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College students with dogs were no less lonely than matched peers during COVID-19 isolation

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Article

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Abstract

Companion animals are widely believed to make people happier, yet pet owners differ from non-owners in ways that also shape well-being. We tested whether living with a dog protected college students from loneliness during the months of COVID-19 isolation before vaccines were available, when a social benefit of dogs should have been easiest to detect. Students aged 18–30 surveyed between May and December 2020 were matched exactly on living situation and by propensity score on demographics, grade point average, employment and survey date, yielding 80 dog owners and 80 non-owners. Owners and non-owners did not differ significantly in loneliness, the pre-specified primary outcome (d = − 0.13, 95% CI − 0.45 to 0.19). Owners reported more positive affect (d = 0.38) and fewer depressive symptoms (d = − 0.30), and need satisfaction leaned the same way, but no secondary outcome differed after correction for multiple comparisons, and anxiety, negative affect and sleep quality did not differ. Within owners, neither the bond with the dog nor the dog's behaviour, history or breed predicted positive well-being. Dog owners were not measurably less lonely than matched non-owners; any benefit for mood appears modest and needs confirmation.

Introduction

Many people are convinced that their animals make them happier. Pet owners describe their dogs and cats as sources of comfort, companionship, and daily joy, and the belief that pets improve human well-being is widespread in popular culture and in the marketing of pets themselves. Herzog [1] argued that a generalized "pet effect" on human mental and physical health is not an established fact but an unsubstantiated hypothesis, because in some studies owners fare no better, or worse, than non-owners. Two decades of comparisons between owners and non-owners have produced positive, null, and negative findings. A meta-analysis of 49 studies found a reliable association between pet ownership and physical activity but only a small and inconsistent association with mental health [2]. A systematic review of pet ownership and loneliness found that only some studies detected a significant association, although studies conducted after the onset of COVID-19 more often found lower loneliness among owners [3].

One reason for these inconsistencies is that the question "Are pet owners happier?" can be answered on more than one dimension. Subjective well-being is usually defined as high life satisfaction, frequent positive affect, and infrequent negative affect [4]. Eudaimonic accounts add that people flourish when their basic psychological needs for autonomy, competence, and relatedness are satisfied [5]. Social connection runs through both traditions. Loneliness, the perception that one's social relationships fall short of what one desires, has serious consequences for emotion, cognition, behavior, and health [6]. Finally, the dual-continua model holds that positive mental health and mental illness are related but distinct dimensions, so that a factor can raise flourishing without reducing distress, or the reverse [7]. A companion animal might therefore matter for one facet of well-being and not another.

Self-determination theory offers a specific prediction about where a pet's contribution should appear. Owners who feel that their pet supports their needs for autonomy, competence, and relatedness report higher well-being, independent of the support they receive from close humans, but this need support is not associated with lower distress [8]. Giving support may matter as well: in a diary study, owners who supported their dog's psychological needs reported higher well-being and less distress [9]. Caring for an animal may also be a source of meaning and competence in its own right. These findings suggest that if dogs benefit their owners, the benefit may lie more on the positive side of mental health than in relief from loneliness, depression, or anxiety. At the same time, closer is not always better: stronger attachment to a pet tends to accompany more, not fewer, symptoms of depression and anxiety, even though it is more often associated with better well-being [10], and pet ownership has been linked to poorer sleep [11].

A strong test of the pet effect requires two things that most studies lack. The first is a setting in which the proposed benefit should be easiest to detect. The months of COVID-19 isolation before vaccines were available offer such a setting. Young adults were among the hardest hit: in June 2020, nearly three quarters of US adults aged 18 to 24 reported at least one adverse mental or behavioral health symptom, the highest prevalence of any age group [12]. College students lost the campus networks that anchor their social lives, and those forced to relocate reported more loneliness and anxiety [13]. Many people turned to animals: close to one in five US households acquired a dog or cat between March 2020 and May 2021 [14], and two in five UK owners who bought a puppy in 2020 said the pandemic influenced the decision [15]. If dogs supply companionship that protects against loneliness, this was the period in which they should have done so.

Pandemic-era findings have been mixed. During the spring 2020 UK lockdown, animal ownership was associated with smaller declines in mental health and smaller increases in loneliness [16]. However, a 12-month UK longitudinal study of more than 6,000 adults found no benefit of living with a pet for depression, anxiety, or loneliness [17], and a US longitudinal study that accounted for confounders found that pet ownership did not alleviate stress or loneliness [18].

The second requirement is a credible comparison group. Pet owners differ from non-owners in gender, age, race and ethnicity, living arrangements, and income [19], and when such differences are handled with propensity score methods, apparent benefits of pets can disappear [20]. Who provides the care may also matter: in one propensity-matched study, owners overall did not differ from non-owners, but primary caregivers reported more physical activity and better emotional well-being [21]. In college samples, selection is likely to be especially strong. Students who live with their parents often share a family dog, whereas most residence halls and many rental units prohibit dogs, and living situation is itself linked to pandemic-era mental health [13].

The present study compared college students who lived with a dog during the pre-vaccine pandemic period (May–December 2020) with closely matched students who did not. We matched owners to non-owners exactly on living situation and by propensity score on demographic, academic, employment, and

timing variables. We pre-specified loneliness as the primary outcome, because social isolation was the defining stressor of this period, social connection is a core component of well-being, and loneliness is the outcome for which a companion-animal benefit is most often proposed. We tested whether dog owners would report less loneliness (H1) and greater basic psychological need satisfaction (H2), and whether they would differ in depression and anxiety (H3); positive affect, negative affect, and life satisfaction (H4); and sleep quality (H6). Self-determination theory and the dual-continua model also raise the possibility that any owner advantage would be larger for positive well-being than for distress; we tested this contrast post hoc. Exploratory analyses examined mindfulness and self-compassion (H5), the role of the dog's primary caregiver (H7), and the pandemic context.

Results

Sample and Balance

Matching produced 80 pairs (N = 160): 39 pairs living with roommates, 36 with parents, and 5 alone. The matched sample was 81.3% women. It was 65.0% White, 19.4% Black, 8.8% Asian, and 7.5% Hispanic, with a mean age of 20.6 years (SD = 2.5; owners 20.6, non-owners 20.7); about one third were first-year students. Before matching, owners and non-owners differed most in residence hall housing (d = − 1.01), GPA (d = − 0.33), employment (d = 0.30), and Asian race (d = − 0.23). After matching, all standardized differences were 0.13 or smaller except for missing GPA (d = − 0.23; 2.5% of owners vs. 7.5% of non-owners); GPA itself was balanced (d = − 0.07), and the missing-GPA indicator was included in the adjusted models (Table 1). Third-shift work, which was not a matching variable, was somewhat more common among owners (16.2% vs. 10.0%) and was included in the adjusted models. Owners' dogs had a median age of 3 years, and owners had a median of 3 years with them. Of owners who answered, 64 (83%) were the dog's primary caregiver; 10 described their dog as an emotional support or working animal, and 13 had acquired their dog after March 13, 2020. Distress was common: 39.4% of the matched sample scored 10 or more on the Patient Health Questionnaire-9, and 48.1% did so on the Generalized Anxiety Disorder-7 scale.

