

Cat Ownership and Schizophrenia-Related Disorders and Psychotic-Like Experiences: A Systematic Review and Meta-Analysis

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Background: It has been proposed that cat ownership may be a risk-modifying factor for schizophrenia-related disorders and psychotic-like experiences (PLE). This study aimed to systematically review and meta-analyze publications that reported the relationship between cat ownership and schizophrenia-related outcomes. **Methodology:** We searched Medline, Embase, CINAHL, Web of Science, and gray literature for publications between January 1, 1980, and May 30, 2023, regardless of geographical location and language. Backward citation search methods were used to locate additional articles. We included studies that reported original data on cat ownership and schizophrenia-related outcomes. We meta-analyzed estimates based on broad definitions (cat ownership, cat bites, and cat contact) with estimates with or without covariate adjustments. We pooled comparable estimates using random-effects models and assessed the risk of bias, heterogeneity, and study quality. **Results:** We identified 1915 studies, of which 106 were chosen for full-text review, ultimately resulting in the inclusion of 17 studies. We found an association between broadly defined cat ownership and increased odds of developing schizophrenia-related disorders. The unadjusted pooled odds ratio (OR) was 2.35 (95% CI: 1.38–4.01), while the adjusted pooled estimate was 2.24 (95% CI: 1.61–3.12). We were unable to aggregate the estimates for the PLE outcomes because of the broad range of measures. **Conclusions:** Our findings support an association between cat exposure and an increased risk of broadly defined schizophrenia-related disorders; however, the findings related to PLE as an outcome are mixed. There is a need for more high-quality studies in this field. **PROSPERO registration:** PROSPERO 2023 CRD42023426974. Available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42023426974

Key words: cat ownership, systematic review, meta-analysis, schizophrenia, schizotypy, psychotic experiences.

Introduction

It has been proposed that cat ownership during childhood may be a risk-modifying factor associated with an increased risk of subsequently developing schizophrenia and related disorders.^{1–3} The proposed causal agent is *Toxoplasma gondii* (*T. gondii*), an intracellular protozoan parasite found in domestic cats. Infection with *T. gondii* has been associated with close contact with cats, ingestion of tissue cysts in undercooked meat of infected animals, and oocysts from food or water contaminated by cat feces.³ This parasite can persist in the central nervous system and has been linked to a broad range of direct and indirect (eg, as a result of subsequent immune activation) physiological changes in the brain that can vary across the lifespan and in response to immunosuppression.^{4,5} Systematic reviews^{6–9} have provided evidence in support of an association between past *T. gondii* infection and an increased risk of schizophrenia. Several studies have reported a significant association between childhood exposure to cats and an increased risk of schizophrenia,^{10,11} however, not all studies have found this association.^{12,13} Similarly, some studies have found an association between cat exposure and increased scores on measures of schizotypy and psychotic-like experience (PLE)^{14,15}; not all studies have found this association.^{16,17} There is a need for a comprehensive systematic review and meta-analysis of these 2 related research questions.

The aim of this study was to conduct a comprehensive systematic review of studies reporting cat ownership and the subsequent development of (1) broadly defined

schizophrenia-related disorders and (2) broadly defined PLE, and to meta-analyze these estimates after sorting them into comparable study types.

Methods

Search Strategy and Identification of Studies

Based on a protocol registered with PROSPERO,¹⁸ this systematic review is PRISMA (*Preferred Reporting Items for Systematic Reviews and Meta-Analyses*)^{19–21} compliant. A comprehensive search strategy was developed to identify research publications on cat ownership (before the age of 25) and the subsequent development of schizophrenia-related disorders. Detailed search strategies are listed in [supplementary table 1](#). Two authors (J.M. and S.S.) independently validated and revised the search algorithms in different databases. Studies published between January 01, 1980 and May 30, 2023, were identified through 4 electronic databases: PubMed-Medline, Embase, CINAHL, and Web of Science. No restrictions were made regarding the geographical location or language of the publications.

Screening, Backward Citation Searching, and Data Extraction

All potential articles from the 4 database searches were uploaded to a commercial software, *Covidence* for the management of Title and Abstract (TIAB) screening, followed by full-text scrutiny. Any discrepancy in the screening process was resolved by the consensus of 2 authors (S.S. and J.M.) (PRISMA flowchart, [figure 1](#)). Articles were screened, followed by full-text scrutiny for inclusion in the relevant article pool. Data were extracted from the final list of the included studies and digitally entered into an Excel spreadsheet.

