Associations of pet ownership with biomarkers of ageing: population based cohort study

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ABSTRACT
OBJECTIVE
To examine the prospective relation between animal companionship and biomarkers of ageing in older people.

DESIGN
Analyses of data from the English Longitudinal Study of Ageing, an ongoing, open, prospective cohort study initiated in 2002-03.

SETTING
Nationally representative study from England.

PARTICIPANTS
8785 adults (55% women) with a mean age of 67 years (SD 9) at pet ownership assessment in 2010-11 (wave 5).

MAIN OUTCOME MEASURE
Established biomarkers of ageing in the domains of physical, immunological, and psychological function, as assessed in 2012-13 (wave 6).

RESULTS
One third of study members reported pet ownership: 1619 (18%) owned a dog, 1077 (12%) a cat, and 274 (3%) another animal. After adjustment for a range of covariates, there was no evidence of a clear association of any type of pet ownership with walking speed, lung function, chair rise time, grip strength, leg raises, balance, three markers of systemic inflammation, memory, or depressive symptoms.

CONCLUSION
In this population of older adults, the companionship of creatures great and small seems to essentially confer no relation with standard ageing phenotypes.

Introduction
The notion that animal companionship might be linked to human health can be traced to ancient writings and, of creatures great and small seems to essentially confer no relation with standard ageing phenotypes.

WHAT IS ALREADY KNOWN ON THIS TOPIC
Half of older people in the UK own a pet and 12% of older Australians report that animals are their predominant form of companionship.

The relation of animal companionship, a potentially modifiable characteristic, with biomarkers of ageing in older people is largely unknown.

WHAT THIS STUDY ADDS
Of 11 biomarkers of ageing, there was no evidence of a clear relation with pet ownership.

pet5—reflecting secular increases over recent years—suggests that interaction with animals is perceived as life enhancing.

There are persuasive prima facie reasons to anticipate that pet ownership may have both negative and positive health consequences. Deleterious impacts on human health could occur if owners delayed their own medical care in preference to pet welfare; grief and distress occurred after a companion animal’s death6; or, most obviously, owners were attacked by their pet.7 The numerous potential zoonotic hazards that might accompany pet ownership have been described, but occurrences seem rare, at least in Western societies.8 9

Alternatively, psychological health may be improved by the perceived sense of companionship provided by pets. The increased physical exertion commensurate with dog ownership10 11 may influence weight regulation and therefore cardiometabolic factors. Additionally, case reports in diagnostic medicine describe the ability of pet dogs to detect the early stages of an epileptic fit and even selected malignancies.8 These supposed benefits arising from human-animal relationships have led to ambitious calls for the comprehensive integration of human, animal, environmental, and ecosystem health.12

Although some empirical evidence links animal companionship with apparent protection against a series of important health outcomes in middle aged populations, including premature mortality, obesity, hypertension, and hyperlipidaemia, systematic reviews13 and position statements 3 suggest that these associations are not universal. Despite 12% of older Australians indicating that an animal was their predominant form of company,15 little is known about the impact of such companionship on physical and psychological biomarkers of ageing in older people—factors that are related to life expectancy, chronic disease, and disability.14 If there is a relation with ageing biomarkers, which may be anticipated given the described links with physical exertion and sense of companionship, the public health implications of animal ownership could be important.

The few studies in this area have almost exclusively utilised a cross-sectional design and focused on single, self reported biomarkers of ageing, particularly depression, which provide only a partial understanding of the health consequences of pet ownership and raise concerns of recall bias, particularly in older groups. Reverse causality may also be a problem, whereby decreased mobility in older age may be the reason for seeking animal companionship, rather than the reverse, and this may have led to the apparent deleterious relation of certain pets with poor health status,16 including suboptimal mental health.17 in some
studies of older people. Accordingly, we examined the prospective link between pet ownership and a selected range of objective biomarkers of ageing proposed for use in large scale population based studies of older people.15

Methods
Study population
The English Longitudinal Study of Ageing (ELSA) is an ongoing, open, prospective cohort study of a representative sample of men and women who, when recruited in 2002-03 (wave 1), were aged 50 or more and living in private households in England.18 Data have been collected biennially in the home using computer assisted personal interviews and self completion questionnaires, with additional nurse visits during alternate waves for the assessment of biomedical data. Comparison of the sociodemographic characteristics of participants against the profile in the national census indicates that the sample remains broadly representative of the English population.18

For the purposes of our analyses, the study baseline is wave 5 (2010-11), when inquiries about pet ownership were first introduced into the study. Cohort members were asked “Do you keep any household pets inside your house/flat?,” followed by items about specific pets (dog, cat, bird, other furry pet, or “other” type of pet).19 We collapsed the last three groups owing to a low prevalence of ownership.

