The relationship of domestic pet ownership with the risk of childhood asthma: A systematic review and meta-analysis

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Background and Objective: The relationship between pet ownership and childhood asthma remains controversial. In recent years, there have been increasing studies with large sample size. Therefore, we conducted this systematic review and meta-analysis to evaluate the relationship between pet ownership and childhood asthma.

Method: Relevant research was retrieved from PubMed, Cochrane, EMBASE, and Web of science. The retrieval was as of October 1, 2021. The Newcastle-Ottawa Scale (NOS) was used to assess the quality of the included studies. Stata 15.0 was used to conduct the meta-analysis.

Results: A total of 60 studies with large sample size published between 1995 and 2021 were included in this systematic review and meta-analysis, which included 18 cohort studies and 42 case-control studies covering 27 countries and 1,871,295 children. As shown by meta-analysis results, cat ownership (OR = 1.18, 95%CI: 1.05∼1.33) and dog ownership (OR = 1.12, 95%CI: 1.00∼1.24) have a significant bearing on the occurrence of childhood asthma. Pet ownership was also positively correlated with the occurrence of severe childhood asthma (OR = 1.15, 95%CI: 1.11∼1.20).

Conclusion: Pet ownership, especially cats and dogs, is associated with the occurrence of asthma in children.

Keywords
domestic, pet ownership, cat, dog, childhood, asthma, severe, meta-analysis

Introduction

Asthma is one of the most common chronic respiratory diseases in the world nowadays. The overall prevalence around the world still remains high in 2019. According to global statistics, in 2019, there were more than 300 million people suffering from asthma. Among them, there are about 30 million patients with asthma in China, among which children account for 6 million. The prevention and control of childhood asthma is a critical challenge (1). In recent years, the prevalence of childhood asthma...
As is well known, there are various risk factors related with the occurrence of asthma, including vitamin D deficiency, gastrointestinal and respiratory microbiota, early exposure to antibiotics, smoking, air pollution, genetic risk factors, stress, ethnic differences, etc. (3). Previous studies have shown that pet grooming is related to the occurrence of allergic rhinitis. Yang et al. (3) proposed in their study that keeping away from hairy pets can reduce the sensitization of children at high risk for allergic diseases. Moreover, Zhang et al. (4) pointed out that pet ownership, serving as a key risk factor for the incidence of air pollution in the crowd, is bound up with the occurrence of allergic rhinitis. The relationship between pet ownership and childhood asthma still remains controversial. The study by Takkouche et al. (5) demonstrated that exposure to furry pets such as cats and dogs was associated with asthma. A systematic review in 2012 involving 11 cohort studies including data from 22,000 children did not support that pet ownership in infancy was associated with the risk of asthma at 6-10 years of age (6).

In recent years, there has been increasing case-control or cohort studies with large sample size on the relationship between pet ownership and childhood asthma. Therefore, we conducted this systematic review and meta-analysis to investigate the relationship between pet ownership and childhood asthma to provide guidance on the prevention of childhood asthma (7–9).

Method

Search strategy

A comprehensive and systematic search was conducted by using PubMed, Cochrane, EMBASE, and Web of science databases. The retrieval was as of October 1, 2021. In order to avoid the risk of omitting original research published during our project, we continued searching the databases mentioned above until we completed this research. The region was not restricted in the search, and the retrieval method was subject headings + free words. The subject heading used in PubMed was asthma [Mesh], Child [Mesh], pet [Mesh]. The retrieval strategy used in PubMed is shown in supplementary document 1.

Inclusion and exclusion criteria

The inclusion criteria were as follows: (1) The study type was case-control or cohort study. (2) The research subjects were children. (3) English literature. (4) The region and publication year were not limited. The exclusion criteria were as follows: (1) Non-English studies. (2) Studies including subjects older than children (>18 years old). (3) In order to avoid the influence brought by small sample size, we decided that studies with a sample size of less than 100 subjects should not be included in this systematic review. (4) Since the included original studies included case-control studies, there might be duplication of study subjects in multiple studies. Thus, if several studies contained the research subjects in the same region at the same time, we excluded studies with smaller sample size. (5) The confounding factors were not adjusted for outcome measures. (6) The original literature was not available.

