Association between dog and cat ownership with cardiovascular disease: A systematic review and meta-analysis

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Abstract

Background: Numerous studies have described the correlation of pet ownership with cardiovascular diseases, with dog and cat ownership emerging as the predominant forms of pet companionship. Nevertheless, the studies that have examined how pet ownership affects cardiovascular diseases are lacking. Consequently, this systematic review and meta-analysis were carried out to investigate associations between owning a dog or cat and all-cause mortality and the risk of cardiovascular diseases and mortality.

Methods: The PubMed, Embase, Web of Science, and Cochrane Library databases were comprehensively searched for identifying observational publications before August 14, 2023, that investigated the potential relationship between ownership of dogs or cats and cardiovascular mortality, all-cause mortality, and cardiovascular disease, encompassing myocardial infarction and stroke. The outcomes were explored with unadjusted, accessible relative risk values and adjusted hazard ratio values. Additionally, this work employed the random-effects model for analysis. Meanwhile, the Newcastle-Ottawa scale was employed to assess study quality.

Results: We included 11 articles, comprising 3,940,200 subjects with an average 9.82-year follow-up. In unadjusted models, dog ownership decreased all-cause mortality by 30 percent (relative risk (RR) 0.70; 95%CI,0.60-0.82) and cardiovascular mortality by 24 percent (RR,0.76; 95%CI,0.69-0.84) in the general population compared with not owning a dog. Moreover, the correlation with all-cause mortality (hazard ratio (HR), 0.98; 95%CI, 0.86-1.12) and cardiovascular mortality (HR, 0.91; 95% CI, 0.78-1.07) was non-significant after adjusting for confounding factors. Nonetheless, dog ownership was slightly related to cardiovascular disease risk (HR, 0.98; 95% CI, 0.96-0.99). Cat ownership was not significantly correlated with all-cause mortality (RR, 0.95; 95%CI, 0.85-1.05; hazard ratio, 1.04; 95% CI, 0.98-1.12), cardiovascular mortality (RR, 0.82; 95% CI, 0.66-1.01; hazard ratio, 0.87; 95% CI, 0.69-1.11),

and cardiovascular disease risk (HZ, 0.84; 95% CI, 0.57-1.22) among the general population. However, when considering only articles with over 10-year follow-up, cat ownership was associated with cardiovascular mortality (RR, 0.73; 95% CI, 0.60-0.88; HR, 0.79; 95% CI, 0.63-0.99). Additionally, owning cats and dogs led to reduced cardiovascular mortality in cardiovascular disease patients (HR, 0.81; 95%CI, 0.78-0.83).

Conclusion: In the general population, dog ownership is weakly related to decreased cardiovascular disease risk, but not markedly related to all-cause mortality and cardiovascular mortality, whereas cat ownership is not associated with all-cause mortality and the risk of cardiovascular diseases but is related to the reduced cardiovascular mortality risk. Long-term pet ownership appears to reduce mortality in people with established cardiovascular diseases, yet further studies are warranted for validation.

Keywords: Dogs, Cats, Ownership, Cardiovascular Diseases, Mortality.

Introduction

Pet ownership has gradually become a common behavior in many people's lives. As reported by the American Veterinary Medical Association's survey of U.S. pet ownership, 56.8% of U.S. households had a pet in 2016, including 38.4% having a dog and 25.4% owning a cat.[1]

In recent years, there have been several articles describing the benefits derived from pet ownership in preventing cardiovascular diseases. Pet ownership is demonstrated to enhance blood pressure control in hypertensive individuals as well as prognostic outcomes in stroke or myocardial infarction patients.[2] Similarly, pet ownership decreased high blood pressure in a study on the US population.[3] Nevertheless, there is ongoing debate over the correlation between types of pets and the occurrence of cardiovascular disease. Long-term dog ownership has been suggested to be related to a higher physical activity level and improved cardiovascular well-being, lowering blood pressure and heart attack risk.[4] Kramer et al. reported in their meta-analysis regarding the relation of dog ownership with mortality that, the mortality decreased by 24% in dog-owning populations compared to non-dog-owning populations.[5] However, the meta-analysis published by Yeh showed that dog ownership was not markedly related to mortality.[6] As for cat ownership, there exists a belief among certain individuals that the act of possessing a cat is correlated with a reduced likelihood of developing cardiovascular disease in comparison to owning a dog.[3] There also appears to be a lack of systematic reviews on the relationship of cat ownership to all-cause and cardiovascular mortality. Therefore, this meta-analysis focused on investigating the relation of dog and cat ownership with cardiovascular diseases, including mortality and morbidity risks, respectively. Furthermore, we separated the population into two groups: the general population and the population with cardiovascular diseases to see if the relation between cat and dog ownership with cardiovascular disease was stronger between different groups.

Methods

This meta-analysis was carried out in line with PRISMA-P guidelines[7]. It was registered at the International Prospective Register of Systematic Reviews. Our study data was sourced from the included journals, and through appropriate questioning of the original authors.

Search Strategy and Selection Criteria

PubMed, Embase, Web of Science, and Cochrane Library databases were comprehensively searched to identify studies up to August 2023 for gathering relevant data using the keywords below: (pet or dogs or cats) AND (ownership or owning or companion) AND (cardiovascular diseases or coronary disease or myocardial Infarction or mortality or death). No limitation was set for the publication year or the article language for a comprehensive search.

The inclusion criteria were: (1) The participants' average age > 20 years, with/without cardiovascular diseases, consisting of the general population and the population with cardiovascular disease; (2) prospective observational studies with a minimum 2-year follow-up period; (3) reported cardiovascular mortality, all-cause mortality, as well as cardiovascular disease risk, including MI and stroke; (4) ability to obtain the all-cause death, cardiovascular death, and cardiovascular disease numbers for dog/cat owners compared with non-dog/cat owners. Studies below were excluded: (1) duplicate publications; (2) cross-sectional studies; (3) studies with no extractable data; (4) letters, reviews, and editorials.

Data Collection and Quality Evaluation

Two researchers, Weiren Yan and Menglong Miao, performed extraction of demographic and outcome data with the pre-designed table. Subsequent disputes were settled down through the third investigator, Lijia Xu. The demographics and outcome data were extracted. The demographics of the included studies embraced the last name of the first author, publication year, sample size, median or mean follow-up period, type of pet ownership, characteristics of participants (age, the percentage of men, the pet (dog/cat) group and non-pet (dog/cat) group number), and the death number from any cause, cardiovascular diseases, and cardiovascular events. (Table1)

We utilized adjusted HR values for examining the results after the outcome data's extraction. We also merged the unadjusted RR values obtained from the available raw data to include the maximum number of studies. We utilized Newcastle-Ottawa Scale for determining study quality enrolled into this meta-analysis for assessing the bias risk.[9] The scale contains 8 items divided into the following domains: Selection, Comparability and Outcome. One study obtains 1 star for every item in selection and outcome domains, whereas two stars in comparability, for a maximum of nine stars.

