



Influence of Housing Quality on Public Health in Lahore, Pakistan

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Abstract: This investigation examined the relationships between housing quality indicators and incidence of health issues among household members in district Lahore, the second largest city of Pakistan after Karachi. The primary data for this study were collected through a population-based survey by using a self-administered questionnaire. Face to face interviews with household members were conducted to acquire the required information about 600 randomly selected houses. Housing quality was assessed by employing physical, social, biological and chemical indicators for housing conditions. Health issues were assessed from the reporting about specific, general and psychological health problems. Pearson's chi square test was performed to determine relationships between housing quality indicators and health issues. Spatial interpolation techniques were applied using ArcMap 10.3 to highlight spatial variation of the reported housing quality indicators and health issues in Lahore district. Results of this study indicated that the residents are suffering from multiple diseases which are caused due to poor housing conditions. More than two-third of the studied households suffered with more than five problems relating to housing conditions. Thus, results of this investigation revealed cause-effect relationships between housing conditions and health issues. The health of the community can be improved with better housing conditions. Therefore, urgent initiative and actions by the concerned authorities are warranted to for improvement of housing quality to minimize the health issues.

Keywords: Housing quality, health issues, correlation, GIS, spatial analysis

1. INTRODUCTION

Pakistan is one of the most rapidly urbanizing countries of South Asia. More than 50% of Pakistan total urban population lives in 8 major cities [1]. According to Pakistan Demographic Profile [2], rate of urbanization in Pakistan is 2.68% during 2010 to 2014. This growing urbanization has a remarkable effect on housing and health issues in Pakistan. Good housing quality is essential for healthy life. Generally, the housing is acknowledged as one of the most vital necessities of healthy human life [3]. Good quality of housing affects occurrence of good health and poor housing is an indicator of poor health of people [4]. Housing is not just a place of shelter but it is more than that embracing all of social facilities and functions that are responsible to a worthy living [5]. Housing enhances the whole well-being and desires of the residents [6].

Housing quality in general denotes to the levels or grades of adequacy of residence unit and it is

related to instant inhabited atmosphere, comprising the design and infrastructure of housing materials used in building, the quantity of interior and exterior space affecting the dwelling housing services and provision of services [7]. Standards of housing quality are frequently cast-off as measures or norms which are appropriate in authorized circumstances in which some questions appear as to the tolerability of structure, comparative to governing laws within the industry of house building. Thus, the definition of housing quality holds many features which comprise the physical state of the building and additional facilities that mark living in a specific extent. The features of housing contained by any neighborhood should be such that gratifies least health values and good living [8]. Housing quality is a more multifaceted perception with wider social and economic meaning. The situation accounts for both quantitative and qualitative magnitudes of housing units, their direct surrounds and requirements of the residents. The measurable dimension of housing

quality denotes mainly detached structural, social and economic elements of housing outcomes which may be measured resulted from the presentation of the housing segment. These factors comprise deliberations such as value, magnitude, occupancy, economic influences, environmental impressions and structural customs of housing standards. Additionally, the qualitative measurement is considerably more general and tough to measure. It signifies the apparent significances and standards of issues, for example, comfort or quality of life that come up with the different types of dwelling, lifestyles, and the preferences and expectations of the inhabitants. Due to the high local and provincial differences in the quantitative and qualitative magnitudes of housing conditions it is not conceivable to describe one consistent set of standards and gauges that relate correspondingly to all zones at all periods [9, 10].

Fertig and Reingold [11] also investigated the relationship of housing with health. They proved through study that low level of housing and living in an unhealthy environment is a dangerous factor effecting public health. There are a number of other studies who assessed straight relationship between health issues and poor housing quality relating to housing condition, infrastructure, overcrowding and services including inadequate water supply, sanitation, electricity infrastructure and house waste management [11-20]. Gilbertson et al. [21] detected a noteworthy association between conditions of housing and mental and physical health of an individual. Poor-housing quality is health vulnerable to its residents. Mostly, it may cause infectious diseases such as tuberculosis, respiratory diseases, and skin-infections. It is also connected with depression, deficiency of vitamin D, anxiety, obesity, diabetes and cardiovascular diseases [22]. Different aspects of a house have different health issues, major of them are ventilation, lighting, disease vector and overcrowding. Proper ventilation is very important for those homes which have indoor cooking setup [23]. Use of wood and coal for burning is the variable of high air pollution. Houses with poor ventilation are a major cause of respiratory diseases, specifically, tuberculosis, bronchitis and asthma [24]. Satisfactory access of sun light is also essential for good houses capable to

be live. Hepatitis A, visual problems and depression are mostly caused by low level of exposure to sun [25]. So, it is very important for every house to have windows. If the houses are not being kept neat and clean then they are infested by disease vectors like bugs, termites, cockroaches, mosquitoes, and moulds [26]. Density of residents and overcrowding in homes is a cause of ill-health because it makes disease transmission from one person to another very easy [27]. Lack of private space may cause anxiety among a family [28]. Overcrowding is correlated to levels of socioeconomic condition and it is a much elaborated determinant of low quality housing [29]. The increasing rate of urbanization and rapidly growing overall population in developing countries has created tremendous pressures on housing market to meet housing needs. The failure of housing marketplace to construct new and affordable housing has created problems for people to live below poverty level and in overcrowded dwellings [7].

For years, housing-quality has been recognized as a major impact source of resident's health but still to date there are major gaps in research on health-based housing assessment especially in Pakistan. In all developed countries quality of housing assessment surveys are taken on large scales. The major contribution of decent housing to public health has been recognized in laws of England for more than a century [30]. But in Pakistan there are no such initiatives or policies have been made by government, who can define and support healthy living. In Pakistan, it is highly needed to conduct researches on housing quality and related health issues. Assessment of quality of housing is necessary to calculate needs which are very basic to public, socioeconomic levels and planning of public health centers in cities of Pakistan. The Planning Commission of Pakistan estimates that by 2030, at least 50 percent of the Pakistani population will live in its cities. This increasing population burden will greatly influence the availability of quality-houses in major cities of Pakistan.

Pakistan's demographic profile [2] indicates that total population of Lahore is 7.566 million, of which 65% live in only 10 percent of the city area. In Punjab, 22 % of the urban population lives just in Lahore [31]. Urban growth rate of Lahore is 4.3 per

annum [1]. Lahore is one of the eight major cities of Pakistan which are highly influenced by the impact of urbanization. Due to rapid urbanization, mishandling of housing schemes, poverty and insufficient housing policies, people of Lahore are bound to live in unhealthy houses. Urban Unit [32] estimated that 40% of the population in Lahore is inhibited in slums with poor municipal and housing services. Population of the city is increasing tremendously. Migratory trends explain an increase in density towards some specific areas of Lahore [1]. Lahore is one of those modern cities of Pakistan which are experiencing outbreaks of many infectious diseases. Public health condition is very poor in Lahore and it varies from localities of poor quality-housing to good quality-housing. According to a disease pattern compiled from Punjab health departments of District Health Information System (DHIS), Secondary Health Care (SHC) and Primary Health Care (PHC) reports on the basis of regular mechanism studies and surveys, 2,971,178 cases of respiratory diseases, 100,204 cases of gastrointestinal disease, 31,163 cases of communicable diseases, 20,093 cases of cardiovascular diseases, 9,018 cases of skin diseases, 1,849 cases of psychiatric diseases, 14,315 cases of eye diseases and 2,615 cases of injuries have been reported in Punjab Province [33].

Population explosion and urbanization have a very bad impact on parameters of good-housing. People are compelled to live in houses having insufficient quality parameters in urban areas. Therefore, there is a great need of effective housing policies to sort out these problems and to fill the gaps which are created by shortage of housing supply. Particularly, access to housing of reasonably minimum quality must be promoted for residents living below the poverty line (Meng and Hall, 2006). With this rapid rate of increase in urbanization, population growth, decline in housing quality and vulnerability to public health there is a need to spatially assess housing quality and rate of its impact on health. Therefore, this study focuses the health-based housing quality by showing relationship of various poor housing parameters/indicators and health issues. Spatial maps are significant tools to

assess spatial distribution of any data. They provide an overall view of variation in selected parameters which can be useful in planning, management and designing necessary policies. Geographical Information System (GIS) techniques were used to map variation into occurrence of disease and to analyze the spatial patterns of housing quality in the city. These techniques can be linked to each other to show the spatial pattern of housing-quality and related health issues in map view. The present study has two variables, housing quality (independent variable) and health issues (dependent variable). Results indicate that the poor housing conditions are causing ill health among the residents. However, the general public health can be improved with improved housing conditions. The study would be helpful to give awareness and set policies for healthy housing at public level.

2. MATERIALS AND METHODS

2.1 Study Area

Lahore is a metropolitan city of Pakistan and is famous for its rich historical background. Population wise, it is the 2nd largest city of Pakistan, 5th largest city in South Asia, and 30th largest city in the world [33]. Lahore is capital of the most populous province in Pakistan, the Punjab, and is a hub of educational, cultural and economic activities. This city is Lahore is situated on the left bank of River Ravi at 31° 15' N - 31° 42' N and 74° 01' E - 74° 39' E. Lahore is divided into nine Towns {i.e., Ravi Town (RT), Shalamar Town (ST), Wahga Town (WT), Aziz Bhatti Town (ABT), Data Gunj Bukhsh Town (DGBT), Gulberg Town (GT), Samanabad Town (ST), Iqbal Town (IT), Nishtar Town (NT), and Cantonment (Lahore Cantt (LC))} and also is an administrative division. Every Town in the district comprises of a cluster of Union Councils (Fig. 1). According to the Three Years Rolling Plan 2010-2013 of District Lahore, total population of Lahore is approximately 8,200,000 and its total area is 2,014 sq. km. Annual growth rate of population is 5.6%, population density is 8,200 persons per sq. km and rural and urban population is 2,076,000 (25.4%) and 6,114,000 (74.6%), respectively [33].