Table 1
Characteristics of dog owners and non-owners before and after matching

Characteristic	Owners, before (n = 144)	Non-owners, before (n = 154)	d before	Owners, matched (n = 80)	Non-owners, matched (n = 80)	d after
Women, %	80	79	0.03	84	79	0.13
Black, %	17	22	−0.12	21	18	0.09
Asian, %	6	13	−0.23	8	10	−0.09
Other or not reported race, %	7	4	0.13	8	6	0.05
Hispanic, %	10	6	0.14	6	9	−0.09
Age, M	20.2	19.9	0.17	20.6	20.7	−0.06
Semesters completed, M	2.4	2.0	0.13	2.8	2.6	0.07
GPA, M	3.23	3.41	−0.33	3.29	3.32	−0.07
GPA missing, %	10	14	−0.12	2	8	−0.23
Employed, %	65	50	0.30	69	64	0.11
Work hours per week, M	16.3	12.1	0.28	17.0	16.8	0.01
Third-shift work, %	15	10	0.13	16	10	0.18
Residence hall, %	3	41	−1.01	6	6	0.00
Living with parents, %	64	25	—	45	45	0.00
Living alone, %	6	11	—	6	6	0.00
Living with roommates, %	31	64	—	49	49	0.00
Days since March 13, 2020, M	198	201	−0.06	201	194	0.12

Note. d = standardized mean difference (owners minus non-owners). GPA = grade point average. Living situation was matched exactly. Third-shift work was not a matching variable.

Primary Outcome: Loneliness

Dog owners and matched non-owners did not differ significantly in loneliness: M = 44.1 (SD = 14.0) vs. 46.0 (SD = 15.4). The mean paired difference was − 1.9 points (95% CI − 6.6 to 2.8), t(79) = − 0.80, P = 0.43, d = − 0.13 (95% CI − 0.45 to 0.19; Table 2). Pair differences were approximately normal (Shapiro–Wilk P = 0.31), and the Wilcoxon signed-rank test agreed (P = 0.59). With covariate adjustment, the estimate moved further toward lower loneliness among owners but remained nonsignificant (d = − 0.23, 95% CI − 0.55 to 0.09, P = 0.16). Results were similar without emotional support or working dogs (70 pairs, d = − 0.18, P = 0.30) and without dogs acquired during the pandemic (67 pairs, d = − 0.05, P = 0.77). By living situation, differences were small among students living with parents (d = − 0.16) or roommates (d = − 0.14). The living-alone stratum (5 pairs) was too small to interpret (d = 0.40, 95% CI − 0.84 to 1.64).

Table 2
Primary and secondary outcomes in 80 matched pairs

Outcome (range)	Owners M (SD)	Non-owners M (SD)	d [95% CI]	P	Adjusted d (p)	FDR q
Primary						
Loneliness (20–80)	44.1 (14.0)	46.0 (15.4)	−0.13 [−0.45, 0.19]	0.43	−0.23 (0.16)	—
Secondary: positive well-being						
Basic need satisfaction (1–7)	5.01 (0.81)	4.76 (0.81)	0.31 [−0.02, 0.64]	0.066	0.36 (0.032)	0.15
Positive affect (10–50)	33.3 (8.0)	30.4 (7.5)	0.38 [0.04, 0.73]	0.030	0.44 (0.008)	0.15
Life satisfaction (5–35)	22.6 (7.2)	21.2 (6.9)	0.21 [−0.12, 0.53]	0.20	0.28 (0.096)	0.36
Secondary: distress and sleep						
Negative affect (10–50)	25.0 (8.2)	24.7 (7.8)	0.04 [−0.25, 0.33]	0.79	−0.05 (0.72)	0.80
Depression, PHQ-9 (0–27)	7.6 (6.2)	9.5 (6.4)	−0.30 [−0.59, −0.01]	0.045	−0.39 (0.007)	0.15
Anxiety, GAD-7 (0–21)	9.5 (6.1)	9.1 (5.7)	0.07 [−0.22, 0.36]	0.65	0.00 (0.99)	0.80
Sleep quality, PSQI (0–21)□	7.5 (3.8)	7.7 (3.3)	−0.04 [−0.31, 0.24]	0.80	−0.16 (0.24)	0.80

Note. d = paired difference (owner minus non-owner) divided by the pooled SD; for distress and sleep, positive d means owners scored worse. Adjusted = all matching variables, third-shift work, and living situation, with pair-clustered standard errors. FDR q = Benjamini–Hochberg false discovery rate adjusted p across the seven secondary outcomes. PHQ-9 = Patient Health Questionnaire-9; GAD-7 = Generalized Anxiety Disorder-7; PSQI = Pittsburgh Sleep Quality Index. □ 70 pairs; higher scores indicate worse sleep.

Secondary Outcomes

No secondary outcome differed after false discovery rate correction (all q ≥ 0.15; Table 2). Before correction, owners reported more positive affect (d = 0.38, 95% CI 0.04 to 0.73, P = 0.030) and fewer depressive symptoms (d = − 0.30, 95% CI − 0.59 to − 0.01, P = 0.045), and basic psychological need satisfaction leaned the same way (d = 0.31, 95% CI − 0.02 to 0.64, P = 0.066). The need-satisfaction subscales were consistent (autonomy d = 0.23, competence d = 0.29, relatedness d = 0.22; all P > 0.07). Life satisfaction was slightly and nonsignificantly higher among owners (d = 0.21, P = 0.20). Anxiety (d =

0.07), negative affect (d = 0.04), and sleep quality (d = − 0.04) did not differ. Covariate adjustment strengthened the differences in positive affect (d = 0.44, P = 0.008), depression (d = − 0.39, P = 0.007), and need satisfaction (d = 0.36, P = 0.032; all uncorrected). The sleep result was unchanged after excluding pairs with a third-shift worker (53 pairs, d = 0.04, P = 0.83). Without emotional support or working dogs, the effects for positive affect (d = 0.44, P = 0.023) and need satisfaction (d = 0.36, P = 0.050) were slightly larger and the effect for depression was similar (d = − 0.29, P = 0.077; all uncorrected).

