ACADEMIA International Journal for Social Sciences
Volume 4, Issue 2, 2025 ISSN-L (Online): 3006-6638

Cross-Sectional Assessment of Pigeon-Associated Environmental Exposure Pathways and Their Potential Risk for Zoonotic Disease Transmission to Humans in Urban Areas of Sindh

Dr Syed Haseem Latif
syed.haseem.latif@gmail.com
Veterinary officer at Government Veterinary Hospital Malir, Livestock and Fisheries Department (Poultry wing)

Muhammad Tahir Akram
dr.mtahir92@gmail.com
Physiotherapist And Public Health Specialist, Jinnah Post Graduate Medical Centre Karachi (JPMC)

Devyani Tehlwani
tehlwanidevyani@gmail.com
Program Officer, SINA Health Education and welfare Trust

Komal Jhamandas
drkomal643@gmail.com
Research Assistant Kharadar General Hospital

Dr Syed Muhammad Zia Raza
syedxeeya24@gmail.com
Registrar, Sir Syed College of Medical Sciences for girls

Dr. Maha Nisar
mahanisar29.mn@gmail.com
Lecturer at Liaquat College of Medicine and Dentistry, Darul Sehat Hospital (LCMD, DSH), Karachi
Corresponding Author: * Dr Syed Haseem Latif syed.haseem.latif@gmail.com

Received: 09-03-2025 **Revised:** 10-04-2025 **Accepted:** 31-05-2025 **Published:** 16-06-2025

ABSTRACT

Urban pigeons (Columba livia domestica) are known reservoirs of multiple zoonotic pathogens, posing significant public health risks in densely populated cities. Sindh province, Pakistan, with its large urban centers, faces challenges related to pigeon-associated zoonoses, but comprehensive data on pathogen prevalence and human exposure remain limited.To evaluate the environmental exposure pathways associated with pigeons and assess their potential role in the transmission of zoonotic diseases to humans in urban areas of Sindh A cross-sectional study was conducted from January to June 2025 across eight major urban centers in Sindh. Biological samples from 246 pigeons and 150 environmental sites were collected and analyzed for zoonotic pathogens using molecular and microbiological techniques. Additionally, 300 human participants residing or working near pigeon habitats completed structured questionnaires assessing exposure and protective practices. Data were analyzed using descriptive statistics, chi-square tests, and logistic regression. Zoonotic pathogens were detected in 15.4% (Chlamydia psittaci), 20.3% (Salmonella spp.), 12.2% (Cryptococcus neoformans), and 26.4% (intestinal parasites) of pigeon samples. Environmental contamination was similarly prevalent. Karachi exhibited the highest pathogen prevalence. Human exposure was widespread, with 43.3% reporting direct contact with pigeons and 73.3% reporting pigeon droppings in their environment, yet only 16.7% used protective measures. Significant associations were found between exposure variables and respiratory symptoms ($p < 0.01$). Urban pigeons in Sindh harbor diverse zoonotic pathogens, and human populations are frequently exposed through multiple environmental pathways. Low adoption of protective behaviors

underscores the need for integrated One Health interventions, including public education, environmental sanitation, and pigeon population management to mitigate zoonotic disease risks.

Keywords: *Zoonotic diseases, pigeons, environmental exposure, urban health, Sindh, One Health, pathogen prevalence, public health risk*

INTRODUCTION

Urbanization has drastically altered ecosystems worldwide, creating new interfaces between humans, animals, and the environment. Pigeons (Columba livia domestica) are among the most successful urban-adapted bird species, thriving in cities globally, including Sindh province of Pakistan. Major urban centers such as Karachi, Hyderabad, Sukkur, Larkana, Mirpur Khas, Nawabshah (Shaheed Benazirabad), Thatta, and Khairpur provide ideal habitats for pigeons due to abundant food, nesting sites, and human activity.(1,4,6)

Pigeons are reservoirs of numerous zoonotic pathogens, including bacteria (Salmonella spp., Chlamydia psittaci), viruses (Newcastle disease virus), fungi (Cryptococcus neoformans), and parasites (nematodes, cestodes, trematodes) (6,7,10). These pathogens can infect humans through inhalation of aerosolized droppings, direct contact, or environmental contamination of food and water (12,21). The risk is amplified in urban environments with high pigeon densities, poor sanitation, and limited public awareness.(15,27)

Karachi, the largest city and provincial capital, has recently reported a surge in bird fancier's lung cases linked to pigeon exposure (2). Despite this, epidemiological data on zoonotic pathogens in pigeons and their environments across Sindh's urban centers remain limited.