Data Synthesis and Analysis

In the analyses concerning pet ownership and cardiovascular mortality and all-cause mortality of the general population, we used unadjusted and adjusted models, respectively. The unadjusted model was represented by RR values

calculated by obtaining raw data from the included articles, whereas the adjusted model was represented by combined HR and RR values directly from the included articles. In the analyses on the relation of pet ownership with cardiovascular events and relation of pet ownership with all-cause mortality in the established cardiovascular population, we used only the adjusted model because of the lack of directly accessible raw data. Figure 1,2 shows the specific studies included in each set of analyses and the process. The combined effect values of RR and HR are calculated with a random effects model (Inverse Variance). I^2 statistics and the Cochran Q test were applied in checking for between-study heterogeneities. $p<0.05$ or $I^2>50\%$ stood for obvious heterogeneity. To identify sources of heterogeneity, subgroup analyses were performed to investigate the heterogeneity sources, such as grouping pets according to their type and length of follow-up. Meanwhile, Egger's test and funnel plot were employed to evaluate publication bias. All analyses were carried out with Stata17.0(Stata Corp, College Station, Texas).

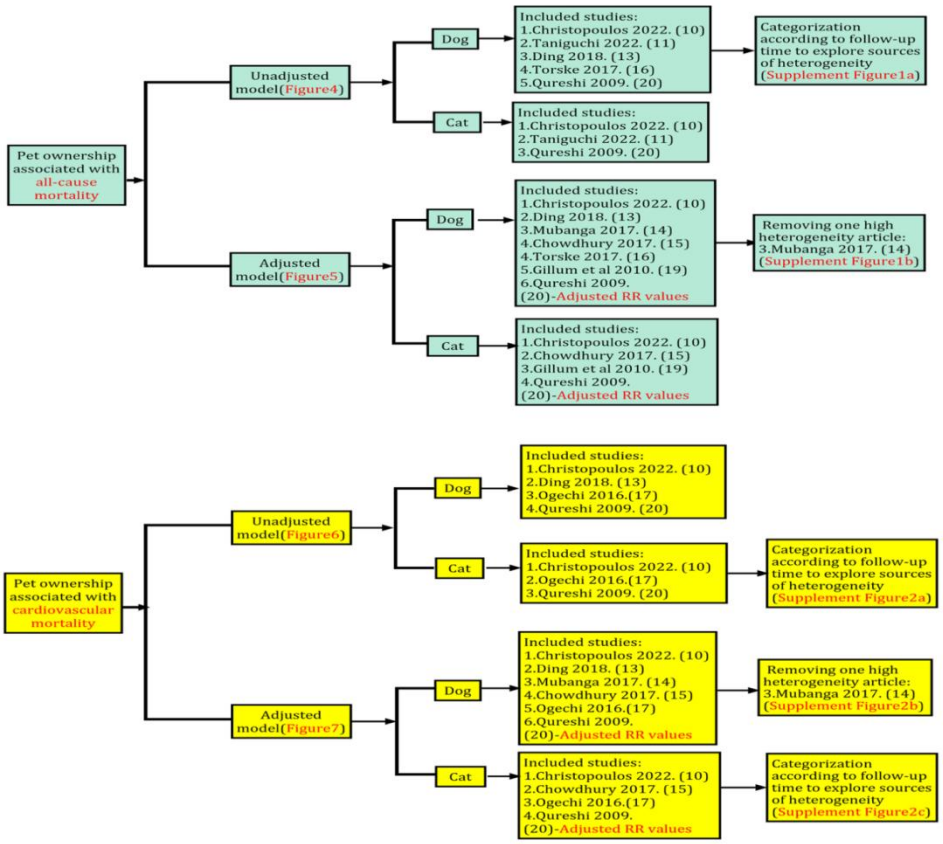

Figure 1. Flowchart showing pet ownership with all-cause mortality and cardiovascular mortality.

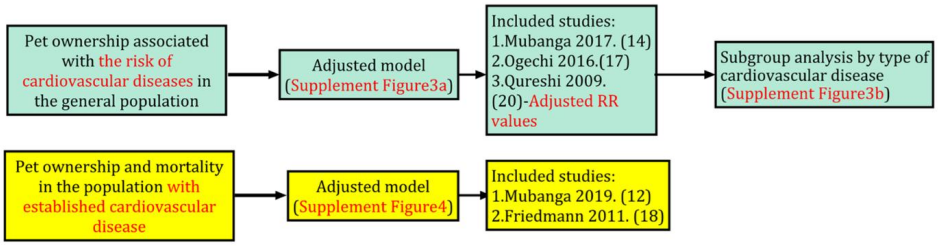

Figure 2. Flowchart showing pet ownership with cardiovascular disease, mortality in a population with established cardiovascular disease.

Results

Study selection and quality assessment

Figure 3 depicts the procedure for literature screening. The final 11 articles satisfying eligibility criteria were enrolled into the present work.[10-20] We enrolled 3,940,200 subjects, the average follow-up time was 9.82 years, and there were altogether 615,560 deaths and cardiovascular disease events. Table 1 summarizes the detailed information from the included studies. Pet ownership is defined as people who own only dogs or cats at the current time.

We then evaluated the studies' quality by the Newcastle-Ottawa Scale. Most of the studies obtained scores >7, indicating superior quality among the included studies. However, one point was deduced from the comparability item as none of the studies displayed control for minor confounders. Furthermore, if the article fails to disclose important lost visit information or if the incidence of lost visits is large, zero points were assigned to the adequacy of cohort follow up.[12-14,18,20] Specific information on quality evaluations is provided in Supplement table 1.