Exploratory Analyses

Owners and non-owners did not differ meaningfully in mindfulness or self-compassion: Cognitive and Affective Mindfulness Scale–Revised d = 0.24 (95% CI − 0.07 to 0.54), Mindful Attention Awareness Scale d = − 0.04, and self-compassion d = 0.04. They were similar in perceived risk of contracting COVID-19 (d = 0.15), COVID-19 precautions (d = 0.10), attitudes toward social-distancing rules (d = 0.05), and trust in COVID-19 information (d = − 0.06). Owners were slightly less likely to report staying home (d = − 0.19) and slightly more likely to report regular exercise (d = 0.12). Perceived COVID-19 risk did not change the owner–non-owner difference in loneliness (interaction d = 0.01, 95% CI − 0.35 to 0.37), need satisfaction, or positive affect.

Among all eligible owners, primary caregivers (n = 108) reported more loneliness (g = 0.49, 95% CI 0.07 to 0.91) and depression (g = 0.54, 95% CI 0.12 to 0.96) than owners whose dog was mainly cared for by someone else (n = 28), along with poorer sleep and lower life satisfaction (Table 3). These differences persisted after adjustment for covariates and living situation, and were of similar size, though not significant, among students living with their parents (loneliness d = 0.46, depression d = 0.44). In matched comparisons, however, primary caregivers did not differ from their matched non-owners in loneliness (64 pairs, d = − 0.15, 95% CI − 0.51 to 0.21) and tended to report less depression (d = − 0.31, 95% CI − 0.63 to 0.01) and more positive affect (d = 0.40, 95% CI 0.02 to 0.78). Owners whose dog slept in their bed did not differ in sleep quality from other owners (d = − 0.10).

Table 3
Exploratory and post hoc comparisons

Comparison	n	Effect [95% CI]
Primary caregivers vs. family-dog owners (all eligible owners)		
Loneliness	108 vs. 28	g = 0.49 [0.07, 0.91]
Depression	108 vs. 28	g = 0.54 [0.12, 0.96]
Sleep quality (higher = worse)	101 vs. 26	g = 0.42 [− 0.01, 0.85]
Life satisfaction	108 vs. 28	g = − 0.38 [− 0.79, 0.04]
Primary caregivers vs. their matched non-owners		
Loneliness	64 pairs	d = − 0.15 [− 0.51, 0.21]
Depression	64 pairs	d = − 0.31 [− 0.63, 0.01]
Positive affect	64 pairs	d = 0.40 [0.02, 0.78]
Post hoc composites (80 pairs; SD units, positive = owners better off)		
Positive well-being	80 pairs	0.30 [0.03, 0.56]
Distress (reversed)	80 pairs	0.08 [− 0.17, 0.32]
Difference, positive minus distress	80 pairs	0.22 [− 0.02, 0.45], P = 0.067
Attachment to dog (owners)		
With loneliness	124	r = 0.13 [− 0.04, 0.30]
With sleep quality (higher = worse)	116	r = 0.27 [0.09, 0.43]
Emotional support or service dog owners vs. other owners (adjusted)□		
Life satisfaction	14 vs. 122	d = − 0.41 [− 1.01, 0.19]
Positive affect	14 vs. 122	d = − 0.18 [− 0.78, 0.42]
Sleep quality (higher = worse)	13 vs. 114	d = 0.24 [− 0.38, 0.86]
Re-matched without emotional support or service dogs		
Loneliness	75 pairs	d = − 0.13 [− 0.48, 0.23]
Positive affect	75 pairs	d = 0.41 [0.07, 0.75]

Note. g = Hedges' g. □ Adjusted for gender, living situation, and primary caregiver role; no other outcome differed (all |d| ≤ 0.09). Exploratory and post hoc results are hypothesis-generating.

Post Hoc Analyses

The 90% CI for the loneliness difference (− 0.39 to 0.14 SD) extended beyond the lower equivalence bounds of d = − 0.30 and − 0.33, so equivalence was not established (two one-sided tests, P = 0.14 for ± 0.30 and P = 0.11 for ± 0.33). The upper limit did, however, rule out greater loneliness among owners of 0.30 SD or more (P = 0.005). Propensity weighting of all 298 eligible students gave the same conclusion as the matched comparison: the effect among owners was d = − 0.17 (95% CI − 0.50 to 0.17) and in all students d = − 0.16 (95% CI − 0.48 to 0.15), with similar doubly robust estimates (all P > 0.23). After weighting, all covariate standardized differences were 0.10 or smaller for the effect among owners.

In standardized composites, the owner advantage was 0.30 SD for positive well-being (95% CI 0.03 to 0.56, P = 0.029) and 0.08 SD for distress (95% CI − 0.17 to 0.32, P = 0.52). The difference between the two continua, 0.22 SD (95% CI − 0.02 to 0.45, P = 0.067), was not significant.

Among owners (n = 124), attachment to the dog was high (M = 58.0 of 69, SD = 9.4) and was weakly and nonsignificantly associated with more loneliness (r = 0.13, P = 0.14), depression (r = 0.14), and anxiety (r = 0.16). It was unrelated to positive affect (r = 0.03) and life satisfaction (r = 0.02). Stronger attachment was associated with poorer sleep quality (r = 0.27, 95% CI 0.09 to 0.43, P = 0.004), including after adjustment for gender, caregiver role, and living situation (partial r = 0.20, P = 0.028). Primary caregivers were more attached than other owners (d = 0.67).

Fourteen eligible owners described their dog as an emotional support animal (n = 13) or a service dog in training (n = 1). Compared with other owners, they did not differ on any outcome after adjustment for gender, living situation, and primary caregiver role (all P ≥ 0.18; Table 3). The largest difference, lower life satisfaction (unadjusted g = − 0.47, 95% CI − 1.02 to 0.09; adjusted d = − 0.41, 95% CI − 1.01 to 0.19), was attenuated by adjustment and requires confirmation in a larger sample. Few of these owners lived with their parents (14% vs. 69% of other owners), and most were their dog's primary caregiver (93% vs. 78%). When these owners were excluded and matching was repeated, 75 pairs were formed and the loneliness result was unchanged (d = − 0.13, 95% CI − 0.48 to 0.23, P = 0.48). No secondary outcome differed after false discovery rate correction (all q ≥ 0.13); before correction, owners again reported more positive affect (d = 0.41, 95% CI 0.07 to 0.75, P = 0.018).

Hypothesis-Generating Analyses

Further exploratory analyses, specified in writing after the matched results were known, examined possible explanations for those results; they are hypothesis-generating (Table 5). The clearest pattern involved third-shift work. Among the 21 matched students who usually worked overnight (13 owners and 8 non-owners), owners reported far fewer depressive symptoms than non-owners, and this owner–non-owner difference was larger than among other students (interaction d = − 0.92, 95% CI − 1.63 to − 0.20, P = 0.013). Owners who worked overnight also leaned toward less loneliness (interaction d = − 0.84, 95% CI − 1.79 to 0.10, P = 0.079) and greater need satisfaction (interaction d = 0.80, 95% CI − 0.05 to 1.64, P = 0.065). Gender and first-year status did not change the owner–non-owner differences (all |interaction d|

≤ 0.58, all P ≥ 0.19). These estimates come from 15 moderation tests in small subgroups, and one P value below 0.05 is close to what chance alone would produce.

