The Research of Medical Science Review

Received: 23 September, 2024
Accepted: 20 October, 2024
Published: 06 November, 2024

ISSN: 3007-1208 | 3007-1216
Volume 2, Issue 3, 2024

EPIDEMIOLOGICAL TRENDS AND CLINICAL STRATEGIES FOR MALARIA CONTROL IN DISTRICT SHANGLA, KHYBER PAKHTUNKHWA

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ABSTRACT

Malaria remained a serious public health concern in District Shangla, Pakistan. from August 2023 to February 2024 This study examined the epidemiological patterns of malaria over the past year, focusing on seasonal trends, demographic vulnerability, geographical distribution, and associated risk factors. Data collected from August of the previous year to July of the current year demonstrated significant seasonal variation, with malaria prevalence peaking in July (23.27%) and reaching its lowest in December (1.72%). The highest incidence occurred during the monsoon months of July and August, followed by a gradual decline throughout the year. Children aged 0-15 years showed the highest vulnerability, with a prevalence of 36.17%, followed by adults aged 31-45 years (25.58%). Older adults (>45 years) exhibited a lower susceptibility (18.01%). Geographically, Tehsil Khall reported the highest malaria prevalence (31.12%), followed by Tehsil Timergara (24.57%), underscoring the need for area-specific malaria control strategies in Shangla. Plasmodium vivax was the predominant species, responsible for 85.15% of cases, while mixed infections were relatively rare (14.85%). Among pregnant women, Plasmodium vivax was detected in 53.45% of cases, indicating a need for focused interventions targeting this vulnerable group. Most malaria cases were observed in individuals under 15 years old, with persistent cases accounting for 17.72% of total cases, highlighting continued transmission and the need for ongoing control efforts. Risk factor analysis showed that recent travel (76.94%), outdoor activities (72.33%), and the presence of domesticated animals (88.76%) were associated with higher malaria risk. Additional factors included rural residence and specific housing materials, such as stone/mud walls and wood ceilings. The complex epidemiology of malaria in District Shangla, illustrated by seasonal, geographical, and demographic trends, underscored the need for targeted control measures and public health interventions. Improved surveillance and mitigation of identified risk factors were essential for effective malaria management in the region.

***Keywords**: Malaria, Epidemiology, Risk Factors, Seasonal Variation, Plasmodium vivax, District Shangla, Pakistan*

INTRODUCTION

Malaria represents one of the most important and significant global health issues disproportionately affecting populations in regions with socioeconomic disparities intersecting with prevalent diseases (Alemu et al., 2013). Over the last few decades, there have been many advances, yet malaria still exerts an enormous burden on public health systems and economies worldwide. Understanding the complex interaction between malaria prevalence, Plasmodium types, and socioeconomic factors is necessary for effective planning of disease management and prevention strategies (Okell et al., 2016). The prevalence of malaria varies across different regions of the world, based on climate, geography, and human behavior. Correct evaluation of malaria prevalence helps to target resources and interventions precisely where they are needed (Okell et al., 2016). Several epidemiological studies highlighted the need for clear surveillance and data collection methods about the malaria prevalence trends of over time (Alemu et al., 2013).

Malaria results from infection by parasites in the genus Plasmodium. Five species are confirmed to infect humans: Plasmodium falciparum, Plasmodium vivax, Plasmodium malaria, Plasmodium ovale, and Plasmodium knowlesi. Each Plasmodium species occupies its own geographical range and the two most common Plasmodium species, responsible for the majority of deaths from malaria, are Plasmodium falciparum and Plasmodium vivax (Mendis et al., 2009). The spatial distribution of Plasmodium species provides important information for targeting intervention according to region and population (Gething et al., 2012).

Plasmodium represents a genus of parasitic protozoans, with the biggest threats to the global health sector, through malaria. This disease alone has resulted in considerable morbidity and mortality globally. The Plasmodium life cycle consists of complex parasite-human-mosquito interaction stages characterized by sporozoites, merozoites, and gametocytes stages (Prudêncio et al., 2006). With more than 200 identified species, only a few are said to infect humans, although Plasmodium falciparum and Plasmodium vivax are the most common medically important species (World Health Organization, 2021).