Physical biomarkers
We utilised follow-up data on biomarkers of ageing as collected at wave 6 (2012-13), around two years after assessment of pet ownership.20 A walking speed test was administered to participants aged 60 years or more, using walking aids if required, and was based on the time taken to walk a distance of 2.4 m and back.21 Measures of physical strength included hand grip (for upper body) and the timed chair stand test (for lower body).22 A hand held dynamometer was used to measure hand grip strength (kg) in the dominant hand. In the chair stand test, the time required to rise from a chair to a full standing position on five occasions with arms folded across the chest was recorded; a slower time reflected poorer function.

Static balance was evaluated in three separate and progressively more difficult tests.23 24 For the side-by-side and semi-tandem stand, we gave participants who could hold their position for 10 seconds a score of 1 for each test outcome. For the full tandem stand, study members able to hold the position for 3-10 seconds scored 1 point, with those able to hold the position for more than 10 seconds allocated 2 points. A final score of 3 or less out of a possible 5 denoted impaired balance.23 A leg raise assessment was administered to all participants aged less than 70 years who successfully completed the side-by-side balance test: with their eyes open, study members were asked to raise one leg for 30 seconds from a standing position. Finally, forced expiratory volume in one second was ascertained using a standard handheld Vitalograph spirometer.25

Immunological biomarkers
A blood sample was drawn from consenting respondents and analysed for inflammatory markers, including acute phase reactants (high sensitivity C reactive protein, white blood cell count) and coagulation products (fibrinogen).26 27 The technicalities of the blood analyses, and the quality assessment of the measurement laboratory, have been described in detail elsewhere.28

Psychological biomarkers
Memory was measured using a word list learning test in which 10 words were presented orally to participants who were then asked to recall as many as possible immediately after reading, and again after a five minute delay during which they completed other survey items.29 30 Scores on both tests were totalled (range 0–20). Depressive symptoms were assessed at baseline and follow-up using the eight item Centre of Epidemiological Studies Depression scale.31 We used a score of 3 or more to define “caseness,”32 33 a threshold that has been validated against standardised psychiatric interviews in older populations.34

Confounding and mediating factors
Other data collected at baseline (wave 5), simultaneous with the assessment of pet ownership, were used to derive covariates. Height and weight were measured directly using standard procedures; body mass index was computed using the conventional formulas.23

The remaining data were self reported. Cigarette smoking was classified as current, former, or never. An assessment of physical activity was based on items about engagement in activities of vigorous, moderate, or mild intensity, from which a 5 point scale was derived (a lower value denoting more sedentary behaviour). Alcohol intake was based on units consumed each week.35 Our socioeconomic variable was total net non-pension household wealth as based on an estimation of the assets of study members and their partners, including, where applicable, properties, businesses, other assets, and any form of investments or savings (except for pension savings), less debts owed by them.36

We created an index of social isolation by assigning scores based on responses to questions about marital status/cohabitation, contact with family or friends, and participation in social groups.38 A higher score indicated less social contact. The degree of loneliness was ascertained using the UCLA loneliness scale (revised);39 a higher score reflecting greater loneliness. Participants were also asked to rate their health on a 5 point scale, with a higher score being less favourable. In regression analyses, we regarded wealth, self reported health, smoking status, and alcohol consumption as confounding factors, and social isolation, loneliness, physical activity, and body mass index as mediating factors. In further post hoc analyses, we also controlled...
Table 1 | Baseline characteristics of participants according to type of pet owned (n=8785). Values are numbers (percentages) unless stated otherwise

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>No pet (n=5815)</th>
<th>Dog (n=1619)</th>
<th>Cat (n=1077)</th>
<th>Other (n=274)</th>
<th>Full cohort (n=8785)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (SD) age (years)</td>
<td>69 (9)</td>
<td>65 (8)</td>
<td>65 (8)</td>
<td>64 (8)</td>
<td>67 (9)</td>
</tr>
<tr>
<td>Women</td>
<td>3199 (55)</td>
<td>900 (56)</td>
<td>617 (57)</td>
<td>147 (54)</td>
<td>4863 (55)</td>
</tr>
<tr>
<td>Lowest wealth fifth</td>
<td>915 (16)</td>
<td>324 (20)</td>
<td>143 (13)</td>
<td>57 (21)</td>
<td>1439 (16)</td>
</tr>
<tr>
<td>Socially isolated</td>
<td>1292 (22)</td>
<td>377 (23)</td>
<td>229 (21)</td>
<td>77 (28)</td>
<td>1975 (22)</td>
</tr>
<tr>
<td>Lonely</td>
<td>1228 (21)</td>
<td>421 (26)</td>
<td>227 (21)</td>
<td>53 (19)</td>
<td>1929 (22)</td>
</tr>
<tr>
<td>Poor self rated health</td>
<td>1610 (28)</td>
<td>509 (31)</td>
<td>269 (25)</td>
<td>88 (32)</td>
<td>2476 (28)</td>
</tr>
<tr>
<td>Mean (SD) body mass index</td>
<td>28 (5)</td>
<td>29 (5)</td>
<td>28 (5)</td>
<td>29 (5)</td>
<td>28 (5)</td>
</tr>
<tr>
<td>Physically inactive</td>
<td>1105 (19)</td>
<td>240 (15)</td>
<td>154 (14)</td>
<td>49 (18)</td>
<td>1548 (18)</td>
</tr>
<tr>
<td>Current smoker</td>
<td>669 (12)</td>
<td>316 (19)</td>
<td>172 (16)</td>
<td>40 (15)</td>
<td>1195 (14)</td>
</tr>
<tr>
<td>Median (interquartile range) alcohol intake (units/wk)</td>
<td>3 (0-9)</td>
<td>3 (0-10)</td>
<td>3 (0-10)</td>
<td>3 (0-10)</td>
<td>3 (0-9)</td>
</tr>
</tbody>
</table>