Table 5
Hypothesis-generating analyses

Analysis	n	Effect [95% CI]
Moderation by third-shift work (dog × third shift)		
Depression	21 vs. 139	d = − 0.92 [− 1.63, − 0.20]
Loneliness	21 vs. 139	d = − 0.84 [− 1.79, 0.10]
Need satisfaction	21 vs. 139	d = 0.80 [− 0.05, 1.64]
Positive affect	21 vs. 139	d = 0.29 [− 0.74, 1.31]
Physical activity, owners vs. matched non-owners		
Total activity (log MET-min/week)	65 pairs	d = − 0.01 [− 0.36, 0.34]
Indirect effect on positive affect through activity (points)	65 pairs	−0.02 [− 0.91, 0.73]
Living situation and caregiving		
Non-owners, with parents vs. with roommates: need satisfaction	36 vs. 39	g = − 0.29 [− 0.75, 0.16]
Family-dog owners vs. matched non-owners: positive affect	13 pairs	d = 0.61 [− 0.41, 1.62]
Family-dog owners vs. matched non-owners: depression	13 pairs	d = − 0.63 [− 1.63, 0.37]
Primary caregivers vs. matched non-owners, life satisfaction: with parents	27 pairs	d = 0.68 [0.06, 1.29]
Primary caregivers vs. matched non-owners, life satisfaction: with roommates	33 pairs	d = 0.04 [− 0.45, 0.52]
Dog acquired during the pandemic vs. earlier (adjusted)		
Loneliness	16 vs. 119	d = 0.17 [− 0.38, 0.71]
Depression	16 vs. 119	d = 0.18 [− 0.35, 0.71]
Survey timing: change in owner–non-owner d per 30 days		
Loneliness	80 pairs	0.04 [− 0.12, 0.20]

Note. All analyses were specified after the main results were known and are hypothesis-generating. Difference in the owner–non-owner difference between third-shift workers (13 owners, 8 non-owners) and other students, divided by the outcome SD, from the covariate-adjusted model with pair-clustered standard errors; for depression and loneliness, negative values favor owners. Gender and first-year status did not moderate (all |d| ≤ 0.58). Adjusted for gender, living situation, and primary caregiver role. Family-dog owners = owners whose dog was cared for mainly by someone else. MET = metabolic equivalent.

Analysis	n	Effect [95% CI]
Depression	80 pairs	0.06 [− 0.09, 0.21]
Kind of connection		
Owner advantage, relatedness minus loneliness (SD units)	79 pairs	0.09 [− 0.23, 0.41]

Note. All analyses were specified after the main results were known and are hypothesis-generating. ⍰ Difference in the owner–non-owner difference between third-shift workers (13 owners, 8 non-owners) and other students, divided by the outcome SD, from the covariate-adjusted model with pair-clustered standard errors; for depression and loneliness, negative values favor owners. Gender and first-year status did not moderate (all |d| ≤ 0.58). ⍰ Adjusted for gender, living situation, and primary caregiver role. Family-dog owners = owners whose dog was cared for mainly by someone else. MET = metabolic equivalent.

Other candidate explanations were not supported. Owners and matched non-owners did not differ in physical activity (total activity d = − 0.01, 95% CI − 0.36 to 0.34, 65 pairs; leisure and travel activity d = 0.07), and activity accounted for none of the owner advantage in positive affect (indirect effect − 0.02 points, 95% CI − 0.91 to 0.73). Living with parents was not itself associated with better outcomes: among non-owners, students living with parents did not differ from those living with roommates (all |g| ≤ 0.29). Owners whose dog was cared for mainly by someone else leaned toward better outcomes than their matched non-owners, who shared their living situation (13 pairs; positive affect d = 0.61, depression d = − 0.63, both with wide confidence intervals). Primary caregivers compared similarly with their matched non-owners whether they lived with parents or with roommates, except that their life satisfaction advantage appeared only among those living with parents (d = 0.68 vs. 0.04). Owners who acquired their dog after March 13, 2020 (n = 16), leaned toward more loneliness and depression than longer-term owners (g = 0.28 and 0.34), but these differences were smaller after adjustment for gender, living situation, and caregiver role (d = 0.17 and 0.18). The owner–non-owner differences did not change reliably across the survey period (all P ≥ 0.41), although the loneliness and depression differences were larger in owners' favor among students surveyed before late October 2020 (d = − 0.39 and − 0.51) than among those surveyed later (d = 0.09 and − 0.16). Finally, the owner advantage was not larger for relatedness than for loneliness (difference 0.09 SD, 95% CI − 0.23 to 0.41).

Ancillary Analyses Among Owners

Comfort from the dog was high (M = 35.0 of 39, SD = 5.7), and 35% of owners scored the maximum on commitment. Seventeen owners (14%) scored at or near the floor of the commitment scale despite high attachment, which suggests that they reversed its response scale; results without them are reported. No bond measure was associated with positive affect or need satisfaction (Table 4). Comfort from the dog was unrelated to positive affect (r = 0.00, 95% CI − 0.17 to 0.18), need satisfaction (r = 0.04, 95% CI − 0.13 to 0.22), and life satisfaction (r = 0.00), and it leaned, nonsignificantly, toward more negative affect (r = 0.15, 95% CI − 0.03 to 0.31) and loneliness (r = 0.17, 95% CI − 0.004 to 0.34). Commitment was unrelated

to need satisfaction (r = 0.11) and competence (r = 0.05), and both estimates were smaller without the 17 likely misreaders (r = 0.03 and 0.02).

Table 4
Ancillary associations among dog owners

Hypothesis	Predictor → outcome	n	r [95% CI]	Adjusted β	q
A1	Comfort from the dog → positive affect	124	0.00 [− 0.17, 0.18]	0.03	0.98
A1	Comfort from the dog → need satisfaction	124	0.04 [− 0.13, 0.22]	0.05	0.95
A2	Commitment → need satisfaction	124	0.11 [− 0.07, 0.28]	0.13	0.55
A2	Commitment → competence	123	0.05 [− 0.13, 0.22]	0.04	0.95
A3	Daily dog outings → physical activity	111	0.24 [0.05, 0.41]	0.24	0.11
A3	Dog accompanies owner → physical activity	121	0.00 [− 0.18, 0.18]	−0.02	0.98
A3	“More exercise” comfort item → physical activity	113	0.02 [− 0.16, 0.21]	0.02	0.98
A3	Physical activity → positive affect	129	0.13 [− 0.04, 0.30]	0.11	0.41
A3	Physical activity → need satisfaction	129	0.14 [− 0.03, 0.31]	0.15	0.41

Note. r = Pearson correlation. Adjusted β = standardized coefficient adjusting for gender, living situation, and primary caregiver role. q = Benjamini–Hochberg false discovery rate across the nine tests. Physical activity = log metabolic equivalent minutes per week. Spearman correlations gave the same pattern.

