Appendix C: Extra models and results

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Disclaimer:

This is an appendix to the bachelor thesis paper "Pet ownership and mental health in the time of COVID-19", included here with the intent of providing as much information and maximal transparency about the project as possible.

All models included in this appendix were run on the same pre-processed data as included in the bachelor thesis paper; mental health outcomes are the same (and are measured in the same way), as are abbreviations. Furthermore, previous measures were used to create new predictor variables. As such, for a complete overview of methods, it is necessary to confer with the "Methods" section of the paper.

Methods and results for all these models are presented in the following. Furthermore, the "Pets, exercise, daily structure, and mental health" section features a small introduction, reviewing the current evidence of the effects of PO on exercise levels and daily structure.

Appendix C.1. PO and mental health - novelty effects?

Appendix C.1.2. Methods

Linear mixed-effects regression models were run to test for possible novelty effects of PO on mental health, using mental health measures as outcome variables (see methods section in bachelor paper) and demographics variables (age, gender, education, number of rooms in household) as random effects. In addition, for each model with loneliness as the outcome, "live with someone" was added as a random effect. The predictors used are described below.

New pet adopters

A "new pet adopters" category was created consisting of pet adopters each follow-up who had not reported owning a pet at baseline.

New vs existing owners

A "new vs existing owners" category was created to compare "new pet adopters" with non-adopting baseline owners, excluding non-owners in each follow-up and PDA's participants who had reported owning a pet at baseline.

First, "new pet adopters" at each follow-up were compared to non-adopters in that follow up- and participants who reported owning a pet at baseline (grouped together) for each mental health measure at each following time point.

Second, using the "new vs existing owners" category, "new pet adopters" at each follow-up were compared to non-adopting (in that follow-up) baseline owners (grouped together) for each mental health measure at each following time point, excluding non-owners in that follow-up and pet adopters who reported having a pet at baseline.

The linear mixed-effects regression models were run using the 'lmer' function from the lmerTest package [1] in RStudio [2].

Appendix C.1.2. Results - "New pet adopters" vs non-adopters-and baseline owners (at each follow-up) and mental health scores (at each follow-up)

All results for "new pet adopters" vs non-adopters- and baseline owners are presented in **Appendix Table A**.

A total of 64 participants were "new pet adopters" at 3 months (vs non-adopters and people who already owned a pet at baseline = 6359), 99 participants were "new pet adopters" at 6 months (vs N = 6524), and 134 were "new pet adopters" at 12 months (vs N = 6594).

There were no significant effects on symptoms of depression, anxiety, loneliness, or anhedonia associated with "new pet adopters" (vs non-adopters and people who already owned a pet at baseline (grouped together)).

Appendix Table A: "New pet adopters" vs non-adopters- and baseline owners - Results of linear mixed-effects regression models

New pet adopters (3 months) and PHQ-9 scores (at each follow-up)

	PHQ-9 (3 months)					PHQ-9 (6 months)					PHQ-9 (12 months)				
Predictors	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*
(Intercept)	7.68	5.91 – 9.44	0.02	-0.25 – 0.29	**<0.001**	7.47	5.53 – 9.41	-0.02	-0.33 – 0.28	**<0.001**	6.71	5.40 – 8.02	0.02	-0.19 – 0.24	**<0.001**
New pet adopters (3 months)	-0.52	-3.53 – 2.49	-0.08	-0.54 – 0.38	0.733	2.87	-0.46 – 6.20	0.45	-0.07 – 0.98	0.091	-0.80	-2.91 – 1.30	-0.13	-0.47 – 0.21	0.453
ICC	0.13					0.14					0.09				
Observations	1475					1433					2569				
Marginal R^2 / Conditional R^2	0.000 / 0.131					0.002 / 0.144					0.000 / 0.087				

New pet adopters (3 months) and GAD-7 scores (at each follow-up)

	GAD-7 (3 months)					GAD-7 (6 months)					GAD-7 (12 months)				
Predictors	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*
(Intercept)	6.07	4.33 – 7.82	0.03	-0.28 – 0.35	**<0.001**	6.05	4.14 – 7.96	0.00	-0.35 – 0.35	**<0.001**	5.22	3.85 – 6.58	0.06	-0.20 – 0.33	**<0.001**
New pet adopters (6 months)	-1.52	-4.06 – 1.02	-0.27	-0.73 – 0.18	0.241	1.95	-0.90 – 4.80	0.36	-0.16 – 0.88	0.179	-0.93	-2.67 – 0.82	-0.18	-0.51 – 0.16	0.297
ICC	0.16					0.17									
Observations	1466					1431					2570				
Marginal R^2 / Conditional R^2	0.001 / 0.165					0.001 / 0.169					0.000 / NA				