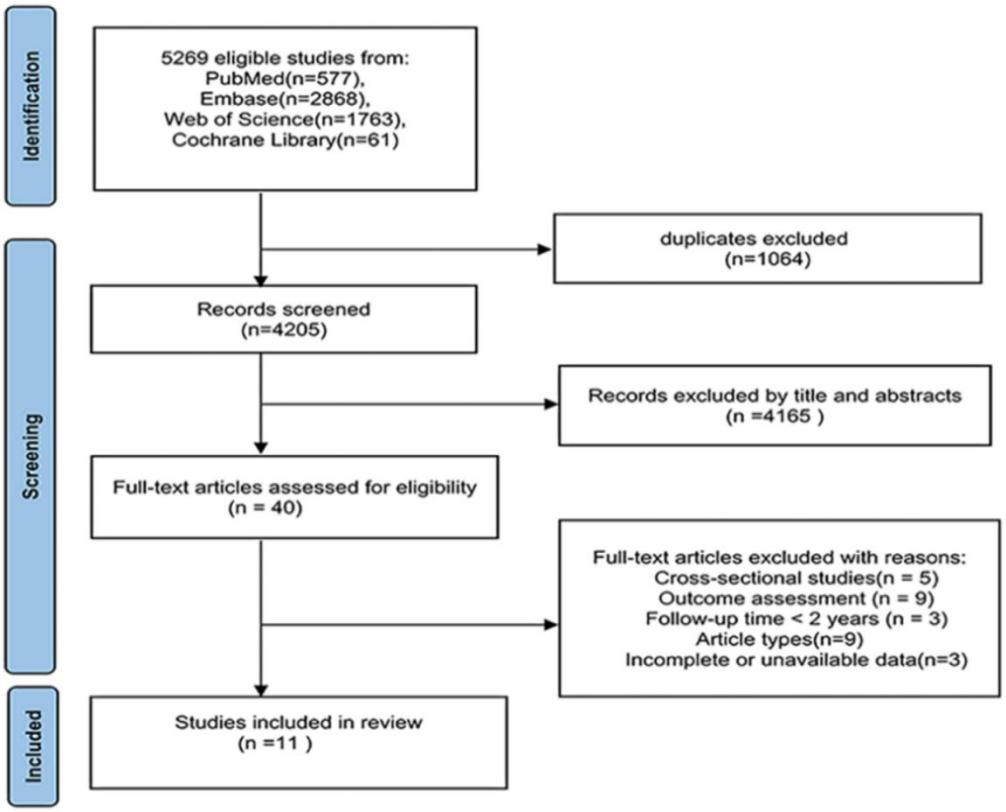

Figure 3. Flowchart for screening literature eligible for inclusion.

Relation of dog/cat ownership with all-cause mortality of general population

The unadjusted model included five trials with accessible raw data.[10,11,13,16,20] Pet ownership showed relation to the decreased all-cause mortality compared with no pet ownership (RR,0.78;95%CI,0.66-0.91). Dog ownership led to a 30% reduction in all-cause mortality in comparison with non-dog ownership (RR, 0.70; 95% CI, 0.60-0.82), but cat ownership did not affect all-cause mortality (RR, 0.95;95% CI, 0.85-1.05; Figure 4). Nevertheless, there was significant heterogeneity in the analyses, especially in the subgroup of dog ownership (I^2 = 95.4%; p<0.001). Publication bias was analyzed among all included studies, but no bias was found (Supplement Figure 1a). A sensitivity analysis was carried out, which discovered one single article explaining heterogeneity but was unable to find one. (Supplement Figure 2a) We then categorized the studies included in the dog ownership group into those with a follow-up time greater than 10 years[10,11] and those with less than 10 years[13,16,20] and performed subgroup analyses (Supplement Figure 3a). No heterogeneity was observed in the subgroups followed up for 10 years, but greater heterogeneity could be seen from subgroups followed up for over 10 years, which suggests there is some volatility and non-uniformity in the results of the connection between long-term dog ownership and all-cause mortality.

There were 6 articles with adjusted HRs[10,13-16,19] and 1 with adjusted RRs[20]

included in the adjusted model, which was chosen among those enrolled articles after controlling for the greatest possible confounder number. After controlling for relevant confounders, the findings revealed that dog (RR, 0.98; 95% CI, 0.86-1.12) and cat (RR, 1.04; 95% CI, 0.98-1.12; Figure 5) ownership was not substantially linked to all-cause mortality. The funnel plot revealed asymmetry, while the p-value upon Egger's test was determined to be 0.006 (Supplement Figure 1b), indicating the possibility of publication bias. At the same time, we discovered significant variability in the dog ownership group, and sensitivity analysis revealed no one article that explained the heterogeneity (Supplement Figure 2b). However, we discovered that one of the studies lacked control for significant confounders like smoking, diabetes, cholesterol levels, and so on, which we feel may be a cause of heterogeneity.[14] Heterogeneity in the dog-owning subgroup was significantly reduced after removing this study,[14] but the results were still not significant (Supplement Figure 3b).

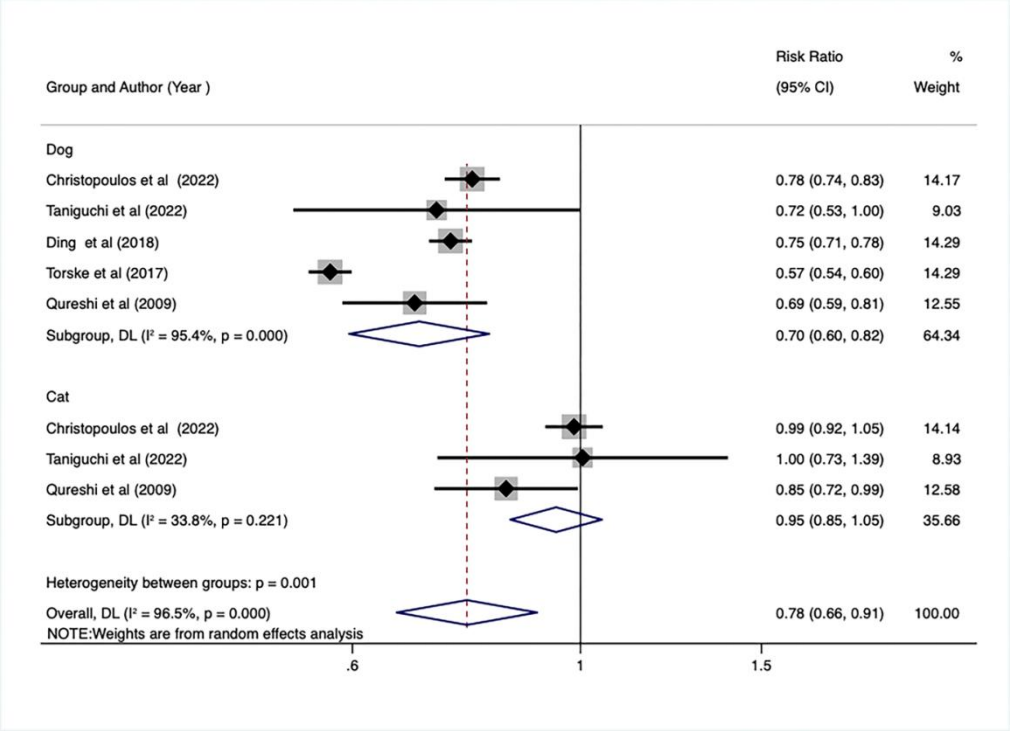

Figure 4. Relation between dog/cat ownership and all-cause mortality in an unadjusted model. I2 represents the measure of between-study heterogeneities, in which I^2 >50% stands for obvious heterogeneity.

