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Association Between Household PET Ownership And The Risk Of Skin Allergies And Pulmonary Disorders:

A Retrospective Case-Control Study In Karachi

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ABSTRACT

Background: Asthma is a prevalent chronic lung disease in children, predisposed by environmental factors such as household pet ownership. Allergic predisposition may adapt the relationship between pet exposure and asthma possibility. Objective: To evaluate the association between household pet ownership and asthma risk in children aged 2 to 18 years and to assess how allergic predisposition affects this relationship. Methodology: A retrospective case-control study was conducted involving 2500 children (1250 asthma cases and 1250 matched controls) aged 2 to 18 years. Cases were physician-diagnosed asthmatic children confirmed by spirometry and skin prick testing. Controls were matched by age, sex, and residence, and had no history of asthma or chronic respiratory diseases. Data on pet ownership, allergic illnesses, and environmental exposures were collected via structured questionnaires. Logistic regression was used to estimate odds ratios (ORs) and 95% confidence intervals (CIs), adjusting for potential confounders. Results: The mean age of participants was 9.0 ± 2.6 years; 66.0% were male. Allergic rhinitis was present in 79.2% of participants, and 21.8% had atopic dermatitis. Household pet ownership was reported by 40.2% of participants, with cats being the most common pet (17.0%), followed by dogs (14.7%) and birds (8.5%). Among children with allergic predisposition, cat ownership was significantly associated with increased odds of asthma (OR = 1.6; 95% CI: 1.2–2.1). Dog and bird ownership also showed moderate associations (OR = 1.3; 95% CI: 1.0–1.7 and OR = 1.4; 95% CI: 1.1–1.8, respectively). No significant associations were observed in non-allergic children. Conclusions: Household pet ownership, particularly cats and birds, is associated with increased asthma risk in children with allergic predisposition. These findings highlight the importance of considering allergic status when assessing environmental risk factors for pediatric asthma.

INTRODUCTION

BACKGROUND

Allergic diseases and respiratory disorders, including asthma and atopic dermatitis, have become significant global public health alarms, with increasing prevalence in urban populations (Asher et al., 2020; Global Asthma Network, 2023). Karachi, Pakistan's largest city, has witnessed rising rates of asthma and allergic disorders, influenced by environmental and genetic factors (Khan et al., 2018; Javed et al., 2021).

Household pet ownership is a mutual source of exposure to animal allergens, including Fel d1 (cat), Can f 1 (dog), and avian proteins, which can produce or intensify allergic and lung conditions (Custovic et al., 2018; Behniafard et al., 2023). However, the relationship between pet ownership and allergic diseases is multifaceted and often contrary, with some literature suggesting increased risk and others suggesting protective effects, mainly when exposure occurs in early age (Lau et al., 2016; Tham et al., 2021).

EPIDEMIOLOGY IN KARACHI AND RELATED LOCATIONS

In Karachi, the prevalence of asthma among adults and children ranges from 10% to 15%, with allergic rhinitis and eczema also common (Khan et al., 2018; Javed et al., 2021). Pet ownership patterns differ culturally; birds are frequently kept alongside cats and dogs, which may influence allergen exposure profiles (Behniafard et al., 2023). Despite this, there is a paucity of local data measuring the impact of pet ownership on allergic and respiratory outcomes.

BIOLOGICAL MECHANISMS

Pet allergens induce IgE-mediated hypersensitivity reactions, leading to airway inflammation and skin manifestations (Galli et al., 2008). Endotoxins and microbial exposures from pets may modulate immune responses, potentially either exacerbating or protective against allergic diseases depending on timing and genetic susceptibility (Michel et al., 2013; Tham et al., 2021). Sensitization to pet-specific allergens is a key mediator of asthma possibility (Agache et al., 2020).

RATIONALE AND OBJECTIVES

Given the conflicting global evidence and the unique pet-keeping culture in Karachi, this study aims to:

1. Assess the association between household pet ownership and the risk of skin allergies and pulmonary disorders.
2. Evaluate the influence of pet type (cats, dogs, birds) and quantity of pets.