Literature screening and information extraction

The retrieved studies were imported into Endnote X9. After excluding duplication, the titles and abstracts were screened and eligible studies were downloaded. A comprehensive screening was performed to determine the included studies. Before information extraction, a spreadsheet of information extraction was prepared for this research, including title, author, publication year, country, study type, time of selecting the research subjects, source area of selecting the research subjects, types of pets, age of disease development, statistical method, and type of asthma and confounders. Our outcome indicator was presented as the odds ratio (OR) value after confounders were controlled.

The aforementioned information extraction was carried out independently by two researchers (Ji and Yao) and cross-checked after completion. If there was any dissent, a third researcher (Zheng) was consulted to assist in determination.

Quality assessment

The types of the included original studies were cohort studies and case-control studies, and thus the Newcastle-Ottawa Scale (NOS) was used (10).

This scale evaluates the quality from three aspects: the selection of study groups, comparability between groups, and exposure/outcome. Among them, the highest scores in the selection of the study groups and the comparability between groups were 4 points and 2 points, respectively. If the exposure and outcomes were separately determined according to case-control study and cohort study, the highest score was 3 points. In the evaluation process, study with a score of >7 indicated high-quality research, and a score of 4-7 indicated moderate-quality research.

Quality assessment was conducted independently by 2 investigators (Ji and Yao) and cross-checked after completion. If
there was any dissent, a third researcher (Zheng) was consulted to assist in determination.

**Statistical analysis**

The statistics used in our study were OR and the 95% confidence interval (OR (95%CI)). The heterogeneity index, $I^2$, was used to measure the heterogeneity of each study. When $I^2 \geq 50\%$, a random-effects model was used. When $I^2 < 50\%$, a fixed-effects model was used. To determine the sources of heterogeneity, subgroup analyses according to pet types was conducted.

The funnel plot was used to visually illustrate publication bias. Begg and Egger's tests were used to perform statistical tests. If there was publication bias, the cut-and-fill method was used to analyze the impact of publication bias on this meta-analysis. All statistical analyses were performed using Stata version 15.0 (StataCorp LLC, College Station, TX). $P < 0.05$ indicated that the difference was statistically significant.

**Results**

**Results of literature screening**

Based on our search strategy, a total of 5,558 studies were retrieved. After excluding duplicates and step-by-step screening, 60 studies were finally included in this meta-analysis. The screening process is shown in Figure 1.

