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A Sociological Analysis of the links Between Climate Change and Infectious Disease Patterns in Urban Punjab, Pakistan.

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Abstract

The study aimed at a sociological investigation of the prevalent patterns of infectious diseases and its relationship with climate change in the urban areas of Punjab, Pakistan. For this purpose areas like Faisalabad, Sahiwal, Layyah, and Jhang were selected. Urban areas from these cities were selected randomly and then proportionately samples were drawn keeping in view the population size of these cities total 375 samples were drawn. A well structured questionnaire comprising of certain questions focusing on the problem statements were selected. Then the responses were put on the analytical tools and certain important results were drawn. Few important results are taken on the momentous variables like, environmental mediator, water stagnation, vector proliferation, urban heat condition, sanitation access, housing quality, and household overcrowding. The main objectives of the study are to explore the social and environmental vulnerability factors (e.g., poverty, overcrowding, sanitation, urban infrastructure) that mediate the impact of climate change on health outcomes, to assess the awareness, perceptions, and adaptive responses of urban communities toward climate-related health risks. The main findings shows moderate levels of water stagnation, vector proliferation, urban heat, and sanitation access received relatively positive assessment. However, concerns related to water contamination, mosquito prevalence, extreme heat, solid waste disposal, and overcrowding may increase environmental vulnerability to infectious diseases.

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INTRODUCTION

Rapid urbanization is transforming the physical and environmental characteristics of cities, particularly in developing countries where population growth is accompanied by expansion of built-up areas and pressure on land and natural resources. Urban development commonly involves the conversion of agricultural land, open spaces and vegetated areas into residential settlements, roads, commercial structures and other impervious surfaces. Such land-use changes adjust local environmental situations and can increase the insecurity of urban populations to climate-related hazards (Jabbar et al., 2022; Jabbar & Yusoff, 2022). Moreover,

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expansion of urban land increases environmental health risks, particularly where development occurs without adequate environmental planning and infrastructure. Urbanization therefore does not simply increase the number of people exposed to climate hazards; it also changes the physical conditions under which those hazards occur (Yang et al., 2021).

Urbanization also modifies the thermal environment of cities by increasing impervious surfaces and reducing vegetation. Buildings, roads and paved shows absorb and preserve solar radiation, while decreased vegetation limits natural cooling through shading and evapotranspiration. At the same time, transport, industries, buildings and other human activities release additional heat into the urban atmosphere. These processes contribute to the formation and intensification of the urban heating in which urban areas are more heated than their nearby rural environments. Rapid urban development and changes in land cover are important factors associated with increasing urban heat, with implications for human health and urban environmental quality (Kotharkar et al., 2018).

It further affects the urban water environment by altering natural drainage, surface runoff and water retention. The expansion of impervious surfaces reduces infiltration and increases the volume and speed of stormwater runoff, while inadequate drainage systems can leave water accumulated in streets, residential areas and vacant plots. Heavy rainfall associated with climatic variability can therefore produce waterlogging and urban flooding, particularly where drainage infrastructure has not developed at the same pace as urban expansion. Flooding can create stagnant water bodies that provide suitable breeding habitats for mosquitoes, while damaged sanitation systems and contaminated surface water can increase human exposure to pathogens (Saddique et al., 2023). Floods also facilitate infectious disease transmission through contaminated water and inundated environments, while mosquito vectors may proliferate after flooding events (Bett et al., 2021). Thus, rainfall variability and flooding become more important health concerns when they interact with poorly planned urban growth, inadequate drainage and limited environmental management.

Urban environmental degradation also occurs through air pollution, solid-waste accumulation and contamination of water and soil. Rapid population growth and increased consumption generate larger quantities of municipal waste, while inadequate collection and disposal can leave waste accumulated in residential and commercial areas. Such waste may retain rainwater and create breeding and resting sites for disease vectors, particularly mosquitoes and rodents. Solid waste in urban environments can support biological disease vectors and zoonotic reservoirs, with Aedes-borne diseases being particularly relevant to waste-associated vector habitats. Air pollution represents another important dimension of urban environmental change. In Pakistan, urban populations are exposed to substantial concentrations of particulate matter from traffic, industry, combustion and other activities (Krystosik et al., 2020).

The combined effects of climate change and urban environmental change are particularly important for infectious disease transmission because pathogens, vectors and human populations are all influenced by environmental conditions. Urban expansion creates dense human settlements, while higher temperatures, changing rainfall patterns, stagnant water and accumulated waste can alter habitats suitable for mosquitoes and other disease vectors. The relationship is therefore not simply a direct effect of climate on disease; it involves interactions

between climatic conditions, land use, infrastructure, population density and human exposure. Climate change, land-use change and urbanization jointly reshape ecological systems and contribute to the emergence and dissemination of infectious diseases (Mora et al., 2022).

