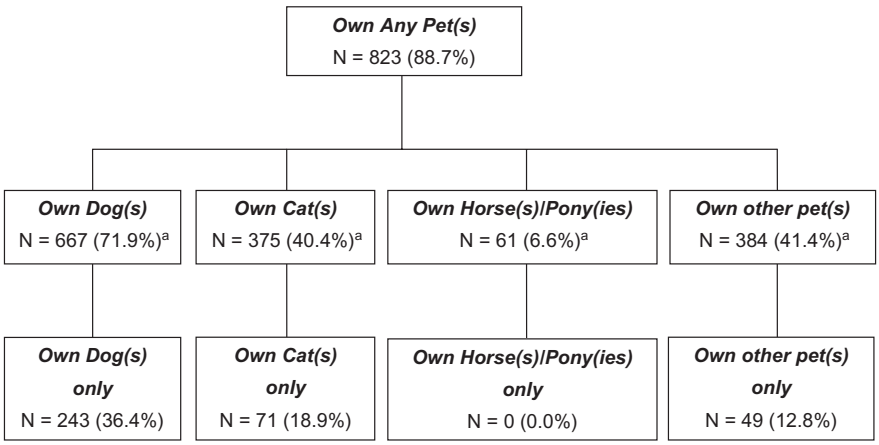

Fig. 1 Summary of pet ownership amongst the 928 adolescents that provided data.
[a]Percentage of the 928 adolescents that provided pet ownership data.

determined by the quintiles in the distribution of the general Victorian population.

Statistical analysis

Adjusted analyses (linear regression methods for the continuous outcomes and proportional odds ordinal logistic regression method for the BMI status outcome) were carried out separately for each of the predictor variables (any pets, any cats, any dogs, any horses/ponies, and average daily time spent caring for/playing with pets). Analyses were adjusted for the covariates of sex, age and SEIFA disadvantage quintile. The SEIFA disadvantage quintile covariate was tested for departure from linearity and is presented as linear effects where the test result was non-significant at the 5% level. We present effect estimates (mean differences for linear regression and odds ratios for logistic regression) and 95% confidence intervals. The four PedsQL outcomes were modestly skewed, so confidence intervals for linear regression parameters were re-estimated using the bootstrap method; as the results were similar, the standard estimates are presented. Using the Brant test,[37] the proportional odds assumption (that the regression lines for the comparison of categories were parallel) was upheld for all predictors in each of the ordinal logistic regression models.

Analyses were conducted using Stata release 10.0 (Statacorp (College Station, TX, USA), 2007).

Results

Pet ownership data were available for 928 adolescents (466 boys and 460 girls) with a mean age of 15.9 (SD 1.2) years; 8.9%, 26.5%, 18.3%, 25.0% and 21.3% were in the most to least disadvantaged SEIFA quintiles, respectively. A total of 924 adolescents completed at least one 'useable' MARCA diary; of these, 94.8% completed four diaries, 0.3% three diaries, 2.7% 2 diaries and 1.7% 1 diary. 23 (2.5%) and 84 (9.1%) of these 924 adolescents provided only school day or non-school day 'useable' diaries, respectively.

The majority of the 928 adolescents (88.7%) reported having a pet in their household and, of these, 75.1% reported no activity involving pets. Figure 1 describes ownership of dogs, cats, horses/ponies and other pets. The most prevalent was dog ownership, reported by more than 70% of adolescents, followed by cats (40.4%); a much smaller number owned horses (6.6%). A large proportion reported a very wide range of less common pets, such as snakes, chickens, guinea pigs and rabbits.

Table 1 provides the summary statistics for each outcome. For those with pets in the household, the median interquartile range (IQR) of time spent interacting with pets was 0 (0–0) min/day, with a range of 0–175 min per day.

Table 2 shows the associations between each of the pet ownership predictors (excluding average daily time spent caring for/playing with pet(s)) and the outcomes. Health outcomes, average daily physical activity level and BMI status were not associated merely with owning any pet or with having dog(s). However, there was some evidence that having cat(s) was associated with worse (higher) systolic blood pressure (coefficient 1.68, 95% CI 0.17 to 3.19; $P = 0.03$). Having horse(s) was associated with slightly better (higher) self-reported PedsQL Physical Summary scores (mean: 85.6 (with horses) vs. 87.8 (no horses), $P = 0.01$), with a similar (though not statistically significant) trend in the parent-proxy score for this measure. These findings should be interpreted with caution, given the relatively weak association ($P = 0.03$ and $P = 0.01$, respectively) and the multiple tests performed (36 in total, each with a 5% chance of a type I error).

Table 2 also suggests that pet ownership per se is not relevant to daily physical activity in this age group. Again, issues of multiple testing should be considered when noting the borderline evidence that horse ownership predicted slightly higher average daily PAL (coefficient 0.06, 95% CI − 0.001 to 0.13; $P = 0.05$).