New pet adopters (3 months) and UCLA Loneliness (4-item) scores (at each follow-up)

	UCLA Loneliness 4-item (3 months)					UCLA Loneliness 4-item (6 months)					UCLA Loneliness 4-item (12 months)				
Predictors	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*
(Intercept)	3.18	2.59 – 3.76	0.03	-0.18 – 0.24	**<0.001**	4.07	2.04 – 6.10	0.31	-0.40 – 1.02	**<0.001**	3.22	2.80 – 3.63	0.08	-0.07 – 0.22	**<0.001**
New pet adopters (3 months)	-0.19	-1.53 – 1.15	-0.07	-0.54 – 0.40	0.781	0.01	-1.53 – 1.55	0.00	-0.53 – 0.54	0.992	-0.16	-1.12 – 0.80	-0.06	-0.40 – 0.29	0.745
ICC	0.08					0.22					0.04				
Observations	1458					1420					2569				
Marginal R^2 / Conditional R^2	0.000 / 0.076					0.000 / 0.221					0.000 / 0.039				

New pet adopters (3 months) and MASQ-AD scores (at each follow-up)

	MASQ-AD (3 months)					MASQ-AD (6 months)					MASQ-AD (12 months)				
Predictors	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*
(Intercept)	14.36	12.05 – 16.68	0.01	-0.24 – 0.26	**<0.001**	14.01	11.63 – 16.39	0.08	-0.19 – 0.34	**<0.001**	14.06	10.99 – 17.14	-0.07	-0.40 – 0.27	**<0.001**
New pet adopters (3 months)	3.51	-1.34 – 8.36	0.38	-0.15 – 0.90	0.156	0.61	-5.29 – 6.52	0.07	-0.58 – 0.72	0.839	2.16	-1.40 – 5.72	0.24	-0.15 – 0.63	0.234
ICC											0.08				
Observations	1230					1129					2132				
Marginal R^2 / Conditional R^2	0.002 / NA					0.000 / NA					0.001 / 0.084				

New pet adopters (6 months) and PHQ-9 scores (6 and 12 months)

	PHQ-9 (6 months)					PHQ-9 (12 months)				
Predictors	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*
(Intercept)	7.50	5.59 – 9.41	-0.03	-0.33 – 0.27	**<0.001**	9.41	4.86 – 13.96	0.45	-0.28 – 1.18	**<0.001**
New pet adopters (6 months)	1.32	-1.10 – 3.74	0.21	-0.17 – 0.59	0.284	-0.33	-1.93 – 1.27	-0.05	-0.31 – 0.20	0.682
ICC	0.14					0.35				
Observations	1513					2629				
Marginal R^2 / Conditional R^2	0.001 / 0.141					0.000 / 0.355				

New pet adopters (6 months) and GAD-7 scores (6 and 12 months)

	GAD-7 (6 months)					GAD-7 (12 months)				
Predictors	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*
(Intercept)	6.03	4.16 – 7.91	-0.01	-0.35 – 0.33	**<0.001**	5.19	3.83 – 6.54	0.06	-0.20 – 0.32	**<0.001**
New pet adopters (6 months)	0.72	-1.34 – 2.79	0.13	-0.24 – 0.51	0.492	0.00	-1.31 – 1.32	0.00	-0.25 – 0.25	0.997
ICC	0.17									
Observations	1511					2630				
Marginal R^2 / Conditional R^2	0.000 / 0.167					0.000 / NA				

New pet adopters (6 months) and UCLA Loneliness (4-item) scores (6 and 12 months)

	UCLA Loneliness 4-item (6 months)					UCLA Loneliness 4-item (12 months)				
Predictors	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*
(Intercept)	4.10	2.12 – 6.08	0.31	-0.38 – 1.00	**<0.001**	3.23	2.80 – 3.66	0.08	-0.07 – 0.23	**<0.001**
New pet adopters (6 months)	-0.02	-1.13 – 1.09	-0.01	-0.40 – 0.38	0.969	-0.04	-0.76 – 0.69	-0.01	-0.27 – 0.25	0.924
ICC	0.22									
Observations	1500					2629				
Marginal R^2 / Conditional R^2	0.000 / 0.218					0.000 / NA				

New pet adopters (6 months) and MASQ-AD scores (6 and 12 months)