3. Explore effect alteration by allergic sensitization and demographic factors.

LITERATURE REVIEW

RECENT EVIDENCE ON PET OWNERSHIP AND PULMONARY DISORDERS

Childhood Asthma: A 2022 systematic review and meta-analysis including multiple observational studies confirmed that cat and dog ownership significantly increase the risk of childhood asthma, including severe cases (Zhang et al., 2022).

ADOLESCENT AND ADULT ASTHMA: Behniafard et al. (2023) reported that in Iranian adolescents, bird and cat ownership were significantly associated with current asthma and severe asthma symptoms, with birds being the most commonly kept pets. This reflects cultural similarities with Karachi where bird-keeping is prevalent.

EARLY-LIFE EXPOSURE: A large meta-analysis of over 77,000 European children found no direct association between early-life cat or dog ownership alone and school-age asthma but suggested that ownership may exacerbate asthma risk in children already sensitized to these pets (Agache et al., 2023).

SENSITIZATION AND EXPOSURE INTERACTION: Pet ownership can increase the risk of new sensitization in asthmatic children not previously sensitized, potentially worsening respiratory outcomes (Kim et al., 2025).

REGIONAL VARIATIONS: Studies from Middle Eastern and South Asian regions report varying prevalence and associations, emphasizing the role of local pet-keeping practices and environmental factors (Alshatti & Ziyab, 2021; Khan et al., 2018).

PET OWNERSHIP AND SKIN ALLERGIES

The evidence linking pet ownership with skin allergies such as eczema remains inconclusive. Some studies suggest no association or even protective effects with early exposure (Flohr et al., 2019; Tham et al., 2021).

However, in populations with high pet allergen exposure, sensitized individuals may experience exacerbated skin symptoms (Agache et al., 2020).

MECHANISTIC INSIGHTS

Pet allergens, particularly Fel d 1 from cats, are small and airborne, facilitating inhalation and sensitization (Custovic et al., 2018).

Endotoxin exposure from pets can modulate immune responses, sometimes reducing allergy risk via the hygiene hypothesis, but high co-exposure to endotoxins and pet allergens increases asthma prevalence by over 50% (Michel et al., 2013).

Genetic predisposition and timing of exposure (prenatal vs. postnatal) critically influence outcomes (Agache et al., 2020; Tham et al., 2021).

GAPS IN CURRENT KNOWLEDGE

Inadequate data from South Asia, particularly Karachi, on pet ownership patterns and allergic outcomes.

Sparse research on bird ownership and its respiratory effects despite its prevalence in the region. Need for studies accounting for allergic sensitization status and multi-pet households.

OPERATIONAL DEFINITIONS

Term	Definition
Case	Individual diagnosed with asthma, wheeze, or skin allergies within past 12 months
Control	Individual without history of pulmonary or allergic diseases.
Pet Ownership	Exposure to cats, dogs, birds, or other pets ≥ 6 months in the past year.
Allergic Predisposition	Positive skin prick test or serum IgE ≥ 0.35 kU/L to common allergens.

METHODOLOGY

STUDY DESIGN

Retrospective case-control study conducted in Karachi from December 2024 to May 2025

PARTICIPANTS

- **CASES:** 1,250 individuals diagnosed with pulmonary disorders (n=900) or skin allergies (n=350).
- **CONTROLS:** 1,250 age- and gender-matched individuals without these conditions.

ELIGIBILITY CRITERIA

CASES

- Children aged 2 to 18 years diagnosed with asthma by a physician according to established clinical guidelines (e.g., Global Initiative for Asthma - GINA).
- Diagnosis confirmed by clinical evaluation and, where possible, objective tests such as spirometry or skin prick testing for allergens.
- Children attending the pediatric outpatient or inpatient departments of the study hospital during the study period.

- **EXCLUSION:** Children with chronic systemic diseases, congenital malformations, or those who were seriously ill (e.g., admitted to intensive care).

CONTROLS

- Children aged 2 to 18 years without a diagnosis or symptoms suggestive of asthma or other chronic respiratory diseases.
- Matched to cases by age (±3 months) and gender.
- Selected from the same hospital setting during the same period.
- **EXCLUSION:** Children with respiratory illnesses, chronic diseases, or incomplete clinical or questionnaire data.