Objectives:

- To explore the social and environmental vulnerability factors (e.g., poverty, overcrowding, sanitation, urban infrastructure) that mediate the impact of climate change on health outcomes.
- To assess the awareness, perceptions, and adaptive responses of urban communities toward climate-related health risks.
- **Hypotheses:**

- H1: Poor sanitation and overcrowded living conditions significantly mediate the relationship between climate change and disease prevalence.

H2: Communities with low awareness of climate change have higher vulnerability to infectious diseases

REVIEW OF LITERATURE

Climate Change and Environmental Health in Punjab

Climate change has increasingly been recognized as an environmental-health concern in Punjab because changes in temperature and precipitation occur alongside dense settlement, urban expansion, and uneven environmental infrastructure. Earlier climatic assessments established that Punjab has experienced significant changes in temperature over time, although the magnitude and spatial distribution of warming have varied across the province. Abbasi et al. (2021), using temperature records from 1970–2019, identified significant increases in mean temperature across Punjab, with comparatively stronger warming toward the southern and western parts of the province and increasing minimum temperatures in central areas. Similarly, Nawaz et al. (2020) assessed temperature datasets covering 1979–2015 and documented significant warming, while also demonstrating spatial differences in the magnitude of change according to location and temperature indicator. These findings indicate that environmental exposure to climate change in Punjab cannot be represented adequately through a single provincial temperature trend. Rather, the health implications of warming need to be considered in relation to the particular climatic and environmental conditions experienced by different populations.

The spatial character of warming became particularly evident when climatic change was examined in relation to urban environments. Nasar-u-Minallah and Ghaffar (2020), analyzing long-term temperature records from Lahore for the period 1950–2018, examined variations in minimum, maximum, and mean temperatures and reported increasing temperature trends over the study period. Their analysis also indicated stronger changes in minimum temperature at the urban station compared with a comparatively rural station, suggesting that urban development and the urban heating effect formed part of the environmental condition of

observed warming in Lahore. These findings are important for environmental-health research because urban populations are exposed to climatic conditions that may differ from those recorded at wider regional scales. The implications of increasing temperature are therefore shaped by the physical characteristics of urban areas, including built-up surfaces, vegetation, population concentration, and access to water. In this respect, climate change and urban environmental change are closely connected processes through which exposure to heat and other environmental stresses may become unevenly distributed across urban communities.

Changes in precipitation provide a more complex picture of climatic variability in Punjab. Unlike temperature, rainfall trends have not followed a consistent province-wide direction, with the magnitude and direction of change varying across stations and periods. Shirazi et al. (2019), examining selected districts of Punjab, identified changes in temperature and precipitation indicators and reported increases in several rainfall measures, including indicators of heavy rainfall, although a number of the observed trends were not statistically significant. More recently, Wahla et al. (2023) examined long-term rainfall variability in central Punjab during 1983–2020 and found substantial interannual and district-level variation, with different rainfall tendencies during different periods and the monsoon contributing approximately 70% of annual precipitation in the study region. Taken together, these studies suggest that rainfall change in Punjab is characterized more by spatial and temporal variability than by a simple linear increase or decrease. Such variability has environmental-health implications because periods of reduced rainfall may contribute to water stress, whereas intense rainfall can increase surface water accumulation, flooding, and pressure on drainage and sanitation systems.

The health significance of these climatic changes becomes clearer when they are considered alongside the social and physical characteristics of urban populations. Zuhra et al. (2019), assessing heat vulnerability in Lahore, examined exposure, sensitivity, and adaptive capacity and found that vulnerability varied spatially across the city. Their analysis associated differences in vulnerability with factors including population density, housing density and materials, water availability, education, vegetation, and pre-existing health conditions. Areas in the central parts of Lahore showed comparatively greater concentrations of vulnerability. These findings demonstrate that exposure to a climatic hazard does not automatically translate into an identical health risk for all residents. Instead, the consequences of climatic stress are mediated by the situations in which people live and by the resources available to them for adaptation. This perspective is particularly relevant to the present thesis because it shifts attention from climate as an isolated physical phenomenon toward the interaction between environmental exposure and the social organization of urban space.

Flooding represents another important pathway through which climatic variability can affect environmental health in Punjab. Rana and Routray (2018), examining urban flood vulnerability in Pakistan, developed a multi-dimensional framework incorporating social, economic, physical/infrastructural, institutional, and attitudinal dimensions of vulnerability. Their findings demonstrated that vulnerability to flooding could not be explained solely by physical exposure to the hazard; rather, differences in social conditions, infrastructure, institutions, and household characteristics contributed to variations in vulnerability. More

recent modelling research on major urban centres of Punjab projected increases in extreme rainfall intensity under future climate scenarios, including changes in 100-year return-period rainfall intensities (Haseeb et al., 2025). Although such projections do not establish a direct relationship with disease prevalence, they indicate the potential for increasing pressure on urban drainage and flood-management systems. Where intense rainfall interacts with inadequate drainage, impervious surfaces, and densely populated settlements, climatic hazards can consequently produce environmental conditions relevant to infectious-disease transmission.

