

Original Article

Evaluating Malaria Prevalence Across Different Age and Gender Groups in Peshawar Through Light Microscopic Analysis

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ABSTRACT

Background: Malaria poses a significant public health challenge in Peshawar, Pakistan, where conditions are ideal for Anopheles mosquito breeding. This study investigates the prevalence of malaria across different demographic groups, employing light microscopy to detect Plasmodium parasites.

Objective: The primary objective was to assess the prevalence of malaria in specific age and gender groups in Peshawar using light microscopy. A secondary aim was to identify demographic patterns in malaria spread to facilitate targeted public health interventions.

Methods: This descriptive cross-sectional study was conducted from January to August 2021. It included 750 participants suspected of having malaria, selected through systematic sampling. Diagnostic procedures involved preparing both thick and thin blood smears stained with Giemsa to identify and quantify malaria parasites.

Results: Among the participants, 299 tested positive for malaria, representing an infection rate of 39.87%. Males exhibited a higher infection rate of 43.83% compared to females at 35.77%. The highest prevalence was observed in the 41-60 age group, with an infection rate of 50.83%. Statistical analysis using a Chi-square test indicated a significant variation in malaria prevalence by gender (Chi-square = 5.079, df = 1, P = 0.0242).

Conclusion: The study confirms a substantial malaria burden in Peshawar, with notable variations by gender and age. These results support the need for more focused malaria control strategies that address the specific vulnerabilities associated with these demographic factors.

Keywords: Age Groups, Gender Differences, Giemsa Stain, Light Microscopy, Malaria, Plasmodium Infection, Public Health.

INTRODUCTION

Malaria continues to pose a significant public health challenge globally, particularly in regions optimal for the propagation of its vectors and parasites (1). Among these regions, Peshawar, a principal urban center in Khyber Pakhtunkhwa, Pakistan, presents a unique set of ecological, climatic, and socio-economic conditions conducive to the breeding of Anopheles mosquitoes (2). The city's dense population and high mobility rate contribute to its vulnerability to malaria, necessitating effective strategies for its prevention, control, and treatment.

Transmission of malaria occurs through the bites of infected female Anopheles mosquitoes, which introduce Plasmodium parasites into the human bloodstream (4). There are several Plasmodium species, but *P. falciparum* and *P. vivax* predominate in Pakistan and pose the greatest threat; the former is associated with severe and often fatal malaria, while the latter is known for causing relapses due to its persistent liver stages (6). The transmission of malaria in Pakistan varies markedly across its diverse landscapes—from arid deserts to fertile plains and mountainous terrains—which influence the ecological zones and subsequently, the prevalence of malaria (7).

The close proximity of Peshawar to Afghanistan and the frequent cross-border movement of people also exacerbate the malaria situation by facilitating the spread of infection (8). Moreover, the city's temperate climate and monsoonal rains create ideal breeding grounds for mosquitoes, underscoring the need for localized understanding of malaria transmission dynamics to optimize intervention strategies.

Diagnostically, light microscopy remains the cornerstone for malaria detection due to its ability to both confirm the presence of parasites and identify their species, thus guiding appropriate treatment decisions (9). Despite the advent of rapid diagnostic tests, light microscopy is indispensable, particularly in resource-limited settings like Peshawar, where it offers a practical and cost-effective method to quantify parasite load (10).

Additionally, the demographic distribution of malaria, influenced by age and gender, is crucial for tailoring public health interventions (11). Age-related immunity and exposure, as well as gender-specific social and behavioral patterns, influence malaria's prevalence and outcomes. For instance, men, often engaged in outdoor occupations such as agriculture or construction, may face higher exposure to mosquito bites during peak times, whereas women might encounter different exposure risks due to varying social roles (12).

In light of these considerations, this study aims to evaluate the prevalence of malaria across different age and gender groups in Peshawar through the analysis of light microscopic data. The objective is to generate insights that can inform more targeted and effective public health responses, ultimately contributing to the reduction of malaria's impact in this high-risk area.

METHODOLOGY

The study employed a descriptive cross-sectional design and was conducted over an eight-month period from January to August 2021 in Peshawar, a major urban center in the Khyber Pakhtunkhwa province of Pakistan. This location was chosen for its high malaria prevalence and critical role as a regional health services hub, making it an ideal setting for epidemiological studies on malaria due to its diverse and highly mobile population.

The sample consisted of 750 patients who presented with symptoms indicative of malaria at various healthcare facilities, including hospitals and community health centers, ensuring a broad representation of the urban population. Patients were selected using convenience sampling. The inclusion criteria encompassed patients of all ages and genders who exhibited specific signs and symptoms of malaria. Conversely, those who had received antimalarial treatment within the prior two weeks were excluded to avoid interference with the diagnostic process. Additionally, individuals who declined to participate in the study were excluded.

Data collection involved drawing approximately 2ml of blood from each patient using a sterile needle and syringe. The samples were then transferred into EDTA-coated tubes to prevent clotting and labeled with a unique identification number to maintain patient anonymity and ensure accuracy in tracking the samples through subsequent diagnostic procedures.