Based on imputed data.
Figure 2 | \( \beta \) coefficients (top panel) and relative risks (bottom panel) for relation of pet ownership with ageing biomarkers: physical functioning (n=8785). Multivariable adjustment is for age, sex, wealth, social isolation, loneliness, self-rated health, physical activity, cigarette smoking, alcohol intake, and body mass index.

Figure 3 | Percentage differences for relation of pet ownership with ageing biomarkers: immune functioning (n=8785). Multivariable adjustment is for age, sex, wealth, social isolation, loneliness, self-rated health, physical activity, cigarette smoking, alcohol intake, and body mass index.

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and the various physical biomarkers of ageing, and statistical significance at conventional levels was rarely apparent. Compared with participants who did not report pet ownership, dog companionship was associated with somewhat slower walking speed and a longer time to rise from a chair; conversely, dog ownership was also related to a slightly higher pulmonary function. Cat owners were more likely to fail the leg raise test than people in the other pet ownership groups. Pet ownership was essentially unrelated to our three immunological markers of C reactive protein, white blood cell count, and fibrinogen. There was no apparent relation between ownership of any type of pet and cognitive function or symptoms of depression.

We carried out some planned subgroup analyses. To make the impact of controlling for groups of variables transparent, we disaggregated the multivariable model into confounding and potential mediating factors (supplementary figures 1-3). We also examined if the relation of pet ownership with ageing biomarkers was modified by the owner’s sex (supplementary figures 4-6); we explored the association of pet ownership with additional health indices that are not considered to be markers of ageing (supplementary figure 7); and, finally, we tested the impact of adjustment of the baseline (wave 4) assessment of each ageing biomarker (supplementary figures 8-11). In summary, in separate analyses of men and women, similar observations were made to those apparent in the full cohort; links between pet ownership and other health indices were few, and where they did exist were again of modest magnitude; and taking into account earlier measurement of the outcome of interest did not materially change our general finding of null results.

**Discussion**

Of the widely used biomarkers of ageing we prospectively related to pet ownership in this study, there was no clear evidence of association. Some possible exceptions were walking speed and chair rise time, which were both less favourable among people reporting dog companionship, although the magnitude of these effects was undoubtedly low.

**Strengths and limitations of this study**

The present study has some strengths, which include its size; the analyses of the prospective relation between pet ownership and health, which reduces concerns about reverse causality; and the range of covariates captured, which allowed us to explore alternative explanations for the associations under investigation.

Our study does of course have its limitations. Firstly, to date, pet ownership was only measured on one occasion. With evidence suggesting that this characteristic is time varying, repeat assessment would provide more accuracy. The same concern could be applied to almost any exposure in epidemiology, however, including those that have subsequently become known causal risk factors for chronic disease (eg, smoking and lung cancer, raised blood pressure and stroke). It is likely that this variation over time in pet ownership would lead to an underestimation of the true effects. Secondly, it may also be that pet ownership has an impact on health outcomes that were not included herein, such as biomarkers of psychological stress (eg, cortisol). Thirdly, we had no information on who was responsible for the care of the pet—study members may report pet ownership, but they may not be the primary caregiver and therefore perhaps not experience the potential health benefits. We also did not have specific details of ownership which, in addition to caretaking, include frequency of interaction, and, in the case of dogs, the care of which may require higher levels of physical exertion, age and breed of the animal, duration of ownership, and, where applicable, time spent walking. Finally, as our study is observational, there is the perennial concern of

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**Figure 4** | ∆ coefficients (top panel) and relative risks (bottom panel) for relation of pet ownership with biomarkers of ageing: psychological functioning (n=8785). Multivariable adjustment is for age, sex, wealth, social isolation, loneliness, self rated health, physical activity, cigarette smoking, alcohol intake, and body mass index.

