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CORRELATION OF MALARIAL MICROSCOPIC FINDINGS WITH SOCIODEMOGRAPHIC AND ENVIRONMENTAL RISK INDICATORS IN SABZAZAR, LAHORE

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Abstract

Background: Malaria remains an important public health concern in many developing countries, including Pakistan. Environmental conditions, population density, and socioeconomic factors can influence the spread of the disease, particularly in urban communities. Microscopic examination of blood smears remains a reliable method for detecting malaria parasites and identifying species. Understanding the relationship between malaria findings and associated risk factors can help in improving prevention and control strategies.

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Objective: To evaluate the correlation between malarial microscopic findings and selected sociodemographic and environmental risk indicators among residents of Sabzazar, Lahore.

Methodology: A cross-sectional study was conducted over a period of four months in Sabzazar, Lahore. A total of 125 participants were included in the study. Sociodemographic information and environmental risk factors, including presence of stagnant water near the house, outdoor sleeping habits, and use of insecticide-treated nets (ITNs), were collected through structured questionnaires and direct field observations. Axillary temperature was measured to assess fever. Blood samples were collected in EDTA vials, and both thick and thin blood smears were prepared. The slides were stained with Giemsa stain and examined under a microscope to detect and identify *Plasmodium* species. The collected data was entered and analyzed using SPSS software 20. Descriptive statistics and appropriate statistical tests were applied to determine associations between malaria positivity and potential risk factors.

Results: Microscopic examination showed that 19.2% of participants were positive for malaria. *Plasmodium falciparum* was the most detected species, while *Plasmodium vivax* was found in fewer cases. Sociodemographic factors such as age and gender did not show a strong association with malaria infection. However, environmental factors like stagnant water near houses, outdoor sleeping, and irregular use of mosquito nets were more common among infected individuals. In addition, malaria-positive participants had slightly lower hemoglobin levels compared to those without infection.

Conclusion: The study demonstrates that environmental and behavioral factors significantly influence malaria transmission in Sabzazar, Lahore. Interventions such as improving environmental sanitation, eliminating potential mosquito breeding sites, encouraging the consistent use of insecticide-treated nets, and promoting protective behaviors can effectively reduce malaria prevalence in the community.

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INTRODUCTION

Malaria is one of the oldest and most important infectious diseases affecting human populations worldwide. It is caused by *Plasmodium* parasites and transmitted through the bite of infected female *Anopheles* mosquitoes. Five species commonly infect humans, including *P. falciparum*, *P. vivax*, *P. malariae*, *P. ovale*, and *P. knowlesi*. Among these, *P. falciparum* is the most severe due to its association with complications such as cerebral malaria and multi-organ failure, while *P. vivax* is more common in Asian countries and is known for recurrent relapses. Malaria continues to place a major burden on healthcare systems and economies, particularly in tropical and subtropical regions where environmental conditions support mosquito breeding and disease transmission. (1)

Globally, malaria remains endemic in more than 100 countries and continues to affect millions of people every year. Pakistan is also significantly affected because of favorable climatic conditions, population density, inadequate sanitation, and limited healthcare access in some areas. Sociodemographic factors such as poverty, low education, overcrowding, and occupational exposure increase the risk of malaria infection. Environmental conditions including stagnant water, blocked drainage systems, poor waste management, and seasonal rainfall further contribute to mosquito breeding and disease spread. In endemic regions, repeated exposure may lead to partial immunity, causing some individuals to become asymptomatic carriers who silently contribute to transmission within the community. (2)

Malaria commonly presents symptoms such as fever, chills, headache, nausea, vomiting, and fatigue, although these manifestations are often nonspecific and resemble other febrile illnesses. Therefore, laboratory confirmation is necessary for accurate diagnosis and proper treatment. Microscopic examination of thick and thin blood smears remains the gold standard diagnostic method because it is cost-effective and allows parasite detection, species identification, and parasite quantification. Advanced diagnostic techniques such as polymerase chain reaction (PCR) provide greater sensitivity and specificity, while rapid diagnostic tests (RDTs) are widely used because of their simplicity, rapid results, and suitability for resource-limited settings. (3)