**Basic characteristics of the included studies**

Among the 60 original studies, 18 were cohort studies (11–28) and 42 were case-control studies (7–9, 29–67), with 1,871,295 children included in this systematic review. The publication years of the included studies were from 1995 to 2021. The included studies covered 27 countries, with 26 from Europe, 15 from Asia, 12 from North America, 3 from Oceania, 3 from South America, and 1 from Africa. The detailed characteristics
| Author    | Author's country | Year | Design  | Sampling location       | Sampling mechanism                      | Sampling time            | Sample size | Age (year) | Gender (boy) | Animals                          | Score |
|-----------|------------------|------|---------|-------------------------|-----------------------------------------|--------------------------|-------------|------------|--------------|----------------------------------|-------|
| Sabeti    | Iran             | 2021 | Case control | Northwestern Iran | Areas urban                            | 2019.11~2020.02          | 1,459       | 14-18      | 791          | U                               | 7     |
| Patra     | India            | 2021 | Case control | Patna city in India   | Schools                                 | 2015-2016                | 1,163       | 6-16       | 723          | U                               | 4     |
| Park      | South Korea      | 2021 | Cohort   | located in Seoul       | Medical centers and public health centers | 2007.11~2015.12          | 1,163       | 0-7        | 597          | Dogs                            | 5     |
| Ali       | Denmark          | 2021 | Cohort   | Denmark                | Universities                            | 2007-2015                | 327         | 0-14       | 278          | Cats, Dogs                       | 4     |
| Zhang     | China            | 2020 | Case control | Zhongshan, China     | Schools                                 | 2016.03-07               | 1,1611      | 5-18       | 6087         | Cats, Dogs, Poultry              | 6     |
| Ouyang    | Finland          | 2020 | Case control | Turku, Oulu          | Universities                            | 1994-2004                | 3,781       | 0-5        | 1646         | Dog                             | 8     |
| Morales-Romero | Mexico     | 2019 | Case control | Guadalajara, Mexico | Schools                                 | 2016.04~06               | 1,992       | 15-18      | 936          | Dog                             | 4     |
| Al-Shatti  | Kuwait           | 2020 | Case control | The State of Kuwait  | Schools                                 | 2016.09~2017.05          | 3,864       | 11-14      | 1695         | Cats, Dogs, Birds, Poultry, Fish, Reptile | 8     |
| Simoneti  | Brasil           | 2018 | Case control | Brazilian             | Universities                            | 2017                     | 191         | 2-4        | 60           | Cats, Dogs                       | 6     |
| Hugg      | Finland          | 2008 | Case control | Imatra, Finland and Svetogorsk, Russia | Schools | 2003.10~2003.11 | 1,093 | 7-14 | 517 | Cats, Dogs, Rodent, Birds       | 8     |
| McConnell | California       | 2002 | Case control | in Southern California | Schools | The spring of 1998 | 3,535 | 9-16 | 1677 | Cats, Dogs, Guinea pigs, Gerbils or hamsters, Mice, Birds, other pets | 7     |
| Dong      | China            | 2008 | Case control | Liaoning, China | Schools                                 | 2007.04                  | 1,0784      | 9-11       | 5432         | Cats, Dogs, Birds, Farm animals, other animals | 7     |
| Eldeirawi | United States    | 2016 | Case control | Chicago               | Schools                                 | 2004.01~05               | 1,816       | 4-18       | 881          | Cats, Dogs                       | 5     |
| Nguyen    | United States    | 2010 | Case control | New York              | Communities                             | 2002~2003                | 1,412       | 0-17       | 748          | U                               | 6     |
| Lindfors  | Sweden           | 1995 | Case control | Sweden               | Hospitals                               | 1990.05~1992.03          | 511         | 1-4        | 383          | Cats, Dogs                       | 7     |
| Oluwole   | United States    | 2013 | Case control | Nigeria              | Communities and schools                 | 2010~2017                | 1,736       | 13-14      | 785           | Cat                             | 5     |
| Zheng     | China            | 2002 | Case control | Beijing, China        | Schools                                 | 1999.01~2001.03          | 1,209       | 9-10       | 710           | Cats, Dogs                       | 7     |
| Martel    | Canada           | 2009 | cohort    | Quebec, Canada        | administrative health databases         | 1990~2002                | 5,226       | 0-10       | 3041          | U                               | 8     |