Backward citation searching was also employed to locate additional potential papers from the references cited by each relevant article, systematic reviews, and gray literature (unpublished data). We wrote to all the corresponding authors of the included studies to seek additional studies. One additional unpublished study was identified using this strategy.²² Several potentially suitable studies lacked explicit data suitable for meta-analysis. After writing to these authors,^{14,23–25} we were able to access additional data for one of these studies.¹⁴

Diagnostic Criteria, Definition of Cat Exposure, and Quality Reporting Scale

In keeping with our previous systematic reviews,²⁶ our preregistered protocol was broad with respect to the diagnosis of schizophrenia-related outcomes. It includes the use of any published diagnostic criteria and encompasses schizophrenia, schizoaffective disorder, and psychosis (including bipolar disorder). With respect to PLE,

we included studies that examined scales related to schizotypy as well as scales specifically designed for PLE. In our protocol, we specified that cat ownership must have occurred before the age 25 years. As a post hoc decision, we included a broader range of exposure variables, including cat ownership (including rodent- and non-rodent-hunting cats), cats living in the house, household pet cats, contact with cats, and cat bites. To assess the overall quality of the study estimates, we employed the Newcastle-Ottawa scale to assess case-control and cohort (including case-cohort) studies independently²⁷ ([supplementary tables 2 and 3](#)).

Data Analysis and Presentation

For the purpose of uniform presentation, we used the pooled odds ratio (OR) as our primary risk measure, as almost all studies reported ORs. The pooled risk estimates (ie, ORs) were estimated using inverse-variance random-effect models. Heterogeneity between studies was assessed using both Q-statistics and I^2 .²⁸ If sufficient estimates were identified, we explored potential publication bias using funnel plots, and Egger's test for the possibility of publication bias.²⁹ Data were presented in graphical format (eg, forest plots). Risk estimates between cat exposure and schizophrenia disorders were presented as pooled estimates using crude OR and adjusted OR (aOR), with no less than 3 studies for pooling.

The “*metafor*” package in R version 3.6.2 was used to produce pooled estimates, and forest plots.³⁰ OR from each study were transformed using the natural logarithm, and standard errors (SE) were calculated from the reported confidence intervals (CIs). In studies with missing CIs, reported *P*-values were used to calculate SEs. All data underlying the meta-analyses are available upon request from the corresponding author.

Results

The results of the detailed search strategy are shown in PRISMA ([figure 1](#) and [supplementary table 4](#)). We identified 1896 studies from 4 electronic databases, while other searches (including backward citation searches) produced 19 additional articles, of which 106 were screened for full-text reviews. Finally, we included 17 studies from 11 countries (Canada, Ethiopia, Egypt, Finland, France, Lebanon, Saudi Arabia, Tunisia, Turkey, the United Kingdom, and the United States of America) and excluded 89 studies for various reasons ([figure 1](#)). No articles were found in languages other than English. The study characteristics of the 17 studies are presented in [supplementary table 3](#).

Cat Exposure and Schizophrenia-Related Disorders

We were able to pool data for unadjusted OR and adjusted OR (aOR) for schizophrenia-related disorders. One study provided both unadjusted and adjusted estimates in separate