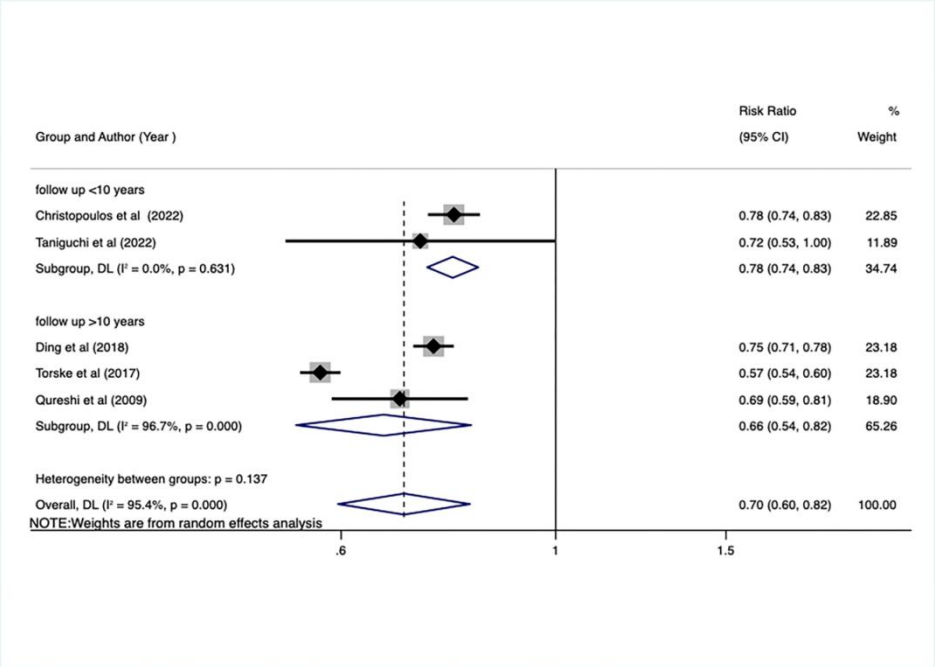

Figure 5. Relation between dog/cat ownership and all-cause mortality in an adjusted model. I2 represents the measure of between-study heterogeneities, in which I^2 >50% stands for obvious heterogeneity.

Relation of dog/cat ownership with cardiovascular mortality of general population

Unadjusted models comprised raw values from four studies depicting cardiovascular mortality.[10,13,17,20] Pet ownership has been demonstrated to lessen overall cardiovascular mortality (RR,0.79;95%CI,0.71-0.87). Dog ownership substantially decreased cardiovascular mortality (RR,0.76;95%CI,0.69-0.84), but cat ownership had no significant connection with cardiovascular mortality (RR,0.82;95%CI,0.66-1.01; Figure 6). The inspection revealed a symmetrical funnel plot, while the p-value obtained upon Egger's test was determined to be 0.467 (Supplement Figure 1c), thereby suggesting the absence of publication bias.

Among them, we found greater heterogeneity in the cat ownership group (I^2=67%, p<0.048), but we could not find any study that contributed to heterogeneity (Supplement Figure 2c). Similarly, we excluded one article[10] with fewer than 10 years of follow-up that investigated the cause of heterogeneity and discovered reduced heterogeneity as well as an association between the cat ownership group and cardiovascular mortality after removing this article (RR,0.73; 95%CI,0.60-0.88; Supplement Figure 4a). However, these results had low validity due to the inclusion of fewer studies.[17,20]

In the adjusted model, 6 studies were included.[10,13-15,17,20] No association of dog (HR,0.91;95%CI,0.78-1.07) and cat ownership (HR,0.87;95%CI,0.69-1.11; Figure 7) with cardiovascular mortality was detected. Funnel plot revealed

symmetry, while p-value upon Egger's test was determined to be 0.844 (Supplement Figure 1d), suggesting the absence of publication bias. In addition, we also performed sensitivity analysis individually for the dog ownership group (Supplement Figure 2d) and the cat ownership group (Supplement Figure 2e); sensitivity analysis revealed no specific cause of heterogeneity. We believe that the causes of heterogeneity in the dog-owning group are the same as stated before. After removing the study,[14] no associations were still found of dog ownership with adjusted cardiovascular mortality (HR,1.00; 95%CI,0.93-1.08; Supplement Figure 4b). Similarly, sensitivity analysis failed to reveal the causes of variability in the cat ownership group.[10] Furthermore, the removal of one article followed up for <10 years greatly reduced result variability and showed an inverse relationship of cat ownership with adjusted cardiovascular mortality (HR,0.79; 95%CI,0.63-0.99; Supplement Figure 4c).

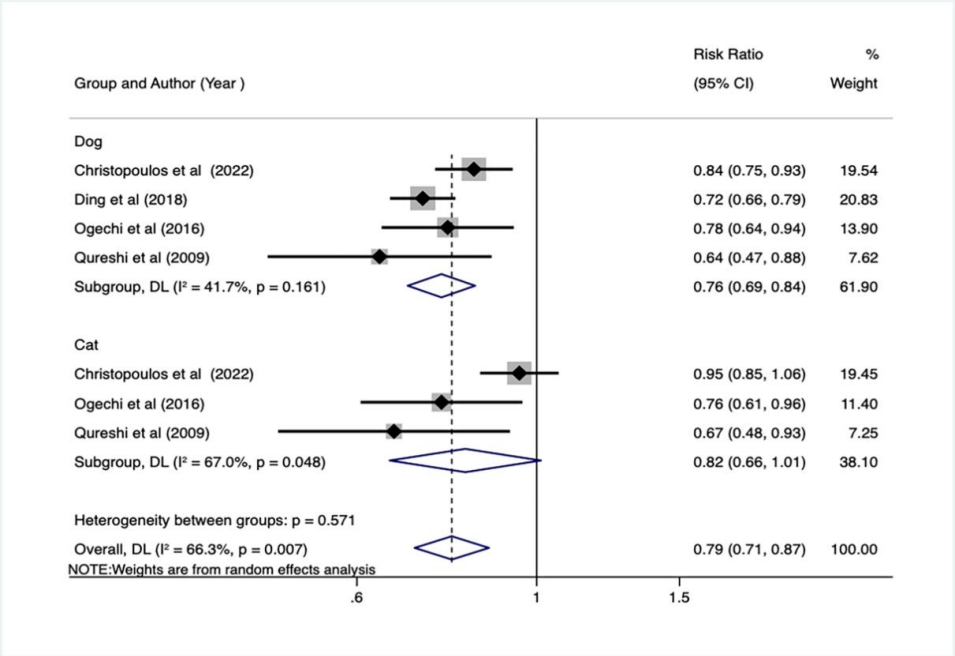

Figure 6. Relation between dog/cat ownership and cardiovascular mortality in an unadjusted model. I2 represents the measure of between-study heterogeneities, in which I^2 >50% stands for obvious heterogeneity.

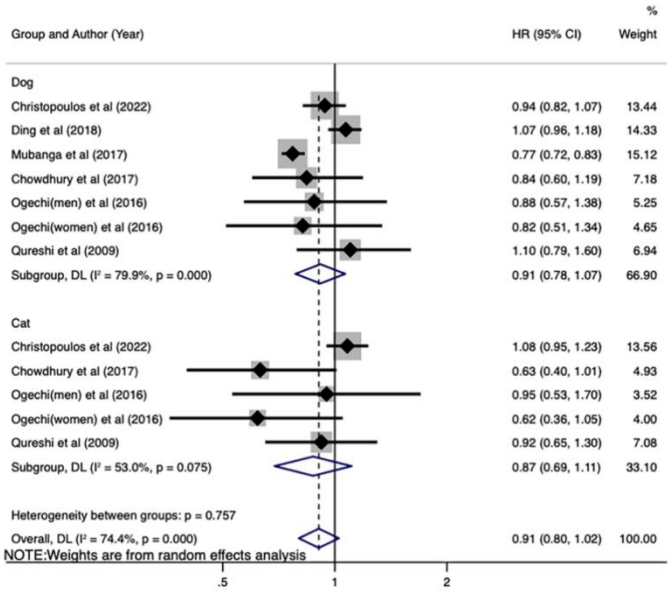

Figure 7. Relation between dog/cat ownership and cardiovascular mortality in an adjusted model. I2 represents the measure of between-study heterogeneities, in which I^2 >50% stands for obvious heterogeneity.