METHODOLOGY

This study investigates the prevalence of diseases associated with unsafe water and other sources of contamination in Faisalabad, sahiwal, Layyah, and jhang Pakistan. The study population consists of individuals affected by these diseases or related contaminants in the selected areas. A simple random sampling technique was applied to draw a sample of 375 respondents from the available lists of the target population.

Data were gathered through a structured questionnaire designed to obtain information relevant to the research objectives. The completed questionnaires were collected, and the responses were subsequently coded and processed using the statistical package for the social science (SPSS). Descriptive statistical techniques were employed for univariate analysis, including the calculation of arithmetic means, modes, standard deviations, and ranges to summarize the relevant study variables. Furthermore, inferential statistical procedures, including t-tests and other appropriate statistical tests, were used to assess differences and associations among the variables under investigation.

To complement the primary data, secondary information was obtained from the archival records of the Meteorological Department. These data provided additional environmental and meteorological context for examining the potential association between climatic conditions, water contamination, and the occurrence of related diseases

RESULTS AND DISCUSSION

Environmental Mediators

Water Stagnation and Drainage Conditions (N = 375)

Item	A	B	C	D	Mean	SD
How many times is standing water observed near your residence	20.0	24.8	55.2	0.0	2.35	0.79
How often are drainage systems blocked in your areas	14.9	39.7	45.3	0.0	2.30	0.72
How would you rate the drainage situation in your area	9.9	64.8	20.3	5.1	2.21	0.68

Item	A	B	C	D	Mean	SD
How frequently does rainwater remain stagnant after rainfall	10.1	40.0	44.8	5.1	2.45	0.74
How adequate is the supply of clean drinking water in your area	19.7	54.9	20.3	5.1	2.11	0.77
How often do you experience water contamination issues	9.9	29.9	45.3	14.9	2.65	0.85
How often does standing water attract mosquitos insect	9.9	35.2	40.3	14.7	2.60	0.86
How frequently are drainage channels cleaned	14.7	40.3	35.2	9.9	2.40	0.86
How severe is water stagnation in your area during monsoon season	9.9	35.2	40.3	14.7	2.60	0.86
How often does stagnant water affect daily activities	25.3	45.3	29.3	0.0	2.04	0.74
How accessible is safe drinking water in your location	18.1	52.8	29.1	0.0	2.11	0.68
Overall, how serious is water stagnation in your area	25.1	44.8	30.1	0.0	2.05	0.74
Water stagnation (index)					**2.32**	**0.29**

Note. Items are scored so that 4 = most severe stagnation / drainage problems. Percentages are row percentages; the final row gives the mean of the item means.

Standing water provides breeding sites for mosquitoes, and the temperature range in which mosquito-borne pathogens are transmitted is expanding with warming (Mordecai et al., 2019).

Water and sanitation conditions form a particularly important component of this pathway because changes in climatic conditions can affect both the availability and quality of water. Sharif et al. (2024), in an integrative review of climatic factors and waterborne infectious outbreaks in Pakistan, examined the relationship between climatic conditions, water-related hazards, and vulnerability.

The findings are relevant to Punjab because urban communities depend heavily on shared water, drainage, and sanitation infrastructure, meaning that disruption to these systems may affect large populations simultaneously. Flooding may contaminate water sources, damage sanitation facilities, and create stagnant water, while periods of inadequate rainfall may place additional pressure on already vulnerable water-supply systems. Consequently, the environmental-health effects of climate variability are mediated through the condition and accessibility of essential urban services.

Vector Proliferation (N = 375)

Item	A	B	C	D	Mean	SD
How often do you observe mosquitoes in your area	9.9	54.7	20.3	15.2	2.41	0.86
How common are flies and insects near living areas	14.7	40.0	45.3	0.0	2.31	0.71
How frequently do vector related diseases occur in your locality	24.3	45.3	20.3	10.1	2.16	0.91
How frequently do stagnant water sources contribute to mosquito breeding	14.7	60.5	24.8	0.0	2.10	0.62
How severe is the mosquito problem during summer and monsoon period	5.1	49.6	40.3	5.1	2.45	0.67
Vector proliferation (index)					**2.29**	**0.44**

Note. Items are scored so that 4 = highest vector proliferation (mosquitoes, flies and insects, vector-related disease, summer/monsoon severity). Percentages are row percentages; the final row gives the mean of the item means.