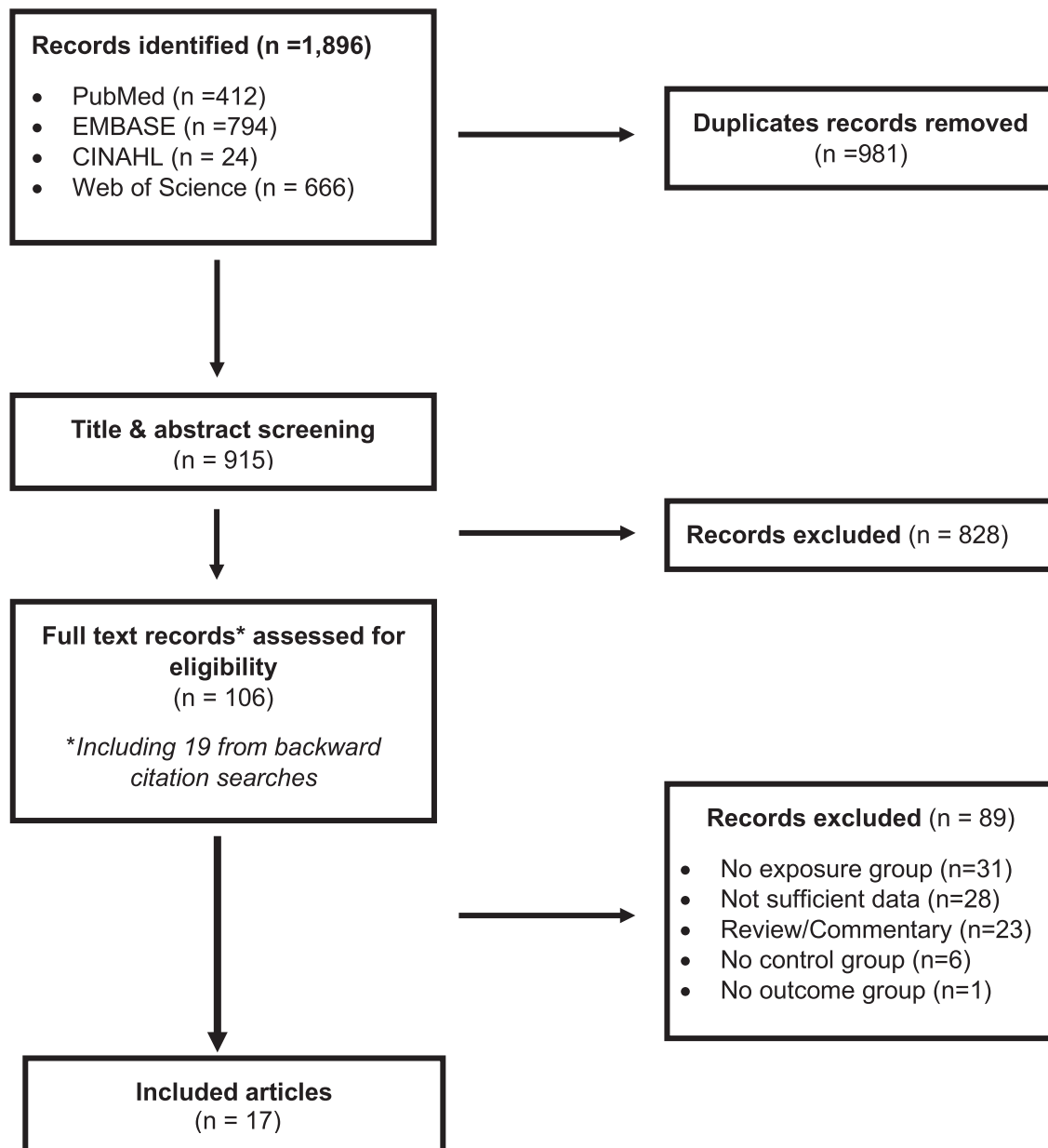


Fig. 1. PRISMA flowchart: Cat ownership and psychosis. Note: *No exposure group = no “cat ownership.” **No outcome group = no schizophrenia-related disorders.

publications.^{2,31} One study³² also provided both unadjusted and adjusted estimates. Overall, cat ownership was associated with an increased risk of schizophrenia-related disorders. Based on data from 9 studies, the unadjusted pooled OR between cat exposure and schizophrenia-related disorders was 2.35 (95% CI: 1.38–4.01)^{1,2,10,12,14,22,31–33} (figure 2). The pooled estimate of aOR based on 6 studies, was 2.24 (95% CI: 1.61–3.12)^{11,13,22,31,32,34} (figure 3). The nature of the covariates included in the adjusted models varied widely between studies: Ademe et al.¹³—marital status, addiction to khat and alcohol; Mouhawass et al.³⁴—marital status, smoking, IgG, and water drinking; Oumaima et al.²²—cat ownership between 0 and 13 years, frequent contact with

cat, and social level; Torrey et al.³¹—conditions of pregnancy, history of miscarriages, place of residence at the time of birth, breastfeeding, and age when first walked without assistance; age when enrolled in first grade; exposure to other animals during pregnancy and from birth to age 13; Yuksel et al.³²—age, gender, race, parental education, and place of birth.