(Continued)
| Author               | Author's country | Year | Design      | Sampling location | Sampling mechanism | Sampling time     | Sample size | Age (year) | Gender (boy) | Animals                        | Score |
|----------------------|------------------|------|-------------|-------------------|--------------------|-------------------|--------------|------------|-------------|--------------------------------|-------|
| Ernst (37)           | Canada           | 1995 | Case control| The island of Montreal | Schools            | 1993-1994        | 1,274       | 5-13       | 500         | Cat                            | 9     |
| Strömberg Celind (28)| Sweden           | 2018 | Cohort      | Western Sweden    | Hospitals          | 2003-2015        | 4,777       | 0-12       | U           | Cat                            | 7     |
| Pokharel (62)        | Nepal            | 2001 | Case control| South West of Delhi | Schools            | 1995.07~1996.08  | 120         | 11-15      | U           | U                              | 5     |
| Collin (15)          | United Kingdom   | 2014 | Cohort      | South-west England | Health Authority   | 1991.4.1~1992.12.31 | 3,768       | 7.5-9      | 189         | Any pet, Cat, Dog, Rabbit, Rodent, Bird | 8     |
| Milanzi (23)         | Netherlands      | 2019 | Cohort      | Netherlands.      | Hospitals          | 1996-1997        | 1,871       | 0-17       | 926         | U                              | 7     |
| Brunekreef (13)      | Netherlands      | 2012 | Cohort      | The world         | Centers            | 2010-2012        | 53,5826     | 6-7        | U           | Cat, Dog                       | 8     |
| Yarnell (45)         | Ireland          | 2003 | Case control| Ireland           | Schools            | 1995.03~04       | 5,035       | 13-14      | 3029        | Not dog or cat                | 8     |
| Mitchell (25)        | New Zealand      | 2007 | Cohort      | New Zealand       | Hospitals          | 1995.10~1997.11  | 871         | 1-7        | 310         | Dog                            | 7     |
| Oberle (58)          | Germany          | 2003 | Case control| Southern Babaria  | Schools            | 1997             | 8,216       | 5-7        | U           | Cat                            | 9     |
| Waser (66)           | Switzerland      | 2005 | Case control| Rural areas of Austria, Germany and Switzerland | Schools | 1999.03-07 | 812         | 9-11       | 414         | Cat, Dog                       | 9     |
| Reklund (12)         | Sweden           | 2006 | Cohort      | Northern Sweden   | Schools            | 1996-2000        | 3,525       | 7-12       | 758         | Cat, Dog                       | 9     |
| Kerkhof (21)         | Netherlands      | 2009 | Cohort      | Netherlands       | Prenatal clinics   | 1996~1997        | 2,951       | 0-8        | 1531        | Cat, Dog                       | 9     |
| Holscher (42)        | Germany          | 2002 | Case control| Zerbst and Hettstedt areas | Schools | 1992-1999 | 7,448       | 5-14       | 3902        | Cat, Dog                       | 7     |
| Garcia (39)          | America          | 2008 | Case control| Bogota, Colombia  | Schools            | 2002.03-09       | 7,085       | 6-14       | 3237        | Cat, Dog                       | 7     |
| Chan-Yeung (16)      | Canada           | 2008 | Cohort      | Winnipeg and Vancouver, Canada | Centers | 1995-2002 | 380         | 0-7        | 200         | Cat, Dog                       | 8     |
| Naydenov (53)        | Denmark          | 2008 | Case control| Bulgaria          | Towns              | 2004             | 4,479       | 2-7        | U           | Cat, Dog                       | 7     |
| Lombardi (46)        | Italy            | 2010 | Case control| Italy             | Schools            | 2002             | 2,0016      | 0-7        | 10288       | Dog                            | 7     |
| Garrett (20)         | Australia        | 1998 | Cohort      | Australia         | Schools            | 1994.03-1995.02  | 148         | 7-14       | U           | U                              | 6     |
| Dong (35)            | China            | 2009 | Case control| Liaoning, China   | Schools            | 2007.04          | 1,2910       | 7-13       | 6416        | Cat, Dog, Bird, farm animals, other animals | 7     |
| Bertelsen (14)       | Norway           | 2010 | Cohort      | Oslo              | Hospitals          | 1992-1993        | 1,019       | 0-10       | 551         | Cat, Dog, other furry pets    | 7     |
| Morass (50)          | Austria          | 2007 | Case control| Tyrol             | Schools            | 2006             | 1,761       | 5-7        | U           | U                              | 6     |
| Janson (43)          | Sweden           | 2007 | Case control| Uppsala, Sweden   | Schools            | 1998.10-1999.12  | 959         | 13-14      | 805         | Cat or dog                     | 5     |
| Neto (54)            | Brazil           | 2019 | Case control| Passo Fundo       | Schools            | 2009.03-2011.12  | 1,003       | 9-11       | 377         | Cat                            | 4     |

