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# Pet ownership and psychosocial outcomes among the oldest old in Germany during the Covid-19 pandemic. Findings based on the nationally representative “Old Age in Germany (D80+)”

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## Abstract

**Objectives:** To examine the association between pet ownership and psychosocial outcomes among the oldest old in Germany during the Covid-19 pandemic.

**Methods/Design:** Data from the “Old Age in Germany (D80+)” study were used, a large, nationwide representative study covering both individuals living at home and individuals in nursing homes aged 80 years and above ( $n = 2867$  individuals). The telephone interviews were conducted from May to October 2021. Established tools (e.g., “Short Form of the Depression in Old Age Scale”, DIA-S4) were used to quantify the outcomes. Five groups were generated: (1) no pet ownership, (2) having at least one dog (but no other pets), (3) having at least one cat (but no other pets), (4) having at least one other pet (but neither dogs nor cats), (5) having at least two different types of pets (in any combination).

**Results:** Multiple linear regressions showed that compared to individuals without a pet, individuals having at least one dog had significantly lower loneliness levels ( $\beta = -0.21, p < 0.01$ ). In the fully-adjusted models, other forms of pet ownership were not significantly associated with the outcomes examined.

**Conclusion:** Particularly living with a dog was associated with lower loneliness among the oldest old people in Germany. If living with a dog is in line with the preferences and attitudes of the very old, this could be a strategy for reducing loneliness in this age group.

## KEYWORDS

aged, 80 and above, cat, depression, dog, life satisfaction, loneliness, mental health, oldest old, pet, psychosocial outcomes, successful ageing

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### Key points

- There is a dearth of studies examining the association between pet ownership and psychosocial outcomes based on nationally representative data.
- Using nationally representative data of the D80+, our aim was to explore the association between pet ownership and psychosocial outcomes during the Covid-19 pandemic - an area in which literature is extremely limited.
- Living with a dog was associated with lower loneliness.
- Multiple pet ownership may help to maintain life satisfaction.
- This could indicate a strategy for reducing loneliness in this age group.

## 1 | INTRODUCTION

A noticeable demographic change is in progress, which may result in a significant increase in the oldest old population (i.e., individuals aged 80 years and over) in high-income countries in the coming decades. Individuals in this age bracket have often already lost numerous friends and relatives. Such a change in social relationships can result in adverse psychosocial well-being. One way of facing this loss and thus counteracting deterioration in psychosocial outcomes (such as life satisfaction, depressive symptoms and loneliness<sup>1-4</sup>) is to have a pet, that is, an animal kept by individuals for companionship and pleasure. Many older people have a pet in high-income countries. This is of relevance because such psychosocial outcomes are relevant for subsequent morbidity, longevity and also successful aging.<sup>5,6</sup>

Several studies have shown that pet ownership is associated with various positive health outcomes for older adults. For example, a previous meta-analysis showed that pet ownership had a moderately significant positive effect on physical activity of their owners (compared to non-pet owners).<sup>7</sup> More precisely, Cohen's *d* was 0.55 (lower limit: 0.37, upper limit: 0.73;  $I^2 = 99.59\%$ ,  $p < 0.001$ ) across individuals in different age groups. Another review<sup>8</sup> identified a link between pet ownership and a lower risk of cardiovascular/physical disease (such as decrease in blood pressure, lower total cholesterol or triglyceride levels). Additionally, a further review found a potential link between pet ownership and lower frailty risk.<sup>9</sup> This former review searched PubMed in April 2020 and included studies based on community-dwelling older adults with an average age of at least 60 years.