Table 1 presents the item-level responses. The overall index has a mean of 2.29 (SD = 0.44) on the 1–4 scale, which falls in the moderate range; 19.5% of respondents scored low, 80.5% moderate and 0.0% high. The highest-scoring item was "How severe is the mosquito problem during summer and monsoon period" (M = 2.45) and the lowest-scoring item was "How frequently do stagnant water sources contribute to mosquito breeding" (M = 2.10). Vector indicators were in the moderate range: mosquitoes, flies and insects are commonly observed near living areas and become more of a problem in the summer and monsoon season. This seasonal rise follows the combination of heat and standing water described above, and it makes vectors the biological expression of environmental stress in the model.

Vector-borne infections provide an important example of this environmental relationship. Mosquito development and survival are influenced by temperature, rainfall, humidity, and the availability of suitable breeding habitats, while pathogen development within vectors is also sensitive to environmental conditions. In Pakistan, dengue research has provided substantial evidence of these interrelationships. Khan et al. (2018), in a systematic analysis of dengue epidemiology in Pakistan from 1980 to 2014, documented the establishment and geographical expansion of dengue and identified climate, urbanization, population growth, socioeconomic conditions, and human mobility as factors relevant to its epidemiological pattern. This broader perspective was supported by research examining dengue transmission across major Pakistani cities. Khalid and Ghaffar (2015) investigated dengue transmission in relation to urban environmental gradients and reported relationships involving climatic conditions together with drainage, urbanization, and population density. Their findings indicated that dengue transmission could not be adequately interpreted through climatic variables alone because the urban environment influenced opportunities for vector breeding and human exposure. Research in Lahore subsequently examined temporal relationships between climatic

conditions and dengue incidence, while more recent spatial analysis considered rainfall, land-surface temperature, water bodies, vegetation, and land use in relation to dengue prevalence (Khan et al., 2024). Collectively, these studies indicate that climatic conditions contribute to the environmental suitability for vector transmission, but their effects are mediated by characteristics of the built environment and patterns of human settlement.

Urban Heat Island Conditions (N = 375)

Item	A	B	C	D	Mean	SD
How would you rate the temperature in your urban area compared to nearby rural areas	25.1	30.4	9.9	34.7	2.54	1.20
How often do you feel extreme heat in your area	14.9	20.3	49.9	14.9	2.65	0.91
How adequate in greenery in your location	34.7	50.1	15.2	0.0	1.81	0.68
How available are parks open green spaces in your area	19.7	30.1	40.3	9.9	2.40	0.91
How much does concrete infrastructure add to heat in your area	4.8	54.7	30.4	10.1	2.46	0.74
How frequently do heatwaves affect your area	4.8	35.5	45.1	14.7	2.70	0.78
How effective in vegetation in decreasing heat in your locality	14.9	55.2	24.8	5.1	2.20	0.75
How would you rate ventilation nearby residential areas	34.7	50.1	10.1	5.1	1.86	0.79
How frequently does indoor heat become uncomfortable	14.9	25.3	45.1	14.7	2.59	0.91
How suitable is urban planning for decreasing heat effects	19.7	50.4	29.9	0.0	2.10	0.70
How often do residents use cooling measures due to excessive heat	9.6	55.2	25.1	10.1	2.36	0.79
Overall, how severe is the urban heat island influence in your area	4.8	69.9	25.3	0.0	2.21	0.51
Urban heat island (index)					**2.32**	**0.43**

Note. Items are scored so that 4 = strongest heat-island conditions (little greenery, high concrete heat, frequent heatwaves). Percentages are row percentages; the final row gives the mean of the item means.

The item-level response are reported in Table 2. The overall in index range from 1 to 4 with a mean value of 2.32 (SD = 0.43), which is considered as moderate; 19.7% of respondents have a low score, 80.3% have a moderate score and 0.0% have a high score. The item with the highest score was “How frequently do heatwaves affect your area” (M = 2.70) and the lowest score was for “How adequate in greenery in your location” (M = 1.81). The items relating to heat received the highest scores: A number of respondents reported that their area experienced

heatwaves and that it was hotter than areas in the surrounding rural region, with many indicating that there was a contribution from concrete infrastructure. Overall the heat-island score is low-to-moderate, with greenery and ventilation of residential areas around the site rated favourably, while the suitability of the urban planning is rated unfavourably. Social production of heat-island conditions – dense construction, distribution of green space and urban planning – and low-income households have difficulty cooling their houses. This is the second climate change - environment - health pathway in the framework.

Heat exposure and heat-related burden of illness are also higher in cities during the heat-island conditions, while the number of people exposed to extreme urban heat has grown quickly in the world's urban population (Heaviside et al., 2017, Tuholske et al., 2021). Urban environmental change has increasingly become an important dimension of climate change because the physical transformation of cities can modify local climatic conditions and alter the ways in which environmental risks are distributed across urban space. Evidence from Lahore showed that urbanization was accompanied by changes in mean annual and minimum temperatures over the period 1950–2007, while maximum temperature did not exhibit the same pattern, indicating that urban development may influence different components of the local thermal environment in distinct ways (Sajjad et al., 2009). The study situated these temperature changes within the broader transformation of Lahore associated with population growth, expansion of built-up areas, and increasing transport activity. Subsequent research developed this perspective through spatial assessments of land-cover transformation. In Lahore, the conversion of vegetated areas into built-up surfaces was associated with changes in land-surface temperature and the urban heating pattern, while the distribution of green cover and built-up land produced considerable spatial variation in thermal conditions (Jabbar & Yusoff, 2022).