On the activity route, owners whose dogs went out more often each day reported more total physical activity (r = 0.24, 95% CI 0.05 to 0.41; adjusted P = 0.014), but the association did not survive correction (q = 0.11) and did not appear for leisure and travel activity (r = 0.09). How often the dog accompanied the owner and the comfort item about exercise were unrelated to activity (both $|r| \le 0.02$). Activity was weakly and nonsignificantly associated with positive affect (r = 0.13) and need satisfaction (r = 0.14), and bootstrapped indirect effects of outings through activity had confidence intervals that included zero.

None of the 44 exploratory associations of problem behaviors, the dog’s history, or dog characteristics with positive affect, need satisfaction, negative affect, or loneliness reached $P < 0.05$ (all $|r| \le 0.17$). Owners of cooperative-breed dogs did not differ from other owners in positive affect (d = 0.03) or need satisfaction (d = 0.02), with or without adjustment for the dog’s weight, and owners of small, medium, and large dogs did not differ in either outcome.

Discussion

During the pre-vaccine months of the COVID-19 pandemic, college students who lived with a dog were not measurably less lonely than closely matched students who did not. The estimate favored owners slightly, and it was similar with covariate adjustment, without emotional support animals or newly acquired dogs, and with reweighting of the full sample instead of matching, but it was never significant. The confidence interval ruled out owners being meaningfully lonelier than non-owners, but it could not rule out a small-to-moderate benefit, so the groups were not statistically equivalent. The clearer hints of a dog-related difference lay elsewhere: before correction, owners reported more positive affect and fewer depressive symptoms, and need satisfaction leaned the same way.

These findings add to a literature that has grown more skeptical of a broad pet effect [1]. Early pandemic reports suggested that animals buffered owners against declining mental health and rising loneliness [16], whereas larger longitudinal and better-controlled studies have found little or no benefit [17, 18]. The present study tested the companionship hypothesis under conditions in which it should apply most strongly: young adults whose usual social contacts were disrupted, during a period of fear and uncertainty with no vaccine in sight. If dogs reduced loneliness substantially, this was the setting in which to detect it. That matched owners were not measurably less lonely suggests that, for most students, a dog in the home did not substitute for the human connection the pandemic took away. As in other matched and propensity-weighted studies [20, 21], apparent differences between owners and non-owners in this sample were largely accounted for by who owns dogs, above all by living situation.

What the loneliness result can and cannot rule out matters for interpretation. The 90% confidence interval excluded greater loneliness among owners of about 0.3 SD or more, so a dog in the home was very unlikely to have made students lonelier. Its lower limit, however, extended to about 0.4 SD in owners' favor, so a small-to-moderate loneliness benefit remains possible. Excluding this benefit would require a larger sample than the 80 pairs available here.

The secondary results lean toward owners on both sides of mental health, but more clearly on the positive side. Owners reported more positive affect and fewer depressive symptoms, and need satisfaction leaned the same way, while anxiety, negative affect, and sleep did not differ. The dual-continua model of mental health [7] treats flourishing and distress as related but distinct, and self-determination accounts of the human–animal bond predict that pets which support autonomy, competence, and relatedness will be associated with greater well-being more than with lower distress [8]. In the composites, the owner advantage was significant for positive well-being but not for distress. The difference between the two continua was not significant, however, so the data do not show that the advantage was confined to the positive side. A dog may add moments of play, purpose, and physical activity to a student's day, and that may lift mood and ease some depressive symptoms without changing the stressors that drive loneliness and anxiety.

This interpretation should be held lightly. The secondary effects did not survive correction for multiple comparisons, and the composites were post hoc. Effects of this size (about d = 0.3 to 0.4) are at the

edge of what 80 pairs can detect. The pattern is best treated as a hypothesis for future work that pre-specifies positive affect and depression as outcomes.

The caregiving and attachment findings caution against assuming that a closer bond is a happier one. Owners who were their dog's primary caregiver reported more loneliness and depression than owners whose family dog was cared for by others, and the most attached owners slept worse. These patterns echo a recent review of 116 studies in which stronger attachment tended to accompany worse mental health symptoms but better well-being [10], consistent with a review of pandemic-era studies that linked stronger attachment to anxiety [22]. In our sample, attachment was unrelated to positive affect and life satisfaction, so only the symptom side of that pattern appeared. Yet primary caregivers were no worse off than their matched non-owners and reported more positive affect. This suggests that the gap within owners reflects students whose family dog lives with them at home faring unusually well, rather than caregiving causing harm. Exploratory analyses suggested that this was not simply an advantage of living at home, because non-owners who lived with their parents fared no better than those who lived with roommates; support or other characteristics of dog-owning families may play a role. Distressed students may also form closer bonds with their dogs or take on more of their care. Cross-sectional data cannot distinguish these explanations, but the positive-affect advantage among caregivers is consistent with eudaimonic accounts in which responsibility for another being is a source of meaning.

Students' own accounts point in the same direction. In a qualitative analysis of open-ended responses from dog owners in the same study, students described their dogs as sources of companionship, activity, structure, and purpose, but these benefits were often tied to what the dog needed: walks happened because the dog needed exercise, and daily routines formed around feeding and care [23]. The same responsibilities could interrupt schoolwork and create worry, so students described the relationship as both supportive and demanding. A relationship that is meaningful but also effortful could plausibly lift positive affect more than it reduces distress, which is consistent with the pattern in the matched comparison.

The ancillary analyses asked whether, among owners, well-being was related to the relationship with the dog or to characteristics of the dog. Neither the comfort owners took from their dog, their commitment to it, or their activity with it, nor the dog's behavior, history, size, or breed function, was associated with positive affect or need satisfaction, and the activity route was weak at each step. Restricted range limits this conclusion, because most owners reported high comfort and commitment, so the data show no evidence of these associations rather than evidence that none exist. Still, the lack of association with the bond or with characteristics of the dog fits explanations at the level of ownership itself, such as selection into dog-owning households on unmeasured traits, or chance, better than an account in which a closer bond produces more happiness.

The lean toward more loneliness and negative affect among owners who took the most comfort from their dog echoes a lockdown study in which comfort from pets accompanied both more positive and more negative affect [24]. Distressed students may lean on their dogs more, which would make comfort

a marker of need as much as a source of well-being. Students' written accounts also described dogs as a reason to leave the house [23], and in the survey data more daily outings went with more total activity. That activity, however, was only weakly related to well-being, so the outdoor routine that dogs require is not, on this evidence, a strong route to student happiness.