Adolescents reported interacting with pets on about one day in 10, and on average only 0.7% of total daily energy expenditure involved interaction with pets. Therefore, it does not seem surprising that there was little evidence of association between average daily time spent caring for/playing with pet(s) and most of the outcomes (Table 3). The statistically strong ($P = 0.001$) association between daily time with pets and adolescent BMI status was inconsistent in the direction of effect between those reporting >0 to <15 min per day and

Table 1 Summary statistics for each outcome measure, for whole group and for those with and without pets separately

Outcome	*n*	Whole sample (*n* = 928)	Value by pet ownership	
			Pets (*n* = 823)	No pets (*n* = 105)
BMI status†	922			
Not overweight	681	73.9	74.1	72.4
Overweight	185	20.1	20.4	17.1
Obese	56	6.1	5.5	10.5
Blood pressure‡				
Systolic	911	115.1 (12.4)	115.3 (12.4)	113.6 (12.7)
Diastolic	911	70.5 (8.4)	70.5 (8.4)	70.1 (8.2)
PedsQL (adolescent self)§				
Physical Summary	927	87.5 (81.3–93.8)	87.5 (81.3–93.8)	87.5 (81.3–93.8)
Psychosocial Summary	915	78.3 (68.3–85.0)	76.7 (68.3–85.0)	80.0 (70–88.3)
PedsQL (parent proxy)§				
Physical Summary	887	90.6 (78.1–96.9)	90.6 (78.1–96.9)	87.5 (78.1–96.9)
Psychosocial Summary	877	80.0 (40.0–90.0)	80.0 (70.0–90.0)	81.7 (69.2–90.0)
KIDSCREEN‡	923	47.5 (7.1)	47.5 (7.1)	47.8 (6.8)
Average daily physical activity level (METs)‡	924	1.6 (0.25)	1.6 (0.25)	1.6 (0.26)
Average time spent with pets per day (mins)§	924	0 (0–0)	0 (0–0.83)	N/A

†Percentage. ‡Mean (SD). §Median (IQR).

Table 2 Relationship between pet ownership (generic and dogs, cats, and horses separately) and health outcomes and physical activity

Outcome	Any pet(s)		Dog(s)		Cat(s)		Horse(s) (pony(s))	
	Effect†,‡ (95% CI)	*P*	Effect†,‡ (95% CI)	*P*	Effect†,‡ (95% CI)	*P*	Effect†,‡ (95% CI)	*P*
BMI status§	0.85 (0.54, 1.34)	0.48	1.03 (0.74, 1.44)	0.84	1.10 (0.81, 1.48)	0.55	1.20 (0.67, 2.15)	0.54
Blood pressure								
Systolic	2.04 (–0.27, 4.35)	0.08	–0.09 (–1.72, 1.54)	0.91	1.68 (0.17, 3.19)	0.03	2.05 (–1.07, 5.18)	0.20
Diastolic	0.48 (–1.21, 2.17)	0.58	0.25 (–0.94, 1.45)	0.68	0.66 (–0.44, 1.77)	0.24	1.11 (–1.17, 3.40)	0.34
PedsQL (adolescent self)¶								
Physical Summary	0.68 (–1.52, 2.89)	0.54	0.49 (–1.07, 2.05)	0.54	–0.45 (–1.90, 1.00)	0.54	3.15 (0.23, 6.07)	0.03
Psychosocial Summary	–1.44 (–3.98, 1.10)	0.27	–0.74 (–2.53, 1.06)	0.42	–1.13 (–2.80, 0.54)	0.19	1.74 (–1.61, 5.09)	0.31
PedsQL (parent proxy)¶								
Physical Summary	2.23 (–1.22, 5.68)	0.21	1.43 (–1.00, 3.87)	0.25	–0.92 (–3.20, 1.36)	0.43	2.20 (–2.40, 6.81)	0.35
Psychosocial Summary	0.31 (–2.67, 3.28)	0.84	0.97 (–1.12, 3.07)	0.36	–1.72 (–3.69, 0.25)	0.09	0.60 (–3.35, 4.56)	0.76
KIDSCREEN	–0.23 (–1.65, 1.19)	0.75	–0.08 (–1.08, 0.93)	0.88	0.25 (–0.69, 1.18)	0.60	0.65 (–1.24, 2.53)	0.50
Average daily physical activity level (METs)	0.03 (–0.02, 0.07)	0.29	0.03 (–0.004, 0.06)	0.09	–0.02 (–0.05, 0.01)	0.18	0.06 (–0.001, 0.13)	0.05

†Adjusted for sex, adolescent age at anthropometric measurement and SEIFA quintile, except for the four PedsQL outcomes. ‡Coefficient estimates for linear regressions (continuous variables), indicating mean differences in outcome; odds ratios for ordinal logistic regression. All outcomes except BMI status are continuous. §ORs from ordinal logistic regression represent estimated relative increase in odds of child being in a higher, compared to a lower, BMI category. ¶Linear regression parameters were re-estimated using the bootstrap method; as the results were similar, the standard estimates are presented.

those who spent ≥15 min per day, so appears likely to be a chance finding.

Discussion

Household pet ownership is common (more than 80%) among Australian adolescents, but neither owning a pet nor time spent caring for/playing with a pet appeared to be related to better adolescent health or well-being. Neither did they contribute to negative outcomes.