Sanitation Access (N = 375)

Item	A	B	C	D	Mean	SD
Does your household have a sewerage connection	4.8	14.9	25.1	55.2	3.31	0.90
How regular is waste collection services in your locality	0.0	5.1	55.5	39.5	3.34	0.57
How accessible are public sanitation services	0.0	25.1	40.0	34.9	3.10	0.77
How frequently do sanitation problems occur in your area	0.0	25.1	60.0	14.9	2.90	0.63
How would you rate clean condition in your neighborhood	0.0	10.1	49.9	40.0	3.30	0.64
How adequate is wastewater management in your area	0.0	25.1	60.0	14.9	2.90	0.63
How frequently do you pay WASA water utility bills	4.8	14.9	55.2	25.1	3.01	0.77

Item	A	B	C	D	Mean	SD
How effective is solid waste disposal in your location	40.0	49.9	10.1	0.0	1.70	0.64
How often do open waste dumps appear near residence	5.1	25.3	59.7	9.9	2.74	0.70
How safe is drinking water sanitation in your area	10.1	4.8	60.0	25.1	3.00	0.84
Overall how satisfied are you with sanitation access in your location	0.0	20.0	65.1	14.9	2.95	0.59
Sanitation access (index)					**2.93**	**0.35**

Note. Items are scored so that 4 = best sanitation access. Percentages are row percentages; the final row gives the mean of the item means.

Safe water, sanitation and hygiene have a well-established effect on the risk of diarrhoeal and other infectious diseases (Pruss-Ustun et al., 2019; Wolf et al., 2022).Water, sanitation and healthcare access provide another pathway through which social inequality can translate climatic stress into infectious disease vulnerability. Climate-related flooding and rainfall variability can contaminate water sources and disrupt sanitation systems, but the resulting health consequences depend substantially on whether households have access to safe water, functional sanitation and effective healthcare services. A recent synthesis of evidence on climate-sensitive diarrheal disease found that climatic changes were repeatedly associated with diarrheal outcomes while also interacting with social determinants, particularly water, sanitation and hygiene conditions (Celegen and Sarioz, 2025). The Pakistani evidence presents a similar pattern. Sharif et al. (2024) identified poverty, illiteracy, limited healthcare accessibility, malnutrition and exposure to water pollution among important vulnerability factors associated with waterborne infectious diseases in Pakistan. These conditions can become more consequential during climatic extremes because floods may damage health facilities, interrupt medical supplies and restrict physical access to treatment, while contaminated water and disrupted sanitation increase exposure to enteric pathogens. Consequently, the same climatic event may produce markedly different health outcomes across urban populations depending on household resources, neighborhood infrastructure and the availability and affordability of healthcare.

Housing Quality (N = 375)

Item	A	B	C	D	Mean	SD
How would you rate the overall condition of your house	5.1	20.0	60.0	14.9	2.85	0.73
How adequate is ventilation in your house	5.1	5.1	50.1	39.7	3.25	0.77
What type of construction material is mainly used in your residence	9.9	19.7	20.0	50.4	3.11	1.04
How would you rate inside air circulation	4.8	14.9	45.3	34.9	3.10	0.83

Item	A	B	C	D	Mean	SD
How sufficient is natural lighting in your residence	0.0	10.1	60.0	29.9	3.20	0.60
How often does your house require repairs	5.1	24.8	45.3	24.8	2.90	0.83
How safe is your house during severe weather condition	0.0	14.9	40.3	44.8	3.30	0.71
How available are green spaces around your area	9.9	24.8	50.4	14.9	2.70	0.84
How comfortable is your home during summer season	0.0	20.0	55.5	24.5	3.05	0.67
How frequently does overcrowding affect living conditions	4.8	34.9	60.3	0.0	2.55	0.59
How would you rate sanitation facilities in your residence	5.1	34.9	40.3	19.7	2.75	0.83
How safe your residence from pests and insects	5.1	30.1	34.9	29.9	2.90	0.89
Housing quality (index)					**2.97**	**0.32**

Note. Items are scored so that 4 = best housing quality. Percentages are row percentages; the final row gives the mean of the item means.