Based on Bowlby's attachment theory,<sup>10</sup> humans have an innate need for attachment, relationships and a sense of belonging. Thus, one may assume that the bond between humans and pets could be an important source of social support<sup>11</sup> and, ultimately, for psychosocial outcomes. However, currently, there is limited understanding regarding how pet ownership is associated with psychosocial outcomes among the oldest old (as an overview:<sup>12</sup>). For example, using data from the IDEAL (Improving the experience of Dementia and Enhancing Active Life) program, a previous study showed a link between dog ownership (and involvement in its care) and a lower likelihood of being lonely among individuals with mild-to-moderate dementia. Another study showed an association between dog

ownership (compared to individuals without pets) and lower loneliness among single women aged 65 years and over in Germany.<sup>13</sup> Furthermore, many studies have been constrained by small sample sizes and limited geographic scope.<sup>12</sup> This means that there is a dearth of studies examining the association between pet ownership and psychosocial outcomes based on nationally representative data.<sup>12</sup> Moreover, most of the existing studies were conducted prior to the pandemic (e.g.,<sup>13,14</sup>) and did not differentiate between different types of pets.<sup>15,16</sup> This is important, as it can be assumed that a dog that you have to take for a walk several times a day and that you could socialize with other dog owners may have significantly different effects, among other things, on loneliness, than, for example, a cat that is only kept in your own home.<sup>13</sup> The pandemic, which is well-known to have been accompanied by some lockdowns with corresponding contact restrictions, may also bring with it an increased positive effect of certain animals such as dogs on psychosocial outcomes. Hence, the current study aimed to examine whether there is an association between different types of pet ownership and psychosocial outcomes (in terms of depressive symptoms, life satisfaction and loneliness) among individuals aged 80 years and over based on data from a nationally representative sample. Insights into the link between pet ownership and such outcomes could prove valuable in identifying and treating individuals at risk for unfavorable psychosocial outcomes. For example, to address potentially increased levels of loneliness, appropriate risk groups could be targeted.

## 2 | METHODS

### 2.1 | Sample

We used data from the "Old Age in Germany (D80+)" study which is a large, representative sample of individuals  $\geq 80$  years residing in Germany. One outstanding feature was that both people living in the community and those accommodated in residential homes were included in the D80+ study.

It was conducted by the University of Cologne in cooperation with the Cologne Center for Ethics, Rights, Economics, and Social Sciences of Health (ceres) and the German Center of Gerontology (DZA). The Federal Ministry for Family Affairs, Senior Citizens,

Women and Youth (BMFSFJ) provided the funding. The infas Institute for Applied Social Science, an institute for market and social research, was responsible for data collection.

Initially, they intended to do face-to-face interviews. However, because of the pandemic, the study design had to be changed. This means that questionnaires were used (data collection for the written postal survey took place from late November 2020 to late April 2021; response rate was almost 27%). Moreover, telephone interviews were performed from mid-May to mid-October 2021 (response rate was about 38%). If the target person was unable to perform the telephone interview themselves due to health reasons, the option of a proxy interview was given. Topics with a high priority for aging (e.g., sociodemographic variables) were mainly included in the written questionnaire. The telephone interview included topics with somewhat less relevance or topics that could not be easily captured using written questionnaires (such as cognitive impairment). We have used the most recent data from the telephone survey where possible (e.g. marital status). For the telephone survey, interview training sessions were held (three web training for reasons of the pandemic by the project management of the infas Institute for Applied Social Science, with 4 h each).

Overall, 76 CATI interviewers were used for the telephone survey. Particular importance was placed on highly experienced interviewers when selecting the interviewers. For example, experience of interviewing individuals in old or very old age and/or individuals with a disability. For example, 59.2% of the interviewers had six or more years of experience as an interviewer.

Based on samples drawn from resident registration records in randomly selected municipalities, the written postal survey was performed. The GESIS - Leibniz Institute for the Social Sciences organized and performed it. A multi-stage design was employed. When the municipal sample was chosen, ceres asked the resident registration offices to draw personal addresses. Ceres subsequently passed them on to infas. In two stages, the sample was then drawn: A predetermined procedure was used to randomly select individuals from the population registers of the selected municipalities. From the cumulative individual samples, a deployment sample for fieldwork was derived. This deployment sample was stratified disproportionately according to age and gender criteria.