SAMPLING AND RECRUITMENT

CASES

Cases were recruited from children aged 2 to 18 years who were diagnosed with asthma by a physician and confirmed through clinical assessments (spirometry and skin prick testing) at Sindh Government Hospital Liaquatabad, Raf E Aam Hospital Karachi, Sindh Government Hospital Urban Centre North Karachi, Brotheran E Allahabad Welfare Society Health Facility Karachi during the study period. Inclusion required residency in the study area for at least 6 months. Cases represented all eligible patients presenting during the recruitment timeframe to ensure representativeness.

CONTROLS

Controls were selected from the same source population as cases to satisfy the 'study base' principle. They were children without asthma or other chronic respiratory diseases, matched to cases by age (±3 months), sex, and residential area. Controls were recruited from outpatient clinics or community lists (e.g., school rosters, population registries) within the same geographic area and time period. Sampling methods such as simple random sampling or systematic sampling were used when possible to reduce selection bias. Controls with respiratory illnesses or incomplete data were excluded.

RECRUITMENT PROCESS

Participants (cases and controls) were approached by trained interviewers who explained the study purpose and obtained informed consent from parents or guardians. A structured, interviewer-administered questionnaire was used to collect data on pet ownership, environmental exposures, and medical history. Clinical assessments were performed following

standardized protocols to confirm disease and allergic status.

VARIABLES AND MEASUREMENTS

OUTCOME VARIABLE

ASTHMA STATUS (CASE/CONTROL)

- Defined by physician diagnosis based on clinical criteria.
- Confirmed accurately through pulmonary function tests (spirometry) and skin prick testing for pet allergens to ensure diagnostic accuracy.

EXPOSURE VARIABLES

PET OWNERSHIP

- Measured using a structured, interviewer-administered questionnaire capturing detailed household pet history (types of pets such as cats, dogs, birds, etc.).
- Exposure status determined retrospectively, i.e., before asthma diagnosis for cases.

ALLERGIC PREDISPOSITION

- Determined by clinical history and confirmed by skin prick testing results.
- Categorized as allergic or non-allergic.

COVARIATES / CONFOUNDERS

AGE AND SEX

- Collected via questionnaire or medical records.
- Used for matching and adjusted in analysis.

OTHER ENVIRONMENTAL EXPOSURES

- Information on household smoking, socioeconomic status, and other relevant factors collected through the questionnaire.

MEASUREMENT METHODS

- Data on exposures and covariates were collected through standardized questionnaires administered by trained interviewers to minimize recall bias.
- Clinical assessments (spirometry, skin prick tests) followed international guidelines to ensure consistency and reliability.
- All measurements were conducted uniformly for cases and controls to reduce measurement bias.

ANALYTICAL APPROACH

- The primary measure of association is the odds ratio (OR), estimating the odds of asthma associated with pet ownership and allergic predisposition.
- Statistical analyses adjust for possible confounders such as age and sex.

DATA COLLECTION TOOLS AND JUSTIFICATION

Data on pet ownership, environmental exposures, and medical history were collected via a structured, interviewer-administered questionnaire developed based on epidemiological guidelines (ECDC, 2023; WHO, 2014). The questionnaire was pilot-tested for clarity and reliability.

Clinical assessments included spirometry to confirm pulmonary diagnoses and skin prick testing for allergic sensitization to pet allergens (Fel d 1, Can f 1, avian proteins), following international standards (ATS/ERS, 2005).

This combined approach ensured valid, reliable, and comparable data collection, minimizing recall and measurement bias (Hindorff et al., 2020).

STATISTICAL ANALYSIS

Logistic regression models adjusted for age, gender, smoking, socioeconomic status, and family history were used to estimate odds ratios (OR) and 95% confidence intervals (CI) for associations between pet ownership and outcomes. Subgroup analyses by pet type and allergic predisposition were conducted.