Table 2 presents the item-level responses. The overall index has a mean of 2.97 (SD = 0.32) on the 1–4 scale, which falls in the moderate range; 0.0% of respondents scored low, 60.0% moderate and 40.0% high. The highest-scoring item was "How safe is your house during severe weather condition" (M = 3.30) and the lowest-scoring item was "How frequently does overcrowding affect living conditions" (M = 2.55). Housing quality was rated moderately high on average: most houses are in good condition, adequately ventilated and built of cement or brick, though a minority rely on wood or temporary material. Housing is a material expression of social position, and in Social Vulnerability Theory it determines how well households are shielded from heat, rain, insects and pests. The weakest aspects were the effect of overcrowding on living conditions, the availability of green space around the area and sanitation facilities inside the residence, which show where climate stress can enter even well-built homes.

Good housing is a recognised determinant of health because poor ventilation, dampness and pests increase infection risk (Krieger & Higgins, 2002).

Housing conditions are increasingly understood as an important social and environmental determinant of infectious disease vulnerability because the dwelling is a major setting in which people experience repeated exposure to environmental hazards and close contact with other household members. The world health organization (WHO) housing and health instructions subsequently consolidated evidence showing that crowded housing is associated with increased exposure to infectious diseases, while inadequate water and sanitation can facilitate

communicable diseases through impaired hygiene and environmental contamination (World Health Organization [WHO], 2018). This relationship has particular relevance to rapidly growing urban areas, where population growth, limited affordable housing, informal settlements, and uneven infrastructure can produce substantial differences in the quality of household environments. Housing therefore does not operate as an isolated physical determinant; its effects are shaped by household resources, access to urban services, neighborhood conditions, and the capacity of residents to modify or improve their living environment. The distribution of healthy housing is consequently also a question of social inequality, since households with fewer economic resources are more likely to experience several housing disadvantages simultaneously (Howden-Chapman et al., 2023).

Household Overcrowding (N = 375)

Item	A	B	C	D	Mean	SD
Number of people currently living in the household	9.9	45.1	34.9	10.1	2.45	0.81
Number of rooms available in the residence	9.9	45.1	34.9	10.1	2.45	0.81
How would you describe the living space in your residence	40.0	49.9	10.1	0.0	1.70	0.64
How frequently does overcrowding create stress in the household	14.7	45.1	35.2	5.1	2.31	0.78
How adequate is ventilation congested room	14.7	60.0	25.3	0.0	2.11	0.62
How often do overcrowded situation affect sleep quality	19.7	30.4	44.8	5.1	2.35	0.85
How would you rate sanitation conditions in your household	19.7	30.4	44.8	5.1	2.35	0.85
How frequently do infectious illness spread among household members	24.8	40.3	29.9	5.1	2.15	0.85
How comfortable are the living conditions in your house	34.9	55.2	9.9	0.0	1.75	0.62
How frequently do household members share bedrooms	14.9	29.9	55.2	0.0	2.40	0.74
How often does overcrowding affect privacy	9.9	24.8	55.5	9.9	2.65	0.79
Overall how severe is overcrowding in your home	34.9	15.2	49.9	0.0	2.15	0.91
Overcrowding (index)					**2.24**	**0.44**

Note. Items are scored so that 4 = most severe overcrowding. Percentages are row percentages; the final row gives the mean of the item means.

Household crowding is a long-established risk factor for the transmission of respiratory and other infections (Baker et al., 2000). Overcrowding provides one of the clearest pathways through which housing conditions can increase infectious disease exposure. A systematic

review conducted for the WHO housing guidelines found that, across most studies, household crowding was associated with respiratory infectious diseases, including influenza, pneumonia, acute respiratory illness and respiratory syncytial virus, although the definition of crowding varied across studies (WHO, 2018). Evidence for gastrointestinal infections also indicated an association between higher household density and diarrhoeal or gastroenteric disease, while evidence for other infections was more variable. This variability is important because household density may represent several related processes rather than a single exposure: more frequent interpersonal contact, greater duration of shared indoor exposure, difficulty separating an infected person, and greater pressure on sanitation and household facilities. More recent systematic evidence has similarly linked household crowding with increased infectious disease occurrence across different pathogens and transmission routes, although substantial heterogeneity between studies remains (Kvalsvig et al., 2023). Research specifically examining tuberculosis has provided further support for the importance of housing conditions. A systematic review of 26 studies found that inadequate housing was associated with several stages of tuberculosis development and outcomes, with overcrowding, ventilation, dampness and other aspects of housing quality contributing to exposure and transmission pathways (Lee et al., 2022).

Hypothesis	**Statement**	**Test**	**Key result**	**Decision**
H1	Climate change indicators are related to the prevalence of infectious diseases	Correlation and multiple regression	r = .136, p = .008; R^2 = .100; air pollution and rainfall variability significant	Supported (weak)
H2	Low awareness is associated with higher vulnerability	Correlation, t-test	r = -.424, p < .001; d = 0.87	Supported

The hypothesis testing results indicate that H1 was weakly supported, as climate change indicators reflected a statistically significant but weak relationship with the prevalence of infectious diseases (r = .136, p = .008). Air pollution and rainfall variability appear as significant predictors, while the model explained 10% of the variance in infectious disease prevalence. H2 was also supported, showing a moderate negative association between awareness and vulnerability ($r = -.424$, $p < .001$), with a large impact size (Cohen's $d = 0.87$). These results highlight the importance of climate-related environmental factors and public awareness in understanding vulnerability to infectious diseases.