(Continued)
| Author                  | Author's country | Year | Design      | Sampling location                          | Sampling mechanism | Sampling time         | Sample size | Age (year) | Gender (boy) | Animals                  | Score |
|------------------------|------------------|------|-------------|-------------------------------------------|-------------------|----------------------|-------------|-------------|---------------|---------------------------|-------|
| de Marco (32)          | Italy            | 2004 | Case control| Europe, North America, and Oceania.       | Centers           | 1991-1993            | 1,8156      | 0-10        | 8683          | Cat                       | 9     |
| Grabenhenrich (19)     | Germany          | 2014 | Cohort      | Germany                                   | Schools           | 1990.01-12           | 1,314       | 0-14        | 494           | Cat, Dog                  | 9     |
| O’Connor (26)          | United States    | 2017 | Cohort      | Baltimore, Boston, New York City, and St Louis. | Hospitals         | 2005.02-2007.03     | 442         | 0-7         | 226           | Cat, Dog                  | 9     |
| Luo (8)                | China            | 2017 | Case control| Tianjin, China                            | Schools           | 2013.04              | 7,366       | 0-8         | 3780          | Cat, Dog, Rodent, Bird, Fish | 7     |
| Dong (33)              | China            | 2008 | Case control| Liaoning China                            | Schools           | 2007.04              | 1,4729      | 4-6         | 7409          | Cat, Dog, Bird, et al     | 5     |
| Fall (18)              | Sweden           | 2015 | Cohort      | Sweden                                    | Hospitals         | 2001.1.1-2010.12.31 | 1,011051    | 0-10        | U             | Dog, farm animals         | 7     |
| Sasaki (65)            | Japan            | 2013 | Case control| Japan                                     | Center            | 2012.06              | 3,066       | 8-10        | 1818          | U                         | 7     |
| Arnduro-Garcia (30)    | United States    | 2015 | Case control| Ecuador                                   | Hospitals         | 2012.10-12           | 179         | 5-15        | 94            | U                         | 8     |
| Medjo (49)             | Serbia           | 2013 | Case control| Belgrade, Serbia                          | Hospitals         | 2012                 | 149         | 7-14        | 90            | Cat, Dog                  | 4     |
| Laptheal (47)          | United States    | 2001 | Case control| United States                             | Households        | 1988-1994            | 8,257       | 6-16        | 4086          | dog                       | 8     |
| Ayuk (29)              | South Africa     | 2018 | Case control| South Africa                              | Schools           | 2001.01-2002.11      | 28,391      | 13-14       | 13965         | Cat, Dog                  | 7     |
| Persanowski (61)       | Sweden           | 2002 | Case control| Sweden                                    | Schools           | 1996                 | 3,431       | 7-8         | 1749          | Cat, Dog                  | 9     |
| Arnedo-Pena (31)       | Spain            | 2009 | Case control| Castellon (Spain)                         | Schools           | 2002                 | 4,492       | 6-7         | 2220          | Cat, Dog                  | 4     |
| Janahi (44)            | Qatar            | 2006 | Case control| Qatar                                     | Schools           | 2003.02-2004.02      | 3,500       | 6-14        | U             | U                         | 4     |
| Furuhat (22)           | Japan            | 2020 | Cohort      | Japan                                     | Hospitals         | 2000.11.0-27         | 45,060      | 1-10        | 23047         | U                         | 5     |
| Chen (40)              | China            | 2013 | Case control| Shanghai, China                           | Schools           | 2011.04-2012.04      | 13,335      | 4-6         | 6753          | Cat, Dog, Rodent, et al   | 6     |
| Fall (17)              | Sweden           | 2018 | Cohort      | Swedish                                   | Hospitals         | 2001.01-2004.12      | 23,585      | 1-6         | U             | Dog                       | 7     |
| Palvo (60)             | Brazil           | 2008 | Case control| SJRP                                      | schools           | 2003.11-2004.10      | 2,206       | 6-7         | U             | U                         | 5     |
| Fedortsiv (38)         | Ukraine          | 2012 | Case control| Ternopil                                   | schools           | 2010                 | 4,871       | 6-14        | 2396          | U                         | 7     |
of the included studies were summarized in Table 1. In addition, the quality assessment results showed that most of the included studies were of high quality (Table 1).