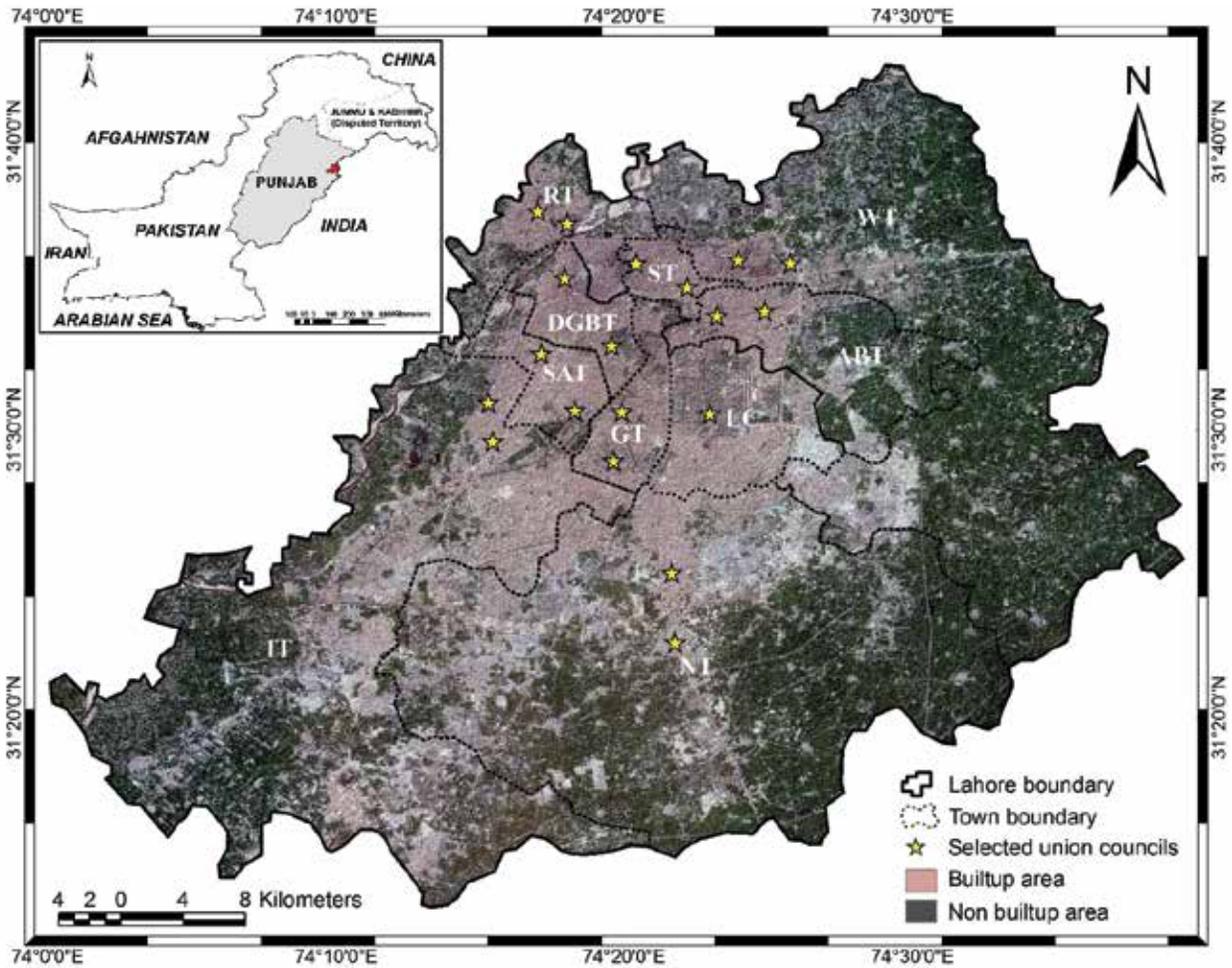


Fig. 1 Location of study area and the surrounding region (as inset). The built-up and non-built-up areas and location of study sites for data collection (yellow stars) are shown. The white coloured letters indicate: RT, Ravi Town; ST, Shalimar Town; WT, Wahga Town; ABT, Aziz Bhatti Town; DGBT, Data Gunj Bukhsh Town; GT, Gulberg Town; ST, Samanabad Town; IT, Iqbal Town; NT, Nishtar Town; and LC, Lahore Cantt.

2.2 Study Design and Data Collection

Face to face interviews and questionnaire responses from the household members were used to acquire the required information of 600 randomly selected houses. One person from each house responded to the questionnaire and the interview. Also, the same person apprised about health status of all family members. Housing quality was gauged using physical, social, biological and chemical indicators of the housing conditions. Health issues were assessed from the feedback about specific, general physical and psychological health issues. Analysis of the data were performed by using SPSS (Statistical Package for Social Sciences), Microsoft Excel and GIS (Geographical Information System). Pearson's correlation and chi square test was performed to

analyze the relationship between housing quality and health issues. Spatial interpolation techniques were applied using Arc GIS 10.3 to highlight spatial variation of reported housing quality indicators and health issues in Lahore. Primary data was collected using multistage sampling techniques of normal distribution. 600 questionnaires were equally distributed in 10 administrative Towns. Subsequently equal number of questionnaires (i.e., 30+30=60) were distributed in each Town among two selected Union Councils (Shahdra and Qaisar Town (in RT), Baghbanpura and Shadbagh (in ST), Daroghawala and Salamatpura (in WT), Dharampura and Fatehgarh (in ABT), Bilal Gunj and Anarkali (DGBT), Model Town and Garden Town (in GT), New muslin Town and Samanabad

Table 1. Housing quality indicators, associated factors and related health issues.

Indicator	Associated Factor	Related Health Issues
1. Physical Indicators		
Temperature	Use of cooling products, use of heating products	Heart attack, fever, blood pressure
Noise	Market area, heavy traffic load, loud speaker, generator	Headache, depression, anxiety, lack of sleep, hearing issues, blood pressure
Building features	Open space availability, open space around boundaries, direct exposure to sun, house area, attached/separated kitchen, exhaust fan/chimney in kitchen, attached/separated wash room, open/concealed wiring of electricity supply, water pipes maintenance,, house paint type and conditions, taste of water	Muscular pain, eye sight issues, obesity, asthma, abdominal pain, dysentery, diarrhea, typhoid, lungs, and respiratory diseases, cough, cholera
Sunlight penetration	Open space around boundaries, window presence, house type (detached, separate, semidetached)	Muscular pain, eye sight issues
House accidents	House maintenance roof fall water fall, part of house fall, electrical sparks, gas pipe damage	Fall injury, death due to injury, burning injury, death due to burning injury
Indoor air quality	Windows presence. attached/separate kitchen, exhaust fan, type of stove, inside smoking	Lungs issues, cough, respiratory diseases, asthma, tuberculosis.
Dampness	Roof leakage, water pipes leakages, damp walls, inside laundry	Cough, skin infection, respiratory infections, lungs disease, asthma, tuberculosis.
Ventilation	Window presence, regular opening of windows	Lungs and respiratory disease, asthma, tuberculosis
2. Biological Indicators		
Molds/fungus	Mold presence in any part of house, e.g., wash room, bed room	Skin allergy, cough, respiratory and lung disease, asthma
Pests	Cockroaches, mites, rates, flies	Abdominal pain, skin allergy, lungs diseases cough
Pets	Dogs, cats, birds, cattle	Pet allergy
3. Chemical Indicators		
Insecticides	Frequency usage	Skin infections, heart diseases, lungs cancer
Herbicides	Frequency of usage	Skin infections, heart diseases, lungs cancer
4. Social Indicators		
Neighborhood	Residential area, market area, industrial area, heavy traffic road, contaminated water canal, disposal sites	Depression, anxiety, aggressiveness, malaria, dengue
Overcrowding	Number of persons per room	Aggressiveness, depression, anxiety, headache, blood pressure, tuberculosis

Town (in ST), Awan Town and Sabzazar (in IT), Gajjumatta and Kahna (in NT) and Cantonment area (LC) (Fig. 1).

2.3 Measures of Housing Quality and Health Issues

Based on extensive literature review, the questionnaire was designed by including selected

housing quality indicators and factors to investigate their effect on the health of the residents (Table 1). Researcher visited respondents personally to collect data. Respondent’s behavior was very good towards answering questionnaire. Some respondents refused to fill up questionnaire; however, many appreciated the exercise by taking interest and filling the questionnaire.

2.4 Data Analysis

Prior to analysis, the data were rechecked and data classification was done for accuracy purposes. The data entry and data tabulation was done using MS Excel and SPSS. Consequently, a database structure was documented which integrates various measures. Afterwards, descriptive, inferential and spatial analyses techniques were applied using SPSS and ArcMap 10.3.

2.4.1 Descriptive Analysis

Descriptive analysis presents a simple summary of whole data in the form of central tendency, mean deviation, frequency distribution and percentages. In present study, descriptive analysis techniques are applied to define elementary features of the data. Descriptive statistics provided unpretentious summaries of sample and measures about study. Three types of techniques were used in descriptive analysis; (a) *Frequencies*, (b) *Proportional Percentages* (c) *Graphical representation* using bar graphs and pie charts.

2.4.2 Inferential Analysis

Inferential analysis is used to determine correlation between housing quality and health issues by using complex designed calculation. Two types of inferential analysis were used in the study.

a) Correlation Analysis

Correlation analysis is a statistical technique which indicate that how strongly two different variables are related to each other. Main results of correlation are defined by value 'correlation coefficient' represented by letter 'r'. The statistical formula for computing correlation coefficient is given below;

$$r = \frac{1}{n-1} \sum \left(\frac{x-\bar{x}}{S_x} \right) \left(\frac{y-\bar{y}}{S_y} \right)$$

Values of correlation coefficient (r) always range between +1 and -1. Value of +1 shows that there exists a positive relationship among variables while value of -1 represents the negative relationship between variables. However, value of 0 denotes that no relationship exists among variables. If there are only two variables to be tested for correlation

analysis, then bivariate analysis techniques are used in correlation analysis. Therefore, in present study a bivariate analysis technique of correlation analysis was used to find out the level of relationship between two major variables of the study (housing quality and health issues) by applying means and standard deviation statistics, Pearson's coefficient and two-tailed test of significance.

(b) Pearson's Chi-square Test

Pearson's chi-square test is a probability test to know that how likely there are chances of a match among two observed frequencies. It measures that by what means the distribution of a type of data gets fit into the distribution of another data. A chi-square test is specifically appropriate for categorical/ordinal/nominal data. Statistical formula for chi-square is given below;

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

where,

O = Observed frequency, Σ = Expected frequency and Σ = Sum of all cells

Chi-square test was used to determine relationship among two variables which are organized in a bivariate type of table. The *p*-value of chi-square test is known as a probability estimate. The *p*-value below 0.05 indicates that there is a relationship between two variables whereas *p*-value greater than 0.05 indicate no correlation. In present study, Pearson's chi-square test was applied to find out those observed indicators of housing quality which may have a significant relation with observed health issues by fitting frequencies with each other in cross-tabulation.