The results of this study are incongruent with Banman's[24] and Rew's[25] positive association between pet ownership and health outcomes in young people. Both used small, clinical or specialised samples, whereas the present study drew on a large, community-based sample. Thus, while pets may provide therapeutic benefits for vulnerable adolescent populations,

Table 3 Relationship between average daily time spent caring for/playing with pet(s) and each outcome of interest. Table displays adjusted measures of effect† (with 95% CI), comparing to the reference group of 0 min ($n = 713$)‡

Outcome	Activity category		*P*
	>0 to <15 min ($n = 140$)‡	≥15 min ($n = 71$)‡	
BMI status§	0.67 (0.42, 1.05)	2.14 (1.29, 3.53)	0.001
Blood pressure			
Systolic	–0.04 (–2.12, 2.03)	0.77 (–2.09, 3.64)	0.86
Diastolic	0.51 (–1.01, 2.03)	0.20 (–1.89, 2.30)	0.80
PedsQL (adolescent self)¶			
Physical Summary	0.36 (–1.63, 2.35)	1.91 (–0.81, 4.63)	0.38
Psychosocial Summary	–0.64 (–2.91, 1.64)	–0.71 (–3.85, 2.43)	0.80
PedsQL (parent proxy)¶			
Physical Summary	0.85 (–2.27, 3.96)	2.22 (–1.96, 6.40)	0.54
Psychosocial Summary	0.54 (–2.14, 3.22)	1.31 (–2.33, 4.95)	0.74
KIDSCREEN	–0.61 (–1.89, 0.67)	1.33 (–0.41, 3.08)	0.17
Average daily physical activity level (METs)	0.01 (–0.04, 0.05)	0.05 (–0.01, 0.11)	0.31

†Coefficient estimates for linear regressions (continuous variables), indicating mean differences in outcome; odds ratios for ordinal logistic regression (BMI status), adjusted for sex, adolescent age at anthropometric measurement and SEIFA quintile. ‡Numbers vary for each outcome. §ORs from ordinal logistic regression represent estimated relative increase in odds of child being in a higher, compared to a lower, BMI category. ¶Linear regression parameters were re-estimated using the bootstrap method; as the results were similar, the standard estimates are presented.

they do not seem to afford the same value to healthy adolescents in the community. Further, these findings may not apply to other age groups with a typically higher level of interaction with their pets. Late adolescence would probably represent a nadir of interaction, as there are so many other distractions. Thus, a different result may be obtained with younger children.

This study shows that, while a high number of adolescents owned a pet, only a small number actually reported caring for/playing with pet(s). The total amount of energy used interacting with pets was very small, so any putative benefits would have to be due to factors indexed by pet ownership (e.g. better regulated households, etc.) or through non-physical activity mechanisms such as stress reduction. It remains possible that higher levels of pet interaction than seen in this study would be associated with health and other benefits.

The results of this study should be considered in the context of its limitations. Its cross-sectional nature precludes conclusions about causal directions, but this is not an issue here since we found no strong associations. A potential loss of generalisability may have been introduced by the 50% loss to follow-up by the third wave of the study; however, this would not alter the internal validity and it seems unlikely that those lost to follow-up would experience pet-associated health gain sufficient to alter these conclusions. School and non-school MARCA recalls were not collected for all adolescents, which may also have introduced a bias. This study relied on adolescent report of pet ownership, but we would expect this to be fairly accurate. The MARCA does not allow for multitasking. Thus, some interactions with pets occurring at the same time as other activities may have been missed. However, if participants were multitasking, they were instructed to report for the activity that was their main focus or estimate the time devoted to both activities. Also, because the MARCA requires participants to report on activities of at least 5 min duration, some interactions with pets, and these could be psychosocially important interactions, may have been missed if they occurred for less than 5 min. Finally, we did not specifically study emotional attachment to pets, which could be an alternative mechanism for pet-related health gain. However, assuming that many adolescents who own pets *are* emotionally attached to them, Table 1 does not suggest that this improves health, as the adolescents who did and did not report pet ownership were virtually identical on all health-related measures.

The strengths of this study included its large-scale, population-based design and recency of the data. This study improved on the limitations of previous studies by (i) the community nature of the cohort, (ii) the reliable and comprehensive nature of the data capturing physical activity levels relating to pet interactions and (iii) the breadth and consistency of the outcomes. This study specified a wide range of health outcomes *a priori* and, because HOYVS focused overtly on mental health and BMI status (not pets), we would not expect major social desirability or other biases relating specifically to the pet data.

Research has shown that pets can confer health benefits in some situations, but it is less clear exactly how. Issues to consider for future research may be the level of attachment to the pet or who is the primary caregiver of the pet. It may be that adults or adolescents who are less attached to their pets, or who are not the primary caregiver, are less likely to care for/play with their pet, or take their dog for a walk, and thus experience health gain. However, based on this study's evidence, it would be premature to embark on pet ownership campaigns as an approach to combat poor mental health and physical inactivity levels in adolescents.

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