	MASQ-AD (6 months)					MASQ-AD (12 months)				
Predictors	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*
(Intercept)	14.02	11.80 – 16.24	0.06	-0.18 – 0.31	**<0.001**	13.76	10.52 – 16.99	-0.10	-0.46 – 0.25	**<0.001**
New pet adopters (6 months)	0.85	-3.23 – 4.93	0.09	-0.36 – 0.54	0.682	1.55	-1.14 – 4.25	0.17	-0.12 – 0.47	0.258
ICC						0.09				
Observations	1189					2184				
Marginal R^2 / Conditional R^2	0.000 / NA					0.001 / 0.093				

New pet adopters (12 months) and mental health scores (12 months)

	PHQ-9 (12 months)					GAD-7 (12 months)					UCLA Loneliness 4-item (12 months)					MASQ-AD (12 months				
Predictors	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*
(Intercept)	9.67	4.97 – 14.36	0.49	-0.27 – 1.24	**<0.001**	5.21	3.85 – 6.57	0.05	-0.21 – 0.31	**<0.001**	3.28	2.85 – 3.71	0.09	-0.06 – 0.25	**<0.001**	13.16	9.31 – 17.01	-0.17	-0.59 – 0.26	**<0.001**
New pet adopters (12 months)	-0.28	-1.59 – 1.04	-0.04	-0.25 – 0.17	0.681	-0.18	-1.27 – 0.90	-0.04	-0.24 – 0.17	0.738	-0.04	-0.63 – 0.56	-0.01	-0.23 – 0.20	0.904	0.97	-1.27 – 3.22	0.11	-0.14 – 0.35	0.394
ICC	0.37															0.13				
Observations	2663					2664					2663					2210				
Marginal R^2 / Conditional R^2	0.000 / 0.370					0.000 / NA					0.000 / NA					0.000 / 0.128				

Appendix C.1.3. Results - "New vs existing owners" (at each follow-up)

OBS: Due to an error in the code, results of "new vs existing owners" for the 6-months follow-up are missing. Because corrections to the code had to be sent back to be run on the real data, and results of this sent back again, this was not doable in terms of time.

All results for "new vs existing owners" are presented in **Appendix Table B**.

3238 non-adopters reported having a pet at baseline (i.e., "existing owners") at the 3-months follow-up, and 3294 at the 12-months follow-up (number of "new pet adopters" is shown in the previous results section).

There were no significant effects on symptoms of depression, anxiety, or loneliness when comparing "new pet adopters" vs "existing owners" at any time point.

There were no significant effects on symptoms of depression, anxiety, or loneliness when comparing "new pet adopters" vs "existing owners" at any time point. However, "new pet adopters" (3 months post-baseline) showed significantly fewer symptoms of anhedonia (higher MASQ-AD scores) at the 3-months follow-up compared to "existing owners" at this time point (beta = 4.82, 95% CI [0.07 – 9.57], p = 0.047).

Appendix Table B: "New vs existing owners" - Results of linear mixed-effects regression models

New vs existing owners (3 months) and PHQ-9 scores (at each follow-up)

	PHQ-9 (3 months)					PHQ-9 (6 months)					PHQ-9 (12 months)				
Predictors	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*
(Intercept)	8.43	6.27 – 10.59	0.06	-0.27 – 0.39	**<0.001**	8.20	6.13 – 10.27	0.02	-0.29 – 0.33	**<0.001**	7.68	6.32 – 9.03	0.11	-0.10 – 0.32	**<0.001**
New vs existing owners (3 months)	-1.10	-4.12 – 1.92	-0.17	-0.63 – 0.29	0.474	2.51	-1.02 – 6.04	0.38	-0.15 – 0.91	0.163	-1.39	-3.58 – 0.80	-0.22	-0.56 – 0.13	0.213
Observations	728					736					1237				
Marginal R^2 / Conditional R^2	0.001 / 0.176					0.002 / 0.160					0.001 / NA				

New vs existing owners (3 months) and GAD-7 scores (at each follow-up)

	GAD-7 (3 months)					GAD-7 (6 months)					GAD-7 (12 months)				
Predictors	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*
(Intercept)	6.57	4.39 – 8.75	0.07	-0.32 – 0.45	**<0.001**	6.40	4.44 – 8.36	0.01	-0.34 – 0.36	**<0.001**	5.77	4.41 – 7.12	0.12	-0.14 – 0.37	**<0.001**
New vs existing owners (3 months)	-1.87	-4.43 – 0.70	-0.33	-0.78 – 0.12	0.154	1.92	-1.03 – 4.87	0.34	-0.18 – 0.86	0.203	-1.21	-3.00 – 0.58	-0.23	-0.57 – 0.11	0.186
Observations	721					734					1236				
Marginal R^2 / Conditional R^2	0.002 / 0.237					0.002 / 0.183					0.001 / 0.138				