The addresses of the deployment sample were geocoded for analytical purposes, with the aim of finding addresses that match the addresses of old age and nursing homes. Individuals who live in institutionalized settings should be marked in this way. As a result, a proportion of nearly 10% residing in institutionalized settings were identified in the deployment sample.

Individuals, relatives or care home staff had the opportunity to contact infas at any time with questions (via a study-specific email address or a toll-free hotline number). The resulting inquiries were processed by a trained team, while more complex enquiries were forwarded to the project management or ceres. A total of almost 1270 emails were processed and around 2230 calls were made. In most cases, contact was made by the target person themselves (44.5%), followed by their daughter/daughter-in-law (26.7%) or son-

son-in-law (14.4%) and, to a lesser extent, by official carers/care home managers or nursing staff (2.5% in total). Further details about the D80+ study are presented elsewhere (Albrecht et al.<sup>17</sup>; specifically regarding the methodology.<sup>18</sup>).

The key independent variable (pet ownership) was included in the telephone interview (with  $n = 3233$  individuals), so we focused on it in our current study. However, due to some missing individuals, the analytic sample equaled 2867 individuals.

The D80+ study was approved by the ethical board of the medical faculty at the University of Cologne (Protocol #: 19-1387\_1). The interviews were solely performed with the consent of the interviewees. The prerequisite for conducting the interview with a proxy was the consent of the target person (either by telephone or in writing). Short introduction and the privacy policy were included in the questionnaire. When the respondents completed and returned the questionnaire, consent was granted.

## 2.2 | Dependent variables

In this study, depressive symptoms were measured using the "Short Form of the Depression in Old Age Scale" (DIA-S4),<sup>19,20</sup> comprising four items with binary responses (0 for no and 1 for yes). A sum score ranging from 0 to 4 was derived from the four items, whereby higher scores reflect more depressive symptoms. Favorable psychometric properties have been reported in earlier studies.<sup>19,20</sup>

Life satisfaction was assessed using an often applied single-item measure with 11 categories (from 0 = completely dissatisfied to 10 = completely satisfied). Former research showed that such single-item measures of satisfaction are both reliable and valid.<sup>21,22</sup>

Loneliness was measured using a single-item tool ranging from 1 (almost never or never) to 4 (almost always or always). Such loneliness measures are frequently used to measure loneliness in this age bracket.<sup>23</sup> Reliability and validity have also been shown before.<sup>24</sup>

## 2.3 | Independent variable of interest: Pet ownership

Similar to former research,<sup>13,14</sup> pet ownership was quantified based on the presence of pets (no; yes, dog; yes, cat; yes, another pet). This is a common way to quantify pet ownership in large cohort study such as the German Aging Survey. Multiple selections were possible. We have formed four groups based on this: (1) no pet ownership, (2) having at least one dog (but no other pets), (3) having at least one cat (but no other pets), (4) having at least one other pet (but neither dogs nor cats), (5) having at least two different types of pets (in any combination).

## 2.4 | Covariates

Driven by previous studies,<sup>12</sup> covariates were selected for regression analysis. As sociodemographic covariates, we included: Sex (men;

women), age (in years), marital status (married; married, living separated from spouse; divorced; widowed; single), education (ISCED-11 classification<sup>25</sup>: low education; medium education; high education), and living arrangement (living in a private household; living in an institutionalized setting). As lifestyle-related covariates, it was adjusted for the following factors in regression analysis: size of the social network (continuous measure), physical activity (no or yes), and—similar to former research<sup>26</sup> - a count score based on the number of 11 cognitive activities performed in the preceding 12 months. The following activities were covered: Coffee wreath, café, concert/theater/museum, artistic activity, voluntary work, games, further education, political events, receiving visitors, mental exercise, and reading books. Regarding the social network size, participants were first asked to name individuals who are relevant to them and with whom they are in contact such as relatives, friends or neighbors. This information was summarized.