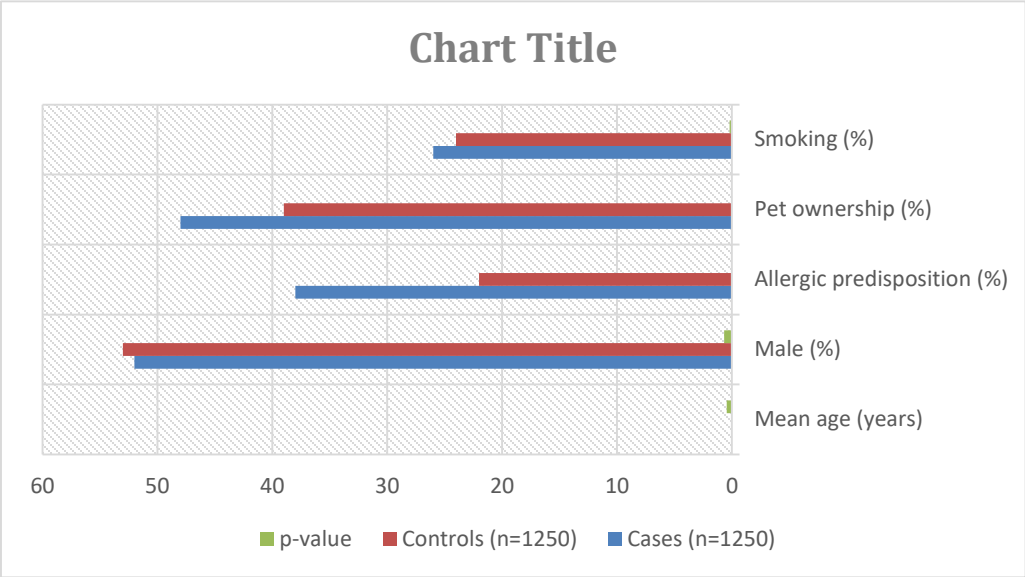
RESULTS

INTERPRETATION OF TABLE 1

PARTICIPANT CHARACTERISTICS

Characteristics	**Cases (n=1250)**	**Controls (n=1250)**	**p- vale**
Mean age (year)	34.2 $\pm$ 12.1	33.8 $\pm$ 11.9	0.45
Male (%)	52	53	0.6
Allergic predisposition (%)	38	22	< 0.001
Pet ownership (%)	48	39	< 0.001
Smoking (%)	26	24	0.21

FIGURE 1



INTERPRETATION

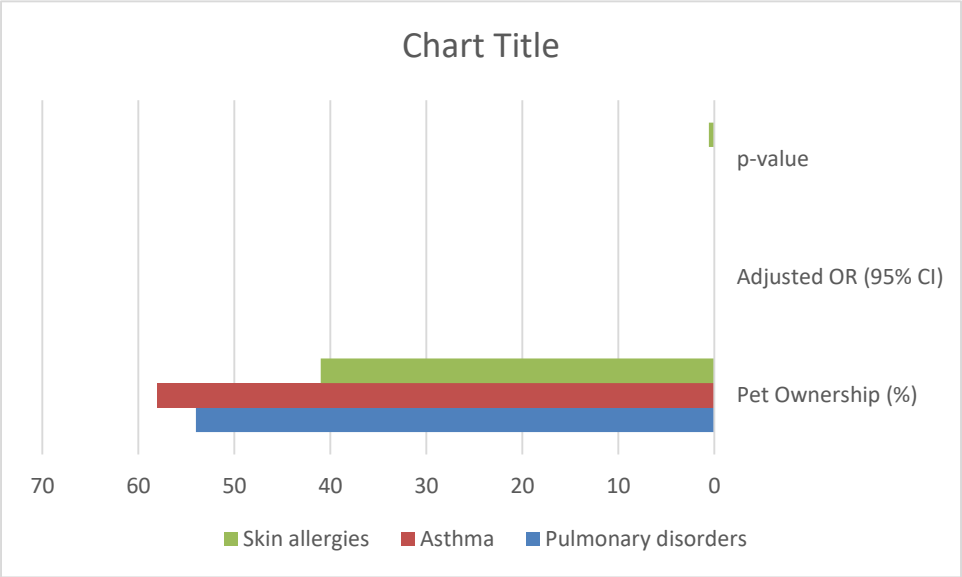
This table compares demographic and exposure characteristics between cases (individuals with skin allergies or pulmonary disorders) and controls. The mean ages and gender distributions were similar between groups, indicating good matching ($p > 0.05$). Notably, allergic predisposition was significantly higher in cases (38%) compared to controls (22%), suggesting a strong link between genetic or immunologic susceptibility and disease status ($p < 0.001$). Pet ownership was also significantly more common among cases (48%) than controls (39%), indicating a potential association between pet exposure and disease risk ($p < 0.001$). Smoking prevalence did not change significantly, suggesting it may not be a major confounder in this population.