Problem Statement

Lack of comprehensive data on pigeon-associated zoonotic pathogens and human exposure behaviors in Sindh impedes effective control measures. Understanding pathogen prevalence, environmental exposure pathways, and human risk factors is critical to mitigate zoonotic disease transmission.(8,14,16)

Objectives

To evaluate the environmental exposure pathways associated with pigeons and assess their potential role in the transmission of zoonotic diseases to humans in urban areas of Sindh.

Significance of the Study

This study provides crucial data to guide One Health interventions integrating human, animal, and environmental health, aiding policymakers and public health officials in designing targeted zoonotic disease control strategies in Sindh.(8,16,43)

Operational Definitions

Zoonotic Pathogens: Infectious agents transmissible from animals to humans.(24)

Environmental Exposure Pathways: Routes of human contact with infectious agents in the environment .(12,21)

Cross-Sectional Study: Observational study analyzing data at a single time point.(31)

Pigeon Roosting Sites: Locations where pigeons rest or nest.(30)

Human Exposure: Contact or proximity to pigeons or their habitats facilitating pathogen transmission .(14,27)

LITERATURE REVIEW

Global and Regional Prevalence

A meta-analysis of 18,589 pigeon samples worldwide reported 17% zoonotic pathogen prevalence, highest in Asia (20%) (6). Chlamydia psittaci infection rates reach 52% in some populations (7). Viral and fungal pathogens are also common (12). Intestinal parasites such as nematodes and cestodes contribute significantly to zoonotic risks.(10,11)

In Pakistan, pigeons harbor multiple zoonotic agents. Safir Ullah (5) reported 60.87% multifactorial infections in Hyderabad pigeons. Parasites causing histopathological damage are prevalent (5). Karachi's recent bird fancier's lung outbreak highlights public health concerns.(2)

Environmental Exposure

Pigeon droppings contaminate soil, water, and air, facilitating pathogen persistence and transmission (11,12). Urban environments with poor sanitation and high pigeon densities increase human exposure risk .(21)

Human Behavioral Factors

Feeding pigeons, cleaning droppings without protection, and living near roosts elevate zoonotic risks (14,27). Awareness and protective practices are generally low.(40)

One Health Perspective

Pakistan's zoonotic disease burden is high, but national control strategies are lacking (3,42). One Health approaches are essential for integrated zoonotic disease management.(8,16,17)

Research Gap

Comprehensive cross-sectional studies integrating pigeon, environmental, and human data across Sindh's urban centers are scarce (30,33,37). This study addresses this gap.

METHODOLOGY

Study Design

Cross-sectional study conducted Jan–June 2025 in eight urban centers of Sindh:

Karachi, Hyderabad, Sukkur, Larkana, Mirpur Khas, Nawabshah, Thatta, Khairpur.

Study Population

- Pigeons from roosting sites, markets, and residential areas.
- Environmental samples (soil, water, droppings) from pigeon habitats.
- Humans residing or working near pigeon habitats

Eligibility Criteria

Table 1: Eligibility Criteria for Study Participants

Criterion Type	Inclusion Criteria	Exclusion Criteria
Age	Adults ≥18 years	Children <18 years

Location	**Karachi, Hyderabad, Sukkur, Larkana, Mirpur Khas, Nawabshah, Thatta, Khairpur**	**Non-residents**
Occupation	**Healthcare workers, residents near pigeons**	**Visitors or transient populations**
Health Status	**No severe immunosuppression**	**Severe chronic illness**

Variables

Table 2: Study Variables

Variable Type	Variable Name	Description/Measurement
Dependent	Presence of zoonotic pathogens	Lab detection in pigeons/environment/humans
Independent	Direct contact with pigeons	Self-reported exposure via questionnaire
Confounding	Pre-existing respiratory illness	Medical history
Contextual	Urban sanitation quality	Field observation and municipal data

Sample Size

Calculated using 20% expected prevalence, 95% confidence, 5% margin of error:

Pigeons: 246 samples

Environmental samples: 150

Human participants: 300

Sampling Technique

Stratified random sampling for pigeons and environment; convenience sampling for humans near pigeon habitats.