2.4.3 Spatial Analysis

Spatial analysis is a type of data analysis which is specifically used to process geographic data. When data are to be related with locations and results are required to show spatial pattern, then, spatial analysis makes it possible by using information of geographic and locational attributes. Geographic Information System (GIS) is best commonly used and user friendly software for spatial analysis. In present study, GIS mapping techniques for interpolation, quantities and charts were used to

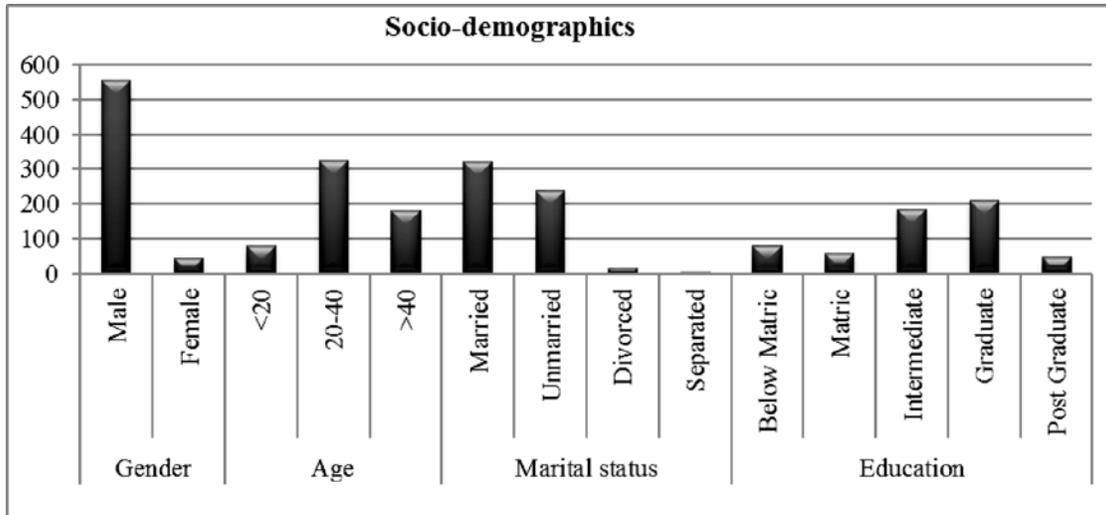


Fig. 2 Socio-demographics of the respondents.

model spatial pattern of housing and health issues in Lahore using ArcMap 10.3 software. For spatial mapping, first of all Union Council wise responses of both poor housing quality (PHQ) indicators and reported health issues (HI) were entered in ArcMap database and associated shape files were generated. Later, these data were used to prepare required maps for spatial analysis from Fig. 4 to Fig. 12.

female. 54.2% of the respondents were among the age group 20-40 years, 13.2% were below 20 years and 30.3% were above 40 years. Married respondents were 55.6%, unmarried 41.1% and a very minute 2.8% were divorced and 0.5% were separated. Generally the respondents were qualified (Fig. 2).

3. RESULTS AND DISCUSSION

3.1 Socio-demographics

Among 600 residents who responded to questionnaires, 92.5% were male and 7.5% were

3.2 Residential Information

Residential information was assembled on the basis of information about house type, area type, and family type and planning to move from current residence. Frequency distribution presents that 40.3% residents live in semi-detached houses, almost equal percentage lives in detached and

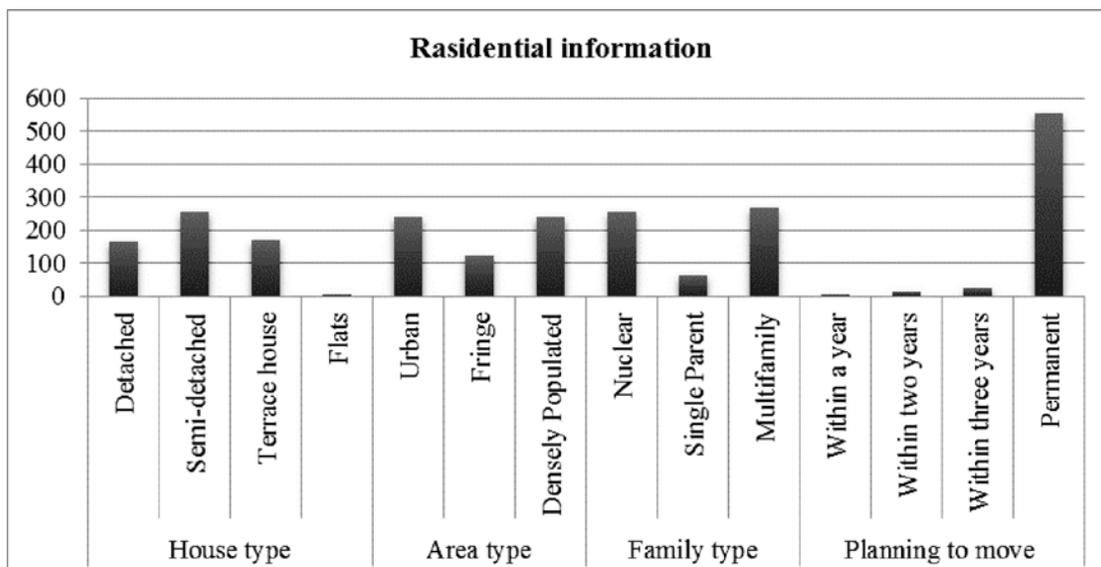


Fig. 3 Residential information.

terrace houses while a small percentage lives in flats. Respondents belonging to fringe area were relatively less in numbers as compared to the respondents of urban area or densely populated area. Majority of the respondents belong to multifamily or nuclear family while belonging to single parent family is very low. The collected data revealed that most of the respondents are permanent residents and only 4.5% residents intended to move from their current residences (Fig. 3).

3.3 Physical Indicators of Poor Housing Quality (PHQ)

Data analysis demonstrated that 27.8% of total respondents do not have open space availability in their houses, 31.8% do not have direct exposure to sun, 63.3% of total respondents do not have open space around the boundaries of house and 18.5% of total respondents have tall building present in both sides of their house boundary. 79.8% of the total respondents have attached kitchen type and 83.5%

respondents use attached bathroom. Three types of paints were assessed; oil paints, white wash and distemper. 68.2% respondents have distemper in their houses, although positive response for white wash with 32.0% was also notable, 44.8% complained of not having good paint condition of their houses while 77.8% change paint after two years or more than two years (Table 2).

3.3.1 Services Supply

The gas supply through surface-pipe wiring was available in 13.3% houses, of which 2.8% respondents experienced gas pipe damage and in 5 houses gas pipe damage had led to fire incidents. In 11.2% houses electricity is supplied through open wiring, 2% experienced electrical spark/damage and fire due to electrical spark/damage. 74.3% of total respondents are facilitated by district water supply, 78% have own water pump whereas 32.5% experience unpleasant taste in water. 9.8% reported water pipe leakage (Table 3).

Table 2. Building aspects of physical indicators.

Variable	No	Yes
	No. (%)	No. (%)
Total	600 (100)	600 (100)
Open space availability in house	162 (27.8)	438 (72.2)
Direct exposure to sun	191 (31.8)	409 (68.2)
Open space around boundaries	380 (63.3)	220 (36.7)
Tall building around house	489 (81.5)	111 (18.5)
Kitchen type		
Attached	121 (20.1)	479 (79.8)
Separated	478 (79.7)	122 (20.3)
Wash room type		
Attached	99 (16.5)	501 (83.5)
Separate	500 (83.3)	100 (16.7)
Paint type		
Oil paints	566 (94.3)	34 (5.7)
White wash	408 (68)	192 (32)
Distemper	191 (31.8)	409 (68.2)
Good paint condition	269 (44.8)	331 (55.2)
Paint change period		
One year	467 (77.8)	133 (22.2)
Two years or more	133 (22.2)	467 (77.8)
Experienced building collapse	585 (97.5)	21 (2.5)
Apart of house collapsed	589 (98.2)	11 (1.8)
Roof collapsed	597 (99.5)	3 (0.5)
Wall collapsed	593 (98.8)	7 (1.2)
Wall collapsed	593 (98.8)	7 (1.2)
Repairing house damage on immediate basis	163 (27.2)	473 (72.8)

Table 3. Services infrastructural aspects of physical indicators.

Variable	No	Yes
	No. (%)	No. (%)
Total	600 (100)	600 (100)
Gas supply wiring condition		
Under-ground pipes	69 (11.5)	53 (88.5)
Surface-pipes	520 (86.7)	80 (13.3)
Gas pipe damage	583 (97.2)	17 (2.8)
Caused fire	595 (99.2)	5 (0.8)
Electricity wiring condition		
Concealed wiring	65 (10.8)	535 (89.2)
Open wiring	533 (88.8)	67 (11.2)
Electrical spark/damage	588 (98)	12 (2)
Caused fire	598 (99.7)	12 (2.0)
Water supply Condition		
District water supply	154 (25.7)	446 (74.3)
Own water pump	128 (21.3)	472 (78.7)
Unpleasant taste in water	405 (67.5)	195 (32.5)
Water pipes leakage	541 (90.2)	59 (9.8)

3.3.2 Moisture Factors

Frequency distribution of collected data designates that 51.8% of total houses have moisture presence. Analysis signifies that common cause of moisture presence in houses is damp walls with the

Table 4. Moisture factors of physical indicators.

Variable	No	Yes
	No. (%)	No. (%)
Total	600 (100)	600 (100)
Moisture in house	289 (48.2)	311 (51.8)
Moisture due to roof leakage	540 (90)	60 (10.0)
Moisture due to water pipes leakage	557 (92.8)	43 (7.2)
Moisture due to inside use of laundry	553 (92.2)	47 (7.8)
Moisture due to damp walls	391(65.2)	209 (34.8)

percentage of 34.8%; roof leakage is also notable having 10% of total responses. Contribution of water pipe leakage and inside use of laundry in moisture occurrence is above 7.0% (Table 4).