Association of dog/cat ownership with cardiovascular disease risk of general population.

3 studies dealing with the association between cardiovascular disease (myocardial infarction, stroke) and dog or cat ownership were included[14,17,20] and we elected to utilize just the adjusted HR and RR values for combined analyses because of the large number of publications. As can be shown, there was a modest connection between dog ownership and cardiovascular disease risk (HR,0.98;95%CI,0.96-0.99), but not between cat ownership and cardiovascular disease risk (HR = 0.84; 95% CI = 0.57-1.22; Supplement Figure 5a). The funnel plot revealed symmetry, while the p-value upon Egger's test was determined to be 0.538 (Supplement Figure 1e), demonstrating the absence of publication bias. The dog ownership group was then split into two categories for subgroup analysis: myocardial infarction and stroke. We discovered that dog ownership showed a markedly closer relation to the decreased myocardial infarction risk (HR,0.97;95%CI,0.95-0.99) than stroke (HR,0.99;95%CI,0.97-1.01; Supplement Figure 5b).

Relation of pet ownership with mortality of the established cardiovascular disease population.

We included 2 articles on the relationship of pet ownership with mortality of the established cardiovascular disease population.[12,18] The funnel plot suggested symmetry, whereas the p-value upon Egger's test was determined to be 0.634

(Supplement Figure 1f), suggesting the absence of publication bias.

Pet ownership is significantly related to lower mortality in people with established cardiovascular disease (HR,0.81; 95% CI,0.78-0.83; Supplement Figure 6); because few qualified studies were enrolled, the specific relation of dog and cat ownership with mortality in the established cardiovascular disease population was not analyzed, which should be substantiated in further research.

Discussion

This meta-analysis comprised 11 studies with approximately 3.5 million participants. We found a substantial correlation between dog ownership with unadjusted all-cause and cardiovascular mortality in the overall population. However, after controlling for major confounders, such as lipids, blood pressure, smoking, and physical activity levels, relations between dog ownership and all-cause, as well as cardiovascular mortality, were no longer significant. Furthermore, dog ownership was shown to be weakly and adversely related to cardiovascular risk, specifically myocardial infarction. Taken together, dog ownership is related to all-cause mortality and cardiovascular mortality in an unadjusted model, but this finding does not appear to be the same as the previous meta-analysis.[6] We believe that long-term dog ownership may not be directly related to the decreased cardiovascular prevalence and mortality but may indirectly affect mortality through mechanisms such as lowering blood pressure, increasing exercise time, and other ways of reducing cardiovascular risk factors so that the results become less significant when these potentially relevant risk factors for cardiovascular disease are controlled for.[21]

Our findings are similar to many previous studies. A 2020 randomized controlled study on 71 community-dwelling persons suggested that dog owners' daily walking and sit-to-stand transitions can considerably improve over a three- to eight-month period.[22] Similarly, European prospective cohort research found that those with pets, particularly dogs, had better blood glucose management, reported more physical activity, and had higher CVH (cardiovascular health) scores.[23] Furthermore, in an U.S. general population study, dog ownership was independently related to a decreased frequency of hypertension.[3] We discovered no obvious relation between cat ownership and mortality as well as cardiovascular disease risk in the general population. However, when only articles followed up for >10 years were included, it was related to decreased both unadjusted and adjusted cardiovascular mortality but not all-cause mortality or cardiovascular risk. There is currently conflicting evidence regarding the relation of cat ownership with cardiovascular risk factors. According to some studies, keeping a cat minimizes the amount of time spent on daily activities when compared to not owning a cat.[24] It has also been discovered that cat ownership is linked to maternal obesity, but dog ownership lowers the chance of maternal obesity.[25] However, several studies in recent years have revealed that keeping a cat can reduce the incidence of cardiovascular disease[26] and lower blood pressure,[3] which does not appear to be consistent with earlier findings. Our investigation found no link between cat ownership and mortality or cardiovascular prevalence, However, cat ownership appeared to lower

cardiovascular mortality in articles with a follow-up duration of more than ten years. Moreover, this conclusion is not very reliable due to the inclusion of fewer studies and substantial selection bias; our findings should be validated by more investigations in this area.

Because of the lack of results regarding how specific pets affect all-cause mortality in the population with established cardiovascular disease, we did not specifically analyze the relation of dog/cat ownership with all-cause mortality in the established cardiovascular disease population; instead, we analyzed only how pet ownership affected all-cause mortality. The relation of pet ownership with 1-year mortality among patients with pre-existing cardiovascular disease is controversial, with 1995 research suggesting the effect of pet ownership on reducing 1-year mortality.[12] However, according to Australian research, pet owners with pre-existing cardiovascular diseases may more likely die or are readmitted into the hospital in 1 year.[27] However, we discovered that pet ownership was strongly related to lower mortality among those with established cardiovascular disease, which is consistent with prior research findings. [5,6] Thus, our findings need to be corroborated by additional research owing to less number of included studies.

Unlike prior meta-analyses on relevant topics, [5,6,28] we conducted separate meta-analyses for both dogs and cats rather than evaluating them as pets in general, thereby contrasting the two types of pets on all levels. In summary, we observed that dog ownership had a greater impact on reducing mortality than cat ownership, as well as an improved effect on preventing the development of cardiovascular disease, which was not reported in prior studies[29,30]. Although we discovered that keeping a cat appeared to minimize cardiovascular mortality, we believe that more research is required to confirm this finding.

This meta-analysis has the following limitations: At first, we utilized both unadjusted and adjusted outcome indicators in our analyses; however, we could not examine unadjusted cardiovascular prevalence and mortality in the population with established cardiovascular diseases because of the few studies enrolled. Furthermore, confounders treated in each publication were not all the same in the adjusted outcome measurements, adding to the higher heterogeneity. In addition, people who own dogs and cats are greatly different in their number, and the conclusions drawn from analyses of the two may be somewhat biased. Finally, because of the large number of findings in the literature, we did not examine the relation of dog/cat ownership with mortality among people having pre-existing cardiovascular diseases in depth.

Conclusion

In unadjusted models, dog ownership was associated with all-cause mortality, cardiovascular mortality, and cardiovascular disease risk, which was consistent with the findings of previous studies[6,7]. However, findings became less significant after adjustment, suggesting that dog ownership indirectly affects mortality and disease risk by lowering cardiovascular risk factors[10,13-17,19,20]. As for cat ownership, we discovered a negative relationship with cardiovascular mortality and no relation to all-cause mortality or cardiovascular disease

risk[10,15,17,19,20]. Pet ownership is probably related to the mortality risk among pre-existing cardiovascular disease patients[12,18]. However, because of the low literature amount enrolled[10-20], more investigations are needed for validation.