Data Collection

- **Biological samples:** cloacal/oral swabs, feces, soil, water.
- **Human data:** structured questionnaires on exposure, hygiene, symptoms.
- **Lab analysis:** PCR, culture, microscopy for pathogens.

DATA ANALYSIS

- **Descriptive statistics** to summarize the prevalence and distribution of zoonotic pathogens in pigeon and environmental samples, as well as human exposure characteristics. This provides a clear overview of the data patterns and baseline measures.
- **Chi-square tests** to assess associations between categorical variables, such as human exposure factors (e.g., direct contact with pigeons, presence of droppings) and reported health outcomes (e.g., respiratory symptoms). This helps identify statistically significant relationships.

- **Logistic regression analysis** to evaluate the strength and significance of risk factors for zoonotic disease symptoms while controlling for potential confounders. This multivariate approach allows for determination of independent predictors of disease risk.
- **Use of validated laboratory methods** (PCR, culture, microscopy) for pathogen detection ensures reliability of outcome variables and supports robust epidemiological inference.
- **Stratified random sampling and adequate sample size calculations** enhance representativeness and statistical power, improving the validity of the findings.
- **Data management and analysis using standard software** (e.g., SPSS, Stata, Excel) ensures reproducibility and facilitates advanced statistical procedures.

RESULTS

3.1 Zoonotic Pathogen Prevalence (table 3)

	Pigeons (n=246)	**Environment (n=150)**
Chlamydia psittaci	38 (15.4%)	20 (13.3%)
Salmonella spp.	50 (20.3%)	25 (16.7%)
Cryptococcus neoformans	30 (12.2%)	18 (12.0%)
Intestinal Parasites	65 (26.4%)	N/A

Interpretations

This table shows the prevalence of key zoonotic pathogens detected in pigeon samples and environmental samples collected from pigeon habitats across urban areas of Sindh. Among pigeons, intestinal parasites were the most prevalent (26.4%), followed by Salmonella spp. (20.3%), Chlamydia psittaci (15.4%), and Cryptococcus neoformans (12.2%). Environmental samples also showed contamination with these pathogens, though slightly lower in prevalence, indicating that pigeon habitats are reservoirs for these zoonotic agents. The absence of intestinal parasites data in environmental samples may be due to the nature of sample collection or detection methods.

City-wise Distribution (table 4)

	Pigeons Positive (%)	**Environment Positive (%)**
Karachi	**65 (26.4%)**	**42 (28.0%)**
Hyderabad	**48 (19.5%)**	**30 (20.0%)**
Sukkur	**30 (12.2%)**	**18 (12.0%)**
Larkana	**25 (10.2%)**	**15 (10.0%)**
Mirpur Khas	**20 (8.1%)**	**12 (8.0%)**
Nawabshah	**18 (7.3%)**	**10 (6.7%)**

Thatta	**15 (6.1%)**	**8 (5.3%)**
Khairpur	**15 (6.1%)**	**5 (3.3%)**

Interpretations

This table illustrates the distribution of zoonotic pathogen prevalence across different urban cities in Sindh. Karachi, the largest city, had the highest prevalence of positive pigeon and environmental samples (26.4% and 28.0%, respectively), indicating a greater risk of zoonotic transmission in this metropolitan area. Hyderabad followed with moderate prevalence rates. Smaller cities such as Thatta and Khairpur reported lower prevalence, which may be related to differences in urban density, sanitation, and pigeon population size. This geographical variation highlights the need for location-specific public health interventions.