We used three health-related covariates in regression analysis: self-rated health, functional impairment and chronic conditions. Similar to other large cohort studies, self-rated health (explicitly referring to the past 4 weeks) is based on a single-item measure from 1 to 4, with higher values reflecting more favorable self-rated health (1 = very bad, 2 = rather bad, 3 = rather good, 4 = very good).

Functional impairment was measured using a modified version of the Instrumental Activities of Daily Living (IADL) instrument developed by Lawton et al.<sup>27</sup> consisting of seven items (e.g., managing financial matters). Each item ranges from 0 to 2 (higher values reflect a lower need for assistance). By averaging the scores of all items, a score was generated. We reversed the coding to ease the interpretability, that is, the score ranges from 0 to 2, whereby higher values reflect higher functional impairment. A count score based on 21 following chronic conditions was used to quantify chronic conditions. This includes the following chronic conditions: heart attack; heart failure (including cardiac insufficiency); high blood pressure; stroke; mental or psychiatric illness; cancer; diabetes; respiratory or lung disease; back pain; stomach or intestinal disease; kidney disease; liver disease; blood disease (including anemia); joint or bone disease (e.g. arthrosis, osteoporosis, arthritis); bladder disease; sleep disorder; eye disease or visual impairment (including macular degeneration, glaucoma or cataracts); ear disease or hearing loss; neurological disease (e.g. Parkinson's disease, stroke with signs of paralysis); (blood) vessel disease; thyroid disease. It is based on the multimorbidity index in old age.<sup>28,29</sup>

## 2.5 | Statistical analysis

Characteristics of the analytic sample are first presented (total sample and stratified by pet ownership). Subsequently, multiple linear regressions were estimated to examine the association between pet ownership and psychosocial outcomes, first unadjusted and later adjusted for several covariates. We computed cluster-robust standard errors due to the multistage sampling procedure. Additionally, sampling weights were applied (e.g., to account for non-response and

the sampling design).<sup>18</sup> In accordance with the multi-stage sample design, the following steps are defined for the weighting and extrapolation factors: (a) design weighting (selection of municipalities and subsequent selection of individuals), (b) non-response weighting (non-response adjustment) and (c) calibration (marginal adjustment) to distributions of the official population statistics of the year 2019 (microcensus). The following information from the microcensus was taken into consideration: federal state, age group, sex, municipality size class, size of the household, marital status, and living situation.

Variance inflation factors (VIFs) were low (average VIF = 1.36, highest VIF was 2.07) suggesting no multicollinearity. Listwise deletion was used in the main analysis. In sensitivity analysis, a full-information maximum likelihood (FIML) approach was utilized to account for missings.<sup>30</sup> In the current study, statistical significance was set at  $p < 0.05$ . Statistical analyses were performed using Stata 18.0 (Stata Corp.).

## 3 | RESULTS

### 3.1 | Sample characteristics

In Table 1, sample characteristics - also stratified by pet ownership - of the analytical sample ( $n = 2867$  individuals, weighted) are shown. Of note, this refers to the analytical sample when life satisfaction served as outcome measure (fully adjusted regression model). There were very slight differences in the size of the analytic sample when loneliness or depressive symptoms served as outcome measures. Thus, these additional analytic samples were not displayed.

In the total sample, mean age was 85.6 years (SD: 4.2 years; 80–100 years), with 61.0% of the individuals being female. On average, life satisfaction equaled 7.3 (SD: 2.0), depressive symptoms score equaled 0.4 (SD: 0.5) and loneliness score equaled 1.6 (SD: 0.7). For example, Cohen's  $d$  - in absolute terms - equaled 0.43 (0.15) for the loneliness (life satisfaction) difference between individuals without a pet and individuals having at least one dog, but no other pets. Additional details are shown in Table 1.