New vs existing owners (3 months) and UCLA Loneliness (4-item) scores (at each follow-up)

	UCLA Loneliness 4-item (3 months)					UCLA Loneliness 4-item (6 months)					UCLA Loneliness 4-item (12 months)				
Predictors	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*
(Intercept)	3.40	2.69 – 4.11	0.10	-0.15 – 0.35	**<0.001**	3.72	2.18 – 5.27	0.18	-0.36 – 0.72	**<0.001**	3.18	2.82 – 3.54	0.06	-0.07 – 0.19	**<0.001**
New vs existing owners (3 months)	-0.32	-1.66 – 1.02	-0.11	-0.58 – 0.36	0.644	-0.01	-1.56 – 1.55	-0.00	-0.54 – 0.54	0.994	-0.07	-1.04 – 0.90	-0.03	-0.38 – 0.32	0.884
Observations	715					727					1236				
Marginal R^2 / Conditional R^2	0.000 / NA					0.000 / NA					0.000 / 0.021				

New vs existing owners (3 months) and MASQ-AD scores (at each follow-up)

	MASQ-AD (3 months)					MASQ-AD (6 months)					MASQ-AD (12 months)				
Predictors	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*
(Intercept)	13.41	10.62 – 16.20	0.00	-0.31 – 0.31	**<0.001**	13.07	10.71 – 15.43	0.05	-0.22 – 0.31	**<0.001**	14.37	11.73 – 17.01	0.01	-0.28 – 0.30	**<0.001**
New vs existing owners (3 months)	4.82	0.07 – 9.57	0.53	0.01 – 1.06	**0.047**	1.24	-4.66 – 7.15	0.14	-0.52 – 0.79	0.679	2.70	-0.85 – 6.25	0.30	-0.09 – 0.69	0.136
Observations	610					578					1034				
Marginal R^2 / Conditional R^2	0.007 / NA					0.000 / NA					0.002 / 0.062				

New vs existing owners (12 months) and mental health scores (12 months)

	PHQ-9 (12 months)					GAD-7 (12 months)					UCLA Loneliness 4-item (12 months)					MASQ-AD (12 months)				
Predictors	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*	*beta*	*95% CI*	*Std. beta*	*Std. beta 95% CI*	*p-value*
(Intercept)	7.73	6.35 – 9.11	0.11	-0.10 – 0.33	**<0.001**	5.73	4.39 – 7.06	0.10	-0.15 – 0.35	**<0.001**	3.20	2.82 – 3.57	0.06	-0.08 – 0.20	**<0.001**	14.20	11.52 – 16.88	-0.02	-0.31 – 0.28	**<0.001**
New vs existing owners (12 months)	-0.85	-2.24 – 0.54	-0.13	-0.35 – 0.08	0.229	-0.49	-1.62 – 0.65	-0.09	-0.30 – 0.12	0.402	0.01	-0.60 – 0.61	0.00	-0.22 – 0.22	0.986	1.40	-0.87 – 3.68	0.15	-0.10 – 0.41	0.226
Observations	1266					1267					1266					1051				
Marginal R^2 / Conditional R^2	0.001 / NA					0.001 / NA					0.000 / NA					0.001 / NA				

Appendix C.2. Pets, exercise, daily structure, and mental health

There is much evidence that exercise/physical activity may help alleviate symptoms of depression and anxiety, though the extent to which this is the case is still unclear [3-6].

Maintaining a daily structure/routine is also generally thought to do the same; however, the evidence is not as strong as the effect of exercise/physical activity.

Daily structures/routines have been studied under the term "social rhythms", a term used in the social zeitgeber literature, which again stems from the "social zeitgeber theory" [7, 8]. The social zeitgeber theory proposed by Ehlers et al., 1988 [9] uses the term "social zeitgebers" ("time givers" [10]) to refer to personal relationships, social demands or tasks that serve to entrain biological rhythms, e.g., circadian rhythms or sleep-wake cycles [9, 11]. Social zeitgebers are distinct from physical zeitgebers - "zeitstorers" ("time disturbers") -

such as sunlight, which serve a similar function [12, 13]. Ehlers et al., 1988 proposed that disruptions of social rhythms, which could cause instability in biological rhythms, could trigger major depressive episodes in vulnerable individuals [9].

