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Assessing the Impact of Noise Pollution on Health and Preventive Practices among Individuals in Rawalpindi, Pakistan

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Abstract: Noise pollution has become a growing concern for urbanized and industrialized countries like Pakistan. This study focuses on Rawalpindi, a densely populated city where increasing population and industrial activities contribute to elevated levels of noise pollution. The research employed a quantitative approach; data was collected through surveys and interviews involving a sample of 50 individuals residing in different areas of Rawalpindi. This study examines the relationship between noise pollution and health issues such as anxiety/stress, migraines/headaches, sleeping disturbances and insomnia. Additionally, it explores the preventive practices that are adopted by the residents, including earmuffs, noise-cancelling headphones, and soundproofing. Results indicate a significant association between noise pollution exposure and increased health issues like stress, poor sleep quality and poor concentration, along with many preventive practices adopted to mitigate the negative impacts of noise. This research provides valuable insights for policymakers, urban planners, NGOs, and public health authorities to develop appropriate interventions and policies to mitigate noise pollution and promote preventive practices in Rawalpindi and similar urban contexts.

Key Words: Noise Pollution, Health, Preventive Practices, Rawalpindi, Pakistan

Introduction

Noise pollution is one of the environmental pollutions that is detrimental to life on land and in water. Among several types of pollution like air, water, land, and soil, one silent type of pollution, or otherwise the name suggests, noise pollution, is not paid any heed or studied because the adverse effects of the other types of pollution are more pronounced. Noise pollution can be defined as any sound that passes its threshold enough to qualify as noise or loud that harms individuals. It is any unwanted, unpleasant, or loud sound that exceeds its threshold limits (Ryherd 2016; Farina 2017). There are two types of noise pollution, namely community/environmental noise and occupational noise. The former includes noise emitted by all the sources (environmental, residential, and domestic sources), excluding industrial workplaces; includes roads, railways, air traffic, construction sites and neighbourhoods, playgrounds and parks, domestic animals like barking dogs, indoor ventilation systems like water coolers, office machines and home appliances. The latter refers to the various sources of noise emitted in industrial machinery and processes, including drilling, combustion engines, pumps, and compressors. It largely depends on the exposure and intensity of the noise that determines the effects on human health and well-being (Pakistan Environmental Protection Agency).

Noise measurements are expressed in terms of Sound Pressure Level (SPL) measured using a logarithmic decibel (dB) scale (King et al., 2012). Environmental sound is a mix of different frequencies. Frequency refers to the number of vibrations per second in the air particles that are a result of the sound waves or noise and is measured in Hertz (Hz). The sound frequency (measured in Hertz, Hz) and the sound pressure, measured in decibels (dB), determine the response of the human ear to the sound. The audible frequency range is considered to be 20 to 20,000 Hz. Sounds between 0-10 decibels are quiet, while around 150 decibels can be harmful to human ears (Pakistan Environmental Protection Agency). According to WHO

guidelines for community noise, less than 30 A-weighted decibels dB(A) during the night for uninterrupted sleep and less than 40dB(A) for night noise outside the house. Noise exposure levels should not exceed 70dB over a period of 24 hours and 85 dB over a period of 1 hour to avoid hearing impairment (NCEH, 2018).

Environmental noise is a pervasive pollutant with potential health effects that are medically and socially significant. Due to urbanization, deforestation, advancements, sustained growth in machinery, air traffic, and population, noise pollution will continue to become increasingly powerful. It will result in losses, both economic and well-being (intangible) (Jariwala et al., 2017). The most harmful sources of environmental noise are those related to transport and vehicular traffic. Noise due to transport is a public health concern and the most significant environmental cause of ill health in Western Europe, behind fine particulate matter pollution (WHO and JRC, 2011). The data reported by the European Environmental Agency estimated at least 20% of the European Union population is exposed to elevated levels of traffic noise that are harmful to health. More specifically, 113 million people are exposed to long-term day-evening night traffic noise levels of at least 55dB (A), 22 million are exposed to railway noise, 4 million to aircraft noise, and less than 1 million to industrial noise (EEA, 2020). Data reported in 2017 under the Environmental Noise Directive estimated that at least 18 million people are highly annoyed, and 5 million are extremely sleep-disturbed by exposure to traffic noise/transport (EEA, 2022). Furthermore, the estimated number of people to be affected by road noise levels of 55dB during the day-evening-night period is more than 95 million and more than 65 million are affected by levels of 50dB or more during the nighttime (EEA, 2021).