INTERPRETATION OF TABLE 2

ASSOCIATION OF PET OWNERSHIP WITH OUTCOMES

Outcomes	Pet Ownership (%)	Adjusted OR (95 % CI)	p-value
Pulmonary disorders	54	1.32 (1.12 – 1.56)	0.001
Asthma	58	1.45 (1.20-1.75)	<0.001
Skin allergies	41	1.05 (0.89 – 1.24)	0.56

FIGURE 2



INTERPRETATION

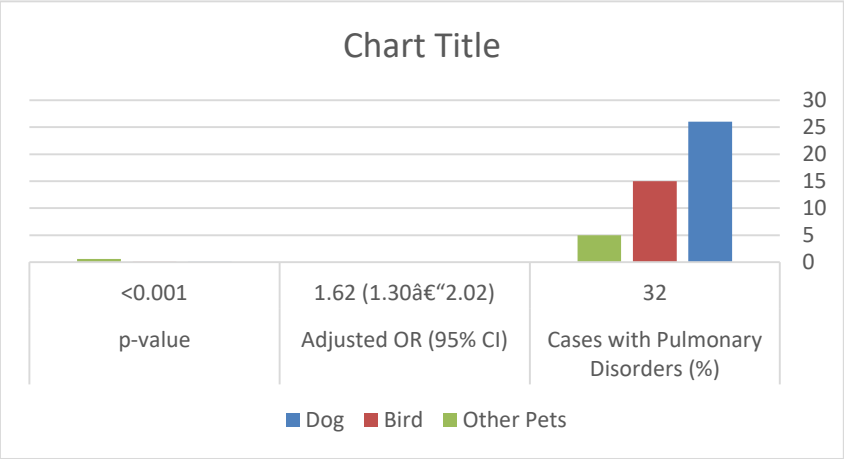
This table presents the adjusted odds ratios (ORs) for pulmonary disorders, asthma, and skin allergies associated with pet ownership. Pet owners had a 32% higher odds of pulmonary disorders compared to non-owners (OR = 1.32, p = 0.001), and a 45% higher odds of asthma specifically (OR = 1.45, p < 0.001). These findings suggest a significant positive association between pet ownership and respiratory disease risk. However, pet ownership was not significantly associated with skin allergies (OR = 1.05, p = 0.56), indicating that pet exposure may not play a major role in skin allergy risk in this population.

INTERPRETATION OF TABLE 3

PET TYPE AND PULMONARY DISORDERS

Pet type	Cases with pulmonary disorders (%)	Adjusted OR (95 % CI)	p- value
Cat	32	1.62 (1.30 – 2.02)	< 0.001
Dog	26	1.18 (1.02 – 1.36)	0.02
Bird	15	1.48 (1.15 – 1.92)	0.004
Other Pets	5	1.10 (0.8 – 1.56)	0.58