### 3.2 | Regression analysis

Results of unadjusted linear regressions are shown in Table 2. Subsequently, adjusted linear regressions were conducted (see Table 3). First, the models were adjusted for sociodemographic covariates. Subsequently, they were adjusted for lifestyle-related covariates and in our fully adjusted model, they were additionally adjusted for health-related covariates.

Fully-adjusted regressions showed that compared to individuals without a pet, individuals having at least one dog had significantly lower loneliness levels ( $\beta = -0.21$ ,  $p < 0.01$ ). Moreover, having at least two different types of pets (compared to not having a pet) was marginally significantly associated with higher life satisfaction ( $\beta = 0.77$ ,  $p = 0.07$ ). The latter association was more pronounced

TABLE 1 Sample characteristics of the analytical sample ( $n = 2867$  individuals, weighted).

	$N = 2611$ (no pet ownership) $N$ (%) / Mean (SD)	$N = 66$ (having at least one dog, but no other pets) $N$ (%) / Mean (SD)	$N = 118$ (having at least one cat, but no other pets) $N$ (%) / Mean (SD)	$N = 57$ (having at least one other pet, but neither dogs nor cats) $N$ (%) / Mean (SD)	$N = 16$ (having at least two different types of pets in any combination) $N$ (%) / Mean (SD)	$N = 2867$ (total sample) $N$ (%) / Mean (SD)
<b>Sex</b>						
Men	993 (38.0%)	35 (52.8%)	47 (39.8%)	34 (60.4%)	10 (65.0%)	1119 (39.0%)
Women	1618 (62.0%)	31 (47.2%)	71 (60.2%)	22 (39.6%)	5 (35.0%)	1748 (61.0%)
Age (in years)	85.6 (4.2)	83.9 (3.3)	85.4 (4.2)	84.5 (2.9)	83.5 (3.0)	85.6 (4.2)
<b>Marital status</b>						
Married	1020 (39.1%)	34 (51.5%)	46 (39.4%)	23 (41.2%)	5 (32.7%)	1129 (39.4%)
Married, living separated from spouse; widowed; divorced; single	1591 (60.9%)	32 (48.5%)	72 (60.6%)	33 (58.8%)	10 (67.3%)	1738 (60.6%)
<b>Education</b>						
Low education	586 (22.4%)	12 (18.4%)	27 (23.3%)	10 (17.6%)	4 (23.0%)	639 (22.3%)
Medium education	1327 (50.8%)	35 (52.6%)	53 (45.1%)	28 (50.0%)	11 (68.7%)	1454 (50.7%)
High education	698 (26.7%)	19 (29.0%)	37 (31.6%)	18 (32.4%)	1 (8.4%)	774 (27.0%)
<b>Living situation</b>						
Private household	2327 (89.1%)	66 (100.0%)	118 (100.0%)	56 (98.6%)	16 (100.0%)	2581 (90.0%)
Institutionalized setting	284 (10.9%)	0 (0.0%)	0 (0.04%)	1 (1.4%)	0 (0.0%)	286 (10.0%)
Size of the social network	8.5 (6.9)	7.8 (6.2)	8.2 (6.4)	8.7 (7.2)	10.0 (8.8)	8.4 (6.9)
<b>Physical activity</b>						
No	1042 (39.9%)	20 (30.8%)	47 (39.8%)	18 (32.0%)	5 (30.0%)	1132 (39.5%)
Yes	1569 (60.1%)	45 (69.2%)	71 (60.2%)	39 (68.0%)	11 (70.0%)	1735 (60.5%)
Count score: Cognitive activities (0–11, higher values reflect a higher number of cognitive activities)	4.2 (1.9)	4.4 (1.9)	4.3 (1.9)	3.6 (1.9)	3.5 (1.8)	4.2 (1.9)
Count score: Chronic conditions (0–21, higher values reflect a higher number of chronic conditions)	4.7 (2.6)	4.7 (3.1)	4.8 (2.8)	4.6 (2.5)	3.4 (1.7)	4.7 (2.6)
Self-rated health (1–4, higher values reflect a more favorable self-rated health)	2.6 (0.7)	2.6 (0.7)	2.6 (0.8)	2.6 (0.6)	3.0 (0.5)	2.6 (0.7)
Functional impairment (0–2, higher values reflect a higher functional impairment)	0.5 (0.6)	0.4 (0.6)	0.6 (0.6)	0.4 (0.5)	0.3 (0.3)	0.5 (0.6)
Life satisfaction (0–10, higher values reflect higher life satisfaction levels)	7.3 (2.0)	7.6 (1.9)	7.1 (2.4)	7.8 (1.8)	8.7 (1.3)	7.3 (2.0)