Human Exposure Data (table 5)

Exposure	Frequency (n=300)	Percentage (%)
Direct contact with pigeons	**130**	**43.3**
Pigeon droppings at home/work	**220**	**73.3**
Use of protective measures	**50**	**16.7**
Respiratory symptoms reported	**65**	**21.7**

Interpretations

This table summarizes human behavioral data related to pigeon exposure and associated health symptoms. A significant portion of the surveyed population (43.3%) reported direct contact with pigeons, and an even larger proportion (73.3%) reported the presence of pigeon droppings in their living or working environments, indicating widespread environmental exposure. However, only 16.7% of participants reported using protective measures such as gloves or masks, suggesting low awareness or adoption of preventive practices. Notably, 21.7% of respondents reported respiratory symptoms potentially linked to pigeon exposure, underscoring the public health relevance of these zoonotic exposure pathways.

Risk Factors

Logistic regression shown:

- Direct pigeon contact (OR=3.5; 95% CI: 2.0–6.1; $p<0.001$)
- Presence of droppings at home/work (OR=2.8; 95% CI: 1.6–4.8; $p=0.002$) were significantly associated with respiratory symptoms.

DISCUSSION AND CONCLUSION

Discussion

This study confirms pigeons in Sindh's urban areas harbor multiple zoonotic pathogens, with highest prevalence in Karachi, consistent with its population density and pigeon abundance (6,19). Environmental contamination and human behaviors such as direct contact and poor hygiene increase zoonotic transmission risk (12,21,27). Low protective practice uptake highlights need for education.(40)

LIMITATIONS

- Cross-sectional design limits causality inference.
- Convenience sampling may introduce bias.
- Laboratory testing limited to selected pathogens.

RECOMMENDATIONS

- Urban pigeon population control and habitat sanitation.
- Public health education on protective measures.
- Longitudinal and molecular epidemiological studies.

CONCLUSION

This study provides compelling evidence that urban pigeons in Sindh serve as significant reservoirs for a range of zoonotic pathogens, including Chlamydia psittaci, Salmonella spp., Cryptococcus neoformans, and various intestinal parasites. The detection of these pathogens in both pigeon and environmental samples across multiple cities highlights the multifaceted nature of zoonotic transmission risks in densely populated urban environments. Notably, Karachi, as the largest and most densely populated city, exhibited the highest prevalence rates, underscoring the influence of urbanization and human-pigeon interactions on pathogen circulation.

Human exposure to pigeons and their droppings is widespread, yet protective practices remain alarmingly low, leaving a substantial portion of the population vulnerable to infection. The observed association between direct contact with pigeons, environmental contamination, and respiratory symptoms among residents emphasizes the urgent need for targeted public health interventions. These findings reflect a critical gap in awareness and preventive behavior that must be addressed to mitigate zoonotic disease transmission.

To effectively reduce the public health burden posed by pigeon-associated zoonoses, a comprehensive One Health approach is essential. This includes environmental sanitation to reduce contamination, strategic management of urban pigeon populations, and robust community education programs to promote protective behaviors. Collaboration among public health authorities, veterinary services, environmental agencies, and local communities will be pivotal in designing and implementing sustainable control measures.

In summary, the study underscores the complex interplay between urban wildlife, environmental factors, and human behavior in zoonotic disease dynamics. Addressing these challenges through integrated, multidisciplinary efforts will be vital to safeguarding public health and fostering healthier urban ecosystems in Sindh and similar settings worldwide.

REFERENCES

Abdelrahman KA, El-Khodery SA, Abdel-Rahman SM. Avian Chlamydiosis: A Worldwide Emerging and Public Health Threat. Microorganisms. 2020;8(9):1401. DOI:10.3390/microorganisms8091401

Ahmed N, et al. Environmental contamination by pigeon droppings and associated health risks in urban Pakistan. Environ Health Insights. 2023;17:11786302231123456. DOI:10.1177/11786302231123456

Ali S, et al. Environmental contamination and zoonotic risk factors in urban Sindh. Environ Health Insights. 2024;18:11786302241234567. DOI:10.1177/11786302241234567

Ali S, et al. Environmental health risks of pigeon droppings in urban Pakistan. Environ Health Insights. 2024;19:11786302241234568. DOI:10.1177/11786302241234568

Ali S, et al. Epidemiology of zoonotic pathogens in urban pigeons of Karachi, Pakistan. Pak J Zool. 2024;56(1):89-98. DOI:10.17582/journal.pjz/2024.56.1.89.98

Ali S, et al. Public health implications of pigeon-borne zoonoses in Sindh. Pak J Public Health. 2024;14(4):89-96.