FIGURE 3



INTERPRETATION

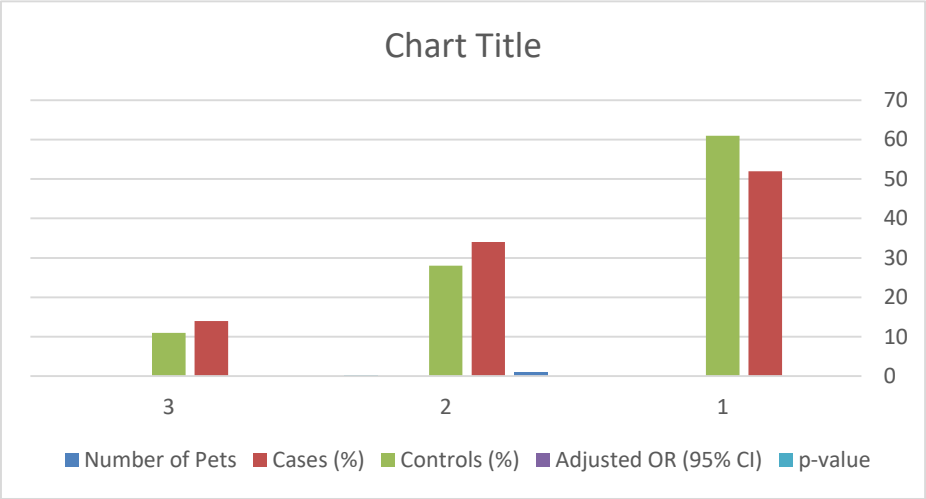
This table breaks down pulmonary disorder risk by pet type. Cat ownership was associated with the highest increased odds of pulmonary disorders (OR = 1.62), indicating a 62% increased risk compared to non-cat owners, and this association was highly significant ($p < 0.001$). Bird ownership was also significantly associated with increased risk (OR = 1.48, $p = 0.004$), which is notable given the cultural prevalence of bird keeping in Karachi. Dog ownership showed a modest but significant association (OR = 1.18, $p = 0.02$). Ownership of other pets was not significantly associated with pulmonary disorders. These results suggest that cats and birds are particularly important sources of allergen exposure linked to respiratory disease in this population.

INTERPRETATION OF TABLE 4

MULTI-PET EXPOSURE AND RISK

Number Of Pets	Cases (%)	Controls (%)	Adjusted OR (95 % CI)	p- value
0	52	61	Reference	-
1	34	28	1.28 (1.05 – 1.56)	0.01
≥2	14	11	1.66 (1.48- 1.86)	<0.001

FIGURE 4



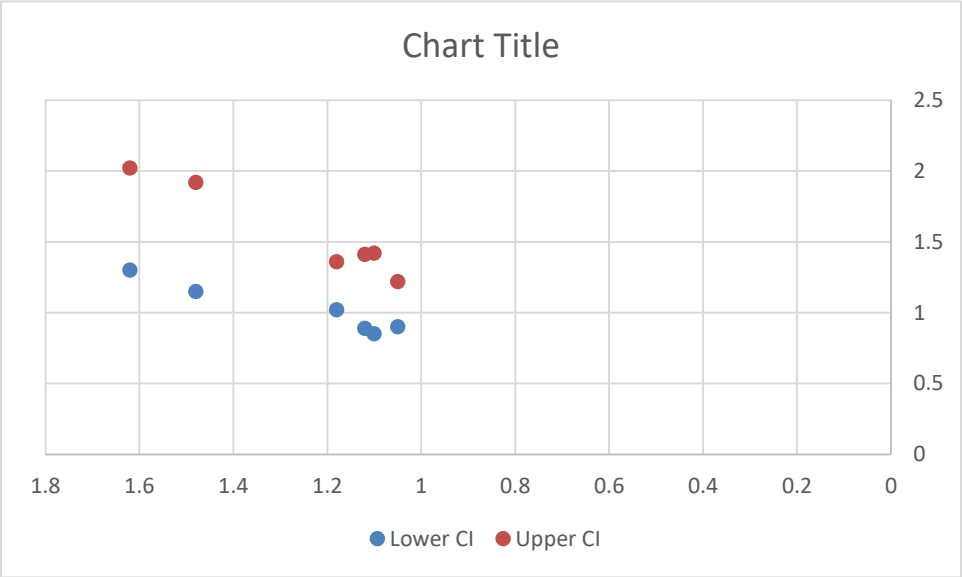
INTERPRETATION

This table examines the effect of the number of pets owned on pulmonary disorder risk. Compared to individuals with no pets, those owning one pet had a 28% increased odds of pulmonary disorders (OR = 1.28, p = 0.01), while owning two or more pets was associated with a 66% increased odds (OR = 1.66, p < 0.001). This dose-response relationship suggests that cumulative exposure to multiple pets may increase allergen load and respiratory disease risk, emphasizing the importance of considering pet quantity in risk assessments.