With respect to heterogeneity, both meta-analyses identified significant heterogeneity (the Q-statistic and I^2 are presented for each forest plot). The unadjusted and adjusted Q-statistics estimates for schizophrenia-related disorders were 106.8 (P -value < .01) and 12.48 (P -value = .03), respectively. The corresponding I^2 values

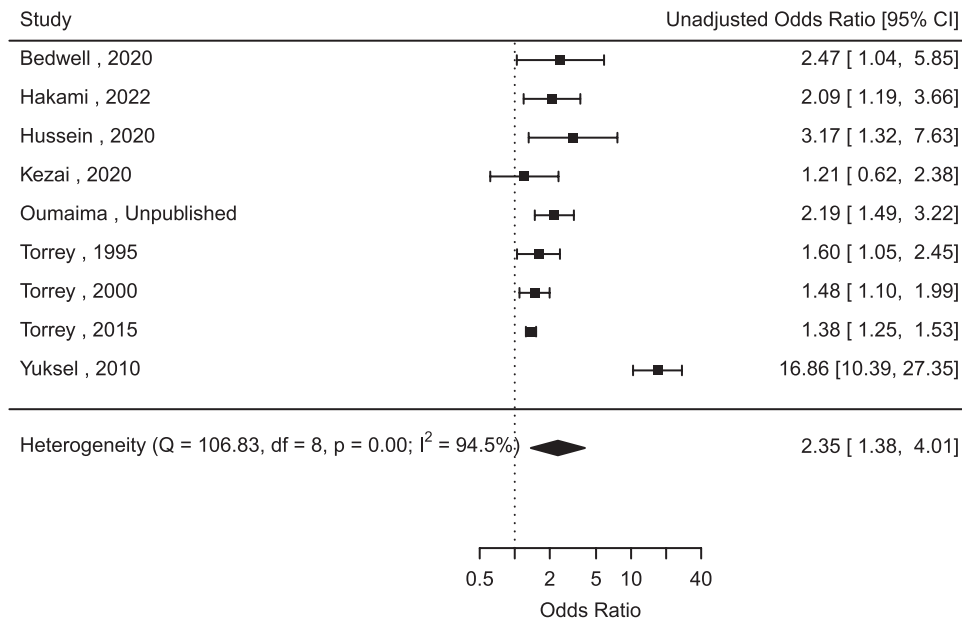


Fig. 2. Forest plot of the random-effects meta-analysis between cat exposure and schizophrenia-related disorders, unadjusted analyses.

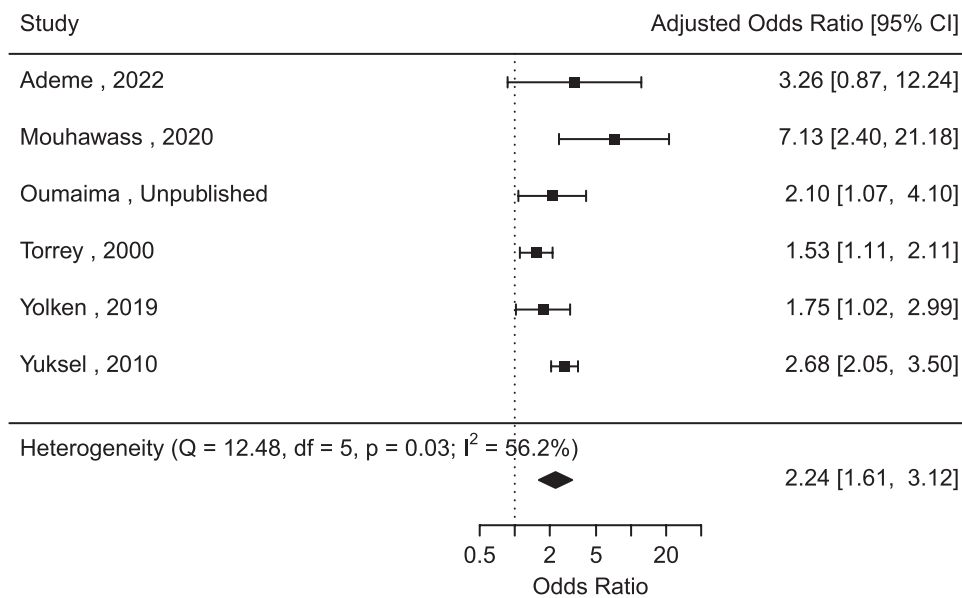


Fig. 3. Forest plot of the random-effects meta-analysis between cat exposure and schizophrenia-related disorders, adjusted analyses.

were 94.5% and 56.2%, respectively. The quality scores for the included studies ranged between 0 and 8 (total score of 9) (supplementary table 2), with 8 studies scoring 4 or less and 9 studies scoring 5 or higher. In keeping with recommendations about the minimal number of estimates required to interpret funnel asymmetry plots (greater than 10),³⁵ we were not able to assess potential publication bias in the included data.