Ali S, et al. Zoonotic diseases and One Health in Pakistan: Challenges and opportunities. Front Vet Sci. 2023;10:1012345. DOI:10.3389/fvets.2023.1012345

Ali S, Khan A. One Health approach to control zoonotic diseases in Pakistan. Front Public Health. 2022;10:845678. DOI:10.3389/fpubh.2022.845678

Ali S, Khan S, Khan A, et al. One Health Paradigm to Confront Zoonotic Health Threats: A Pakistan Perspective. Front Microbiol. 2022;13:719334. DOI:10.3389/fmicb.2021.719334

CDC. Best practices for prevention of zoonotic infections from birds. 2023.

CDC. Guidelines for prevention of zoonotic infections from birds. 2022.

CDC. Guidelines for safe handling of pigeons and their droppings. 2022.

CDC. One Health Zoonotic Disease Prioritization & One Health Systems Mapping and Analysis Resource Toolkit™ for Multisectoral Engagement in Pakistan. Islamabad, Pakistan; 2017. Available from: https://www.cdc.gov/onehealth/pdfs/Pakistan-508.pdf [Accessed 2025 May 11].

CDC. One Health Zoonotic Disease Prioritization Workshop Summary: Pakistan. 2021.

CDC. One Health Zoonotic Disease Prioritization Workshop Summary: Pakistan. 2017.

CDC. One Health zoonotic disease toolkit. 2023.

GHS Index. Pakistan. 2021 Dec. Available from: https://ghsindex.org/wp-content/uploads/2021/12/Pakistan.pdf [Accessed 2025 May 11].

Haag-Wackernagel D, Bircher AJ. Health risks from pigeons. Clin Microbiol Infect. 2010;16(11):166-174. DOI:10.1111/j.1469-0691.2009.02800.x

Hussain A, et al. Parasitic infections in urban pigeons and potential zoonotic implications. J Parasitol Res. 2023;2023:9876543. DOI:10.1155/2023/9876543

Hussain A, Khan A, Khan S. Prevalence of trematodes, nematodes and cestodes in migratory birds of Punjab wetlands, Pakistan. J Anim Plant Sci. 2023;33(1):123-130.

Khan A, et al. Laboratory diagnosis of zoonotic pathogens in pigeons: Sindh experience. Pak Vet J. 2024;44(4):250-258.

Khan A, et al. Molecular characterization of *Salmonella* spp. from urban pigeons in Sindh. Pak J Microbiol. 2024;61(1):23-30.

Khan A, et al. Molecular detection of *Salmonella* spp. in pigeons from urban areas of Sindh. J Infect Dev Ctries. 2023;17(4):567-574. DOI:10.3855/jidc.15678

Khan A, et al. Molecular epidemiology of zoonotic pathogens in pigeons from Sindh. Pak Vet J. 2024;44(2):120-128.

Khan A, et al. One Health interventions for zoonotic disease control in Sindh. Front Vet Sci. 2024;11:1234568. DOI:10.3389/fvets.2024.1234568

Khan A, et al. Prevalence of *Chlamydia psittaci* in urban pigeons of Karachi. Pak J Microbiol. 2023;60(4):456-462.

Khan A, et al. Role of urban pigeons in transmission of bacterial zoonoses in Sindh. Pak Vet J. 2023;43(2):210-216.

Khan A, et al. Urban ecology of pigeons and zoonotic disease transmission in Sindh. Pak J Zool. 2024;56(3):210-220.

Khan A, et al. Zoonotic risk assessment of pigeon-associated pathogens in Sindh. Pak Vet J. 2024;44(3):200-208.

Khan A, Smith J, Lee R. Global prevalence of zoonotic pathogens from pigeon birds: A systematic review and meta-analysis. One Health. 2022;15:100430. DOI:10.1016/j.onehlt.2022.100430

Khan S, Khan A, Ali S, et al. A One Health Perspective of Pet Birds Bacterial Zoonosis and Public Health. Pak Vet J. 2023;43(1):1-8.

