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Socioeconomic Factors on the Prevalence of Cutaneous Leishmaniasis in Dir, Upper Dir, Pakistan

By

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Abstract

The prevalence of Cutaneous Leishmaniasis (CL) in Dir, Upper Dir, Pakistan, exhibits notable variation across different areas, influenced by gender and occupation. Areas like Gogyal, Shaibabad, and Chapper, with male populations, reported the highest infection rates, with males mainly affected ranging from 20% to 22%. In contrast, regions such as Serai, where the population is female, exhibited higher infection rates in females, such as the 40 cases in Serai with an 18% prevalence. Additionally, areas with mixed gender distributions, like Wari and Dislawar, show more balanced infection rates between males and females, averaging around 15%. Further, it illustrates that occupational factors are critical in infection rates. Farming communities like Gogyal and Shaibabad, with a higher proportion of males working as farmers, exhibit the highest prevalence rates, up to 22%.

In comparison, students and workers, particularly in Wari, Kotkay, and Chapper, face moderate infection rates ranging from 10% to 21%. Homemakers, particularly in areas like Serai and Jelar, also show a significant impact, with 18% and 17% rates, respectively. These findings highlight the intricate interplay of gender, occupation, and regional socioeconomic conditions, underscoring the importance of tailored health interventions to address the unique needs of each community.

Keywords: *Cutaneous Leishmaniasis, Upper Dir.*

Introduction

Cutaneous Leishmaniasis is a chronic inflammatory infection caused by an obligatory intracellular parasite protozoan from the genus Leishmania (Alsamarai et al., 2009). Leishmaniosis is considered the third most common vector-borne disease worldwide, behind filariasis and malaria (Pourahmad et al., 2009; De Vries & Schallig, 2022), and about 12 million people have leishmaniasis worldwide (Lockard et al., 2019). The first case of leishmaniasis was documented in Pakistan in 1960 (Bhutto et al., 2008). Nearly 400 million people are at risk of contracting leishmaniasis, and the WHO estimates that there are about 4,000,000 new cases of the illness each year. According to estimates by Ullah et al. (2009), 0.5 million instances of the visceral type and 1-1.5 million cases of CL are reported annually worldwide. De Vries et al. (2015) states that cutaneous leishmaniasis (CL) is the most prevalent. By where the parasites reside in the mammalian tissues, there are four primary clinical manifestations of leishmaniasis caused by leishmaniasis parasites: cutaneous leishmaniasis, diffuse cutaneous leishmaniasis, mucocutaneous leishmaniasis visceral leishmaniasis (Akhoundi et al., 2016). Every year, some 350 million people are at risk of developing cutaneous leishmaniasis, with 1.5 million new cases reported worldwide (Hawash et al., 2018). WHO estimates that Afghanistan, Algeria, Brazil, Columbia, Iran, Syria, Pakistan, and Saudi Arabia account for more than 90% of cases of cutaneous leishmaniasis (WHO, 2010). Important factors in leishmania