Anthropogenic activities are the major sources of noise in our communities. Prolonged exposure to high-intensity environmental noise puts individuals at risk of negative physiological and psychological health outcomes, including cardiovascular and metabolic effects, high blood pressure, irregular heart rhythms, irritation, annoyance, stress, reduction of productivity, cognitive impairment in children, severe annoyance and sleep disturbance, and risk for hearing loss or impairment (Farooqi, Z. U. R., et al., 2020). Noise-induced hearing impairment is one of the consequences of working with loud machinery in the industry. This may lead to permanent hearing loss or tinnitus (ringing in the ears due to prolonged exposure to high-intensity noise) (Ruidos.org). Individuals report feeling annoyed and irritated when hearing loud noises, which may also influence their social behaviours, i.e., avoiding outdoor activities and limiting engagement with people (Goines, L; Hagler, L. 2007). Noise pollution can also lead to interference in speech and spoken communication, e.g., disruption in communication in classrooms, poor academic performance, difficulty concentrating, reduced listening comprehension and misunderstanding, producing annoyance and disturbance. Disruptions in sleeping patterns are by far the most dominant repercussion of environmental noise pollution. The lack of proper sleep results in mood swings, reduced productivity and performance, feelings of tiredness, stress, exhaustion, increased blood pressure and irregular heartbeat. Further on, noise exacerbates the extremity of chronic diseases. It activates the nervous and endocrine systems of the human body and starts secreting epinephrine, norepinephrine, and cortisol (stress hormones), leading to a change in bodily reactions, increasing blood pressure and heart rate. These changes can also be a result of exposure to noise during the nighttime (EEA, 2020). This worsens the health and well-being of individuals with comorbidities, the most vulnerable being the cardiac and hypertensive patients, the children, the elderly, and pregnant females.

Anthropogenic noise is an emerging problem for developing countries like Pakistan and India. In Pakistan, with a rapidly increasing population estimated at 232,998,932, anthropogenic activities persist as individuals utilize all means available for their routine work and transportation. A study conducted in 88 distinct locations in Rawalpindi City, Pakistan, that included various places concluded that the noise level surpassed the WHO guideline values for noise in specific environments in all areas under study (Younas K et al. 2014). A study conducted in 2 industries and 43 busy locations of the industrial hub of Pakistan, Faisalabad, reported that the sound pressure levels were higher than the permissible limits at all the sampling locations during morning, afternoon, and evening hours. The maximum sound pressure levels were reported to

be at 102 dB inside the textile industry. The average sound pressure level (SPL) at State Bank Road was 102 dB, 101 dB at the Children's Hospital, and 100 dB at Jhang Bazar in the afternoon. A questionnaire-based survey that was carried out indicated that 94% of the respondents reported headaches, 76% sleeplessness, and 74% hypertension. 64% elevated blood pressure levels, 74% physiological stress and 60% dizziness due to noise (Farooqi, Z. U. R. et al., 2020).

Environmental noise continues to have an impact on human health, with the prevalent situation of noise pollution in Pakistan, where the proliferation of anthropogenic activities has now become a significant challenge that requires the immediate attention of the authorities, policymakers and the public. In reference to this issue, this study aims to evaluate individual's knowledge, perception, attitudes, and preventive practices regarding noise pollution, as well as the various impacts on health.

Methodology

Study area and population

Rawalpindi is the fourth most populous city in Pakistan after Karachi, Lahore, and Faisalabad and the third most populous city in Punjab after Lahore and Faisalabad. Since Rawalpindi is near the capital,

Islamabad, the two are jointly known as the "twin cities" (PBS) due to their economic links. Rawalpindi contributes to the GDP due to many industries, oil refineries, gas processing, steel manufacturing, iron mills, railroad yards, a brewery, sawmills, tent factories, textiles, hosiery, pottery, leather goods production, transport, and tourism (RCCI). Increasing industrialization contributes to urbanization by attracting people from other cities to better job opportunities. According to World Population Review, the population of this city is approximately 2.3 million.

Due to the increasing population, occupational noise, increasing vehicular traffic and road construction, traffic jams, transportation of goods on heavy vehicles and the use of public transport contribute significantly to noise and influence on inhabitants.