Meta-analysis results

The overall risk analysis on pet ownership and the onset of childhood asthma

A random-effects model ($I^2 = 79.1\%$) was used for the meta-analysis on 60 included studies. The results showed that the pet ownership was significantly correlated with the risk of childhood asthma onset (OR = 1.14, 95%CI: 1.08-1.21). Supporting information included the results of sensitivity analysis and publication bias assessment (Figure 2) ($P < 0.05$).

Subgroup analysis

First, we performed a subgroup analysis based on pet types. The results of the meta-analysis on 33 studies ($N = 716,085$) showed that cat ownership is significantly related to the occurrence of childhood asthma (OR = 1.18, 95%CI: 1.05-1.33, $I^2 = 75.4\%$, Figure 3). The results of the meta-analysis on 36 studies ($N = 1,728,907$) showed that dog ownership is significantly associated with the occurrence of childhood asthma (OR = 1.12, 95%CI: 1.00-1.24, $I^2 = 79.6\%$, Figure 4). The results of the meta-analysis on 11 studies ($N = 86,743$) showed that other furry pet ownership was not associated with the occurrence of childhood asthma (OR = 1.03, 95%CI: 0.82-1.30, $I^2 = 54.9\%$, Figure 5). This study takes samples mainly from schools (OR = 1.223, 95%CI: 1.012-1.480, $I^2 = 77.4\%$) and hospitals (OR = 1.132, 95%CI: 1.040-1.233, $I^2 = 79.0\%$). Only few studies conducted subgroup analysis by gender, so it is insufficient to conduct a subgroup analysis by gender in our study. In addition, our study demonstrated that pet ownership was also significantly associated with severe childhood asthma (OR = 1.15, 95%CI: 1.11-1.20, $I^2 = 67.9\%$, Figure 6).

Discussion

This systematic review and meta-analysis on a large number of original studies with quantities of observational samples presented that pet ownership was significantly correlated with the risk of childhood asthma. There was a clear relationship between cat and dog ownership and the risk of childhood asthma. In addition, pet ownership was associated with the risk of severe childhood asthma. These results were obtained after pooling individual studies and adjusting the confounders.

Bronchial asthma is the most common chronic airway inflammatory disease in children. In recent years, the incidence of this disease has been increasing in our country, and asthma has become a public health issue attracting global attention. The etiology of asthma is complicated and closely related to genetic background, environmental factors, and immune function, including vitamin D deficiency, gastrointestinal and respiratory microbiota, early exposure to antibiotics, smoking, air pollution, genetic risk factors, stress, ethnic differences, etc. (2).
Cats and dogs have been companions for humans for thousands of years. Pet ownership provides various health benefits for humans, including ameliorating loneliness, attenuating psychological changes, promoting relationships, and acting as a protective factor against certain diseases, such as cardiovascular disease (68). In spite of these advantages, our study found that pet ownership, especially cats and dogs, could increase the risk of childhood asthma.