Though several limitations to the social zeitgeber hypothesis have been pointed out [8, 13], there is some evidence that social rhythm disruption/irregularity is linked to increased depression and anxiety [14]. Also, in the case of COVID-19, Murray et al., 2021 found that, especially during lockdown, stability/timing of daily routines were impacted, which was associated with higher levels of depression. Therefore, it is possible that stabilizing daily routines could help reduce depression and anxiety [8].

Taken together, exercise and maintaining a daily structure might be protective in terms of depression and anxiety, and if pets provide these benefits to their owners, PO could be associated with fewer symptoms of depression and anxiety compared to non-PO. So, what does the current research tell us about the effects of PO on exercise and daily structure?

Results indicate that dog owners get more exercise than non-dog owners - and that this effect may even extend to POs vs non-POs.
In a 2013 review examining the relationship between dog ownership and physical activity, the authors found that dog owners showed higher levels of walking and physical activity than non-dog owners and that dog walkers were more likely than non-dog walkers to meet recommended levels of physical activity [15]. A recent study investigating the association between dog ownership and physical activity in the general adult population in the UK supports these findings [16]. However, a 2020 study of people living in Singapore found that there were no differences in physical activity levels - or mental health scores - between POs and non-POs - though it did find that main pet caregivers reported higher levels of physical activity, as well as higher emotional well-being and energy, compared to non-POs [17]. Nevertheless, according to a cross-sectional analysis of a large UK study on people between ages 59-79, both mild and moderate exercise was significantly higher for POs than non-POs. These effects were at the same time higher in dog owners than owners of other pets [18]. It should also be noted, though, that two studies have found that only ~65% of dog owners walked their dog [19, 20], and in the case of COVID-19 in the UK, one study found that dogs were being walked less by their owners during the first lockdown compared to pre-lockdown [21].

It is possible that when no effect is found of PO on levels of physical activity, these results could be blurred because, even though dog owners might get more exercise compared to non-dog owners, e.g., cat or fish owners do not - or might even report lower levels of physical activity compared to non-owners in those pet categories.

Though there is an apparent lack of quantitative evidence to support this, PO (primarily dog ownership) is also believed to play an important role in helping owners maintain a daily structure/routine. For example, Friedmann et al., 1980 describe how pets provide a focus of pleasurable daily activity (e.g., walking, talking to, petting animals) and may provide a source of order and responsibility for their owners [22]. In addition, owners describe that their pets compel them to perform certain activities, even when in pain or fatigued, i.e., the pets provided them with motivation for maintaining certain routines and encouraged adherence to a sleep routine [23].

Appendix C.2.1. Methods

Regarding exercise and daily structure (or "social rhythms"), while not much is still unknown on the latter, age, gender as well as education level has been associated with levels of physical activity [24, 25]. In addition, studies have also found SES to be linked to leisure-time physical activity [26-28].

Concerning daily structure, a study from 1994 found that "lifestyle regularity" - as measured through the "Social Rhythm Metric" (SRM) [29, 30] - was related to age, though not gender [31].

Exercise and daily structure levels were both measured at baseline and each follow-up using the item "over the past two weeks, how often have you", with the "exercised" item used to determine exercise levels, and the "maintained your normal daily structure (wake up, bed time, meal times, etc.)" item for daily structure. Each of these items had included five answer options: "not at all", "one or two days", "several days", "more than half the days", and "nearly every day or every". For the analysis, these answers were scores from 0-4, ranging from "0 = not at all" to "4 = nearly every day".

The associations between different categories of PO and exercise and daily structure outcomes were tested using multiple ordinal mixed-effects regression models, with each PO category as predictor variables, exercise and daily structure as outcome variables, and demographic variables (age, gender, education, number of rooms in household) as random effects.

First, each pet owner type in each subcategory was compared to non-owners in that subcategory (as in previous models) for exercise and daily structure levels at baseline measure.

Second, "new pet adopters" at each follow-up were compared to non-adopters in that follow-up and people who reported owning a pet at baseline for exercise and daily structure levels at each following time point.

Ordinal mixed-effects logistic regression models were run using the 'clmm' function from the *ordinal* package [32] in RStudio [2].

Appendix C.2.2. Results - PO types and exercise and daily structure

Exercise

Dog owners were significantly more likely to report higher exercise levels (in the past two weeks prior to baseline assessment) than non-dog owners (beta = 0.27, 95% CI [0.18 – 0.35], $p < 0.001$). Cat owners, by contrast, were significantly more likely to report lower exercise levels (in the past two weeks prior to baseline assessment) than non-cat owners (beta = -0.24, 95% CI [-0.32 – -0.16], $p < 0.001$).