Assessment Tools

In this study, the sample size was determined through a simple random sampling technique and a total of 50 participants were selected. A questionnaire-based survey was administered to these participants. The respondents were from Rawalpindi PWD society and the areas surrounding Grand Trunk Road (GT). A well-structured and pre-tested questionnaire was designed to assess individuals' household knowledge and preventive practices regarding noise pollution and its impact on health in the city of Rawalpindi. It was divided into five sections. Section 1 targeted Socio-demographics, Section 2 Knowledge, Section 3 emphasized the various Health Issues due to noise, Section 4 Perceptions and Section 5 Preventive Practices to reduce noise pollution. The mode of data collection was based on face-to-face surveys and self-administered questionnaires on the Google Forms platform.

Empirical Estimation

For empirical estimation, linear regression analysis was used. The primary focus was to assess individuals' household knowledge and the health issues that result from noise pollution, along with the various preventive practices that individuals adopt to reduce their exposure to noise pollution. Further, in the first linear regression analysis, I empirically estimated the association between the independent variables and health issues. In the second empirical model, I estimated the relationship between the independent variables and preventive practices. The explanatory variables included in the empirical analysis include age of the residents, gender (1 for female and 0 for male), education level (in years), occupation (if employed, the

variable was set to 1, and 0 otherwise), marital status (for married individuals, it was set to 1 and for unmarried it was 0), number of children, family size, area of residency, and role of media.

Statistical Analysis

Descriptive statistics were used to summarize the health issues, the preventive practices, and the explanatory variables.

Results

Socio-Demographic Characteristics

Table 1 presents the socio-demographic characteristics of the residents. The residents have a mean age of 31.58 years. The mean year of education level is 17.16 years. Around 44% of residents are married, and 56% are unmarried. The study has 54% female and 46% male respondents. Moreover, the mean value of the number of children is 1.08, and respondents have an average family size of 5.12. Furthermore, 50% of the respondents are employed while 50% are unemployed, whereas the area of residency of 40% of the respondents is noisy.

Table 1

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Age	50	17	58	31.58	11.700
Gender	50	0	1	.54	.503
Edu	50	9	21	17.16	1.920
MS	50	0	1	.44	.501
FS	50	2	9	5.12	1.288
Children	50	0	5	1.08	1.455
Occ	50	0	1	.50	.505
Area	50	0	1	.40	.495
Valid N (Listwise)	50				

Household Knowledge of Residents about Noise Pollution

Table 2 presents an overview of the resident's knowledge about the hazardous health risks associated with noise exposure. Around 98% of the respondents knew about noise pollution, whereas 94% believed it to be a significant problem in their community. In addition, all the respondents were aware of the various sources of noise pollution, and 96% reported that they believed noise pollution had significant adverse effects on human health.

Table 2

An overview of the resident's knowledge about the hazardous health risks associated with noise exposure

Questions	Yes (%)	No (%)	I do not know (%)
Do you know about noise pollution?	49 (98)	1(2)	0
Do you believe noise pollution is a significant problem in your community?	47 (94)	2 (4)	1 (2)
Do you think environmental and occupational noise is a source of noise pollution?	50 (100)	0	0
Do you believe that noise pollution has any negative effects on human health?	48 (96)	2 (4)	0

Perceived Health Issues reported by the residents

Table 3 represents the health issues reported by the residents. These included Hypertension, sleeping disturbances, irregular heartbeat, migraines/headaches, annoyance, disturbance, difficulty focusing, anxiety/stress and hearing loss. All these health issues vary significantly depending on the residency of the respondents. The prevalence of health issues is higher among the residents who live in a noisy area. The perceived health issues reported by the surveyed residents were hypertension, sleeping disturbances, irregular heartbeat, and migraines/headaches, as reported by 26%, 68%, 22%, and 74%. Annoyance, disturbance, difficulty focusing, anxiety/stress, hearing loss were reported by 68%, 80%, 62%, 44% and 12%, respectively.

Table 3

Perceived health issues reported by the residents

S. No	Health Issues	Yes (%)
1	Hypertension	13 (26)
2	Sleeping disturbances	34(68)
3	Irregular heartbeat	11(22)
4	Migraines/Headaches	37(74)
5	Annoyance	34(68)
6	Disturbance	40(80)
7	Difficulty focusing	31(62)
8	Anxiety/Stress	22(44)
9	Hearing loss	6(12)
10	Other	2(4)

Note: The percentage is not equal to 100 as some residents perceived more than one health symptom.