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Table1. Characteristics of the Included Studies.

Author, year	Country	Population	Duration of Follow-Up (y)	Pet type	Sample size	Mean Age	Male (%)	No. of pet owners: No. of non-pet owners	No. of events(mortality、morbidity)
Christopoulos et al,[10] 2022	Greece	Participants of the SHARE project over than 50	9.91*	Dog、Cat	23274	64.2	45.8	dog: non-dog=1379:5616 cat: non-cat=1280:5220	All-cause (5163); Cardiovascular (1832)
Taniguchi et al,[11] 2022	Japan	Participants of the Ota Genki Senior Project aged 65-84	3.5†	Dog、Cat	11228	74.2	48.5	dog: non-dog=963:7727 cat: non-cat=706:9281	All-cause (589)
Mubanga et al,[12] 2019	Swedish	Participants of the Swedish National Patient Register aged 40 to	12‡	Dog	336313	AMI Group:71 IS Group:73	AMI Group:63.9 IS Group:55	AMI Group: dog: non-dog=10287:171409 IS Group: dog: non-dog=7344:147273	AMI Group: All-cause (69232); IS Group: All-cause (67277)

		85							
Ding et al,[13] 2018	Australia	Participants from the Health Survey for England (HSE)	11.45†	Dog	59352	46.5	45.5	dog: non-dog=17,071:42,281	All-cause (8,169); Cardiovascular (2,451)
Mubanga et al,[14] 2017	Swedish	National Cohort	12‡	Dog	3432153	48	57	dog: non-dog=448298:2,983,855	All-cause (502896); Cardiovascular (76106); AMI (172999); IS（136305）
Chowdhury et al,[15] 2017	Australia	Participants from the Second Australian National Blood Pressure study	10.9*	Dog、Cat	4039	71.6	49.5	pet: non-pet=1456:549	All-cause (958); Cardiovascular (499)
Torske et al,[16] 2017	Norway	Participants of the HUNT study	18.5*	Dog	53418	50.3	45.8	dog: non-dog=10668:42750	All-cause (12698)

Ogechi et al,[17] 2016	United States	Participants of NHANES III study	12.8†	Dog,Cat	3964	63.1	47.5	dog: non-dog=813:3151 cat: non-cat=525:3439	Cardiovascular (671); AMI (184); Stroke (143)
Friedmann et al,[18] 2011	United States	post-MI patients enrolled in PR-HAT	2.8‡	Dog, Cat	460	61	85.2	pet: non-pet=266:187	All-cause (17)
Gillum et al,[19] 2010	United States	Participants of NHANES III study	8.5†	Dog、Cat	11384	>40	46	dog: non-dog=1250:7706 cat: non-cat=2428:7706	All-cause (2049)
Qureshi et al, [20] 2009	United States	Participants of NHANES II study	13.4†	Dog、Cat	4435	50.2	41.8	dog: non-dog=1932:843 cat: non-cat=1015:2000	All-cause (1072); Cardiovascular (326); AMI (280); Stroke (46)

SHARE, the Survey of Health Ageing and Retirement in Europe; HUNT, the Nord-Trøndelag Health Study; NHANES, National Health and Nutrition Examination Survey; PR-HAT, Psychosocial Responses in the Home Automated External Defibrillator Trial; AMI, Acute Myocardial Infarction; IS, Ischemic Stroke

* Median duration of follow-up.

† Mean.

‡ Total

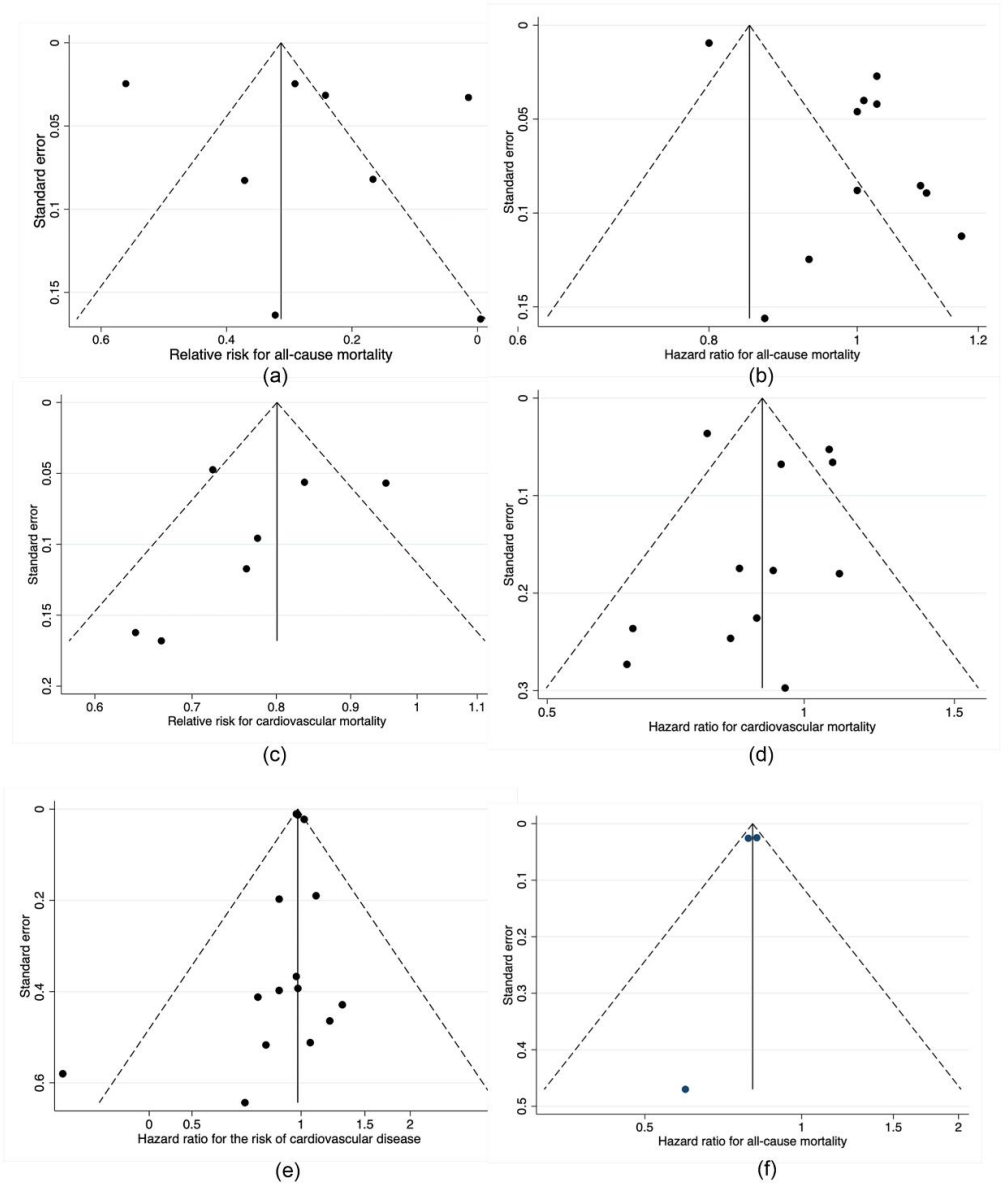
Supplementary Appendix

Association between dog and cat ownership on cardiovascular disease: A systematic review and meta-analysis