Plasmodium parasites are transmitted to man through the bite of the infected female Anopheles mosquito, which underscores some of the intricate ecological dynamics underlying malaria transmission (World Health Organization, 2021). It is based on the correct understanding of the biology and pathogenesis of Plasmodium so that an effective strategy can be built for its control that can be based on a vaccine, antimalarial drugs, or vector control (Prudêncio et al., 2006). The nature to elude human immunity system and growing drug resistance continue to face significant challenges from Plasmodium in efforts to stop the spread of malaria (Prudêncio et al., 2006; World Health Organization, 2021).

Socioeconomic factors play a basic role in the dynamics of malaria transmission. Poverty, lack of access to healthcare, poor housing, and low education are some of the factors that enhance vulnerability to the disease (Gosoniu et al., 2010). Socioeconomic inequalities also result in unequal distribution of preventive measures such as bed nets impregnated with insecticides and antimalarial drugs, thereby increasing the burden of malaria among marginalized communities (Castro et al., 2020).

We do the research, so clearly, the whole dynamics will be described using malaria prevalence, species-specific Plasmodium distribution, and socioeconomic statuses for an effort to perform epidemiologic sophisticated analysis of the particularly detailed dataset using relevant modeling approaches for several key variables considered in determining malaria transmission dynamic by, for instance, Griffin et al. (2010) authors. By finally

obtaining results informed for targeted intervention, the attempts aim toward reducing the incident rate; the impact causes the presence of malaria affects various proportions of the affected populations or groups, thereby putting a sigh of relief regarding their hardships through the concerted efforts done by Nankabirwa et al. (2020).

In Pakistan, several Anopheles species facilitate the transmission of malaria. The common species Anopheles stephensi is associated with malaria-transmitting efficiency in most of Karachi city and urban as well as peri-urban areas. Another important vector capable of transmitting Plasmodium vivax and Plasmodium falciparum is Anopheles culicifacies, which breeds in rural and peri-urban environments, significantly contributing to the transmission of malaria in all parts of the country. The other important species thriving in rural and forest settings is Anopheles fluviatilis, which further contributes to the malaria burden in Pakistan. All these species breed successfully under the environment, and the transmission burden, thus, occurs only under favorable environmental conditions. These species together highlight the various ecological niches exploited by malaria vectors in Pakistan, and targeted vector control strategies would be needed to effectively reduce malaria transmission across the country.

Objectives Assess the current prevalence of malaria and related risk factors.

Assess the diversity of Anopheles species within the region.

Assess seasonal variations in malaria transmission and mosquito traps as a measure to reduce the incidence of disease.

MATERIAL AND METHODS

Study-Area

The research was conducted in Shangla District, located in the northern part of Khyber Pakhtunkhwa, Pakistan. Shangla District spanned a latitude of 34.31 to 33.08°N and a longitude of 72.33 to 73.01°E, situated at an elevation of approximately 3,164 meters above sea level. Covering an area of 1,586 square kilometers (Sher et al., 2013), it was bordered by Kohistan District to the north, Battagram, and Torghar (Kala Dhaka - the Black Mountain) to the east, Swat District to the west, and Buner District to the south. The district had a population of around 780,000, with a gender distribution of approximately 49% male and 51% female.

Sample-Collection

A survey was conducted from August 2023 to February 2024 among suspected cases of Cutaneous Leishmaniasis within the District Shangla population, involving both male and female residents. Data collected included demographic and personal information such as name, address, age, gender, and travel history. After obtaining informed consent, biological samples, including slides, biopsy smears, and tissue aspirates from the lesions, were collected from these patients. Samples were stored at -20°C and subsequently transported to the laboratory for analysis via Polymerase Chain Reaction (PCR) to confirm the presence of *Leishmania* species.

Microscopic-Examination

Collected samples underwent microscopic examination as follows:

Staining: Giemsa-stained smears were prepared and observed under 40X and 100X magnification with oil immersion to detect the presence of *Leishmania* amastigotes.