One exploratory pattern deserves follow-up because of where these data were collected. Many students at this university pay for their education by working overnight package-handling shifts through a university–employer partnership. Among the third-shift workers in our matched sample, owners reported far fewer depressive symptoms than non-owners, and they leaned toward less loneliness and greater need satisfaction. Overnight work disrupts sleep and separates students from the daytime rhythms of campus and social life, so these may be the students for whom a dog's companionship and daily routine matter most. The subgroup was small (21 students), the pattern emerged from exploratory moderation tests, and it should be treated as a hypothesis. Studies of working students, and of shift workers more broadly, could test it directly.

Open-ended responses from these third-shift workers offer an illustrative, not confirmatory, view of this pattern. All participants were asked: "We wish we could interview you in-person to learn about your experience as a student living through the COVID-19 pandemic. How has being in quarantine affected your routine and everyday life? Your health and wellbeing? Please write a few paragraphs to describe your experience, changes you have witnessed, and how they have affected you personally." The question did not mention dogs and preceded the questions about participants' dogs. All responses from the 21 third-shift participants (13 owners, 8 non-owners; one owner did not respond) were read, and representative excerpts were selected. Non-owners described loneliness, lost routine, and declining mental health ("Being in quarantine has been lonely and boring"; "I feel like I ha[ve] no routine or structure to my life"). One described the particular position of a student whose overnight job continued: "I never got laid off though because [my employer] will not shut down for anything, so I was lucky to keep my job but I was a little jealous of the people whose lives slowed down a little. Later on into the quarantine I struggled with not being able to go anywhere for stress relief." Owners described similar strain ("My mental health has somewhat declined while in quarantine because I hate being in one place with the same people but I also hate being alone in my room"), but 2 of the 12 who responded mentioned their dogs without being asked, as a source of structure and emotional support ("I have my ESA [emotional support animal] with me on campus, so she has helped me stay in some kind [of] schedule!"; "The pandemic on top of my anxiety took a big toll on me. Having [my dog] really improved my well-being and he knows when I am having panic attacks and or depressive episodes. If anything [my dog] has kept me from going insane and he's the entire reason I am thriving today"). These accounts are consistent with the possibility that a dog's presence and care needs give structure to students whose schedules are otherwise disrupted.

This was a cross-sectional study at a single university, so causal conclusions are limited even with matching. Matching cannot address unmeasured differences, most importantly pre-pandemic mental health and family income. Dog ownership was defined by a dog living in the student's home and does not

capture students separated from dogs at a family home. Recruitment through a study of dog cognition may have drawn owners who were especially engaged with their dogs, consistent with the high attachment scores. Participants were limited to undergraduates aged 18–30, as the study protocol specified, so the findings may not extend to older or nontraditional students. The sample was predominantly women, the living-alone and family-dog subgroups were small, and several instruments were adapted to a past-week time frame. Well-being was measured with hedonic and need-satisfaction scales; measures of meaning or flourishing would test the eudaimonic interpretation more directly. Sleep times were self-reported and required rule-based cleaning. Finally, data were collected throughout 2020, so the sample spans changing phases of the pandemic, although survey date was balanced by matching. After matching, missing grade point average was somewhat more common among non-owners than owners; this indicator was included in the adjusted models. The ancillary analyses within owners were specified after the matched results were known, most owners scored near the top of the comfort and commitment scales, and some owners appear to have reversed the commitment scale. Only 8 owners lived alone with their dog, too few to test whether dogs matter most for students with no other housemates.

Three implications follow. First, studies of companion animals and well-being should treat selection into ownership as the central design problem. In this sample, owners and non-owners differed by nearly a full standard deviation in residence hall housing alone, and by large margins in whether they lived with parents or roommates. Second, the question “Do pets make people happier?” should be split by dimension, because the answer may differ for positive well-being, distress, and loneliness. Third, null results should be reported with the effects they can and cannot rule out. Here the data ruled out a harmful effect of dog ownership on loneliness but not a modest benefit, a distinction that a P value alone conceals in a field where small samples and positive expectations are common.

In a carefully matched sample of college students aged 18–30 surveyed before COVID-19 vaccines were available, living with a dog was not associated with significantly less loneliness, anxiety, or negative affect. Owners showed modest, uncertain advantages in positive affect and depressive symptoms that did not survive correction for multiple comparisons, and neither the most attached, the most committed, nor the most active owners were the ones doing best. Dog owners were not measurably less lonely than matched non-owners during pandemic isolation. Whether they make students somewhat happier, and somewhat less depressed, is a question for longitudinal work that pre-specifies those tests.

Methods

Participants and Procedure

Participants were students at the University of Louisville (Louisville, Kentucky, USA), a large public urban university who enrolled in a study of companion dogs and college stress. Undergraduates aged 18–30 who were fluent in English were eligible, whether or not they lived with a dog. Students were recruited mainly through the university’s SONA research participation system, with additional announcements in

courses and departmental newsletters. Owners and non-owners enrolled independently. Participants received research participation credit and a $10 prepaid card. The main campus lies in a dense urban area bordered by an interstate highway and freight-rail corridors, about 5 km north of an airport that houses an overnight air-cargo hub [25]. Students completed online questionnaires in REDCap between May 18 and December 17, 2020. Every participant was therefore surveyed before COVID-19 vaccines became available to young adults: the first US emergency use authorization was issued on December 11, 2020, and eligibility opened to everyone 16 and older on April 19, 2021 [26]. Dog ownership was defined by a "yes" answer to "Is there a dog living with you in your home?" All participants answered an open-ended question about their experience of the pandemic; excerpts from third-shift workers' responses are quoted in the Discussion without names or other identifying information. Dog owners' responses to a separate open-ended question about their relationship with their dog during the pandemic are reported elsewhere [23]. The study was approved by the University of Louisville Institutional Review Board (IRB #2019.0571; initially approved 15 November 2019 and later amended for online data collection) and was conducted in accordance with the Declaration of Helsinki and relevant guidelines and regulations. All participants provided informed consent.

Of 332 enrolled students, 34 were excluded: 2 surveyed before the US national emergency declaration, 5 missing dog ownership, living situation, age, or semesters completed, 16 with no loneliness data, and 11 whose recorded age was above 30, outside the protocol's eligibility range. The remaining 298 students (144 dog owners, 154 non-owners) were eligible for matching.

Measures

Internal consistency is reported for the matched sample unless noted.

Loneliness (primary outcome) was measured with the 20-item UCLA Loneliness Scale [27]. Each item is worded in the lonely direction, with responses from 1 (*never*) to 4 (*often*); totals range from 20 to 80 (α = 0.96).