CONCLUSION

Table 1 indicate that the overall water stagnation index was 2.32 (SD = 0.29), indicating a moderate level of water stagnation and drainage-related concerns in the study areas. Water contamination (M = 2.65, SD = 0.85) and mosquito attraction due to standing water (M = 2.60, SD = 0.86) recorded relatively higher mean scores, highlighting potential environmental conditions that may contribute to infectious disease transmission. Table 2 shows that the overall vector proliferation index was 2.29 (SD = 0.44), indicating a moderate level of vector-related environmental concerns in the study areas. Mosquito prevalence during summer and monsoon (M = 2.45, SD = 0.67) and mosquito observation in residential areas (M = 2.41, SD = 0.86) recorded the highest mean scores, highlighting the potential role of seasonal conditions in vector proliferation and infectious disease transmission. Table 3 shows that the overall urban heat island index was 2.32 (SD = 0.43), indicating a moderate level of urban heat-related concerns in the study areas. Heatwaves (M = 2.70, SD = 0.78) and extreme heat (M = 2.65, SD = 0.91) recorded the extreme mean scores, while limited greenery (M = 1.81, SD = 0.68) highlights the importance of improving green spaces to help decrease urban heat. Table 4.24 indicate that the overall sanitation access index was 2.93 (SD = 0.35), reflecting respondents' generally moderate-to-positive assessments of sanitation access in their areas. Regular waste collection (M = 3.34, SD = 0.57) and household sewerage connections (M = 3.31, SD = 0.90) received the highest mean scores, whereas solid waste disposal (M = 1.70, SD = 0.64) was rated lowest, highlighting a key sanitation-related concern. Table 4 indicate that the overall housing quality index was 2.97 (SD = 0.32), indicating a generally moderate-to-positive assessment of housing conditions among respondents. Housing safety during severe weather (M = 3.30, SD = 0.71) and ventilation (M = 3.25, SD = 0.77) received the extreme mean scores, whereas overcrowding (M = 2.55, SD = 0.59) and limited green spaces (M = 2.70, SD = 0.84) remained notable concerns that may increase environmental vulnerability. Table 4.22 indicate that the overall household overcrowding index was 2.24 (SD = 0.44), suggesting a moderate level of overcrowding-related concerns among respondents. Overcrowding's effect on privacy recorded the highest mean score (M = 2.65, SD = 0.79), while limited living space (M = 1.70, SD = 0.64) and household comfort (M = 1.75, SD = 0.62) reflected concerns about residential conditions that may increase vulnerability to infectious diseases.

REFERENCE

Bett, B. K., Tumusiime, D., Lindahl, J. F., Roesel, K., Delia, G., & others. (2021). The role of floods on pathogen dispersion. In *Floods and health: Impacts and management*. Springer.

Jabbar, M. T., Nasar-u-Minallah, M., & Yusoff, M. M. (2022). Predicting the impact of land use changes on thermal environment in Lahore, Pakistan: Implications for urban planning. *Geography, Environment, Sustainability*. https://doi.org/10.24057/2071-9388-2023-2862

Jabbar, M. T., & Yusoff, M. M. (2022). Assessing the spatiotemporal urban green cover changes and their impact on land surface temperature and urban heat island in Lahore (Pakistan). *Geography, Environment, Sustainability*. https://doi.org/10.24057/2071-9388-2021-005

Kotharkar, R., Ramesh, A., & Bagade, A. (2018). Urban heat island studies in South Asia: A critical review. *Urban Climate, 24*, 1011–1026. https://doi.org/10.1016/j.uclim.2017.12.006

Krystosik, A. R., Njoroge, G., Odhiambo, L., Forsyth, J. E., Mutuku, F. M., & LaBeaud, A. D. (2020). Solid wastes provide breeding sites, burrows, and food for biological disease vectors, and urban zoonotic reservoirs: A call to action for solutions-based research. *Frontiers in Public Health, 7*, 405. https://doi.org/10.3389/fpubh.2019.00405

Mora, C., McKenzie, T., Gaw, I. M., Dean, J. M., von Hammerstein, H., Knudson, T. A., Setter, R. O., Smith, C. Z., Webster, K. M., Patz, J. A., & Franklin, E. C. (2022). Over half of known human pathogenic diseases can be aggravated by climate change. *Nature Climate Change, 12*, 869–875.