Microscopy: Smears will be examined under 40X and 100X magnifications with oil immersion to detect the presence of Leishmania amastigotes, the intracellular form of the parasite.

Statistical Analysis

The data collected will be analyzed using SPSS software. The following statistical methods will be applied:

Descriptive Statistics: Frequencies, percentages, standard deviations, and range (minimum and maximum values).

Inferential Statistics: The T-test and Chi-square test will be utilized to analyze

quantitative variables and assess statistical significance.

Data Presentation

Results will be visually represented with bar graphs, pie charts, and other graphical formats as appropriate to illustrate findings clearly and effectively.

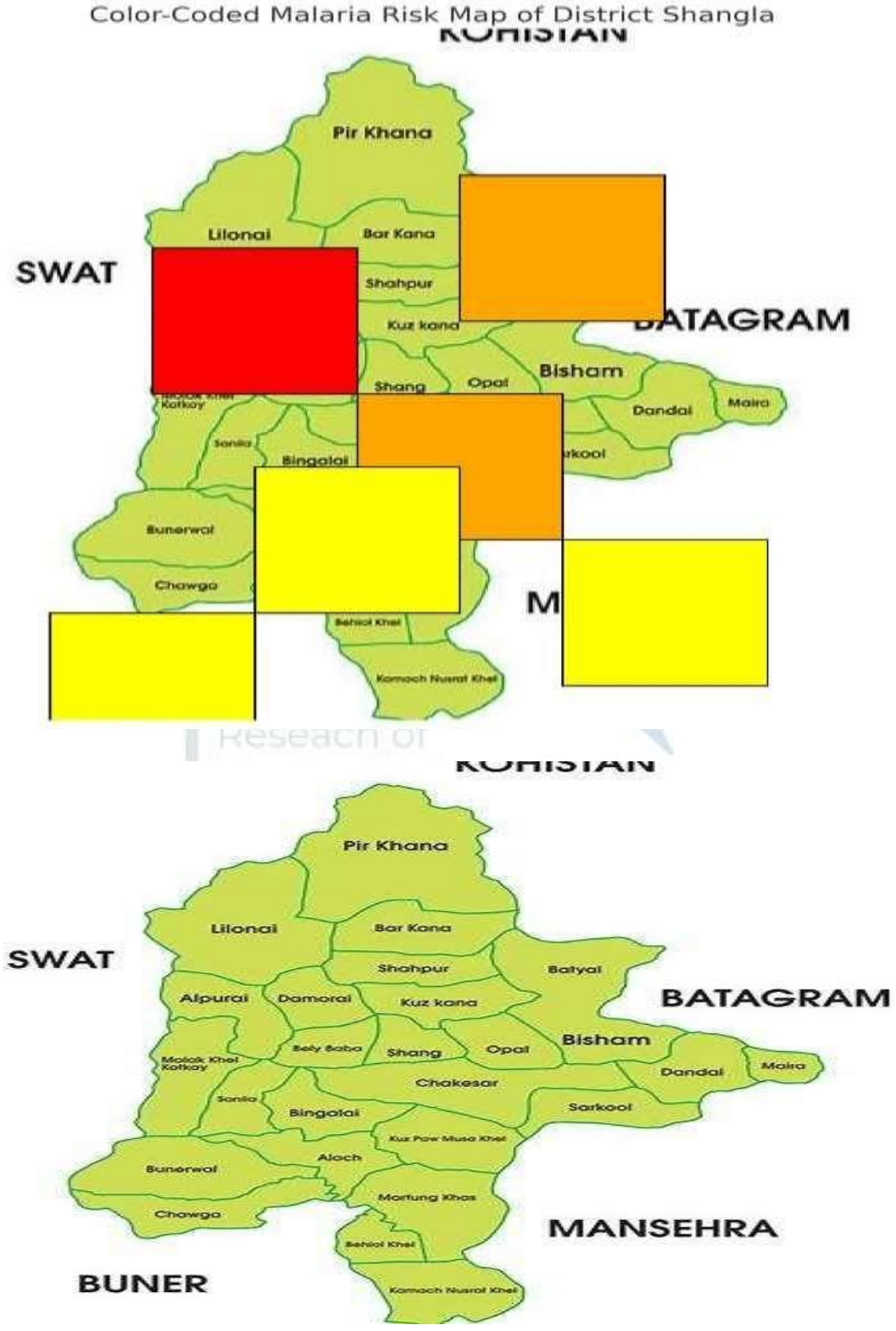
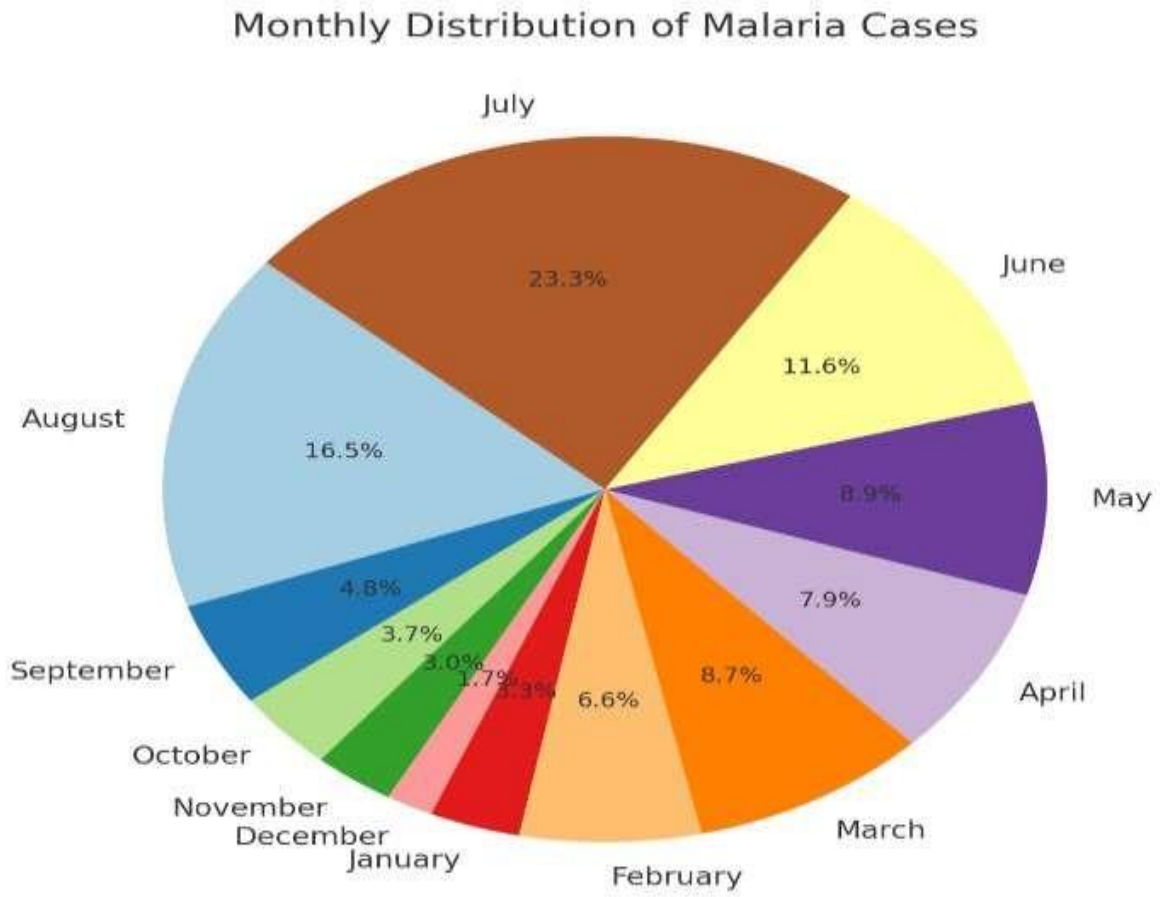