Secondary outcomes. Basic psychological need satisfaction was measured with the 21-item Basic Psychological Needs Scale [28], scored as a mean (1–7; α = 0.87) and as autonomy, competence, and relatedness subscales (α = 0.71, 0.69, and 0.79 in the full sample). Positive and negative affect over the past week were measured with the Positive and Negative Affect Schedule [29] (each 10–50; α = 0.88 and 0.87). Life satisfaction was measured with the Satisfaction With Life Scale [30] (5–35; α = 0.88). Depression was measured with the Patient Health Questionnaire-9 [31] (0–27; α = 0.89) and anxiety with the Generalized Anxiety Disorder-7 scale [32] (0–21; α = 0.92), with instructions referring to the past week. Sleep quality was measured with the Pittsburgh Sleep Quality Index [33] adapted to the past week; higher global scores (0–21) indicate worse sleep.

Exploratory measures. Mindfulness was measured with the 10-item Cognitive and Affective Mindfulness Scale–Revised [34] (α = 0.87) and the Mindful Attention Awareness Scale [35] (α = 0.90). Self-

compassion was measured with the long form [36] or short form [37] of the Self-Compassion Scale, because the survey switched versions partway through data collection (short form n = 94, α = 0.86; long form n = 67, α = 0.93); scores were expressed as item means (1–5). Dog owners completed the Lexington Attachment to Pets Scale [38] (0–69; α = 0.92) and reported whether they were their dog's primary caregiver. Pandemic context was assessed with study-developed items on perceived likelihood of contracting COVID-19, protective behaviors, and attitudes toward social-distancing rules.

Covariates. Students reported gender, race, ethnicity, age, semesters completed, current grade point average (GPA), employment, weekly work hours, and usual work shift, along with housing type and number of roommates. Third-shift (overnight) work was common in this sample, because many students at the university work overnight package-handling shifts at a nearby air-cargo hub in exchange for tuition support through a university–employer partnership.

Data Preparation

All scale scores were rebuilt from item-level data and checked against the survey's response coding. Sleep efficiency on the Pittsburgh Sleep Quality Index was computed from reported bed and wake times, wrapping past midnight. Twelve-hour-clock entries were reinterpreted only when that produced a conventional night schedule, efficiency above 100% was capped, and the global score required all seven components. Sleep efficiency was set to missing for 14 participants whose times or hours of sleep were implausible.

Matching

We estimated each student's propensity to own a dog by logistic regression on gender, race (Black, Asian, other or not reported, vs. White), Hispanic ethnicity, age, semesters completed, GPA (with an indicator for missing GPA), employment, work hours, days since March 13, 2020, residence hall housing, and living situation. Dog owners were then matched one to one without replacement to non-owners within the same living situation (with parents, alone, or with roommates), using greedy nearest-neighbor matching on the logit of the propensity score with a caliper of 0.2 standard deviations [39]. Matching used only whether the loneliness questionnaire was completed, not its scores. Balance was judged by standardized mean differences, with $|d| < 0.10$ as the target and < 0.20 as acceptable.

Analysis Plan

Hypotheses, outcome tiers, and the analysis plan were written down and discussed with all co-authors before any outcome was compared between groups; the plan was not publicly registered. The primary test (H1) compared loneliness within matched pairs using a two-tailed paired t test at α = 0.05. Effect sizes are Cohen's d (mean paired difference divided by the pooled standard deviation) with 95%

confidence intervals. A Wilcoxon signed-rank test checked robustness to non-normality. A covariate-adjusted model regressed each outcome on dog ownership, all matching variables, third-shift work, and living situation, with standard errors clustered by pair. Secondary outcomes (basic needs, positive affect, negative affect, life satisfaction, depression, anxiety, sleep) formed one family, and Benjamini–Hochberg false discovery rate correction was applied across it [40]. Pre-specified sensitivity analyses removed pairs whose dog was a service or emotional support animal, pairs whose dog was acquired after March 13, 2020, and, for sleep, pairs including a third-shift worker. Exploratory analyses (H5, H7, pandemic context, and moderation of the owner–non-owner difference by perceived COVID-19 risk) report effect sizes without significance claims.

Five post hoc analyses were added after the planned results were known and are labeled as such. (a) An equivalence test for loneliness used two one-sided tests with bounds of d = ± 0.30 and ± 0.33 [41]. (b) A robustness check re-estimated the loneliness effect in all 298 eligible students, using propensity weights for the average effect among owners and for the average effect in all students, with and without covariates. (c) Positive well-being (positive affect, basic needs, life satisfaction) and distress (loneliness, depression, anxiety, negative affect) composites were formed from standardized scores, to test whether the owner advantage differed between the two continua. (d) Among owners, attachment was correlated with each outcome. (e) Owners of emotional support or service dogs were compared with other eligible owners, without adjustment (Welch t test, Hedges' g) and with adjustment for gender, living situation, and primary caregiver role, the covariates used in the other owner-only analyses; matching and the primary and secondary analyses were then repeated after excluding these owners.

Six further hypothesis-generating questions were written down before they were examined: whether physical activity (Global Physical Activity Questionnaire [44], log metabolic equivalent minutes per week) differed between matched owners and non-owners and accounted for the positive-affect difference (indirect effect estimated from paired differences, with 5,000 bootstrap resamples of pairs); whether the advantage of owners whose dog was cared for by others reflected living with parents (owner–non-owner comparisons by caregiver role and living situation, and non-owners living with parents vs. roommates); whether owners who acquired their dog after March 13, 2020, reported more distress than longer-term owners (adjusted for gender, living situation, and caregiver role); whether owner–non-owner differences changed with survey date; whether the owner advantage was larger for relatedness than for loneliness; and whether gender, first-year status (0–1 semesters completed), or third-shift work moderated owner–non-owner differences (dog × moderator interactions in the covariate-adjusted model, with standard errors clustered by pair). Outcomes were loneliness, positive affect, depression, need satisfaction, and life satisfaction. These analyses are reported with effect sizes and 95% CIs and interpreted as hypothesis-generating.

Ancillary Analyses Among Owners

To understand the owner advantages in positive affect and need satisfaction, we tested ancillary hypotheses within owners only. These hypotheses and their analysis plan were written down on November 11, 2026, after the matched comparisons were known but before any of the owner-level associations below were examined. Student research assistants had looked at some dog-related variables in 2022; those analyses did not inform these hypotheses. All 144 eligible owners were included; 124 completed the bond measures.

Comfort from the dog was measured with the 13-item Comfort from Companion Animals Scale [42] (items scored 0–3, total 0–39; α = 0.91). Commitment was measured with the 10-item Miller-Rada Commitment to Pets Scale [43], which asks whether the owner would give up the dog if it damaged furniture, needed costly veterinary care, or was hard to housebreak (1 = strongly agree to 5 = strongly disagree; total 10–50, higher scores indicating more commitment; α = 0.98). Physical activity in a typical week was measured with the World Health Organization Global Physical Activity Questionnaire [44], scored as metabolic equivalent minutes per week across work, travel, and recreation and log-transformed; a score for leisure and travel activity alone served as a check. On the study's dog questionnaire, owners reported how many times a day the dog went outside; how often the dog accompanied them in daily activities (1–10); the dog's weight, age, sex, neuter status, and source; how long they had owned the dog and whether it was acquired after March 13, 2020; ratings of the dog's aggression toward people and toward other dogs, separation anxiety, and obedience (each 1–10); and whether the dog was stressed by strangers. Breeds were grouped by historical function as cooperative workers (herding dogs and gundogs), independent workers (hounds, terriers, livestock guardians, and sled dogs), or companion breeds [45]; mixes spanning more than one group and unknown breeds were excluded from that comparison.