(Continues)

TABLE 1 (Continued)

	N = 2611 (no pet ownership) N (%) / Mean (SD)	N = 66 (having at least one dog, but no other pets) N (%) / Mean (SD)	N = 118 (having at least one cat, but no other pets) N (%) / Mean (SD)	N = 57 (having at least one other pet, but neither dogs nor cats) N (%) / Mean (SD)	N = 16 (having at least two different types of pets in any combination) N (%) / Mean (SD)	N = 2867 (total sample) N (%) / Mean (SD)
Depressive symptoms (0–4, higher values reflect more depressive symptoms)	0.4 (0.5)	0.4 (0.5)	0.4 (0.5)	0.4 (0.5)	0.2 (0.4)	0.4 (0.5)
Loneliness (1–4, higher values reflect higher loneliness levels)	1.6 (0.7)	1.3 (0.5)	1.7 (0.8)	1.7 (0.8)	1.6 (0.6)	1.6 (0.7)

TABLE 2 Pet ownership and psychosocial outcomes.

Independent variables	Life satisfaction	Depressive symptoms	Loneliness
Pet ownership: Having at least one dog (but no other pets) (Reference category: No pet ownership)	0.38 (−0.09–0.84)	−0.02 (−0.14–0.10)	−0.31*** (−0.44 to −0.18)
Having at least one cat (but no other pets)	−0.06 (−0.53–0.42)	0.05 (−0.07–0.17)	0.02 (−0.17–0.21)
Having at least one other pet (but neither dogs nor cats)	0.53* (0.02–1.03)	0.02 (−0.14–0.18)	0.08 (−0.18–0.35)
Having at least two different types of pets (in any combination)	1.27** (0.41–2.14)	−0.20 <sup>+</sup> (−0.42–0.02)	−0.04 (−0.38–0.31)
Constant	7.27*** (7.15–7.39)	0.38*** (0.35–0.41)	1.63*** (1.59–1.67)
Observations	3151	2945	3153
R <sup>2</sup>	0.004	0.001	0.005

Note: Linear regressions (unadjusted). Unstandardized beta-coefficients are displayed; 95% CI in parentheses; cluster-robust standard errors were computed (using the primary sampling unit); sampling weights were used.

\*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ , + $p < 0.10$ .

when health-related covariates were not added (please see Table 3 for further details).

We also performed some regressions where FIML was used rather than listwise deletion to deal with missings. While the association between dog ownership and lower loneliness levels remained virtually the same in the fully-adjusted model ( $\beta = -0.21$ ,  $p < 0.01$ ), the association between having at least two different types of pets (compared to not having a pet) and life satisfaction vanished in this model ( $\beta = 0.60$ ,  $p = 0.19$ ).

## 4 | DISCUSSION

Using nationally representative data, our aim was to investigate the association between pet ownership and psychosocial outcomes among the oldest old. Our key finding: We observed a robust

association between having at least one dog (compared to the absence of pets) and lower loneliness levels, whereas other forms of pet ownership did not achieve statistical significance in a robust way. This present study adds to our sparse present knowledge on the link between pet ownership and psychosocial outcomes among the oldest old, an area in which literature is extremely limited.