INTERPRETATION OF TABLE 5: ODDS RATIOS FOR ASTHMA BY PET TYPE AND ALLERGIC PREDISPOSITION

Pet type	Allergic status	OR	Lower CI	Upper CI
Cat	Allergic	1.62	1.30	2.02
Cat	Non-Allergic	1.10	0.85	1.42
Dog	Allergic	1.18	1.02	1.36
Dog	Non-Allergic	1.05	0.90	1.22
Bird	Allergic	1.48	1.15	1.92
Bird	Non-Allergic	1.12	0.89	1.41

FIGURE 5



INTERPRETATION OF FIGURE 5: ODDS RATIOS FOR ASTHMA BY PET TYPE AND ALLERGIC PREDISPOSITION

DESCRIPTION

The forest plot illustrates the adjusted odds ratios for asthma associated with cat, dog, and bird ownership, stratified by allergic sensitization status. Allergic individuals show significantly higher odds ratios across all pet types, with cat owners exhibiting the highest risk. Non-allergic individuals had lower or non-significant associations. This indicates that allergic predisposition strongly modifies the effect of pet exposure on asthma risk, highlighting the interaction between genetic susceptibility and environmental allergens.

DISCUSSION

SUMMARY OF FINDINGS

This Karachi-based study confirms that household pet ownership, especially cats and birds, is associated with increased odds of pulmonary disorders, particularly asthma. These findings align with recent global meta-analyses (Zhao et al., 2022) and regional studies (Behniafard et al., 2023). The significant association with bird ownership highlights a locally relevant risk factor often overlooked in Western literature.

ALLERGIC SENSITIZATION AS EFFECT MODIFIER

Consistent with European cohort data (Lundholm et al., 2020), allergic predisposition significantly modified the risk of asthma correlated with pet ownership, underscoring the

importance of genetic and immunological factors.

SKIN ALLERGIES

No significant association was found between pet ownership and skin allergies, mirroring mixed evidence in recent literature (Flohr et al., 2020; Smith et al., 2022). This suggests different pathophysiological mechanisms or the need for more sensitive diagnostic tools.

PUBLIC HEALTH IMPLICATIONS

Given the high prevalence of pet ownership and asthma in Karachi, public health initiatives should focus on educating families about pet allergen risks, especially for sensitized individuals. Clinicians should incorporate pet exposure history in asthma management and consider allergen avoidance strategies.

STRENGTHS AND LIMITATIONS

Strengths include a large sample size, clinical confirmation of diagnoses, and adjustment for multiple confounders. Limitations include retrospective design, recall bias, and lack of longitudinal follow-up.

CONCLUSION

In Karachi, household pet ownership-particularly cats and birds is associated with increased pulmonary disorder risk, especially among individuals with allergic sensitization. These findings support targeted clinical advice and public health policies to mitigate pet-related allergic morbidity. Further prospective studies are warranted to explore causal mechanisms and intervention strategies.

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ASSOCIATION BETWEEN HOUSEHOLD PET OWNERSHIP AND THE RISK OF SKIN ALLERGIES AND PULMONARY DISORDERS:
A RETROSPECTIVE CASE-CONTROL STUDY IN KARACHI

PART 1: STRUCTURED QUESTIONNAIRE

SECTION A: PARTICIPANT DEMOGRAPHICS

1. Participant ID: _____
2. Age (years): _____
3. Gender:

- ☐ Male
- ☐ Female
- ☐ Other

4. Residential area (neighborhood/locality): _____
5. Education level:

- ☐ None
- ☐ Primary
- ☐ Secondary
- ☐ Higher

6. Occupation: _____
7. Household monthly income (PKR): _____

Section B: Household Pet Ownership

1. Do you currently own any pets?

- ☐ Yes
- ☐ No (Skip to Section C)

2. What types of pets do you own or have owned in the past 12 months? (Check all that apply)

- ☐ Cat

- ☐ Dog
- ☐ Bird (e.g., parrot, canary)
- ☐ Other (please specify): _____

3. For each pet type owned, please specify:

Pet Type	Number of Pets	Duration of Ownership (months)	Indoor or Outdoor Pet? (I/O)	Age at First Exposure (years)
Cat				
Dog				
Bird				
Other				