Cat exposure and PLE

We identified 6 studies reporting an association between cat exposure and PLE.^{14-17,36,37} As these outcomes were

not assessed on comparable scales, it was not possible to pool these estimates. We have summarized these studies in detail. One US study based on undergraduate psychology students ($n = 354$)³⁷ found no association between cat ownership and scores on a schizotypy scale, but when comparing those bitten by a cat (vs not bitten), the bitten subgroup had higher scores on a schizotypy scale. A study based on those with and without mental disorders ($n = 161$) found a similar association between cat bite and higher scores on measures of schizotypy and PLE.¹⁴ A Canadian study that recruited community-based volunteers ($n = 1986$) found that, compared with those without cat ownership, the subgroup with rodent-hunting cats

had higher scores on PLE scales¹⁵(this was not found comparing those with non-rodent-hunting cats).

A high-quality birth cohort study from Finland³⁶ reported cat exposure under the age of 7 years had significantly higher scores on perceptual aberration, schizoid, and social anhedonia scales, but only social anhedonia persisted in the adjusted analyses. Similarly, a high-quality birth cohort study from the United Kingdom¹⁷ found that cat exposure during childhood (ie, 4 and 10 years) was associated with higher PLE at age 13 years; however, these findings did not persist after adjustment for potential confounding variables. A high-quality population survey from Finland¹⁶ found no association between cat exposure (previous or current) and clinically relevant PLE (models adjusted for a range of demographic variables and *T. gondii* seropositivity). As *T. gondii* seropositivity is a marker of past exposure to the putative risk-modifying factor linking cat ownership and the risk of schizophrenia (ie, *T. gondii* infection in the central nervous system), the inclusion of this variable as a covariate could weaken any association between cat ownership and PLE.

Discussion

Our systematic review identified 17 articles from 11 countries published over the last 44 years. With respect to studies that examined cat exposure and schizophrenia and related disorders, we were able to generate 2 pooled estimates, both of which found a significant positive association between broadly defined cat ownership and an increased risk of schizophrenia-related disorders. After adjusting for covariates, we found that individuals exposed to cats had approximately twice the odds of developing schizophrenia. We note that several of these studies had low-quality scores.

We were unable to pool estimates of the association between cat ownership versus PLE or schizotypal disorders. Although the results of these studies were mixed, higher-quality studies reported that the associations found in unadjusted models may have reflected the inclusion of potentially confounding variables. We note that some studies reported null findings based on 1 analysis (eg, hazard ratios between cat ownership before age 13 years and subsequent schizophrenia) but significant findings based on other analyses (eg, between cat ownership from age 9 to 12 years and subsequent schizophrenia).¹¹ These findings suggest that the critical window of exposure is not well defined. The handling of covariates to be included in adjusted analyses needs to be based on a grounded conceptual framework based on the best available scientific knowledge.^{38,39} Within this framework, putative mediating, moderating, or confounding variables need to be handled appropriately.^{40,41} When there is insufficient background knowledge to confidently map out how covariates influence causal models, authors are encouraged to report the unadjusted and adjusted results for a range of competing models.

Preregistration of the study plan with clear directional hypotheses, and a prespecified plan for examining different types of candidate exposures (eg, cat ownership, cat bites, rodent-hunting cats), critical windows (eg, before a certain age, prior to the onset of the mental health outcome of interest), and analytic strategies (eg, causal models and the selection of covariates) could provide reassurance that any subsequent findings are less likely the result of chance.

In conclusion, our review provides support for an association between cat ownership and schizophrenia-related disorders. Our field needs to generate novel candidate environmental risk factors, especially those that are potentially modifiable. Within that context, there is a need for more high-quality studies, based on large, representative samples to better understand cat ownership as a candidate risk-modifying factor for mental disorders.

Supplementary Material

Supplementary material is available at [https://academic.oup.com/schizophreniabulletin/](https://academic.oup.com/schizophreniabulletin/advance-article/doi/10.1093/schbul/sbad168/7458104).

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Authors' contributions

S.S. and J.J.McG. conceived the study. C.L., J.J.McG., and S.S. conducted the analysis. S.S., and J.J.McG. drafted and edited the manuscript. All authors contributed to the refinement of the study protocol and approved the final manuscript.

Conflict of interest

The authors have declared that there are no conflicts of interest in relation to the subject of this study.

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