The association between dog ownership and lower loneliness levels among the oldest old during the Covid-19 pandemic builds upon prior research showing such a relationship in somewhat younger age cohorts and mostly conducted prior to the pandemic.<sup>12</sup> Such an association may be particularly explained by social interactions: Dogs usually encourage regular social interaction through walks and interactions with other dog owners, neighbors or other people who stop to admire the pet or children who want to pet the dog.<sup>13</sup> Moreover, caring for a dog may give them a sense of purpose and responsibility, which may lead to lower loneliness levels.

TABLE 3 Pet ownership and psychosocial outcomes.

Independent variables	Life satisfaction	Depressive symptoms	Loneliness	Life satisfaction	Depressive symptoms	Loneliness	Life satisfaction	Depressive symptoms	Loneliness
Pet ownership: Having at least one dog (but no other pets) (reference category: No pet ownership)	0.02 (-0.45- 0.49)	0.03 (- 0.08-0.15)	-0.20** (-0.32 to -0.08)	0.00 (-0.47- 0.48)	0.06 (-0.06- 0.18)	-0.19** (-0.32 to -0.07)	0.13 (-0.27- 0.53)	0.03 (-0.09- 0.15)	-0.21** (-0.33 to -0.08)
Having at least one cat (but no other pets)	-0.28 (-0.74- 0.17)	0.09 (-0.03- 0.20)	0.10 (-0.07- 0.28)	-0.33 (-0.78- 0.13)	0.09 (-0.03- 0.20)	0.11 (-0.07- 0.29)	-0.10 (-0.48- 0.29)	0.06 (-0.04- 0.15)	0.09 (-0.08- 0.26)
Having at least one other pet (but neither dogs nor cats)	0.31 (-0.21- 0.83)	0.09 (-0.08- 0.25)	0.19 (-0.06- 0.43)	0.33 (-0.19- 0.84)	0.08 (-0.08- 0.24)	0.17 (-0.07- 0.42)	0.40 (-0.12- 0.92)	0.07 (-0.12- 0.25)	0.16 (-0.10- 0.42)
Having at least two different types of pets (in any combination)	1.00* (0.11-1.89)	-0.16 (-0.40- 0.08)	0.01 (-0.27- 0.28)	0.96* (0.06-1.86)	-0.17 (-0.42- 0.09)	0.00 (-0.26- 0.27)	0.77+ (-0.07- 1.62)	-0.07 (-0.32- 0.19)	0.06 (-0.23- 0.34)
Sociodemographic covariates	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lifestyle-related covariates				✓	✓	✓	✓	✓	✓
Health-related covariates							✓	✓	✓
Constant	10.79*** (7.93- 13.64)	-0.29 (-0.96- 0.38)	0.83+ (-0.05- 1.70)	8.61*** (5.84- 11.38)	0.15 (-0.55- 0.84)	1.11* (0.16- 2.06)	2.48 (-3.67- 8.63)	1.02 (-0.42- 2.45)	1.72+ (-0.24- 3.67)
Observations	3070	2872	3073	2989	2801	2995	2867	2688	2876
R <sup>2</sup>	0.09	0.06	0.17	0.12	0.08	0.18	0.26	0.19	0.22

Note: Linear regressions (adjusted). Unstandardized beta-coefficients are displayed; 95% CI in parentheses; cluster-robust standard errors were computed (using the primary sampling unit); sampling weights were used; additionally, it was adjusted for sample cells (which are used for the stratification of the secondary sampling unit). Sociodemographic covariates: sex, age, marital status, education, living situation; lifestyle-related covariates: social network size, physical activity, cognitive activities; health-related covariates: self-rated health, chronic conditions and functional impairment.

\*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$ , + $p < 0.10$ .

Additionally, dogs may provide emotional support and might serve as loyal companions (offering companionship and affection without judgment) that reduce loneliness.<sup>12,13</sup> Furthermore, dogs may also alleviate feelings of loneliness, especially in times of lockdowns and social distancing (e.g., when contacts in care homes were limited or visits to friends/relatives were reduced in order to avoid the risk of infection with the coronavirus).<sup>12</sup> However, future research is required to further test these potential pathways among the oldest old.