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Literature Review

Bah, M. S. et al., 2021 report that malaria infection in under-five children is strongly influenced by socioeconomic and environmental determinants. Their cross-sectional findings indicate that children from poorer households, those with uneducated mothers, and those living in poorly constructed housing are at significantly higher risk of infection. Age also plays a role, with older children showing increased vulnerability due to greater exposure. The study highlights that malaria distribution is not random but closely linked with inequality in living standards, awareness, and access to preventive measures. It concludes that improving education, housing quality, and socioeconomic conditions can substantially reduce malaria burden in endemic populations.

Bio, R. et al., 2024 and related studies emphasize that malaria prevalence in pregnant women and community populations is driven by combined environmental and sociodemographic factors. Their findings show that proximity to mosquito breeding sites, poor sanitation, lack of education, and inadequate housing significantly increase infection risk. Preventive behaviors such as insecticide-treated net use are shown to reduce transmission, while limited awareness increases vulnerability. The study also reports moderate prevalence in high-risk groups, particularly in resource-limited settings. It concludes that integrated interventions addressing both environmental control and health education are essential for reducing malaria transmission and protecting vulnerable populations effectively.

Irshad, H. et al., 2025 along with supporting regional studies demonstrate that malaria transmission in Pakistan and similar endemic settings is shaped by weak vector control strategies, socioeconomic disparities, and environmental conditions. Poor housing, stagnant water, and limited access to preventive tools contribute significantly to infection rates. Seasonal variation and population movement further intensify transmission patterns. The study also highlights that reliance on single prevention strategies is insufficient, as integrated approaches such as insecticide-treated nets and indoor residual spraying show better outcomes. It concludes that strengthening comprehensive

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vector control programs and improving public health infrastructure is necessary for sustained malaria reduction.

Dana, D. D. et al., 2026 and outbreak-focused studies identify environmental and behavioral risk factors as key drivers of malaria transmission. Factors such as stagnant water accumulation, proximity to mosquito breeding sites, poor housing conditions, and inconsistent use of preventive measures significantly increase infection risk. Seasonal rainfall patterns further enhance mosquito breeding and disease spread. The studies also highlight diagnostic challenges due to asymptomatic infections and limited awareness in communities. These factors contribute to continued transmission despite control efforts. The findings conclude that effective malaria control requires strong vector management, improved community awareness, and early detection strategies to prevent outbreaks and reduce disease burden.

Methodology

A cross-sectional study design was used to assess malaria prevalence and its association with sociodemographic and environmental factors among residents of Sabzazar, Lahore. The study was conducted over four months following synopsis approval in community screening settings and local clinics, where individuals of all ages and genders were included after giving informed consent. A total of 125 participants were recruited using a non-probability convenience sampling technique. The sample size was calculated using Cochran's formula based on an estimated prevalence of 9%, a 95% confidence level, and a 5% margin of error, ensuring adequate representation for analysis.

Participants were selected based on defined inclusion and exclusion criteria. Residents of Sabzazar with suspected malaria symptoms who agreed to participate and provide blood samples for microscopic examination along with completing a structured questionnaire were included in the study. Individuals were excluded if they had recent antimalarial treatment, chronic illnesses, pregnancy without consent, incomplete data, or had lived in the area for less than six months. Those

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who refused consent or did not provide blood samples or complete the questionnaire were also excluded to maintain data accuracy and reliability.

Blood sample collection and microscopic examination were performed using standardized procedures to ensure diagnostic accuracy. Capillary blood was obtained through sterile finger prick after proper antiseptic cleaning of the site. Both thick and thin blood smears were prepared on clean slides, air-dried, and appropriately fixed, with thin films treated using methanol. All slides were stained using Giemsa stain and examined under a light microscope using oil immersion at 100× magnification. Thick smears were used for parasite detection, while thin smears were used for species identification, and each slide was thoroughly examined across multiple fields.