There were no significant effects on reported exercise levels (in the past two weeks prior to baseline assessment) for ownership in the other PO type categories: cat and dog owners (beta = 0.08, 95% CI [-0.07 – 0.22], p = 0.307); other POs (beta = -0.05, 95% CI [-0.16 – 0.06], p = 0.356).

Neither was there any significant effect of PO vs non-PO in general on reported exercise levels (in the past two weeks prior to baseline assessment) (beta = -0.03, 95% CI [-0.10 – 0.05], p = 0.516).

Daily structure

For almost all PO type categories, there was a significant negative effect on reported daily structure levels (in the past two weeks prior to baseline assessment) compared to people who did not belong in that category: dog owners (beta = -0.09, 95% CI [-0.18 – 0.00], p = 0.039); cat owners (beta = -0.13, 95% CI [-0.21 – -0.05], p = 0.002); cat and dog owners (beta = -0.24, 95% CI [-0.39 – -0.09], p = 0.002).

The effect extended to POs vs non-POs in general (beta = -0.11, 95% CI [-0.19 – -0.03], p = 0.006).

The exception was other POs, where no significant effect on reported daily structure levels (in the past two weeks prior to baseline assessment) was observed (beta = -0.06, 95% CI [-0.17 – 0.06], p = 0.331).

Appendix C.2.3. Results - "New pet adopters" vs non-adopters and baseline owners (at each follow-up) and exercise and daily structure (at each follow-up)

A total of 64 participants were "new pet adopters" at 3 months (vs non-adopters and people who already owned a pet at baseline = 6359), 99 participants were "new pet adopters" at 6 months (vs N = 6524), and 134 were "new pet adopters" at 12 months (vs N = 6594).

Exercise

There were no significant effects on reported exercise levels (in the past two weeks prior to baseline assessment) for "new pet adopters" (vs non-adopters and people who already owned a pet at baseline) (3 months post-baseline) at the 3-months follow up (beta = 0.15, 95% CI [-0.73 – 1.03], p = 0.732) or the 6-months follow-up (beta = -0.90, 95% CI [-1.93 – 0.12], p = 0.08). Neither was there any effect on exercise levels for "new pet adopters" (6 months post baseline) at the 6-months follow-up (beta = -0.21, 95% CI [-0.92 – 0.50], p = 0.557)

There was, however, a significant positive effect for "new pet adopters" (measured at each follow-up) on reported exercise levels at 12 months (in the past two weeks prior to 12-months follow-up): "new pet adopters" (3 months) (beta = 0.70, 95% CI [0.07 – 1.32], p = 0.029); "new pet adopters" (6 months) (beta = 0.56, 95% CI [0.08 – 1.04], p = 0.023); "new pet adopters" (12 months) (beta = 0.85, 95% CI [0.45 – 1.25], p < 0.001).

Daily structure

There were no significant effects on reported daily structure levels (in the past two weeks prior to baseline assessment) for "new pet adopters" (3 months post-baseline) (vs non-adopters and people who already owned a pet at baseline) at any of the follow-ups: 3-months follow-up (beta = -0.61, 95% CI [-1.56 – 0.34], p = 0.21); 6-months follow-up (beta = -0.55, 95% CI [-1.61 – 0.52], p = 0.32); 12-months follow-up (beta = -0.11, 95% CI [-0.80 – 0.58], p = 0.75). Neither was there any effects for "new pet adopters" (6 months post-baseline) at following time points (6-months post-baseline (beta = -0.09, 95% CI [-0.86 – 0.67], p = 0.81); 12-months post-baseline (beta = -0.09, 95% CI [-0.62 – 0.45], p = 0.75)), nor for "new pet adopters" (12 months post-baseline) at the 12-months follow-up (beta = 0.21, 95% CI [-0.25 – 0.67], p = 0.37).