3.3.3 Indoor Air Quality

Data collected based on indoor air quality indicators show that 77.5% of houses have chimney and Exhaust fan. 98.7% houses use gas stove for cooking. 76.8% houses have windows in every bed room and they open it on regular basis which improve the quality of indoor air. In only 17.7 % of houses people smoke inside house and 21.7% houses has bad smell (Table 5).

Table 5. Indoor air quality factors of physical indicators of housing quality

Variable	No	Yes
	No. (%)	No. (%)
Total	600 (100)	600 (100)
Chimney/Exhaust fan presence	135 (22.5)	465 (77.5)
Stove type		
Gas stove	8 (1.3)	592 (98.7)
Wood stove	568 (94.7)	32 (5.3)
Window presence in every bed room	139 (23.2)	461 (76.8)
Window opened regularly	174 (29.0)	426 (71.0)
Inside smoking	494 (82.3)	106 (17.7)
Feel bad smell in house	470 (78.3)	130 (21.7)

3.3.4 Indoor Temperature

About 20% of the respondents reported that their houses are unbearably hot during summer months. Two types of cooling products was mentioned in questionnaire air conditioner and water cooler, 51.5% use air conditioner while 42.7% use water cooler. In winters 17.7% houses are unbearable cold and majority 91.2% use gas heaters as heating product, 4.3% use coal burning (Table 6).

Table 6. Indoor temperature factors of physical indicators of housing quality.

Variable	No	Yes
	No. (%)	No. (%)
Total	600 (100)	600 (100)
Feel house unbearable hot in summers	479 (79.8)	121 (20.2)
Types of cooling products used		
Air conditioner	291 (48.5)	309 (51.5)
Water cooler	344 (57.3)	256 (42.7)
Feel house unbearable cold in summers	494 (82.3)	106 (17.7)
Types of heating products used		
Gas heater	53 (8.8)	547 (91.2)
Electric heater	566 (94.3)	34 (5.7)
Coal burning	574 (95.7)	26 (4.3)

3.3.5 Indoor Noise

Analysis of physical indicators related to noise proves that more than half (59.3%) feel noise in house, 20.0% respondents complained road traffic passing nearby house as a source of noise, 5.7% declared overcrowding in house is causing noise, 5.0% reported market area near of house, 16.7% reported noise severity on regular basis (Table 7).

Table 7. Indoor noise factors of physical indicators of housing quality.

Variable	No	Yes
	No. (%)	No. (%)
Total	600 (100)	600 (100)
Feel noise in house	356 (59.3)	244 (40.7)
Noise source		
Road traffic	480 (80)	120 (20)
Overcrowding	566 (94.3)	34 (5.7)
Market area	570 (95.0)	30 (5.0)
Generator	547 (91.2)	53 (8.8)
Loud speaker	543 (90.5)	57 (9.5)
Noise severity		
Regularly	500 (83.3)	100 (16.7)
Occasionally	497 (82.8)	103 (17.2)

3.3.6 Spatial Analysis of Physical Indicators of PHQ

Factors among physical indicators are highly varying in the region. Physical indicators of PHQ were maximum in Ravi Town, Nishtar Town and Aziz Bhatti Town. Gulberg Town, Samanabad Town and Iqbal Town are showing minimum value of poor physical indicators. Moisture presence,

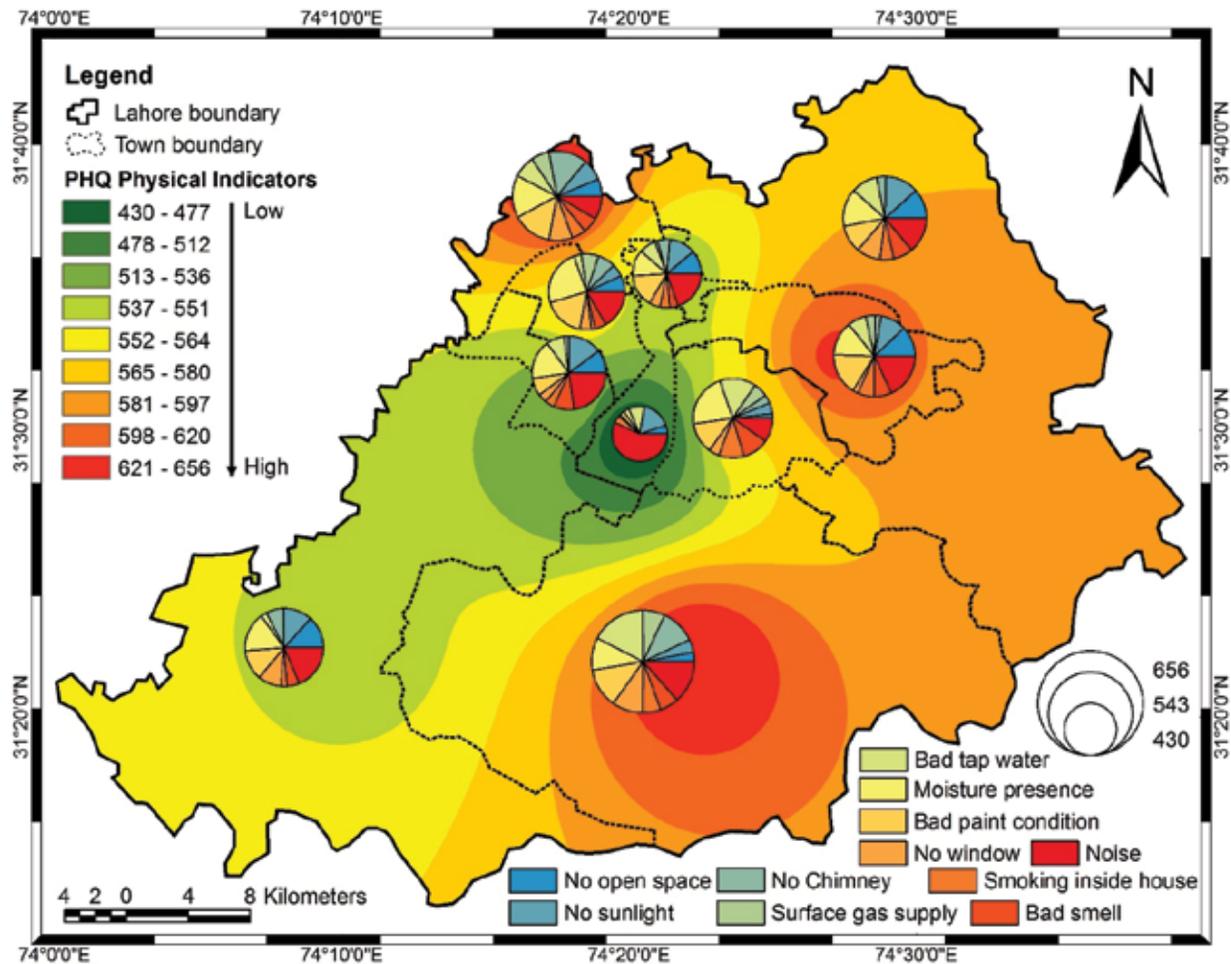


Fig. 4 Spatial distribution of physical indicators in Lahore.

noise and no open space response is higher than the other factors. Furthermore, reported values of moisture presence are highest in Data Gunj Bakhsh, Ravi and Nishtar Town. Highest values of noise are reported in Gulberg Town (Fig. 4).

3.4 Biological Indicators of PHQ

71% of families have fungus/mold presence in their houses, out of which 18.5% claimed to have fungus presence in just their washrooms, 13.5% have rats, 28.8% have cockroaches, 6.2% have mites and 36.7% have flies. 51.5% have pets in their houses of which 23.5% have dogs, 9.5% have cats, 2.8% have cattle and 14.3% have birds (Table 8).

Spatial analysis of biological indicators shows highest number in Ravi Town, Lahore Cantt and Aziz Bhatti Town. The pie chart information indicated that insect pests were in highest proportion and fungus was present in much lower proportion (Fig. 5).

Table 8. Biological indicators of poor housing quality.

Variable	No	Yes
	No. (%)	No. (%)
Total	600 (100)	600 (100)
Fungus presence in house	174 (29.0)	426 (71.0)
Fungus presence in wash room	489 (81.5)	111 (18.5)
Fungus presence in bed room	531 (88.5)	69 (11.5)
Fungus presence in entire house	584 (97.3)	16 (2.7)
Pests presence in house	432 (72)	168 (28.0)
Rats	519 (86.5)	81 (13.5)
Cockroaches	427 (71.2)	173 (28.8)
Mites	563 (93.8)	37 (6.2)
Flies	380 (63.3)	220 (36.7)
Pets presence	291 (48.5)	309 (51.5)
Dog	459 (76.5)	141 (23.5)
Cat	543 (90.5)	57 (9.5)
Cattle	583 (97.2)	17 (2.8)
Birds	513 (85.5)	87 (14.3)