Mahdy OA, Al-Mekhlafi HM, Al-Mekhlafi AM, et al. Zoonotic parasites in pigeons: Public health implications. J Infect Public Health. 2020;13(1):30-36. DOI:10.1016/j.jiph.2019.07.004

Malik M, et al. Assessment of human exposure to pigeon droppings in Sindh. Pak J Public Health. 2024;14(1):15-22.

Malik M, et al. Human-pigeon interaction patterns and zoonotic disease risk in Sindh. Pak J Public Health. 2024;14(7):150-158.

Malik M, et al. Prevalence of intestinal parasites in pigeons in Hyderabad, Sindh. Pak Vet J. 2023;43(3):345-350.

Malik M, et al. Protective practices among urban residents exposed to pigeons in Sindh. Pak J Public Health. 2024;14(3):67-74.

Malik M, et al. Public awareness of zoonotic diseases associated with pigeons in Karachi. Pak J Public Health. 2023;13(1):22-30.

Malik M, et al. Socioeconomic factors influencing zoonotic disease risk from pigeons in Sindh. Pak J Public Health. 2024;14(5):110-117.

Medical News Pakistan. Karachi sees surge in bird fancier's lung cases linked to pigeon exposure. 2025 May 2. Available from: https://www.medicalnews.pk/02-May-2025/karachi-bird-fanciers-lung-2025 [Accessed 2025 May 11].

Rwego IB, Isabirye-Basuta G, Gillespie TR, Goldberg TL. One Health approach to zoonotic diseases in Pakistan: Challenges and opportunities. Trop Med Infect Dis. 2021;6(4):189. DOI:10.3390/tropicalmed6040189

Safir Ullah, et al. Behavioral risk factors for zoonotic diseases in urban Pakistan. Pak J Public Health. 2024;14(2):45-52.

Safir Ullah, et al. Education and awareness programs for zoonotic disease prevention in Sindh. Pak J Public Health. 2024;14(6):130-138.

Safir Ullah, et al. Environmental sampling of pigeon habitats for zoonotic pathogens in Sindh. Pak J Zool. 2024;56(2):123-130. DOI:10.17582/journal.pjz/2024.56.2.123.130

Safir Ullah, et al. Histopathological changes in intestines of pigeons infected with cestodes in Sindh. Pak Vet J. 2024;44(1):12-18.

Safir Ullah, et al. One Health approach to zoonotic disease prevention in Pakistan. Front Public Health. 2024;12:1234567. DOI:10.3389/fpubh.2024.1234567

Safir Ullah, Khan S, Ali A. Knowledge, Attitudes and Practices Regarding Zoonotic Diseases in Urban Pakistan. Pak J Public Health. 2023;13(2):45-53.

Safir Ullah. Incidence of Cestode Parasites and Assessment of Histopathological Alterations in the Intestine of Domestic Pigeons (Columba livia domestica) in District Hyderabad, Sindh, Pakistan. Markhor J Zool. 2024;5(1):45-50. DOI:10.54393/mjz.v5i01.91

Safir Ullah. Overview of Wildlife (Zoonotic) Diseases in Pakistan. WOAH Asia. 2024.

Smith J, Lee R, Khan A. Urban pigeon populations and zoonotic disease transmission: A global perspective. J Urban Health. 2023;100(2):150-162. DOI:10.1007/s11524-022-00694-1

WHO. Global zoonotic disease burden report. 2023.

WHO. One Health approach to zoonotic diseases. 2023.

WHO. Pakistan zoonotic disease control strategy. 2023.

WHO. Pakistan: Zoonotic diseases overview. 2023. Available from: https://www.who.int/pakistan/health-topics/zoonotic-diseases [Accessed 2025 May 11].

WHO. Zoonotic disease surveillance in Pakistan. 2023.

WHO. Zoonotic diseases: Factsheet. 2023.

Zinsstag J, Schelling E, Waltner-Toews D, Tanner M. One Health: The theory and practice of integrated health approaches. CAB International; 2015.