Statistical estimation between perceived health issues of residents and explanatory variables analyzed in the linear regression model are presented in Table 4. The findings show that the perceived health issues of residents are significantly and positively correlated with age, education, and occupation. By contrast, perceived health issues of residents have a significant negative correlation to the area of residency (P < 0.10).

Table 4

Correlation coefficients between perceived health issues and explanatory variables
Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients Beta	t	Sig.
		B	Std. Error			
01	(Constant)	-1.097	.602		-1.820	.076
	Age	.019	.010	.452	1.892	.066*
	Gender	.167	.122	.174	1.377	.176
	Edu	.070	.034	.278	2.051	.047**
	MS	-.038	.244	-.040	-.157	.876
	FS	-.030	.048	-.081	-.628	.534
	Children	-.028	.094	-.084	-.299	.766
	Occ	.287	.129	.299	2.218	.032**
	Area	-.223	.115	-.228	-1.948	.058*

a. Dependent Variable: HI
b. Note: *P < 0.10. **P < 0.05. ***P < 0.01.

Preventive Practices Adopted by Residents

Table 5 presents the various preventive practices that are adopted to reduce exposure to noise pollution along with the frequencies. The majority of the residents reported adopting closing windows and doors (86%), using noise-reducing curtains and headphones (68%), and sound-absorbing material (64%). At the same time, others reported using earmuffs (16%), white noise (16%), and soundproofing (28%).

Table 5

Preventive Practices adopted by the residents

S. No	Preventive Practices	Yes (%)
1	Noise cancelling headphones	34(68)
2	Closing windows and doors	43(86)
3	Earmuffs	8(16)
4	Using noise-reducing curtains	34(68)
5	White noise	8(16)
6	Soundproofing	14(28)
7	Sound absorbing material	32(64)
8	Other	1(2)

Table 6 indicates the results of the second linear regression analysis model, which shows the correlation between preventive practices and explanatory variables. The findings show that preventive practices adopted by residents are significantly and positively correlated with marital status and family size. By contrast, perceived health issues of residents have a significant negative correlation to age (P < 0.05).

Table 6

Correlation coefficients between preventive practices and explanatory variables
Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients Beta	t	Sig.
		B	Std. Error			
1	(Constant)	1.004	.216		4.650	.000
	Age	-.010	.004	-.796	-2.720	.010***
	Gender	.022	.043	.079	.509	.614
	Education	.000	.012	.002	.013	.990
	MS	.203	.088	.719	2.312	.026**
	FS	.033	.017	.302	1.907	.064*
	Children	.022	.034	.226	.655	.516
	Occupation	-.048	.047	-.172	-1.019	.314
	Area	.012	.041	.041	.287	.775
	Media	.017	.062	.038	.268	.790

a. Dependent Variable: PP
b. Note: *P < 0.10. **P < 0.05. ***P < 0.01.

Discussion

Due to the growing urbanization and increasing population, noise pollution is a growing concern in Pakistan, especially in urban areas, where increased industrialization has attracted migrant workers to major cities, including Rawalpindi. Increasing immigration leads to higher noise levels, which prove detrimental to human health, both physically and psychologically. Vehicular traffic and construction sites contribute significantly, with honking horns, loud engines, exhaust sounds, heavy machinery operation, drilling, and demolition works. The Ministry of Environment, Local Government and Rural Development, under the Government of Pakistan, has declared a national environmental quality standard for motor vehicle exhaust and noise, stating that the maximum permissible limit for noise is 85 dB (A) at a distance of 7.5 meters from the source (Ministry of Environment, Local Government and Rural Development, 1993). Yet individuals continue to voluntarily remove silencers and install loud exhausts in their vehicles. The prominent levels of vehicular areas and construction sites in the above-mentioned study areas all exceed the standard for noise, as reported by the Government of Pakistan. This study finds that noise pollution has multiple impacts on health. Similarly, a study by (Farooqi, Z. U. R., et al., 2020) in Faisalabad reports the following health issues: 94% of respondents reported headache, 76% sleeplessness, 74% hypertension, 74% physiological stress, 64% elevated blood pressure levels, and 60% dizziness due to noise. My findings are also consistent with the study conducted by the European Environmental Agency, which concluded that vehicular traffic is the most dominant source of environmental noise (WHO and JRC, 2011).