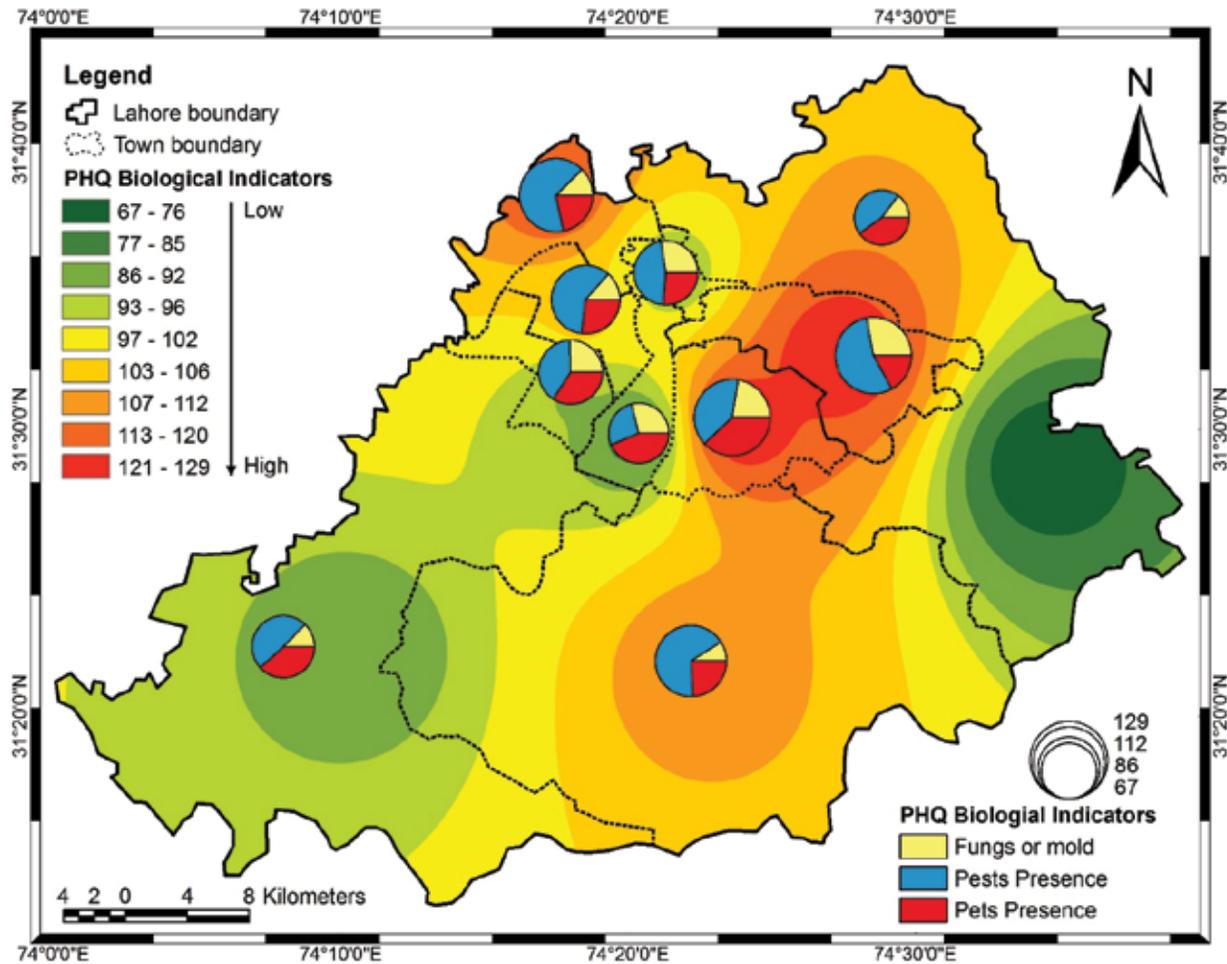


Fig. 5. Spatial distribution of biological indicators in Lahore.

3.5 Social Indicators of PHQ

Data elaborates that 13.7% expressed annoyance to have contaminated water canal in neighborhood of their house and 19.7% complained to have disposal site in near of their house. 16.1% reported overcrowding in houses (Table 9).

Social indicators of poor housing quality also vary in Lahore relative to its Towns. Spatial map illustrates that level of social indicators is highest in Ravi Town as compared to other Towns of Lahore. Gulberg Town and Samanabad Town has lowest level. Factors of market area presence, overcrowding and nearby disposal sites presence are higher (Fig. 6).

3.6 Chemical Indicators of PHQ

Analysis of chemical indicators reveals that 84.7% of total respondents do not use insecticides at their homes. 72.7% of total respondents do not use

Table 9. Social indicators of housing quality.

Variable	No	Yes
	No. (%)	No. (%)
Total	600 (100)	600 (100)
Satisfaction of neighborhood safety	42 (7.0)	558 (93.0)
Neighborhood area type		
Residential area	60 (10)	540 (90)
Market area	438 (73)	162 (27)
Industrial area	552 (92)	48 (8)
Heavy traffic road	495 (82.5)	105 (17.5)
Contaminated water canal	518 (86.3)	82 (13.7)
Disposal site	482 (80)	118 (19.7)
House area sufficient for whole family	97 (16.1)	503 (83.8)
One person per room	462 (77)	138 (23)
Two persons per room	235 (39.2)	365 (60.8)
More than two persons per room	515 (85.8)	85 (14.2)

herbicides but 27.30% use herbicides every year.

Analysis describes that incidences of chemical indicators of housing quality are few in number.

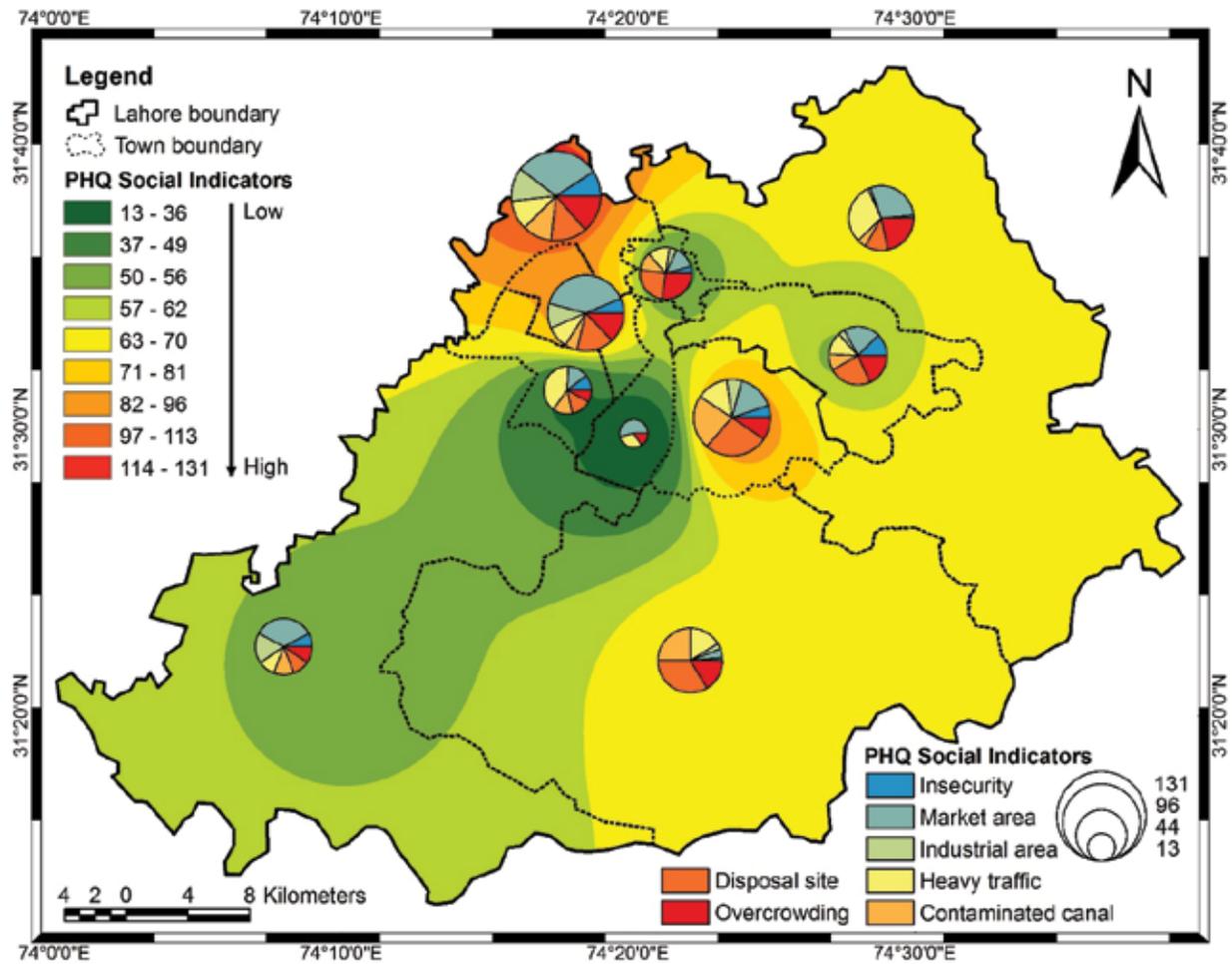


Fig. 6. Spatial distribution of social indicators in Lahore.

However, Gulberg Town, Samanbad Town have highest level of herbicides usage as compared to other Towns. Nishtar Town has negligible response to herbicides (Fig. 7).

3.7 Specific Health Issues (SHI)

Specific health issues (SHI) referred to chronic illness which requires serious medical attention. Gastrointestinal illness was reported by 13.3%. Vector borne diseases included 19.3% responses of

malaria. High frequency rate of responses denotes that most of the population suffers from typhoid, malaria and skin allergy (Table 11).

Spatial analysis demonstrates that gastrointestinal illness occurs in majority of persons. Ravi Town has a highest number of gastrointestinal illness and vector borne diseases. SHI are distinctively higher in Ravi Town and Shalamar Town (Fig. 8).

3.8 General Health Issues (GHI)

GHI refers to those diseases or health issues which are very common to occur and are not fatal. Majority of respondents (45.6%) reported persistent cough and 42.6% claimed eye sight issues. Fever, headache, and blood pressure were reported around 30% which is quite considerable. Self-reported cases of abdominal pain were 26.0%, while 25.5% suffering from muscular pain, and 21% claimed to

Table 10. Chemical indicators of housing quality.