Supplement Table1

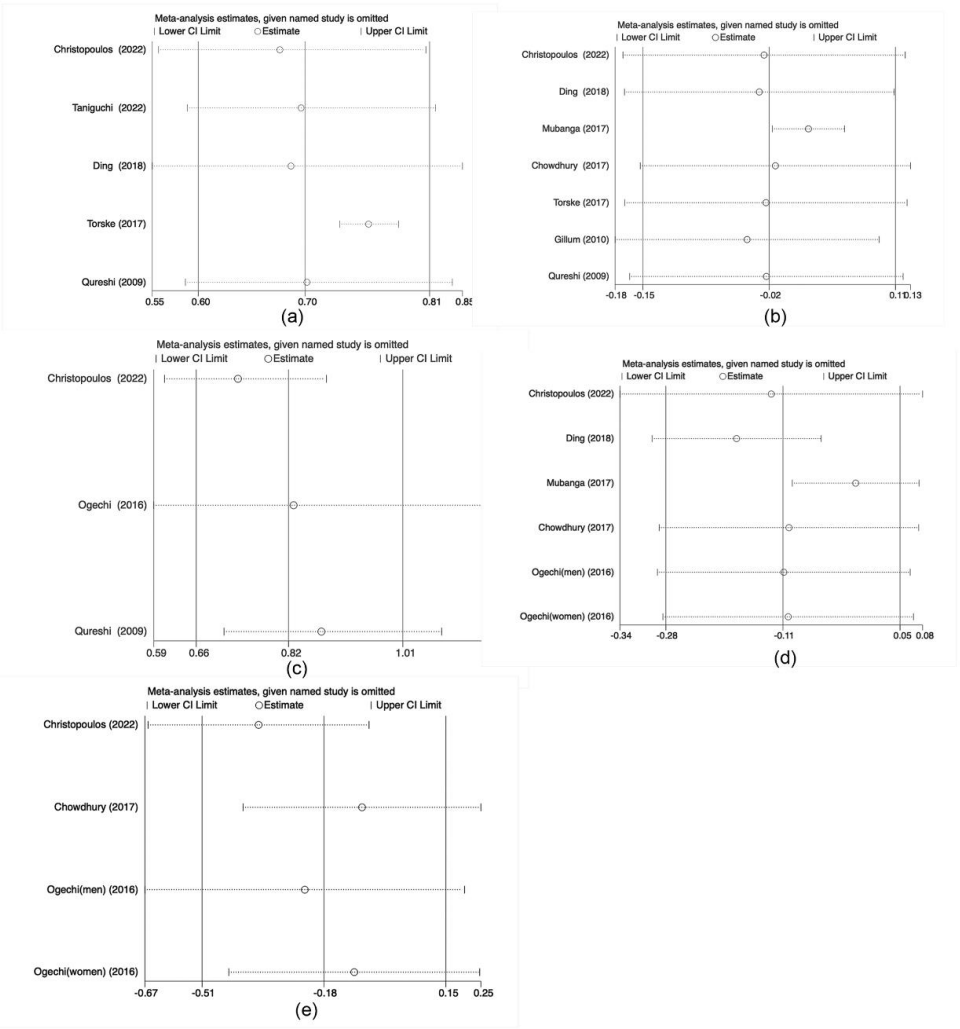
Study	Selection (0-4)	Comparability (0-2)	Outcome (0-3)	Total (0-9)
Christopoulos et al,[10] 2022	4	1	2	7
Taniguchi et al,[11] 2022	4	1	3	8
Mubanga et al,[12] 2019	4	1	2	7
Ding et al,[13] 2018	4	1	2	7
Mubanga et al,[14] 2017	4	1	2	7
Chowdhury et al,[15] 2017	4	1	3	8
Torske et al,[16] 2017	4	1	3	8
Ogechi et al,[17] 2016	4	1	3	8
Friedmann et al,[18] 2011	3	1	2	6
Gillum et al,[19] 2010	4	1	3	8
Qureshi et al, [20] 2009	4	1	2	7

Supplement Figure1

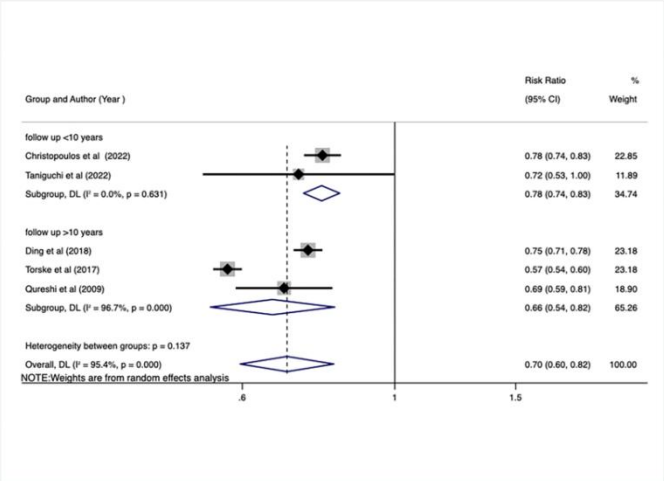


(a): Egger's test t =-2.75, df = 5, p-value = 0.559
(b): Egger's test t =3.53, df = 8, p-value = 0.006
(c): Egger's test t =-0.79, df = 4, p-value = 0.467
(d): Egger's test t =0.20, df = 6, p-value = 0.844
(e): Egger's test t =-0.63, df = 3, p-value = 0.538
(f): Egger's test t =-0.65, df = 2, p-value = 0.634