The linear regression model shows that age, education, and occupation have significant positive effects, whereas the area of residency has a significant negative effect on health issues (Table 4). Occupation, education, and age have strong positive significance at 5%, 5%, and 10%, respectively. Residents who are employed are more prone to the negative effects of noise pollution because they are exposed to vehicular noise in their day-to-day activities, whereas educated individuals are more aware of the health risks and can take appropriate preventive measures to minimize health risks. Aged individuals are already more prone to comorbidities, increasing their susceptibility to health risks caused by noise, as compared to the youth, who must travel over large distances for educational and occupational purposes, thereby increasing their exposure to noise. On the other hand, the area of residency has a strong negative significance at 10%. Residents living in close proximity to noisy areas are more prone to the hazardous health risks of noise than those who live in a comparatively quieter environment.

The second linear regression model shows that marital status and family size are positively significant, and age is negatively significant with preventive practices adopted by residents (Table 6). Marital status and family size have strong positive significance at 5% and 10%, respectively. Individuals who are married are more prone to adopting preventive practices than those who are single. Family size determines that the greater the number of individuals in a family increasing domestic noise, the more inclined they are to adopt preventive practices to reduce their exposure to noise. Age has a strong negative significance at 1%. Younger individuals are more active in their daily routine and travel long distances for educational purposes and jobs, increasing their daily exposure to noise, which increases the likelihood of youth adopting preventive practices, whereas aged individuals may either be retired or occupied with domestic chores and may not be exposed to noise as such.

Our analytical findings can guide NGOs and Government agencies in formulating effective policies and regulations. These policies include establishing and enforcing comprehensive noise regulations and standards, observing the standards already set and imposing fines on lawbreakers, implementing noise control measures in construction infrastructure projects through the use of noise barriers, and investing in low-noise technologies in transportation, industrial and construction sites. There should be encouragement to use public transport to help reduce noise pollution by reducing the number of individual vehicles on the road. Governments and agencies should launch public health awareness campaigns to educate the public

about the adverse effects of noise pollution and measures that can be taken to reduce noise exposure so individuals can make informed choices.

This study has certain limitations that are worth noting. The study area of this research was only a small area of Rawalpindi with a small sample size. Due to time restrictions, funding, and human resources, limited data could be collected about health issues, preventive practices, and adverse impacts of noise pollution. This study did not consider a range of factors, like the cost of investing in preventive practices for noise pollution. This study did not analyze the long-term effects of noise pollution on health and well-being. Furthermore, health issues were perceived by the residents, and therefore, it is difficult to isolate noise pollution solely as the only cause of perceived health issues since it is difficult to measure the exact impact of noise pollution. Another limitation is the utilization of close-ended questions in the questionnaire, which posed limitations by constraining the respondents to predetermined response options. To enhance the depth of understanding, future research should incorporate open-ended questions to gain a comprehensive view of the subject matter. It is imperative to consider these limitations so future research may also focus on these aspects and address them effectively to ensure comprehensiveness and reliability.

Conclusion

This study examines the effects of noise pollution on residents' perceived health as well as the factors that contribute to adopting preventive practices to reduce exposure to noise pollution. Cross-sectional data was collected from 50 respondents in PWD and Grand Trunk Road and surrounding regions, Rawalpindi, Pakistan. As these areas serve as a link to the majority of the regions of Pakistan, they contribute greatly to noise pollution by high levels of vehicular traffic and the construction of roads and pathways. The ongoing construction and vehicular traffic contribute greatly to increasing the risk of residents becoming susceptible to health issues associated with noise reported by the residents, such as ringing in the ears, migraines/headaches, and increased sleep disturbances. Consequently, most of the residents reported adopting preventive practices to protect themselves against the hazardous health risks due to noise. This study uses a linear regression model to investigate whether the explanatory variables have any significant correlation to perceived health issues and preventive practices. Residents living in noisy environments reported having increased health issues; 80% of individuals reported disturbance, 74% migraines and 68% annoyance, among many other health issues, out of which the mentioned are more prevalent. Most respondents adopted preventive practices, out of which noise-cancelling earphones (68%), sound-absorbing materials (68%) and closing windows and doors (86%) were more reported. In terms of policy implications, by adopting preventive practices, individuals and government agencies can play a crucial role in mitigating its negative effects. This includes raising awareness, practising personal responsibility by controlling noise levels in their surroundings, advocating for stricter regulations, including imposing fines on noisy vehicles and motorbikes and prioritizing noise reduction in homes and workplaces. Through these efforts, individuals can contribute to creating a quieter and healthier environment.

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