Variables	No	Yes
	No. (%)	No. (%)
Total	600 (100)	600 (100)
Use of insecticides	508 (84.7)	92 (15.3)
Every week	587 (97.8)	13 (2.2)
Every month	467 (77.8)	133 (22.2)
Every year	235 (39.2)	365 (60.8)
Use of herbicides (per year)	436 (72.7)	164 (27.30)

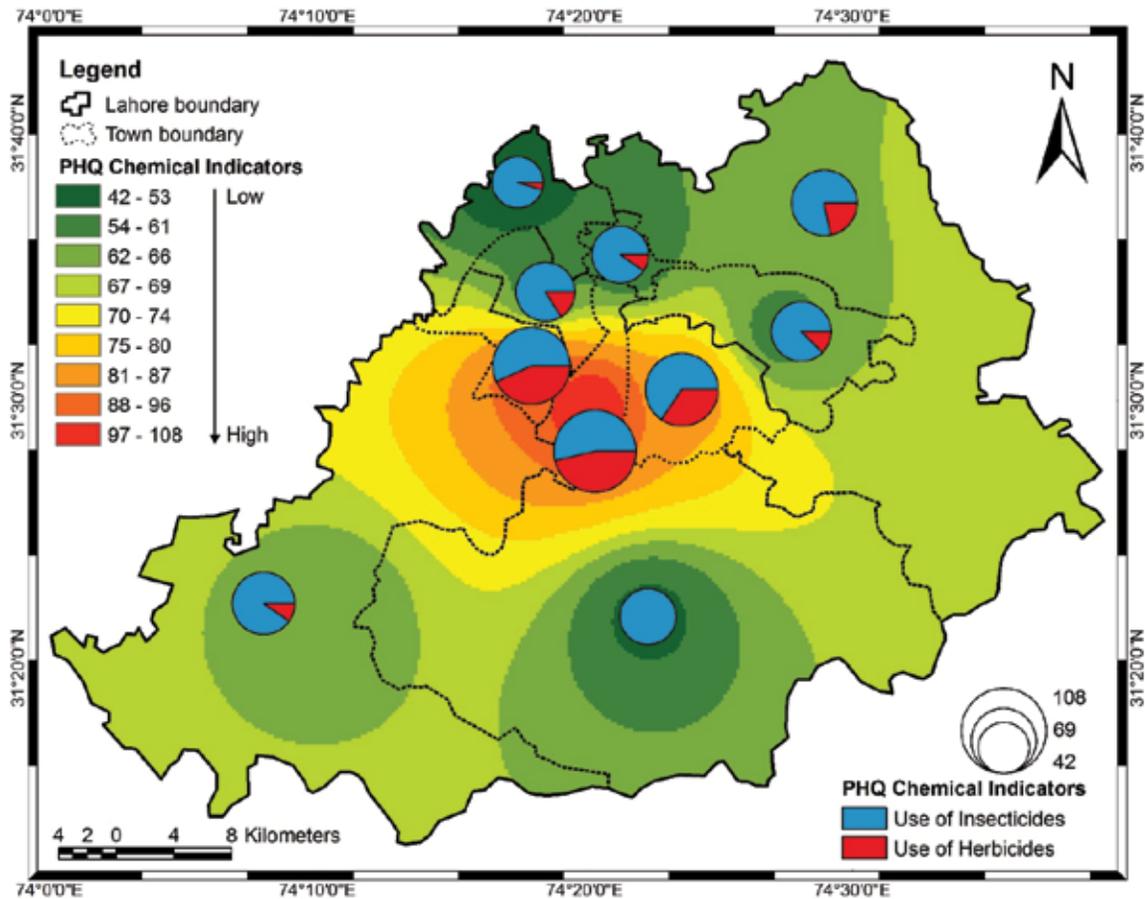


Fig. 7. Spatial distribution of chemical indicators in Lahore.

Table 11. Specific health issues.

Variable	No	Yes
	No. (%)	No. (%)
Total	600 (100)	600 (100)
Respiratory infections		
Lungs cancer	599 (99.8)	1 (0.2)
Asthma	556 (92.7)	44 (7.3)
Tuberculosis T.B.	566 (92.7)	44 (7.3)
Gastrointestinal illness		
Diarrhea	520 (86.7)	80 (13.3)
Cholera	513 (85.4)	87 (14.5)
Dysentery	578 (96.2)	22 (3.7)
Typhoid	466 (77.5)	134 (22.3)
Vector borne diseases		
Malaria	484 (80.5)	116 (19.3)
Dengue	494 (82.2)	106 (17.6)
Cardio vascular diseases		
Heart attack	529 (88.0)	71 (11.8)
Angina	569 (94.7)	31 (5.2)
Allergies		
Pet allergy	595 (99.0)	5 (0.8)
Skin allergy	480 (79.9)	120 (20.0)
Dust allergy	531 (88.4)	69 (11.5)
Pollen allergy	567 (94.3)	33 (5.5)

have obesity, these frequencies are also noteworthy. Minimum response was given to hearing issues (4.5%) and cold (12.2%). Accidental injuries due to fall and burn were reported by a few respondents (Table 12).

General health issues were highest in Ravi Town. The respondents in Nishtar Town and Wahga Town also reported high incidents of GHI. Gulberg Town has shown lowest value of GHI (i.e., 84). Samanabad Town and Iqbal Town also have low level of GHI. Frequent cough and abdominal pain, week eye sight and muscular pain is reported by majority of persons among general physical health issues (Fig. 9).

3.9 Psychological Health Issues (PHI)

Psychological health issues (PHI) represents those health issues which are related to behavioral problems like aggressiveness, lack of sleep and laziness. Aggressive behavior is highly responded by 28.7% persons as compare to other selected psychological health issues. 21.1% cases reported

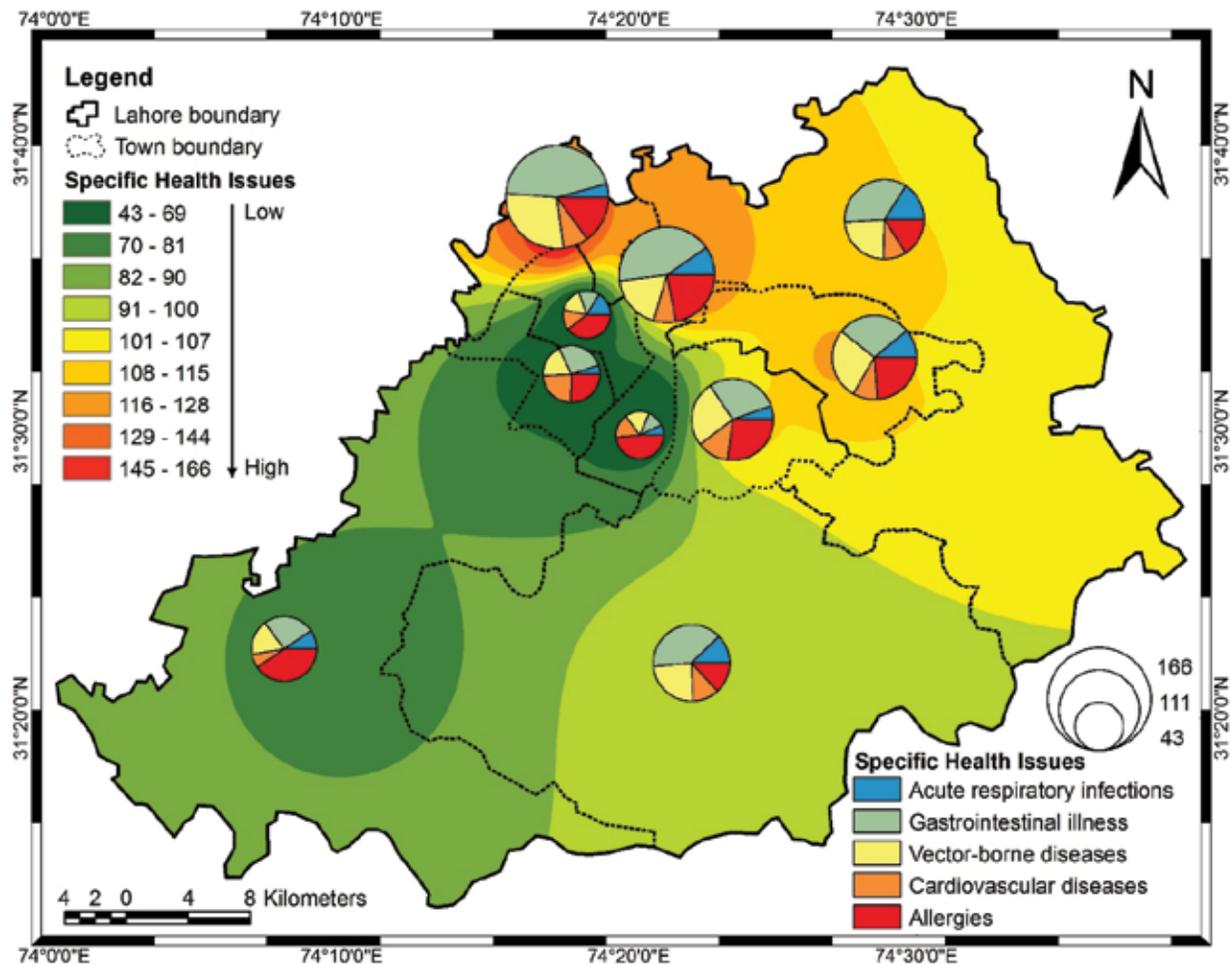


Fig. 8. Spatial distribution of specific health issues in Lahore.

depression which is also considerable. Lack of sleep (13.5%) and laziness (12.3%) were responded similarly (Table 13).

Occurrence of laziness and lack of sleep is less as compared to aggressiveness and depression. Spatial analysis indicate that highest number of psychological issues exists in Ravi Town, Aziz Bhatti Town, Data Gunj Bakhsh Town and Lahore Cantt.

3.10 Inferential Analysis

Inferential analysis was performed to analyze association between indicators of poor housing quality and health issues. Two types of tests were used in inferential analysis.

3.10.1 Pearson's Correlation Analysis

Pearson's correlation analysis is a type of inferential analysis based on technique of statistics, which can be performed to describe that how strongly

Table 12. General health issues observed in the survey.