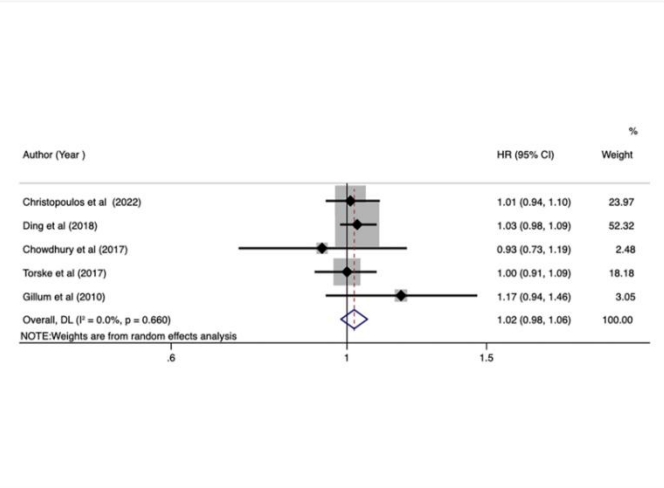
Supplement Figure2



Supplement Figure3

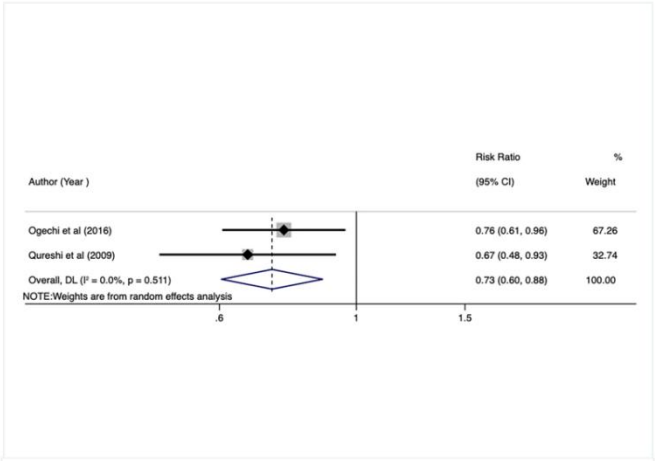


(a)
Association of between dog ownership and all-cause mortality, with a subgroup analysis by follow-up time.
I^2 is a measure of heterogeneity between studies, where I^2 >50% indicates significant heterogeneity.

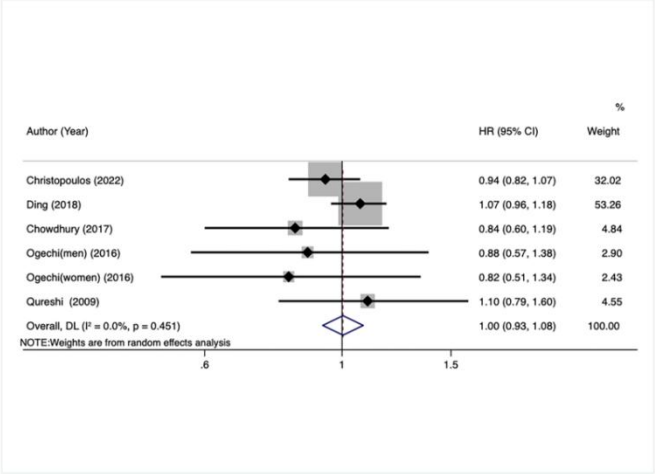


(b)
Association of dog ownership with all-cause mortality in the adjusted model after removing one high heterogeneity article.
I^2 is a measure of heterogeneity between studies, where I^2 >50% indicates significant heterogeneity.

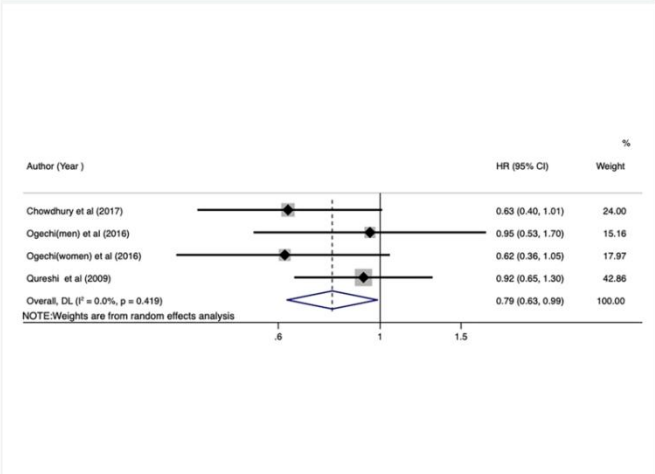
Supplement Figure4



(a)
Association of cat ownership with CVD mortality including studies with duration of follow up >10 years in the unadjusted model.
I^2 is a measure of heterogeneity between studies, where I^2 >50% indicates significant heterogeneity.

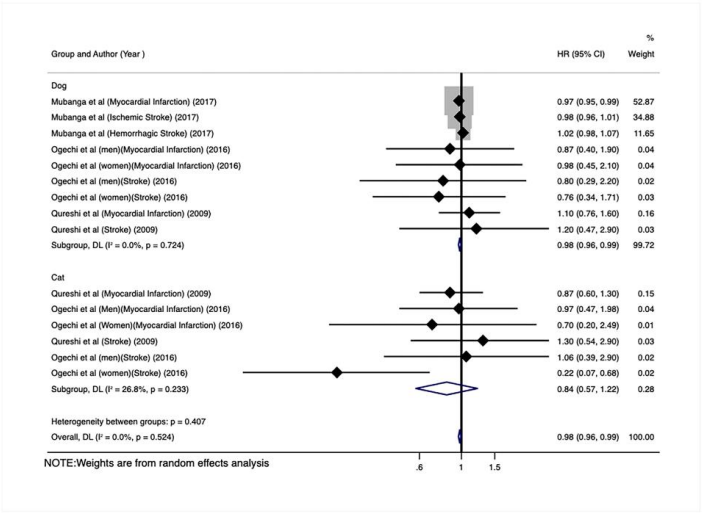


(b)
Association of dog ownership with CVD mortality in the adjusted model after removing one high heterogeneity article.
I^2 is a measure of heterogeneity between studies, where I^2 >50% indicates significant heterogeneity.

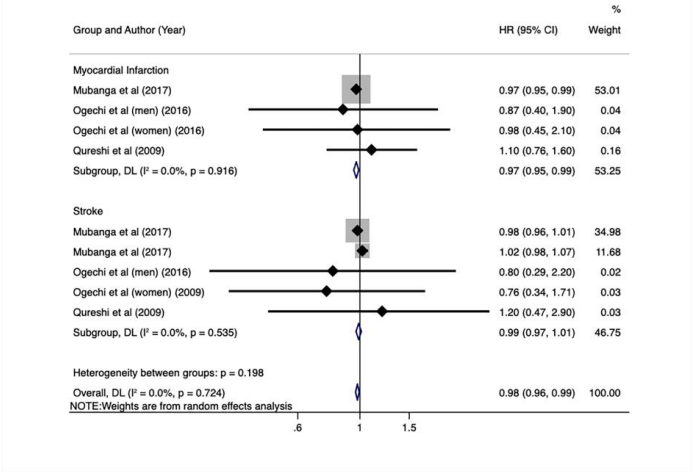


(c)
Association of cat ownership with CVD mortality including studies with duration of follow up >10 years in the adjusted model.
I^2 is a measure of heterogeneity between studies, where I^2 >50% indicates significant heterogeneity.

Supplement Figure5



(a)
Association of dog/cat ownership with cardiovascular disease in the adjusted model.
I^2 is a measure of heterogeneity between studies, where I^2 >50% indicates significant heterogeneity.



(b)
Association of dog ownership with cardiovascular disease in the adjusted model, with a subgroup analysis by type of cardiovascular disease.
I^2 is a measure of heterogeneity between studies, where I^2 >50% indicates significant heterogeneity.

Supplement Figure6

Association of pet ownership with all-cause mortality in the adjusted model in the population with established cardiovascular disease.
I^2 is a measure of heterogeneity between studies, where $I^2 > 50\%$ indicates significant heterogeneity.