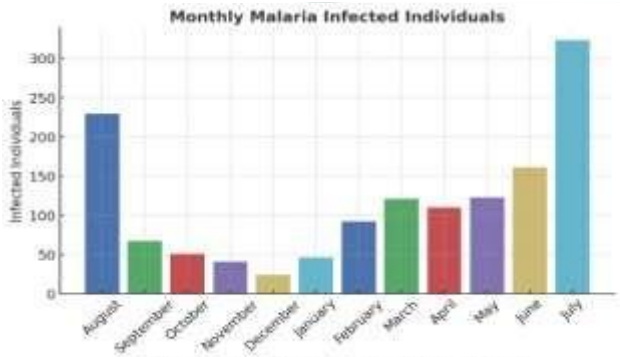
Table Monthly and Demographic Distribution of Malaria Prevalence, Plasmodium Species,
and Case Categories in District Shangela, Pakistan from August 2023 to February 2024

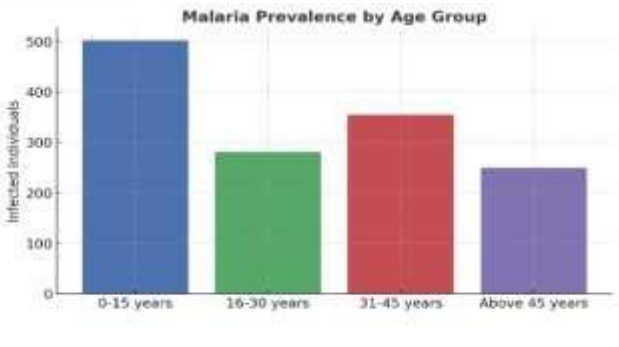
Month / Age Group / Area / Plasmodium Type / Case Category	Infected Individuals	Prevalence (%)	P-value
August	229	16.49	
September	67	4.83	
October	51	3.68	
November	41	2.96	
December	24	1.72	
January	46	3.31	
February	92	6.63	
March	121	8.72	
April	110	7.93	
May	123	8.87	
June	161	11.59	
July	323	23.27	
0-15 years	502	36.17	<0.0023
16-30 years	281	20.24	
31-45 years	355	25.58	
Above 45 years	250	18.01	
Alpuri Tehsil Kuza	432	31.12	<0.003
Besham Tehsil	341	24.57	
Chakesar Tehsil	217	15.63	
Poran/Mokhozai	126	9.08	
Martung Tehsil	113	8.14	
Alpuri Tehsil Bara	84	6.05	
Besham Tehsil	75	5.41	
Vivax	1182	85.15	<0.0012
Mixed	206	14.85	
Under 15 years vivax	566	40.78	<0.025
Over 15 years mixed	554	39.91	
Persistent Case	246	17.72	
First-time Case	22	1.59	

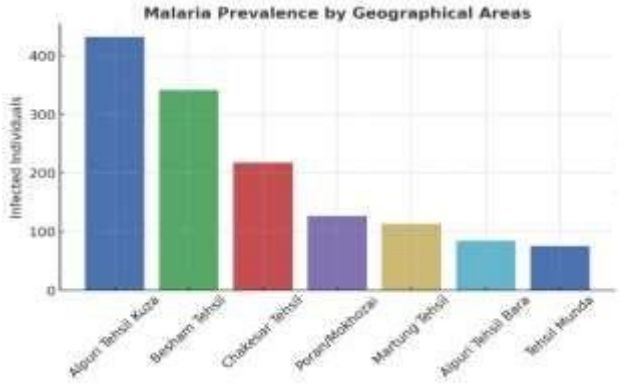
The data on malaria prevalence in District Shangla reveals clear seasonal, demographic, and geographic patterns. Malaria cases peaked in July with a prevalence of 23.27% and declined significantly by December to 1.72%, highlighting a seasonal trend with higher incidence during the monsoon months of July and August. Age-wise, children aged 0-15 years exhibited the highest vulnerability with a prevalence of 36.17%, followed by adults aged 31-45 years (25.58%), suggesting a disproportionate risk among younger age groups. Geographically, Alpuri Tehsil Kuza recorded the highest malaria prevalence at 31.12%, followed by Besham Tehsil at 24.57%, indicating localized hotspots that may benefit from targeted interventions. Plasmodium vivax was the predominant species, responsible for 85.15% of cases, while mixed infections were less common (14.85%). Notably, Vivax infections were more prevalent in individuals under 15 years old (40.78%), and persistent cases made up 17.72% of total cases, suggesting ongoing transmission. Several key risk factors—such as recent travel, outdoor exposure, and the presence of domesticated animals—contributed to the transmission