Saddique, A., Khaliq, A., & others. (2023). Devastating floods to dengue epidemic—a deadly combination for Pakistan? *Journal of Global Health Reports*. https://doi.org/10.1097/GH9.0000000000000323

Yang, D., Ye, C., & Xu, J. (2021). Land-use change and health risks in the process of urbanization: A spatiotemporal interpretation of a typical case in Changzhou, China. *Land, 10*(8), 820. https://doi.org/10.3390/land10080820

Akthar, T. M., & Reid, M. (2024). The urgency of climate-resilient health systems in Pakistan: Lessons from the 2022 floods. *International Journal of Public Health, 69*.

Alamgir, W., & Shan, H. (2023). The multifaceted consequences of climate change on human health. *Life and Science, 4*(1), 2.

Alied, M., Salam, A., Sediqi, S. M., Kwaah, P., Tran, L., & Huy, N. T. (2023). Disaster after disaster: The outbreak of infectious diseases in Pakistan in the wake of 2022 floods. *Annals of Medicine and Surgery, 86*, 891–898.

Bostan, N., Javed, S., Nabgha-e-Amen, Eqani, S. A. M. A. S., Tahir, F., & Bokhari, H. (2017). Dengue fever virus in Pakistan: Effects of seasonal pattern and temperature change on distribution of vector and virus. *Reviews in Medical Virology, 27*(1).

Bouma, M. J., Dye, C., & van der Kaay, H. J. (1996). Falciparum malaria and climate change in the Northwest Frontier Province of Pakistan. *American Journal of Tropical Medicine and Hygiene, 55*(2), 131–137.

Busri, A., et al. (2025). Climate change implications of smog in Pakistan: Amplifying factors and health burden of PM2.5 exposure. *Indus Journal of Bioscience Research, 3*(10), 214–223.

Erling, V., Jalil, F., Hanson, L., & Zaman, S. (1999). The impact of climate on the prevalence of respiratory tract infections in early childhood in Lahore, Pakistan. *Journal of Public Health Medicine, 21*(3), 331–339.

Jabeen, A., Ansari, J., Ikram, A., Khan, M. A., & Safdar, M. (2022). Impact of climate change on the epidemiology of vector-borne diseases in Pakistan. *Global Biosecurity, 4*.

Khan, F., Shah, S., Shah, S., & Khan, S. A. (2024). *Climate change and human health: Impacts and vulnerability*.

Khan, J., Khan, I., Ghaffar, A., Khalid, B., & Khalid, B. (2018). Epidemiological trends and risk factors associated with dengue disease in Pakistan (1980–2014): A systematic literature search and analysis. *BMC Public Health, 18*(1), 745.

Malik, S. M., Awan, H., & Khan, N. (2012). Mapping vulnerability to climate change and its repercussions on human health in Pakistan. *Globalization and Health, 8*(1), 31.

Naqvi, S. A. A., et al. (2019). Changing climatic factors favor dengue transmission in Lahore, Pakistan. *Environments, 6*(6), 71.

Riaz, S., et al. (2022). *Climate shift: A major factor in spread of Aedes aegypti and abundance of dengue in Pakistan*.

Saeed, A., et al. (2022). Modelling the impact of climate change on dengue outbreaks and future spatiotemporal shift in Pakistan. *Environmental Geochemistry and Health*.

Sharif, F., Shahzad, L., & Batool, M. (2024). The association between climatic factors and waterborne infectious outbreaks with a focus on vulnerability in Pakistan: Integrative review. *International Journal of Environmental Health Research*, 1–18.

Wattoo, M. M., Chaudhry, A., Rana, Z. N., Rashid, J., & Afzal, S. (2020). Spatial and temporal epidemiology of vector-borne diseases in Punjab province of Pakistan—2018. *Global Biosecurity, 3*(1).

Jabbar, M., & Yusoff, M. M. (2022). Assessing the spatiotemporal urban green cover changes and their impact on land surface temperature and urban heat island in Lahore (Pakistan). *Geography, Environment, Sustainability, 15*(1), 130–140. https://doi.org/10.24057/2071-9388-2021-005

Çeleğen, İ., & Sarıöz, A. (2025). Climate-driven infectious disease risks: a global scoping review of epidemiological patterns, methodological gaps, and policy imperatives. *BMC Infectious Diseases, 25*(1), 1770.

Howden-Chapman, P., Bennett, J., Edwards, R., Jacobs, D. R., Nathan, K. M., & Ormandy, D. (2023). Review of the impact of housing quality on inequalities in health and well-being. *Annual Review of Public Health, 44*, 233–254. https://doi.org/10.1146/annurev-publhealth-071521-111836

Lee, J.-Y., Kwon, N., Goo, G.-Y., & Cho, S.-I. (2022). Inadequate housing and pulmonary tuberculosis: A systematic review. *BMC Public Health, 22*, 622. https://doi.org/10.1186/s12889-022-12879-6