Appendix C.3. References

1. Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. (2017). lmerTest Package: Tests in Linear Mixed Effects Models. *Journal of Statistical Software, 82*(1), 1-26. https://doi.org/10.18637/jss.v082.i13
2. RStudio Team. (2021). RStudio: Integrated Development Environment for R. RStudio, PBC: Boston, MA. http://www.rstudio.com/
3. Biddle, S. (2016). Physical activity and mental health: evidence is growing. *World Psychiatry, 15*(2), 176. https://doi.org/10.1002/wps.20331
4. Carek, P. J., Laibstain, S. E., & Carek, S. M. (2011). Exercise for the Treatment of Depression and Anxiety. *The International Journal of Psychiatry in Medicine, 41*(1), 15-28. https://doi.org/10.2190/PM.41.1.c
5. Cooney, G., Dwan, K., & Mead, G. (2014). Exercise for Depression. *JAMA, 311*(23), 2432-2433. https://doi.org/10.1001/jama.2014.4930
6. Ströhle, A. (2009). Physical activity, exercise, depression and anxiety disorders. *Journal of neural transmission, 116*(6), 777. https://doi.org/10.1007/s00702-008-0092-x
7. Boland, E. M., Stange, J. P., LaBelle, D. R., Shapero, B. G., Weiss, R. B., Abramson, L. Y., & Alloy, L. B. (2016). Affective Disruption From Social Rhythm and Behavioral Approach System (BAS) Sensitivities: A Test of the Integration of the

Social Zeitgeber and BAS Theories of Bipolar Disorder. *Clinical Psychological Science, 4*(3), 418-432. https://doi.org/10.1177/2167702615603368

8. Murray, G., Gottlieb, J., & Swartz, H. A. (2021). Maintaining Daily Routines to Stabilize Mood: Theory, Data, and Potential Intervention for Circadian Consequences of COVID-19. *The Canadian Journal of Psychiatry, 66*(1), 9-13. https://doi.org/10.1177/0706743720957825
9. Ehlers, C. L., Frank, E., & Kupfer, D. J. (1988). Social Zeitgebers and Biological Rhythms: A Unified Approach to Understanding the Etiology of Depression. *Archives of general psychiatry, 45*(10), 948-952. https://doi.org/10.1001/archpsyc.1988.01800340076012
10. Merriam-Webster. zeitgeber. *Merriam-Webster.com dictionary.* Retrieved 15 February 2022 from https://www.merriam-webster.com/dictionary/zeitgeber
11. Nusslock, R., Abramson, L., Harmon-Jones, E., Alloy, L., & Coan, J. (2009). Psychosocial interventions for bipolar disorder: Perspective from the behavioral approach system (BAS) dysregulation theory. *Clinical Psychology: Science and Practice, 16*(4), 449-469. https://doi.org/10.1111/j.1468-2850.2009.01184.x
12. Ehlers, C. L., Kupfer, D. J., Frank, E., & Monk, T. H. (1993). Biological rhythms and depression: the role of zeitgebers and zeitstorers. *Depression, 1*(6), 285-293. https://doi.org/10.1002/depr.3050010602
13. Grandin, L. D., Alloy, L. B., & Abramson, L. Y. (2006). The social zeitgeber theory, circadian rhythms, and mood disorders: Review and evaluation. *Clinical psychology review, 26*(6), 679-694. https://doi.org/10.1016/j.cpr.2006.07.001
14. Margraf, J., Lavallee, K., Zhang, X., & Schneider, S. (2016). Social Rhythm and Mental Health: A Cross-Cultural Comparison. *PLoS One, 11*(3), e0150312. https://doi.org/10.1371/journal.pone.0150312
15. Christian, H. E., Westgarth, C., Bauman, A., Richards, E. A., Rhodes, R. E., Evenson, K. R., Mayer, J. A., & Thorpe, R. J. (2013). Dog Ownership and Physical Activity: A Review of the Evidence. *Journal of Physical Activity and Health, 10*(5), 750-759. https://doi.org/10.1123/jpah.10.5.750
16. Westgarth, C., Christley, R. M., Jewell, C., German, A. J., Boddy, L. M., & Christian, H. E. (2019). Dog owners are more likely to meet physical activity guidelines than people without a dog: An investigation of the association between dog ownership and physical activity levels in a UK community. *Scientific reports, 9*(1), 5704. https://doi.org/10.1038/s41598-019-41254-6

17. Goh, Y. X., Tan, J. S. Q., Syn, N. L., Tan, B. S. W., Low, J. Y., Foo, Y. H., Fung, W., Da Hoong, B. Y., Pang, J., & Phase IV CHP 2020 Group 8 (2020). Association between pet ownership and physical activity levels, atopic conditions, and mental health in Singapore: a propensity score-matched analysis. *Scientific reports, 10*(1), 19898. https://doi.org/10.1038/s41598-020-76739-2

18. Mein, G., & Grant, R. (2018). A cross-sectional exploratory analysis between pet ownership, sleep, exercise, health and neighbourhood perceptions: the Whitehall II cohort study. *BMC Geriatrics, 18*(1), 176. https://doi.org/10.1186/s12877-018-0867-3