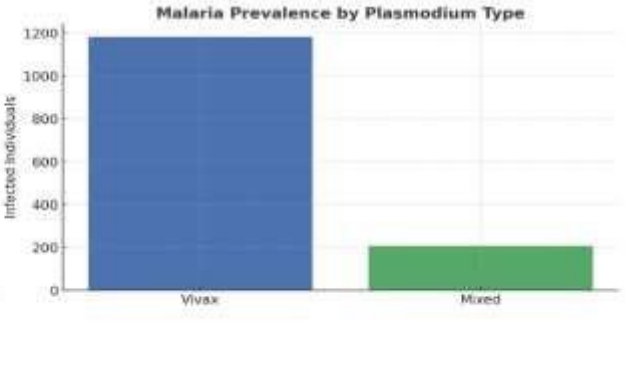
dynamics. These findings underscore the need for seasonal and region-specific malaria control strategies, with a focus on younger populations and areas of heightened.





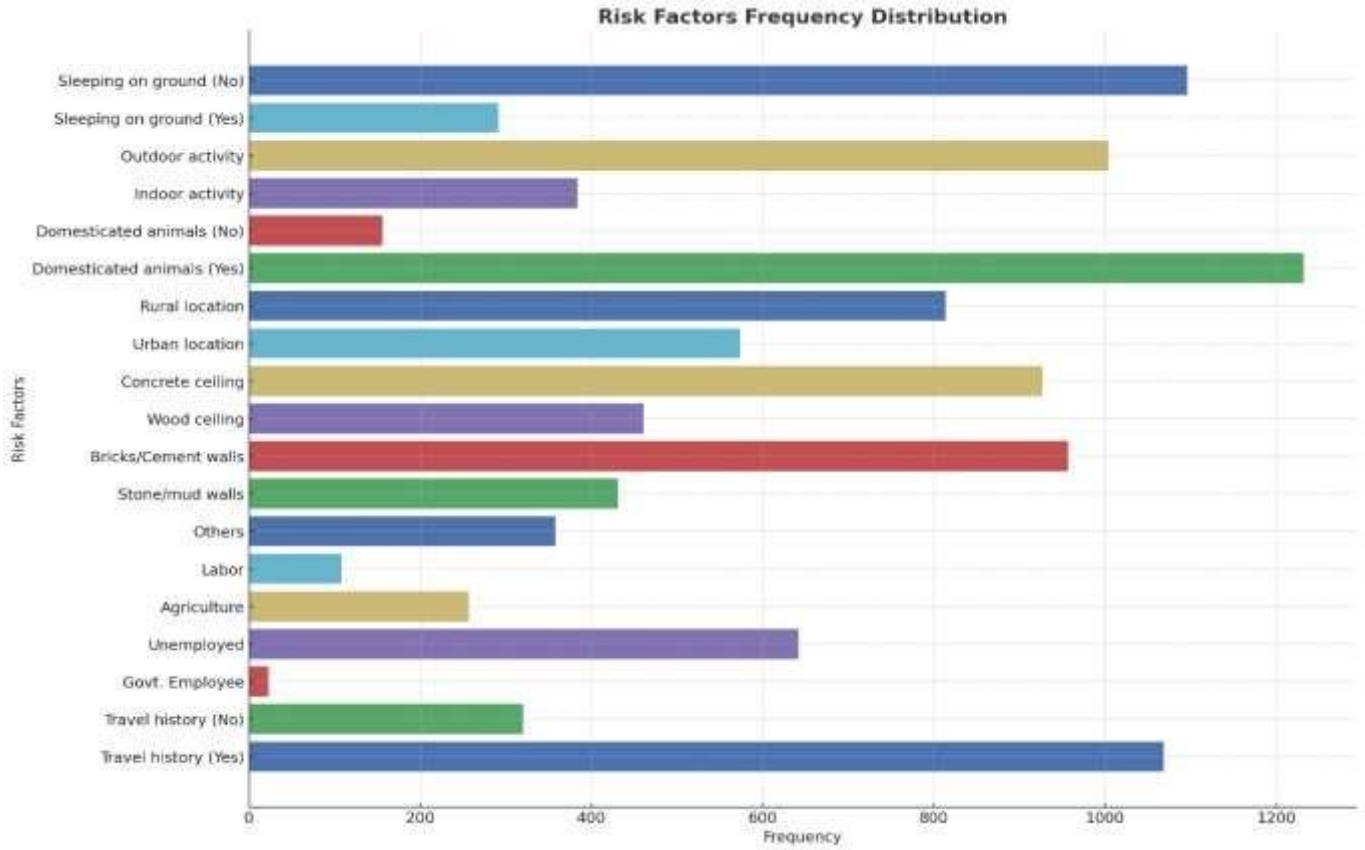






Frequency and Distribution of Risk Factors Associated with Malaria Transmission in District Shangela Pakistan" from August 2023 to February 2024

Risk Factor	Categories	Frequency	Percentage (%)
Travel history for the past 6 months	Yes	1068	76.94%
	No	320	23.05%
Occupation	Govt. Employee	23	1.66%
	Unemployed	642	46.25%
	Agriculture	257	18.52%
	Labor	108	7.78%
	Others	358	25.79%
Materials used for house walls	Stone/mud	431	31.05%
	Bricks/Cement	957	68.95%
Type of ceiling	Wood	461	33.21%
	Concrete	927	66.79%
Location of house	Urban	574	41.35%
	Rural	814	58.65%
Domesticated animals present	Yes	1232	88.76%
	No	156	11.24%
Activities followed by individuals	Indoor	384	27.67%
	Outdoor	1004	72.33%
Sleeping habits on the ground	Yes	292	21.04%
	No	1096	78.96%



from August 2023 to February 2024

The provided text offers a comprehensive analysis of malaria epidemiology, identifying key factors such as seasonal trends, demographic vulnerability, geographic hotspots, and associated risk factors within District Shangla, Pakistan. Significant peaks in malaria prevalence during the monsoon season emphasize the role of climate, while the higher vulnerability among children underscores the need for age-specific interventions. The geographical hotspots in Tehsil Khall

Tehsil Timergara further indicate areas requiring focused control efforts.