In the laboratory, both thick and thin blood films were prepared immediately after collection. Thick films were used to detect the presence of malaria parasites, while thin films facilitated species identification. A 10% Giemsa solution, adjusted to a pH of 7.2, was used for staining, which was meticulously controlled to maintain consistent quality, with each slide stained for precisely 15 minutes. Slides were examined under a high-powered lens by trained laboratory technicians, with each smear read independently by two technicians to minimize diagnostic errors. The species presence was confirmed by observing the morphology of the Plasmodium species within the red blood cells.

To ensure the reliability of the results, rigorous quality control measures were implemented. Microscopes were recalibrated every hour, staining reagents were regularly maintained, and ongoing training was provided to personnel. All findings were further verified by a senior parasitologist to assess inter-observer reliability.

Data analysis was conducted using Microsoft Excel and GraphPad Prism software. Descriptive statistics such as frequencies, percentages, and means for both categorical and continuous variables were calculated. The prevalence of malaria was determined as a proportion of the screened population found to be positive. Inferential statistical tests, including Chi-square tests for associations between prevalence and age groups, and t-tests to compare age and gender, were performed. A p-value of less than 0.05 was considered statistically significant.

RESULTS

In the study conducted over eight months (January 2021 to August 2021), a total of 750 participants were screened for malaria parasites using light microscopy, irrespective of their age and gender. The objective was to evaluate the prevalence of malaria across different age and gender groups in Peshawar.

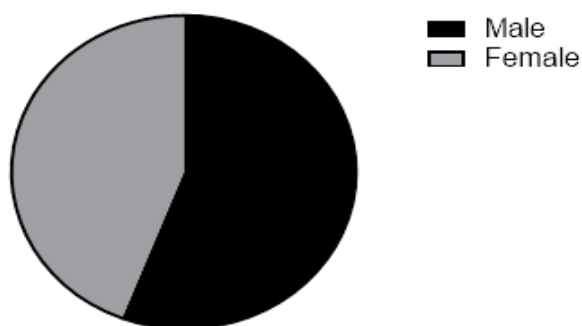
Overall Screening Results

From the 750 suspected cases, 299 (approximately 39.87%) tested positive for malaria parasites, while the remaining 451 (60.13%) were negative. This shows a substantial presence of malaria infection among the participants.

Table 1: Screening results of all the patients

Description	Count
Total Screened	750
Positive Cases	299
Negative Cases	451
Percentage Positive	39.87%

Measures of association Between males and females, the study was able to obtain a significant difference regarding the prevalence of malaria. Out of 381 male participants, 167 tested positive, with a positivity rate of about 43.83%. Out of 369- female participants 132 tested positively, with a positivity rate of around 35.77%. The above computation indicates that males have a higher prevalence compared to females in the sample population.



Total=299

Figure 1 Gender based analysis

Age Group Analysis

Again, the occurrence of malaria significantly differed across the various people’s age in the research. The youngest participants, under 20 years, had 201 screened. Of the total, 67 tested positive, which linearly had a positivity rate of 33.33%. For 21-40 years age, a total of 234 was screened and found 86 positive, which is 36.75%. The highest participants screened were 40-60 years, where a total of 240 was done and 122 turned positive, having a positivity rate of 50.83%. This is an indication that the groups had the highest prevalence. For those who were above the age of 60 years were a total of 75, and 24 turned positive; thus, the positivity rate was 32.00%. This clearly shows that as age increases, the probability of testing positive increases up to middle age before dropping.

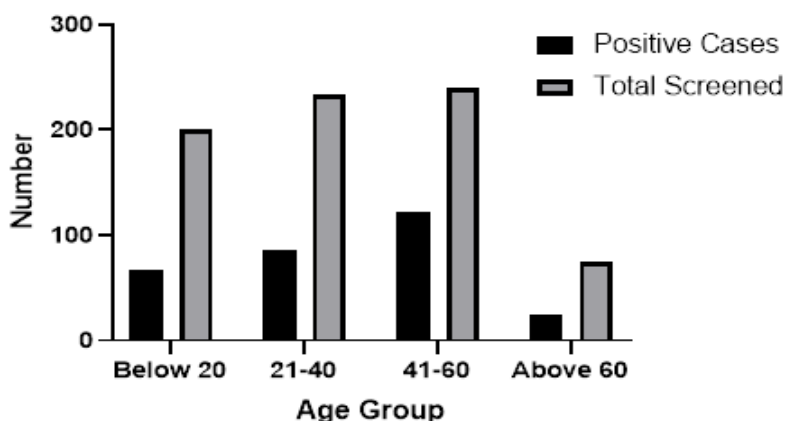


Figure 2 Age group analysis

Statistical Significance of Gender Differences in Malaria Prevalence

A Chi-Square test was also used to establish statistically significant differences in prevalence between male and female participants. The results show that the Chi-square value is 5.079 while the degree of freedom is 1 with a P value of 0.0242 is determined.