Three hypotheses were tested. A1 predicted that greater comfort from the dog would be associated with higher positive affect and need satisfaction. A2 predicted that greater commitment would be associated with higher need satisfaction, especially competence. A3 predicted that more daily outings with the dog, more frequent accompaniment by the dog, and stronger endorsement of the comfort item about getting more exercise would be associated with more physical activity, and that more activity would be associated with higher positive affect and need satisfaction. Associations were estimated as Pearson correlations with 95% confidence intervals, with Spearman correlations as a check, and as standardized coefficients from regressions adjusting for gender, living situation, and primary caregiver role. Benjamini–Hochberg correction was applied across the nine A1–A3 tests. Negative affect, life satisfaction, and loneliness were examined as secondary and contrast outcomes. Problem behaviors, the dog's history, and dog characteristics were examined as exploratory, with effect sizes and confidence intervals only. With 129 owners, power was 80% to detect r = 0.24 (two-tailed α = 0.05).

Use of Generative AI

Generative AI (Claude, Anthropic) was first used for the analyses in this paper in November 2026, after data collection was complete. It was used to check and correct questionnaire scoring, clean sleep questionnaire data, conduct propensity score matching, write statistical analysis code, search and verify the literature, draft manuscript text, and extract third-shift workers' open-ended responses and suggest excerpts; the authors read all of those responses and chose the excerpts quoted. Analyses were conducted in Python (pandas, SciPy). The authors reviewed and verified all analyses and text and take full responsibility for the content.

Declarations

Additional information

Competing interests:

The authors declare no competing interests.

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Author Contribution

S.E.S.: conceptualization, methodology, formal analysis, investigation, project administration, supervision, writing – original draft, writing – review and editing. E.C.: data curation, formal analysis, writing – review and editing. D.M.S.: conceptualization, funding acquisition, investigation, project administration, resources, writing – review and editing. All authors reviewed and approved the manuscript.

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Data Availability

De-identified data and analysis code are available from the corresponding author on reasonable request, under the terms of a data use agreement between the University of Louisville and Brigham Young

University, which permits analysis and publication of these data.

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Figures

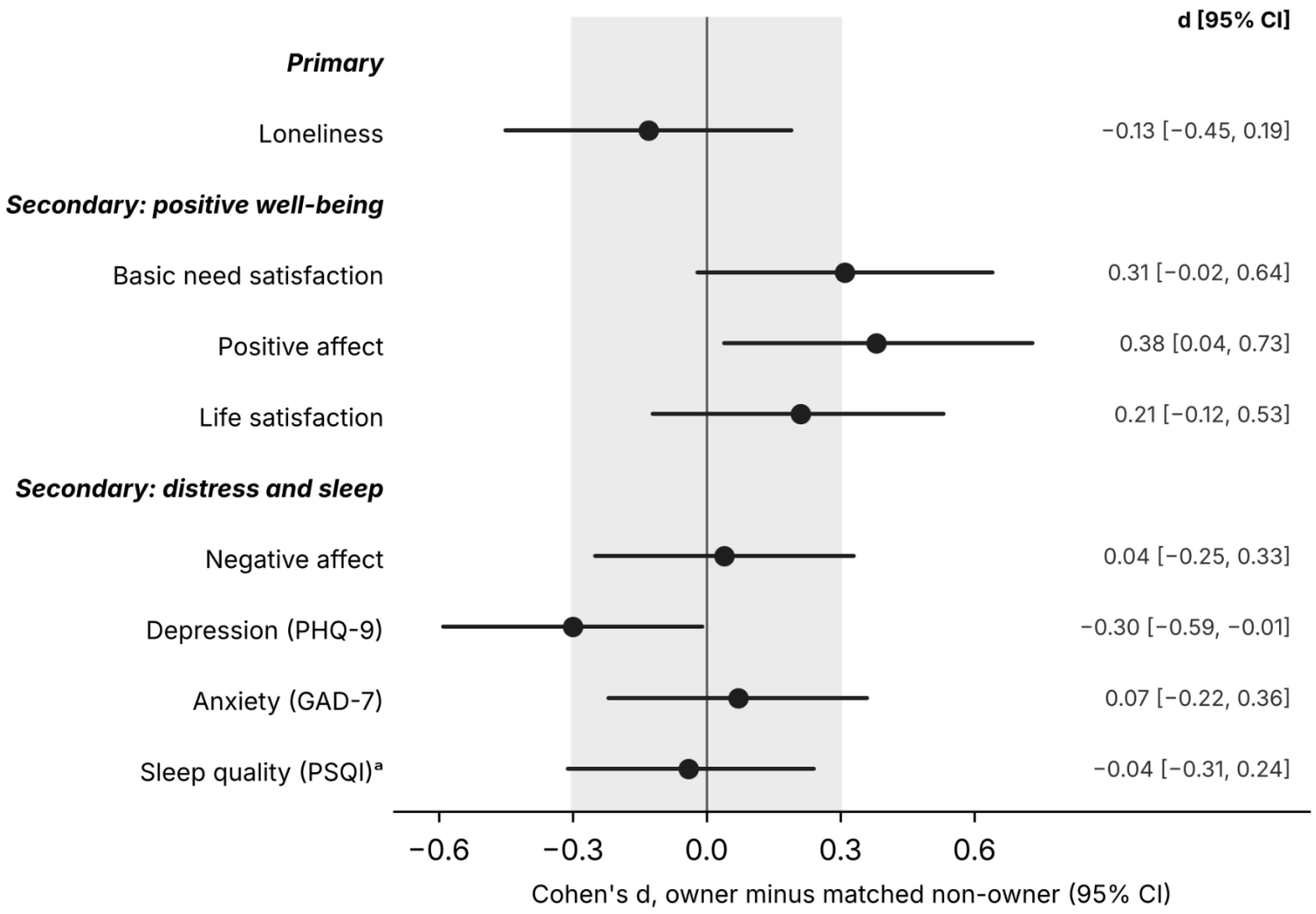


Figure 1

Standardized differences between dog owners and matched non-owners on the primary and secondary outcomes. Points are Cohen's d (owner minus non-owner) with 95% confidence intervals for 80 matched pairs (sleep, 70 pairs); the shaded band marks the ±0.30 bounds used in the post hoc equivalence test. For depression, anxiety, negative affect and sleep, positive values mean owners scored worse.