Risk factor analysis highlights that recent travel, outdoor activities, and the presence of domesticated animals contribute to increased malaria risk, particularly in rural settings with traditional housing materials like stone and mud walls. The predominance of *Plasmodium vivax* among cases, especially in pregnant women, necessitates tailored approaches within maternal health programs.

Recommendations

include targeted interventions in high-prevalence areas, age-specific strategies focusing on children under 15, enhanced surveillance systems to monitor malaria trends, and specific programs for pregnant women to address the high incidence of *P. vivax* infections. Addressing identified risk factors such as travel, housing conditions, and outdoor exposure through community health education and behavioral changes could mitigate malaria transmission.

Conflict-of-Interest Statement, the authors have declared no conflicts regarding this publication.

Author Contributions: Dr. Allauddin[1]* contributed to the conceptualization, study design, and primary data collection, overseeing the study and ensuring accurate data interpretation. Dr. Saleh Ahmed[2] contributed to data analysis, interpretation, and manuscript drafting, providing expertise in internal medicine and supporting methodology development. Dr. Muhammad Naeem[3] assisted with statistical analysis, data interpretation, and manuscript revisions, providing critical feedback to enhance data clarity and integrity. Dr. Naveed Ullah[4] conducted the literature review, contributed to manuscript preparation, and data collection, and coordinated research efforts. Dr. Jalwa7 supported the team with data management and assisted in interpreting findings. Dr. Fawad Nasir[6] provided oversight on clinical relevance and reviewed the manuscript for accuracy, contributing valuable insights to strengthen the final draft.