Relation between gender and malaria tests results

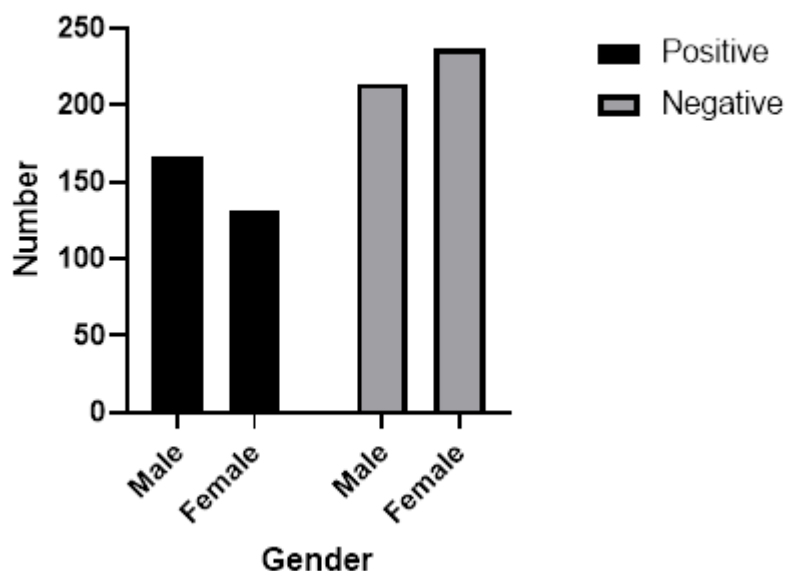


Figure 3 Statistical Significance of Gender Differences in Malaria Prevalence

43.83% for males and 35.77% for females. This output gives a clue that gender-specific risks influence the risk of malaria disease. Therefore, gender causes may be due to different exposure between males and females or sensitivity. These findings can shape gender-sensitive malaria prevention and control programs.

DISCUSSION

The study conducted in Peshawar over an eight-month period yielded significant insights into the prevalence of malaria across various demographic groups, revealing notable variations influenced by age and gender. With a positive detection rate of 39.87% among the 750 individuals tested, the findings underscore the persistent threat of malaria within this region, which remains a concern given the endemic nature of the disease and the challenges in accessing effective prevention measures.

Our analysis indicated a higher prevalence of malaria in males at 43.83% compared to females at 35.77%, with a statistically significant difference ($p=0.0242$). This disparity is likely attributable to gender-specific behaviors and occupational activities that increase exposure to mosquito vectors, particularly during nighttime hours when mosquito activity is highest. Such findings are consistent with previous studies conducted in the region, including a 2017 study in District Shangla, Malakand division, which reported a prevalence of 13.99% with higher rates in males (65.24%) than in females (34.76%) (15).

Additionally, the highest prevalence observed in the 41-60 age group (50.83%) suggests a significant role of occupational exposure in malaria transmission, as individuals in this age range are often engaged in outdoor labor such as agriculture. This pattern aligns with other regional studies that have similarly identified this cohort as particularly vulnerable due to greater vector exposure (17).

The study's strengths include its comprehensive approach to sampling across diverse healthcare settings in Peshawar, enhancing the generalizability of the findings to the urban population. Moreover, the use of both thick and thin blood films for diagnosis allowed for accurate identification of malaria species, contributing to the robustness of the diagnostic process.

However, the study also faces limitations. The use of convenience sampling may introduce bias, as it does not randomly select participants and thus may not fully represent all demographic segments. Additionally, the reliance on symptomatic individuals for the sample may overlook asymptomatic carriers who also play a crucial role in the transmission dynamics of malaria.

In conclusion, the study highlights the significant prevalence of malaria in Peshawar, with marked disparities across gender and age groups that can inform targeted public health interventions. The findings emphasize the need for continued efforts in vector control and public health outreach, particularly tailored towards high-risk groups identified through the study. Further research is warranted

However, the test statistic yields a z value of 2.254. The P value obtained is less than 0.05, indicating that the observed differences in prevalence are significant. This test result implies that the proportion of prevalence varies significantly among the participants. Therefore, the null hypothesis reporting the absence of an association between sex and the malaria prevalence is accepted. The symbol * next to the summary of the P value indicates this meaning. Therefore, the distribution of malaria and prevalence is not the same among male and female participants. The males had more malaria cases compared to females, according to the higher positivity percentage

to explore the impact of asymptomatic carriers on malaria transmission and to evaluate the effectiveness of current preventive strategies in reducing the burden of malaria in endemic regions.

CONCLUSION

The study conducted in Peshawar highlights a significant skew in malaria prevalence towards males and working-age individuals, who are more frequently exposed to environments conducive to mosquito breeding. Factors such as inadequate urban planning, poor waste management, and prevalent outdoor activities contribute to this increased exposure. Despite urban development, signs of haphazard growth exacerbate these challenges, underscoring the necessity for targeted interventions. To mitigate malaria incidence effectively, it is crucial to improve urban infrastructure and waste management practices, coupled with enhanced vector control measures, particularly in areas demonstrating rapid urbanization and high mosquito activity.

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