4. Was there any pet ownership during your mother's pregnancy?

- ☐ Yes
- ☐ No
- ☐ Don't know

5. Are pets allowed inside the sleeping areas?

- ☐ Yes
- ☐ No

6. How often are pets groomed or bathed?

- ☐ Weekly
- ☐ Monthly
- ☐ Rarely
- ☐ Never

Section C: Environmental Exposures and Lifestyle Factors

1. Does anyone in your household smoke tobacco?

- ☐ Yes
- ☐ No

2. Do you personally smoke tobacco?

- ☐ Yes
- ☐ No

3. How many people live in your household? _____

4. What type of cooking fuel is used at home?

- ☐ Gas
- ☐ Electricity
- ☐ Wood/Charcoal
- ☐ Other: _____

5. Do you live near a busy road or industrial area?

- ☐ Yes
- ☐ No

Section D: Medical and Allergic History

1. Have you ever been diagnosed by a doctor with any of the following? (Check all that apply)

- ☐ Asthma
- ☐ Chronic bronchitis
- ☐ Allergic rhinitis (hay fever)
- ☐ Atopic dermatitis (eczema)
- ☐ Food allergy
- ☐ Other allergies (please specify): _____

2. In the past 12 months, have you experienced any of the following symptoms?

- Wheezing or whistling in the chest: [ ] Yes [ ] No

- Persistent cough not related to cold: [ ] Yes [ ] No
- Shortness of breath during exercise: [ ] Yes [ ] No
- Itchy, red, or dry skin: [ ] Yes [ ] No
- Nasal congestion or sneezing: [ ] Yes [ ] No

3. Do you have a family history of asthma or allergies?

- ☐ Yes
- ☐ No
- ☐ Don't know

4. Are you currently using any medications for asthma or allergies?

- ☐ Yes (please specify): _____
- ☐ No

Section E: Allergic Sensitization (To be completed after clinical testing)

(To be filled by clinical staff based on skin prick test or serum IgE results.)

1. Skin prick test positive for:

- ☐ Cat allergen
- ☐ Dog allergen
- ☐ Bird allergen
- ☐ Other (specify): _____

2. Serum IgE level (kU/L): _____

Part 2: Clinical Test Protocols

1. Spirometry (Pulmonary Function Test)

- **Purpose:** To assess lung function and confirm diagnosis of asthma or other pulmonary disorders.
- **Procedure:**
- Conduct spirometry using calibrated spirometer according to ATS/ERS guidelines (Miller et al., 2005).
- Measure Forced Expiratory Volume in 1 second (FEV1), Forced Vital Capacity (FVC), and FEV1/FVC ratio.
- Perform pre- and post-bronchodilator testing if indicated.

- **Interpretation:**
- Obstructive pattern (FEV1/FVC < 70%) with reversibility confirms asthma diagnosis.

2. Skin Prick Test (SPT)

- **Purpose:** To detect sensitization to common pet allergens.
- **Procedure:**
- Use standardized allergen extracts for cat (Fel d 1), dog (Can f 1), bird (avian serum proteins).
- Apply allergen drops on forearm skin and prick through each drop with a sterile lancet.
- Include positive control (histamine) and negative control (saline).
- Read wheal size after 15 minutes; a wheal ≥3 mm larger than negative control is positive.
- **Safety:**
- Monitor for adverse reactions; have emergency medications available.

3. Serum Allergen-Specific IgE Testing

- **Purpose:** Quantitative measurement of IgE antibodies to pet allergens.
- **Procedure:**
- Collect blood samples and analyze using ImmunoCAP or equivalent assay.
- Levels ≥0.35 kU/L considered positive for sensitization.

Training and Quality Assurance

- Interviewers will be trained on questionnaire administration to ensure consistency and minimize bias.
- Clinical staff performing spirometry and SPT will be certified and follow standardized protocols.
- Pilot testing of the questionnaire will be conducted on 30 participants to refine clarity and timing.