Variable	No	Yes
	No. (%)	No. (%)
Total	600 (100)	600 (100)
Eye sight problems	344 (57.2)	256 (42.6)
Abdominal pain	444 (73.9)	156 (26.0)
Muscular pain	447 (74.4)	153 (25.5)
Fever	420 (69.9)	180 (30.0)
Cough	326 (54.3)	274 (45.6)
Burn injury	596 (99.3)	4 (0.7)
Death due to burn injury	599 (99.7)	1 (0.1)
Hearing issues	573 (95.5)	27 (4.5)
Obesity	474 (78.9)	126 (21.0)
Headache	409 (68.1)	191 (31.8)
Blood pressure	417 (69.5)	183 (30.5)
Cold	527 (87.7)	73 (12.2)
Fall injury	590 (98.3)	10 (1.7)
Death due to fall injury	598 (99.7)	2 (0.3)

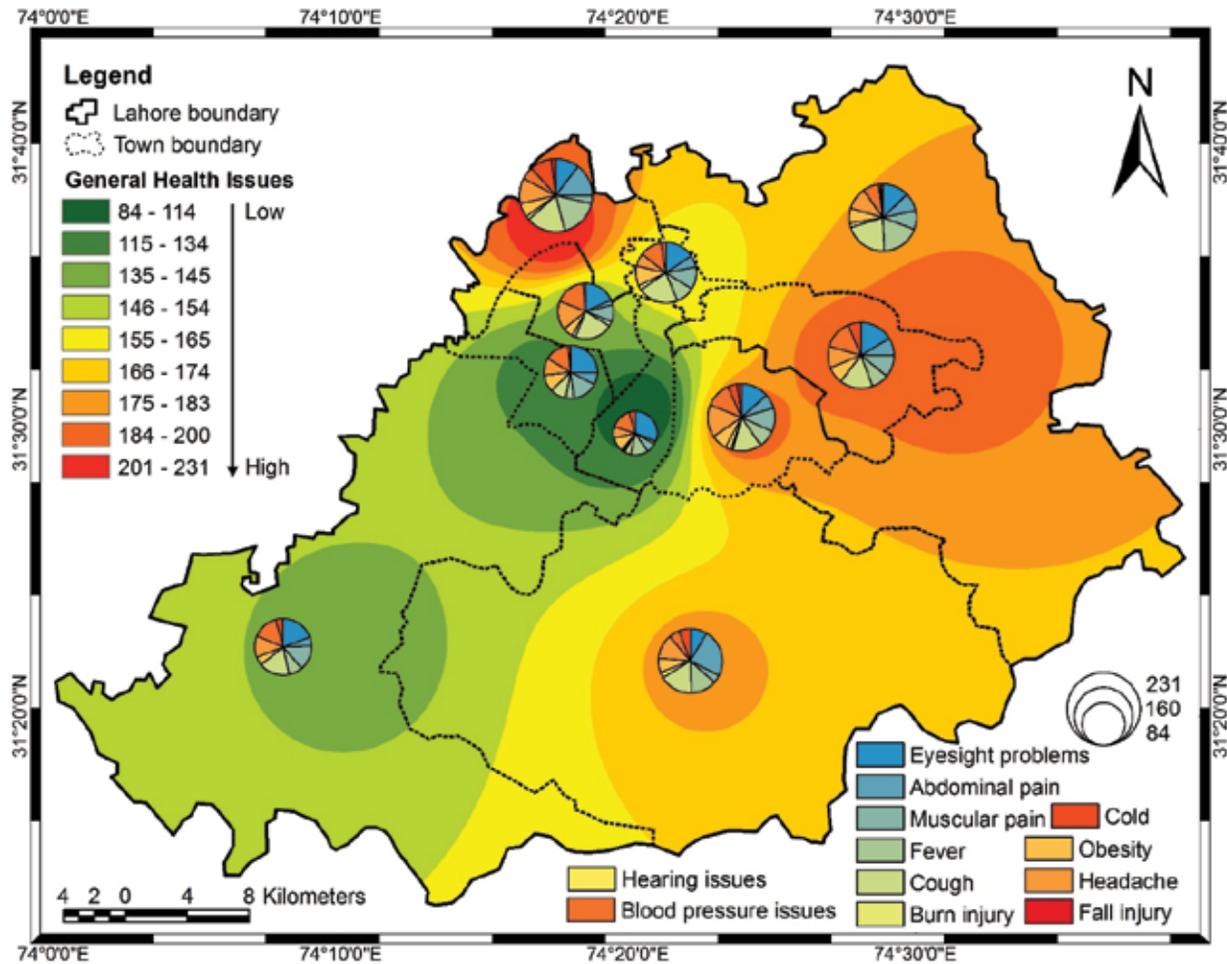


Fig. 9. Spatial distribution of general physical health issues in Lahore.

Table 13. Psychological health issues.

Variable	No	Yes
	No. (%)	No. (%)
Total	600 (100)	600 (100)
Depression	473 (78.7)	127 (21.1)
Aggressive behavior	428 (71.2)	172 (28.7)
Lack of sleep	519 (86.4)	81 (13.5)
Laziness	526 (87.7)	74 (12.3)

a relationship exists between two variables. The outcomes of Pearson’s correlation analysis are precise by significance of “correlation coefficient” (r). Correlation coefficient (r) values range from +1 to -1. The value of +1 shows a positive relationship amongst variables but if the r is -1 then it denotes that there is a negative relationship between variables. Coefficient value (r) of 0 proves null relationship among variables. The analysis indicate a significant positive relationship between housing quality and health issues by showing (r =0.118) at level of $p < 0.05$.

3.10.2 Pearson’s Chi-square Test

Chi square analysis was applied between indicators of housing quality and selected diseases individually. Purpose of Pearson’s chi square test was to find out those indicators of housing quality which are probably causing health issues, by fitting different frequencies with each other in cross tabulation. The P -value below 0.05 reflects that poor housing quality is causing health problems and if P -value is greater than 0.05 then, it shows no correlation between poor housing quality and health issues. The asterisks with P -values show three of the most commonly used levels of significance. If a P -value is less than 0.05 it is flagged with one asterisk (*). If a P -value is less than 0.01 it is flagged with two asterisks (**). If a P -value is less than 0.001 it is flagged with three asterisks (***). This test was applied on all observed health issues and all observed housing quality indicators. Finally only those indicators were selected who have shown

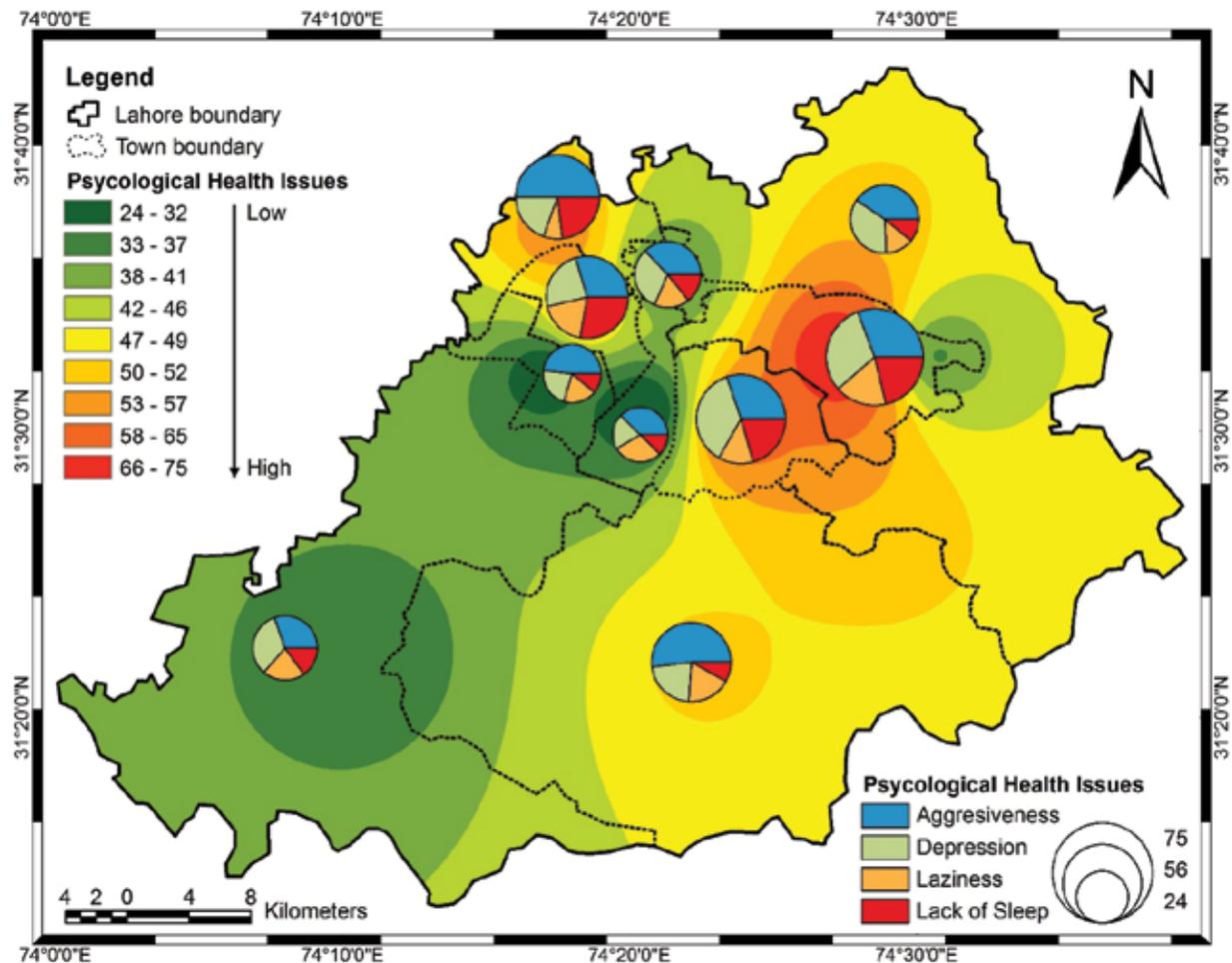


Fig. 10. Spatial distribution of psychological health issues in Lahore.

Table 14. Pearson correlation coefficients of housing quality and health issues.

Variables	r^1	Mean	SD
1- Housing	-	35.19	5.57
2- Health	0.118	5.09	2.76

¹ r is correlation coefficient, and SD is standard deviation

significant p -value, i.e., $P < 0.05$ (Table 15).