19. Oka, K., & Shibata, A. (2012). Prevalence and Correlates of Dog Walking Among Japanese Dog Owners. *Journal of Physical Activity and Health, 9*(6), 786-793. https://doi.org/10.1123/jpah.9.6.786

20. Slater, M., Robinson, L., Zoran, D., Wallace, K., & Scarlett, J. (1995). Diet and exercise patterns in pet dogs. *Journal of the American Veterinary Medical Association, 207*(2), 186-190. Retrieved 15 February 2022 from https://pubmed.ncbi.nlm.nih.gov/7601712/

21. Christley, R. M., Murray, J. K., Anderson, K. L., Buckland, E. L., Casey, R. A., Harvey, N. D., Harris, L., Holland, K. E., McMillan, K. M., Mead, R., Owczarczak-Garstecka, S. C., & Upjohn, M. M. (2021). Impact of the First COVID-19 Lockdown on Management of Pet Dogs in the UK. *Animals, 11*(1), 5. https://doi.org/10.3390/ani11010005

22. Friedmann, E., Katcher, A. H., Lynch, J. J., & Thomas, S. A. (1980). Animal companions and one-year survival of patients after discharge from a coronary care unit. *Public health reports, 95*(4), 307. Retrieved 15 February 2022 from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1422527/

23. Janevic, M. R., Shute, V., Connell, C. M., Piette, J. D., Goesling, J., & Fynke, J. (2020). The Role of Pets in Supporting Cognitive-Behavioral Chronic Pain Self-Management: Perspectives of Older Adults. *Journal of Applied Gerontology, 39*(10), 1088-1096. https://doi.org/10.1177/0733464819856270

24. Gubelmann, C., Vollenweider, P., & Marques-Vidal, P. (2017). Of weekend warriors and couch potatoes: Socio-economic determinants of physical activity in Swiss middle-aged adults. *Preventive Medicine, 105*, 350-355. https://doi.org/10.1016/j.ypmed.2017.10.016

25. Jones, S. A., Wen, F., Herring, A. H., & Evenson, K. R. (2016). Correlates of US adult physical activity and sedentary behavior patterns. *Journal of Science and Medicine in Sport, 19*(12), 1020-1027. https://doi.org/10.1016/j.jsams.2016.03.009

26. Beenackers, M. A., Kamphuis, C. B., Giskes, K., Brug, J., Kunst, A. E., Burdorf, A., & Van Lenthe, F. J. (2012). Socioeconomic inequalities in occupational, leisure-time, and transport related physical activity among European adults: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity, 9*(1), 1-23. https://doi.org/10.1186/1479-5868-9-116

27. Rasmussen, C. L., Dumuid, D., Hron, K., Gupta, N., Jørgensen, M. B., Nabe-Nielsen, K., & Holtermann, A. (2020). Day-to-Day Pattern of Work and Leisure Time Physical Behaviours: Are Low Socioeconomic Status Adults Couch Potatoes or Work Warriors? *BMC Public Health, 21*(1), 1342. https://doi.org/10.1186/s12889-021-11409-0

28. Stalsberg, R., & Pedersen, A. V. (2018). Are Differences in Physical Activity across Socioeconomic Groups Associated with Choice of Physical Activity Variables to Report? *International Journal of Environmental Research and Public Health, 15*(5), 922. https://doi.org/10.3390/ijerph15050922

29. Monk, T. H., Kupfer, D. J., Frank, E., & Ritenour, A. M. (1991). The social rhythm metric (SRM): measuring daily social rhythms over 12 weeks. *Psychiatry Research, 36*(2), 195-207. https://doi.org/10.1016/0165-1781(91)90131-8

30. Monk, T. K., Flaherty, J. F., Frank, E., Hoskinson, K., & Kupfer, D. J. (1990). The Social Rhythm Metric: An Instrument to Quantify the Daily Rhythms of Life. *The Journal of Nervous and Mental Disease, 178*(2), 120-126. https://doi.org/10.1097/00005053-199002000-00007

31. Monk, T. H., Petrie, S. R., Hayes, A. J., & Kupfer, D. J. (1994). Regularity of daily life in relation to personality, age, gender, sleep quality and circadian rhythms. *Journal of Sleep Research, 3*(4), 196-205. https://doi.org/10.1111/j.1365-2869.1994.tb00132.x

32. Christensen, R. H. B. (2019). ordinal — Regression Models for Ordinal Data. R package version 2019.12-10. https://CRAN.R-project.org/package=ordinal