Ethical approval was obtained from the Ethical Committee of Superior University Lahore, and all research procedures followed strict ethical guidelines. Written informed consent was obtained from all participants, and confidentiality and anonymity were maintained throughout the study. Participants were informed that there were no risks involved and that they had the right to withdraw at any time without consequences. All data were securely stored using password protection and locked systems to ensure privacy and data safety throughout the research process.

Data collection and analysis were conducted systematically over the study period. Information was gathered through structured questionnaires covering sociodemographic characteristics, environmental conditions, and clinical symptoms, along with laboratory-confirmed malaria results. Axillary temperature was recorded, and febrile cases were further evaluated. Data were entered into SPSS for statistical analysis, where descriptive statistics were used to summarize variables, and chi-square, t-tests, and ANOVA were applied to assess associations. Results were presented in tables and charts, and statistical significance was used to interpret findings and draw conclusions.

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Results

A total of 125 participants from Sabzazar, Lahore, were included in the study with a mean age of 29.4 ± 12.3 years. Males constituted 57.6% (72) and females 42.4% (53) of the sample. Most participants (61.6%) were aged 18–35 years, while smaller proportions belonged to children (<18 years), middle-aged (36–50 years), and older adults (>50 years). All participants had lived in the area for at least six months and had no recent history of antimalarial treatment. Blood smear microscopy showed that 19.2% (24/125) were positive for malaria infection, indicating a notable burden in the study population.

Malaria Species Distribution (Pie Chart) Malaria distribution (n=24)

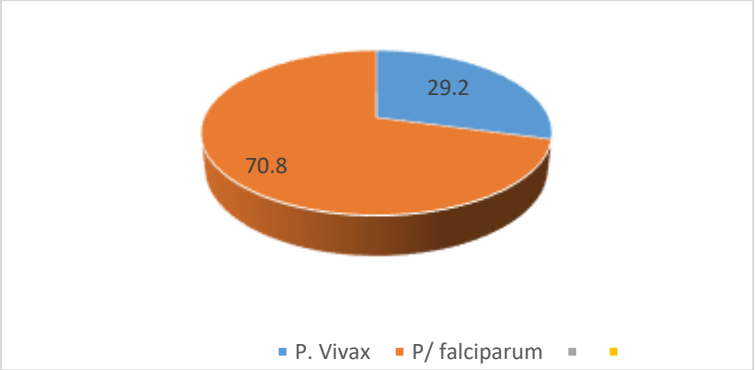

Fig 5.1 illustrates the distribution of malaria among the 24 positive cases in the study. *Plasmodium falciparum* accounted for most infections, representing 71%, while *Plasmodium vivax* accounted for 29%. The chart highlights the predominance of *P. falciparum* in Sabzazar, Lahore, consistent with global trends in endemic regions.

Among the positive cases, Plasmodium falciparum was the dominant species, accounting for 70.8% (17 cases), while Plasmodium vivax represented 29.2% (7 cases). Age-wise distribution showed that the highest number of malaria-positive cases occurred in the 18–35 years group (15 cases), followed by children and older adults. However, statistical analysis showed no significant association between malaria positivity and age or gender ($p > 0.05$), indicating that infection was distributed relatively across demographic groups without strong statistical variation.

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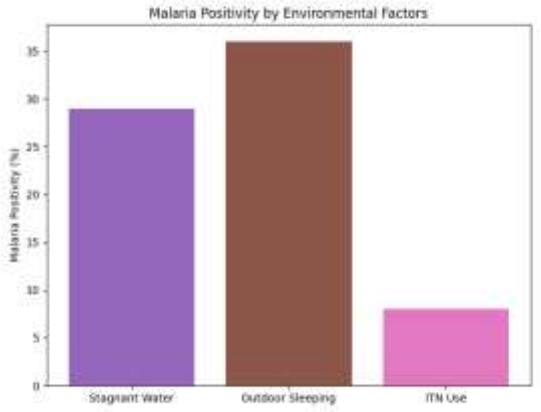
Table 5.5: Association of Malaria with Environmental Factors

Factor	Positive n (%)	Negative n (%)	χ^2	p-value
Stagnant Water Nearby	14 (29.2)	34 (70.8)	12.5	0.001
Outdoor Sleeping	10 (35.7)	18 (64.3)	8.9	0.003
ITN Use	5 (8.3)	55 (91.7)	10.7	0.001

Malaria positivity was significantly higher among participants with stagnant water near their residence and those who sleep outdoors. ITN users had significantly lower malaria positivity.