3.11 Association between Poor Housing Quality (PHQ) and Health Issues (HI)

Poor housing quality (PHQ) indicators in Lahore shows varying trend between the Towns, i.e., increasing number of PHQ indicators represents poor housing condition and thus are related to increased number of health issues in those areas [11-20] (Fig. 12). The proportion of physical indicators of PHQ is higher than other indicators. Spatial analysis of all the factors of PHQ reveals that Ravi Town has highest level of poor housing quality with

the frequency of 941 poor indicators, followed by Aziz Bhatti Town, Lahore Cantt and Nishtar Town. However, Gulberg Town represented least value of 631 (Fig. 11). Highest number of health issues was observed in Ravi Town. Households in Shalamar Town, Aziz Bhatti Town, Wahga Town, Lahore Cantt and Nishtar Town are also suffering from multiple health issues. Gulberg Town, Samanabad Town, Iqbal Towns and Data Gunj Bakhsh are observed as comparatively healthy areas (Fig. 12). Finally, our analysis proved that poor condition of houses is associated with poor health. Different poor housing conditions are affecting occurrence of different types of health issues in the study area

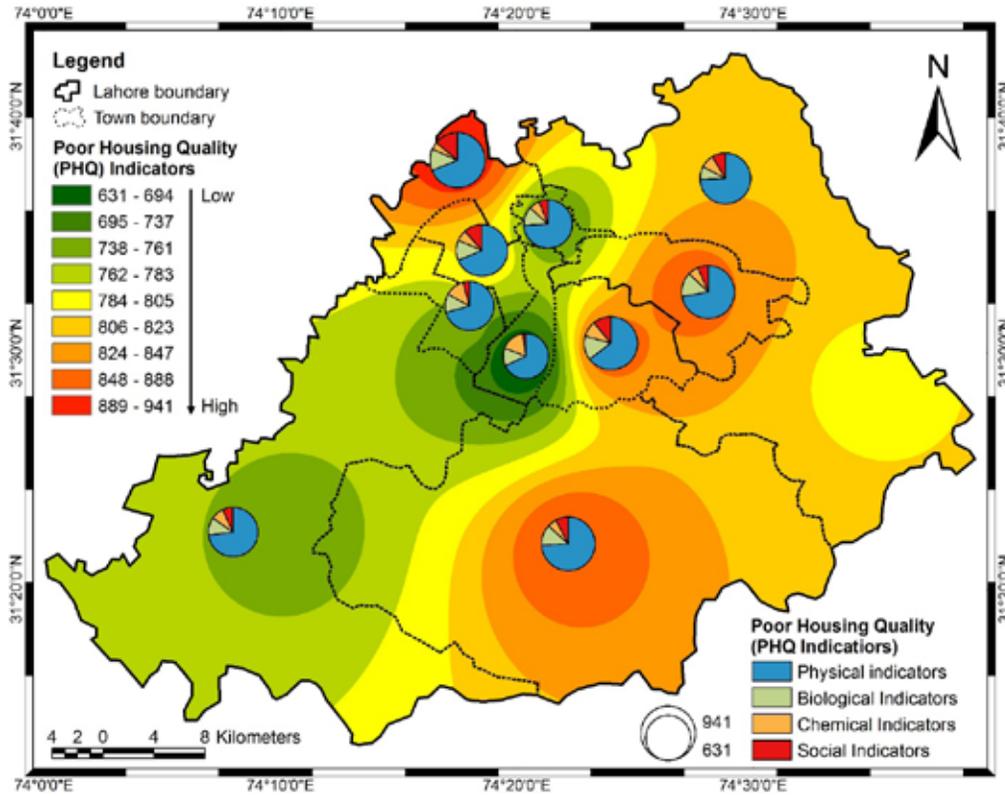


Fig. 11. Spatial distribution of poor housing indicators in Lahore. Red and orange colour exhibit very poor housing conditions related to worse health conditions in these areas (Fig. 12).

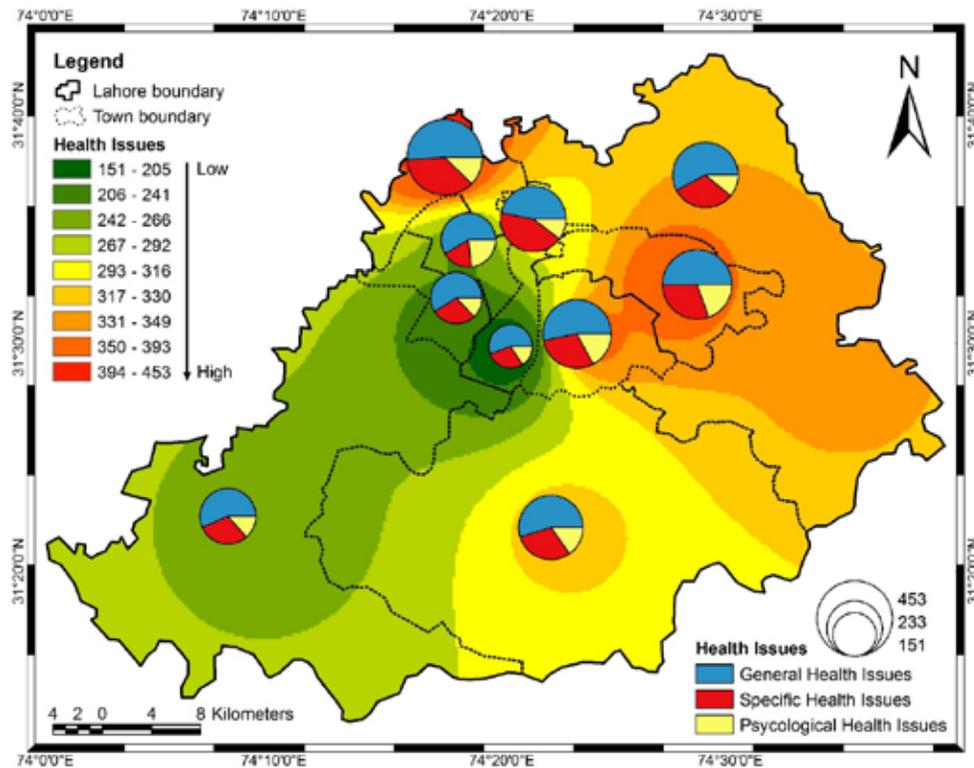


Fig. 12. Spatial distribution of health issues in Lahore. Red and orange colour exhibit high disease incidence areas because of poor housing quality in these areas.

Table 15. Final model of chi-square test giving significant *P*-value between poor housing quality indicators and health issues.

Sr. no.	Estimated relationship of two different frequencies	<i>P</i> -value
Factors of housing quality indicators affecting occurrence of abdominal pain		
1	Pests in houses are causing abdominal pain	0.015*
2	Fungus in homes is causing abdominal pain	0.003*
3	Disposal sites near house is a factor causing abdominal pain	0.002*
4	District water supply having unpleasant taste is a cause of abdominal pain	0.000**
Factors of housing quality indicators affecting occurrence of Cholera		
5	District water supply is reason behind cholera occurrence.	0.000***
Factors of housing quality indicators affecting occurrence of diarrhea		
6	District water supply is causing diarrhea	0.002**
7	Attached bathroom usage is causing diarrhea	0.001***
Factors of housing quality indicators affecting occurrence of Typhoid		
8	District water supply is a cause of typhoid	0.005**
Factors of housing quality indicators affecting occurrence of Cough		
9	Moisture presence in houses is causing cough	0.000***
10	White wash in houses is causing cough	0.002**
11	Air conditioner usage is causing cough	0.013*
12	No open space availability in houses is causing cough	0.016*
13	Industries near house is causing cough	0.032*
14	Overcrowding in homes is causing cough	0.005**
Factors of housing quality indicators affecting occurrence of tuberculosis		
15	Moisture presence in houses is causing tuberculosis	0.024*
16	Lack of open space availability in houses is causing tuberculosis	0.001***
17	Pests present in houses area causing tuberculosis	0.011*
Factors of housing quality indicators affecting occurrence of cold		
18	Moisture presence in houses is causing cold	0.043*
19	Usage of Air conditioner is causing cold	0.05*
Factors of housing quality indicators affecting occurrence of weak eyesight		
20	No open space around boundaries is affecting eye sight	0.011*
Factors of housing quality indicators affecting occurrence of skin allergy		
21	White wash in houses is causing skin allergy	0.02*
22	Fungus in houses is causing skin allergy	0.001***
23	Water cooler usage is causing skin allergy	0.005**
24	Overcrowding in houses is causing skin allergy	0.017*
Factors of housing quality indicators affecting occurrence of headache		
25	Moisture in houses is causing headache	0.003**
26	White wash in houses is causing headache	0.003**
27	Overcrowding in houses is causing headache	0.049*
28	Noise in houses in causing headache	0.000***
29	Bad smell in houses is causing headache	0.013*
Factors of housing quality indicators affecting occurrence of malaria		
30	Contaminated canal near house is causes malaria	0.031

Table 15 contd.....

Table 15 (contd.....)

Sr. no.	Estimated relationship of two different frequencies	P-value
31	Disposal site near house is causing malaria	0.000***
32	Industries near house is causing malaria	0.002**
Factors of housing quality indicators affecting occurrence of dengue		
33	Market area near house is causing dengue	0.05*
Factors of housing quality indicators affecting occurrence of hearing issues		
34	Noise in house is causing hearing issues	0.000***
Factors of housing quality indicators affecting occurrence of obesity		
35	Lack of open space availability in houses is causing obesity	0.000***
36	Overcrowding in house is causing obesity	0.000***
Factors of housing quality indicators affecting occurrence of blood pressure		
37	Overcrowding in house is causing blood pressure issues	0.000***
38	Fungus in house is causing blood pressure issues	0.001***
Factors of housing quality indicators affecting occurrence of heart attack		
39	Pests presence in house is affecting heart attack occurrence	0.021*
Factors of housing quality indicators affecting occurrence of muscular pain		
40	Fungus presence in house is causing muscular pain	0.029*
41	Lack of open space in house is causing muscular pain	0.000***
42	Insufficient exposure of sun in house is causing muscular pain	0.000***
Factors of housing quality indicators affecting occurrence of burn injury		
43	Gas supply through surface pipes is causing burn injuries	0.03*
Factors of housing quality indicators affecting occurrence of depression		
44	Moisture presence in house is affecting depression occurrence	0.000***
45	Fungus presence in houses is affecting depression occurrence	0.046*
46	Bad smell in house is affecting depression occurrence	0.005**
47	Noise in house is affecting depression occurrence	0.003**
Factors of housing quality indicators affecting occurrence of aggressiveness		
48	Moisture presence in house is affecting occurrence of aggressiveness	0.034*
49	Fungus presence in houses is affecting occurrence of aggressiveness	0.046*
50	Noise in houses is affecting occurrence of aggressiveness	0.000***
Factors of housing quality indicators affecting occurrence of lack of sleep		
51	Noise in house is affecting occurrence of lack of sleep	0.007**

(Table 15). However chemical indicators have not shown any relation with health issues.

3.12 Limitations

Researcher was unable to approach old Anarkali part of Lahore (area of old and critical condition of housing) due to non-cooperative behavior of residents of the colony. Residents didn't answer the questionnaire as they were quite security conscious and also they didn't allow researcher to enter their house to examine and assess housing conditions by self.

4. CONCLUSIONS

This investigation is a first approach to highlight the association between housing quality and health issues in Lahore using public level data. The poor housing conditions in Lahore's households are linked with ill health among the residents; the general public health can be improved with improved housing conditions. The results of this study may attract attention of the local and provincial government authorities to improving housing and health issues in Lahore.

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