Currently, the mechanism underlying the positive correlation between pet ownership and the risk of childhood asthma remains unclear. Herre et al. (69) found that cats could secrete a type of protein, Feld 1, which was similar to Derp 2, the allergen in dust mites. Feld 1 can enhance signaling through innate receptors TLR4 and TLR2. The allergen from dogs, Canf 6, is a type of lipoprotein allergens with similar characteristics to Feld 1. Studies believed that Feld 1 and Canf 6 belonged to a group of allergen immunomodulatory proteins which significantly amplified LPS/TLR signaling in macrophage-like cells, thereby enhancing innate immune signaling and promoting airway hypersensitivity in patients with asthma. Other studies have found (70, 71) that pet is the main source of household endotoxins. Endotoxins are considered as pro-inflammatory agents which may be associated with promoting asthma (71, 72). A study by Akramiene et al. (73) and Douwes et al. (74) found that pet ownership increased the indoor concentration of fungi and dust. β-(1, 3)-d-glucan (beta-glucan), a glucose polymer existing in the fungal cell wall, was positively associated with the variability of peak expiratory flow (PEF) in children with asthma. Maheswaran et al. (75) discovered that exposure to β-glucan was a risk factor for atopic asthma. β-glucan can induce DC to stimulate Th17 cells, and the activation of Th17 cells may trigger inflammatory responses.

In recent years, there has been increasing case-control or cohort studies with large sample size on the relationship...
between pet ownership and childhood asthma. A study by Morales-Romeroden et al. (51) found that exposure to cats and dogs increased the risk of childhood asthma. Ayuk et al. (29) found that cat ownership is associated with severe asthma after investigating 258,267 children aged 13-14 in 10 African centers. Eldeirawi et al. (36) discovered that exposure to such pets as cats and dogs in utero is linked to an increased chance of asthma when studying Mexican American children aged 4-18. In the study of the relationship between bronchial hyperreactivity and the occurrence of asthma in children at the age of 7, Park et al. (27) found that dog ownership significantly increases the risk of non-atopic asthma. In 2020, in a survey on 11,611 students in Zhongshan City, China, Zhang et al. (9) found that pet ownership was associated with the prevalence of childhood asthma and the occurrence of asthma-related symptoms, especially in those who owned cats, poultry or slept with pets. A study in Tianjin demonstrated that (8), exposure to pets at an early age was positively correlated with asthma in Tianjin. A survey of 12 districts in 3 cities in Liaoning Province presented that pet ownership increased the risk of childhood asthma. In a cohort study by Ali et al. (11) found that pet ownership was positively related with the prevalence of asthma. In a population-based birth cohort study by Strömberg Celind et al. (28), it was also discovered that cat ownership increased the risk of uncontrolled asthma. The findings of these studies were consistent with our results on the association
FIGURE 5
Forest plot of the association between furry pet ownership and childhood asthma.

FIGURE 6
Forest plot of the association between pet ownership and severe childhood asthma.
between pet ownership and childhood asthma, suggesting that our conclusion was reliable. Sensitivity analysis also proved the reliability of our results.

There were some advantages in our study. First, our research was based on a large number of studies with large sample size, which ensured the level of evidence. Second, the time of the studies included in our research was continuous, from 1995 to 2021. There will be literature reports in 2021. Third, the included studies involved all regions around the world, which weakened the influence brought by environment, race, and attitudes to a certain extent. Fourth, there was no publication bias in our research. Last, this research was the first proposing the association between pet ownership and severe asthma. Nonetheless, there were still some limitations. First, limited to the information in the original studies, we could not summarize the relationship between pet ownership and risk of childhood asthma according to different age groups. Second, limited to the information in the original studies, we were unable to obtain detailed information on the types of pets. Third, it was impossible to quantify and compare the risk of asthma in children with various pets other than cats and dogs.

Conclusion

We found that pet ownership, especially cats and dogs, was positively correlated with the occurrence of childhood asthma. Pet ownership was also positively correlated with the occurrence of severe childhood asthma. However, we did not deny human’s love for pet. When raising pets, it is better to choose those with less impact on the occurrence of childhood asthma. Furthermore, the contact of pets with infants should be avoided. At the same time, hygiene management of pets requires to be enhanced.

Data availability statement

The original contributions presented in this study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Author contributions

XJ, YY, and CH contributed to the conception and design of the study. YY organized the database. PZ performed the statistical analysis. XJ wrote the first draft of the manuscript. YY, PZ, and CH wrote sections of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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Conflict of interest

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

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