Hematological analysis revealed a significant difference in hemoglobin levels between malaria-positive and malaria-negative participants. The mean hemoglobin level in infected individuals was 10.8 ± 1.6 g/dL compared to 12.4 ± 1.8 g/dL in non-infected individuals, and this difference was statistically significant ($p < 0.001$). These findings indicate a clear association between malaria infection and anemia in the affected population, suggesting that malaria contributes to hematological impairment in infected individuals.

Malaria Positivity by Environmental Factors (Bar Chart)



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This bar chart illustrates the percentage of malaria-positive participants in relation to key environmental factors. Malaria positivity was highest among participants living near stagnant water (29%) and those who sleep outdoors (36%), while participants using insecticide-treated nets (ITNs) had the lowest positivity (8%). The chart highlights the role of environmental and behavioral risk factors in malaria transmission

Environmental risk factor analysis showed strong associations with malaria positivity. Participants living near stagnant water (29.2%), those who slept outdoors (35.7%), and those not using insecticide-treated nets had significantly higher infection rates, while ITN users showed the lowest positivity (8.3%). Statistical testing confirmed significant associations between malaria and these environmental factors ($p < 0.05$). Overall, the findings highlight that while demographic factors were not significant, environmental exposure and preventive practices played a major role in malaria transmission in Sabzazar, Lahore.

Discussion

Malaria remains a significant public health concern in Sabzazar, Lahore, with an overall prevalence of 19.2% observed in the present study. Plasmodium falciparum was identified as the dominant species, followed by Plasmodium vivax, reflecting the typical distribution seen in endemic regions. The study highlights that malaria continues to persist even in urban settings, largely due to environmental conditions such as stagnant water and poor sanitation. The use of microscopy proved effective in confirming cases and identifying species, supporting its continued role as a reliable diagnostic tool in resource-limited settings. These findings collectively emphasize the ongoing transmission of malaria in the study area.

Sociodemographic analysis showed no significant association between malaria positivity and variables such as age and gender, suggesting that exposure risk in this urban population is relatively uniform. However, environmental and behavioral factors demonstrated a strong statistical association with malaria infection. Individuals living near stagnant water, practicing outdoor

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sleeping, and not using insecticide-treated nets had significantly higher infection rates. These findings strongly indicate that transmission is primarily driven by modifiable environmental and behavioral risks rather than demographic differences. Similar trends reported in other regional studies further reinforce the importance of environmental management and preventive behaviors in controlling malaria transmission.

The study also revealed a notable reduction in hemoglobin levels among malaria-positive individuals, indicating a clear association between malaria infection and anemia. This is consistent with the known pathophysiology of malaria, where destruction of red blood cells and impaired hematopoiesis contribute to decreased hemoglobin levels. Although not all cases showed severe anemia, the overall trend highlights the broader systemic impact of malaria beyond acute febrile illness. In addition, the urban context of Sabzazar demonstrates that infrastructure-related issues such as poor drainage and waste accumulation significantly contribute to vector breeding and sustained transmission. These findings underline the need for integrated health and environmental interventions.

Conclusion

This study demonstrates that malaria in Sabzazar, Lahore, is mainly driven by environmental and behavioral factors rather than sociodemographic characteristics. The moderate prevalence, predominance of Plasmodium falciparum, and associated reduction in hemoglobin levels highlight both the clinical and public health importance of the disease. Strengthening environmental control measures, improving community awareness, and promoting consistent use of preventive tools such as mosquito nets are essential for reducing transmission. Overall, the findings provide useful evidence for policymakers to design targeted malaria control strategies in urban settings.

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