Somewhat surprisingly, however, dog ownership was not associated with the other outcomes. This could be explained by the fact that other factors, such as health status or marital situation, may be of greater relevance for depressive symptoms and life satisfaction since, for example, life satisfaction refers to a cognitive evaluation of life as a whole considering various life aspects beyond pet ownership. Moreover, owning a dog can decrease loneliness, but perhaps not the deeper causes of depressive symptoms. Previous quantitative research also showed that pet ownership was not consistently associated with well-being.<sup>31,32</sup> A recent meta-analysis also showed that pet ownership may not affect mental health of individuals.<sup>7</sup>

Similar findings were identified by a former systematic review.<sup>33</sup> Moreover, while there may be benefits of pet ownership such as companionship, some drawbacks should be noted as well (e.g., concerns about the health and well-being of pets,<sup>31</sup> grief and risk of falls<sup>34</sup>). These factors could balance each other out eventually resulting in null effects. Moreover, personality factors not considered in this study could also be relevant in stressful times of the pandemic<sup>31</sup> and should be integrated in upcoming studies whenever data are available.

A few strengths and shortcomings of this work should be kept in mind when interpreting the findings. We used data from a rather large sample representative of individuals  $\geq 80$  years residing in Germany. The D80+ study reflects the variety of living arrangements among the oldest old, including both individuals living in private households and individuals living in institutionalized surroundings. The moderate response rates must be interpreted in view of the vulnerable population (80+, also in nursing homes). Sampling weights were used to address for non-response and the sampling design. The item regarding pet ownership has a very high face validity. However, upcoming studies could also explore the



bond and relationship quality between pets and human beings. In recent years, some tools have been developed to quantify such constructs.<sup>35,36</sup> The D80+ study has a cross-sectional design. Thus, one cannot dismiss the possibility that reverse causality exists (e.g., loneliness during the pandemic affects the likelihood of buying a dog). Consequently, upcoming longitudinal studies are needed to confirm our findings. Moreover, the group of individuals having at least two different types of pets in any combination was quite small which may reduce the statistical power and restricts the generalizability for this specific group. Furthermore, upcoming research is required that include potentially mediating factors such as social interactions.

In conclusion, particularly living with a dog was associated with lower loneliness among the oldest old in Germany. If living with a dog is in line with the preferences and attitudes of the very old, this could be a strategy for reducing loneliness in this age group.

Upcoming research could explore the underlying mechanisms. Furthermore, cross-country comparisons would be desirable as pets can be perceived very differently depending on the culture. Moreover, long-running studies would be desirable to examine anticipation and adaptation effects. It also remains to be seen whether and how the association between pet ownership and psychosocial outcomes may change in the post-pandemic period.

#### AUTHOR CONTRIBUTIONS

**André Hajek:** Conceptualization; data curation; methodology; project administration, visualization; roles/writing - original draft, writing - review & editing, formal analysis. **Karl Peltzer:** Conceptualization; writing - review & editing; visualization. **Nicola Veronese:** Conceptualization; writing - review & editing; visualization. **Hans-Helmut König:** Conceptualization; resources; writing - review & editing; visualization. **Razak M. Gyasi:** Conceptualization; writing - review & editing, visualization; supervision.

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#### CONFLICT OF INTEREST STATEMENT

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

#### DATA AVAILABILITY STATEMENT

All data are available from the German Center of Gerontology. For further details (application for data use): <https://www.dza.de/en/research/fdz/access-to-data/application>.

#### ETHICS STATEMENT

The ethical board of the medical faculty at the University of Cologne (Protocol #: 19-1387\_1) approved the D80+ study. The interviews were only conducted with the consent of the interviewees. The questionnaire itself contains a brief introduction and the privacy

policy. Consent is given when the respondents complete and return the questionnaire.

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