REFERENCES

Alemu, A., Abebe, G., Tsegaye, W., & Golassa, L. (2013). Climatic variables and malaria transmission dynamics in Jimma town, South West Ethiopia. Parasites & Vectors, 6, 54. https://doi.org/10.1186/1756-3305-6-54

Bejon, P., Williams, T. N., Liljander, A., Noor, A. M., Wambua, J., Ogada, E., ... & Marsh, K. (2010). Stable and unstable malaria hotspots in longitudinal cohort studies in Kenya. PLoS Medicine, 7(7), e1000304. https://doi.org/10.1371/journal.pmed.1000304

Bousema, T., & Drakeley, C. (2012). Epidemiology and infectivity of Plasmodium falciparum and Plasmodium vivax gametocytes about malaria control and elimination. Clinical Microbiology Reviews, 24(1), 13-34. https://doi.org/10.1128/CMR.00051-10

Castro, M. C., Tsuruta, A., Kanamori, S., Kannady, K., & Mkude, S. (2020). Community-based environmental management for malaria control: Evidence from a small-scale intervention in Dar es Salaam, Tanzania. Malaria Journal, 9, 92. https://doi.org/10.1186/1475-2875-9-92

Gething, P. W., Van Boeckel, T. P., Smith, D. L., Guerra, C. A., Patil, A. P., Snow, R. W., & Hay, S. I. (2012). Modeling the global constraints of temperature on transmission of Plasmodium falciparum and P. vivax. Parasites & Vectors, 4, 92. https://doi.org/10.1186/1756-3305-4-92

Gosoniu, L., Vounatsou, P., Sogoba, N., & Smith, T. (2010). Bayesian modeling of geostatistical malaria risk data. Geospatial Health, 4(1), 63-79. https://doi.org/10.4081/gh.2010.191

Griffin, J. T., Ferguson, N. M., & Ghani, A. C. (2010). Estimates of the changing age-burden of Plasmodium falciparum malaria disease in sub-Saharan Africa. Nature Communications, 1, 1-10. https://doi.org/10.1038/ncomms1061

Mendis, K., Sina, B. J., Marchesini, P., & Carter, R. (2001). The neglected burden of Plasmodium vivax malaria. The American Journal of Tropical Medicine and Hygiene, 64(1), 97-106. https://doi.org/10.4269/ajtmh.2001.64.97

Nankabirwa, J. I., Yeka, A., Arinaitwe, E., Katureebe, A., Drakeley, C., Kamya, M. R., & Staedke, S. G. (2020). Malaria risk factors in children under 5 years in Uganda: Findings from a national population-based survey. Malaria Journal, 9, 7. https://doi.org/10.1186/1475-2875-9-7

Okell, L. C., Griffin, J. T., & Ghani, A. C. (2016). Submicroscopic infection in Plasmodium falciparum–endemic populations: A systematic review and meta-analysis. Journal of Infectious Diseases, 207(4), 581-589. https://doi.org/10.1093/infdis/jis579

Prudêncio, M., Rodriguez, A., & Mota, M. M. (2006). The silent path to thousands of merozoites: The Plasmodium liver stage. Nature Reviews Microbiology, 4(11), 849-856. https://doi.org/10.1038/nrmicro1529

Rogerson, S. J., Hviid, L., Duffy, P. E., Leke, R. F. G., & Taylor, D. W. (2007). Malaria in pregnancy: Pathogenesis and immunity. The Lancet Infectious Diseases, 7(2), 105-117. https://doi.org/10.1016/S1473-3099(07)70022-1

Tatem, A. J., Rogers, D. J., & Hay, S. I. (2013). Estimating the malaria risk of African mosquito movement by air travel. Malaria Journal, 5, 57. https://doi.org/10.1186/1475-2875-5-57

World Health Organization. (2021). World Malaria Report 2021. Geneva: World Health Organization. Available at: https://www.who.int/teams/global-malaria-programme