### Part A: Memory

<table>
<thead>
<tr>
<th>Age and sex</th>
<th>P value</th>
<th>Multivariable</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No pet</td>
<td>0 (reference)</td>
<td>0.01</td>
<td>0 (reference)</td>
</tr>
<tr>
<td>Dog</td>
<td>-0.31 (-0.52 to -0.09)</td>
<td>0.01</td>
<td>-0.16 (-0.37 to 0.06)</td>
</tr>
<tr>
<td>Other pet</td>
<td>0.10 (-0.15 to 0.35)</td>
<td>0.4</td>
<td>0.05 (-0.19 to 0.28)</td>
</tr>
<tr>
<td>Cat</td>
<td>-0.28 (-0.70 to 0.14)</td>
<td>0.2</td>
<td>-0.06 (-0.46 to 0.34)</td>
</tr>
</tbody>
</table>

### Part B: Depressive symptoms

<table>
<thead>
<tr>
<th>Age and sex</th>
<th>P value</th>
<th>Multivariable</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No pet</td>
<td>1 (reference)</td>
<td>0.001</td>
<td>1 (reference)</td>
</tr>
<tr>
<td>Dog</td>
<td>1.28 (1.14 to 1.44)</td>
<td>0.001</td>
<td>1.09 (0.98 to 1.22)</td>
</tr>
<tr>
<td>Other pet</td>
<td>1.05 (0.90 to 1.22)</td>
<td>0.5</td>
<td>1.05 (0.92 to 1.21)</td>
</tr>
<tr>
<td>Cat</td>
<td>1.24 (0.95 to 1.60)</td>
<td>0.1</td>
<td>1.09 (0.87 to 1.37)</td>
</tr>
</tbody>
</table>

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confounding by unknown factors. Randomised trials of the health consequences of pet ownership in an older population could be conducted, although binding of participants and investigators would be impossible and the generalisability of findings from what are often highly select participants in trials is moot.

Comparison with other studies
With the exception of mental health outcomes, we are unaware of any observational studies that have examined the links between pet ownership and biomarkers of ageing. For depression, evidence from some cross-sectional studies suggests that people who report owning animals experience a higher prevalence of such symptoms, whereas in a one-year follow-up of a small group of older, community dwelling Canadians, animal companionship showed no relation with later psychological health ascertained using a non-standard questionnaire. A small, quasi-intervention study comprising people with multiple sclerosis found an apparent improvement in walking speed after utilisation of a service dog.

Conclusion
In the present study, the companionship of creatures great and small seems to confer essentially no relation with later physical and psychological biomarkers of ageing.

The English Longitudinal Study of Ageing was developed by a team of researchers based at University College London, the Institute for Fiscal Studies, and the National Centre for Social Research, UK.

Contributors: GDB conceived and designed the study, prepared an analytical plan, and wrote the manuscript. SB prepared an analytical plan and analysed all data. PZ and SB built the dataset. All authors commented on earlier versions of the manuscript. GDB and SB act as guarantors.

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Competing interests: All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work. SB is the very proud owner of two naughty tortie Persian cats but, sadly, zero pugs. GDB, a vicarious rabbit owner as a child, does not currently own an animal but his home does have a minor moth infestation. PZ years for the parrots of her youth, Romeo and Juliet, but present living circumstances thankfully preclude such tragic romantic dalliances. RWG has a longstanding affection for dogs, not cats, and is the fond owner of a magnificent labrador, Tilda, named after the fond owner of a magnificent labrador, Tilda, named after the month of her birth. MSK is the very proud owner of two naughty tortie Persian cats but, sadly, zero pugs. AEK is the fond owner of a magnificent labrador, Tilda, named after the month of her birth. MD is the fond owner of a magnificent labrador, Tilda, named after the month of her birth. CR is the very proud owner of two naughty tortie Persian cats but, sadly, zero pugs. JKH is the very proud owner of two naughty tortie Persian cats but, sadly, zero pugs. JAY is the very proud owner of two naughty tortie Persian cats but, sadly, zero pugs. MCA is the very proud owner of two naughty tortie Persian cats but, sadly, zero pugs. ACR is the very proud owner of two naughty tortie Persian cats but, sadly, zero pugs. 

Ethical approval: Data collection for this study was approved by the London Multicentre Research Ethics Committee.

Data sharing: The data described herein are curated by the UK Data Archive at the University of Essex and can be downloaded free of charge for non-commercial purposes from the Economic and Social Data Service (www.esds.ac.uk). Syntax for our analyses are available from SB.

Transparency: The lead author (GDB) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported, and that no important aspects of the study have been omitted: and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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