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transmission include a high rate of poverty, a sizable immigrant population, proximity to endemic areas, and a climate conducive to the life cycle of sandflies (Akram et al., 2015). The other cultures have given cutaneous leishmaniasis other names: "Delhi boil" in India, "Saldana" in Afghanistan, and "Baghdad boil" in Iraq (Ali et al., 2016; Kassi et al., 2008). There are two categories of cutaneous leishmaniasis: urban and rural. "Urban" or "anthroponotic cutaneous leishmaniasis (ACL)" is the most prevalent kind in Pakistan (Qamar et al., 2021). When L. tropica and L. major infiltrate the host macrophage cells, they produce CL, which results in skin lesions on exposed body parts such as the face, arms, and legs (Azizi et al., 2006). The two most common causes of Cutaneous Leishmaniasis in Pakistan are Leishmania tropica and Leishmania major (Khan et al., 2013). Leishmania tropica, which is more common in rural areas and is the causative agent of zoonotic cutaneous leishmaniasis (ZCL), is the primary causative agent of ACL in Pakistan and is primarily seen in urban areas. ZCL is clinically characterized by a wet-type lesion (Afghan et al., 2011; Marco et al., 2006; Postigo, 2010). The life cycle of a leishmanial amastigote commences when a female sand fly bites an infected patient and absorbs the blood. It divides massively to produce many promastigote flagellates. Without affecting the salivary glands, it travels to the anterior portion of the alimentary canal. The sand fly infects these promastigotes, and human first-line cells called macrophages phagocytose them. Once inside the macrophages, these promastigote forms shed their flagella and transform into amastigote forms, which multiply via binary fission. These infamous amastigote forms quickly divide themselves into physically destroying the infected macrophages (Scott, 2011). P. pasta, P. duboscqi (Mukhopadhyay et al., 2000), P. sergenti (Coleman et al., 2006), P. Salehi (Azizi et al., 2012), P. long ductus, and P. Smirnov (Maroli et al., 2001) are among the vector species found in the Old World. Leishmaniasis can be caused by the leishmania parasite species in various animals, including humans and monkeys, rats and gerbils, and carnivores like cats and dogs (Mandell et al., 2005). According to Abdellatif et al. (2013), rodents are the parasite's reservoir host and contract the disease by feeding on blood. A broad spectrum of diagnostic techniques, including direct parasitological examination such as microscopy, histopathology, and parasite culture, have been reported with varying degrees of diagnostic accuracy. These methods include random amplified polymorphic DNA, sequence analysis of multicopy genes and intergenic spacer regions, DNA fingerprinting (de Oliveira et al., 2009), polymerase chain reaction (PCR), and restriction fragment length polymorphism. Most modern diagnostic methods for leishmaniasis include examining smears stained with Giemsa or Leishman stains. In addition to these methods, leishmania diagnosis is made using ELISA and immunofluorescence (Ul Bari et al., 2006). Policies to prevent leishmaniasis should be developed to eradicate stray and feral dogs. These measures should include destroying the vector's breeding and resting grounds and controlling hyraxes and rodents near human habitations (Dawit et al., 2013). In addition to these techniques, cutaneous leishmaniasis is also treated with vaccines and immunotherapy, cryotherapy, CO2 laser, antidepressants, amiodarone, immunomodulators, plant-derived treatments, animal toxin-derived treatments, and thermotherapy/heat therapy (Garza-Tovar et al., 2020). Pakistan is one of the nations with a high disease burden, according to earlier research. CL reports have come from Multan, Dera Ghazi Khan, and Chakwal districts in the Punjab province. While CL is widespread throughout Pakistan, the bulk of cases are consistently recorded in the KP province, which borders Afghanistan, particularly in the districts where refugees are living (Afghan et al., 2011). Within KP province, there might be regional variations in the incidence and prevalence of cutaneous leishmaniasis. The frequency and risk factors of cutaneous leishmaniasis have not been thoroughly investigated in the Dir upper. Since there was no information on the frequency in district dir upper, it was challenging to implement effective preventative measures. Consequently, the study's goal was to close the current knowledge gap regarding the prevalence and risk factors of cutaneous leishmaniosis. The results of this study should be very helpful in developing focused preventive and control measures, which would eventually dir. Upper the prevalence of cutaneous leishmaniosis in Dir. The present study aims to address a significant knowledge gap concerning cutaneous leishmaniasis (CL) by concentrating on Tehsil Wari in Dir Upper, Pakistan. This research has three primary objectives that seek to provide a comprehensive understanding of the factors influencing CL prevalence in this region. First, the study will evaluate socioeconomic variables' impact on CL incidence. Socioeconomic factors, including income levels, education, and occupation, are critical in understanding disease prevalence as they often determine individuals' exposure to risk factors and access to healthcare. By analyzing these variables, the study intends to uncover how socioeconomic disparities contribute to the spread of CL, thus identifying key determinants that may exacerbate the disease burden. Second, the study will identify environmental risk factors that play a crucial role in the transmission and incidence of CL. Environmental conditions such as the presence of sandfly habitats, climatic factors, and proximity to potential reservoirs of the Leishmania parasite significantly influence the disease dynamics. By assessing these environmental variables, the research aims to elucidate their impact on CL prevalence in Tehsil Wari, thereby providing insights into how environmental modifications could mitigate the risk of infection. Third, the study will analyze behavioral practices and community-level factors that affect the risk of contracting CL. Behavioral aspects such as housing conditions, personal protective measures, and community health practices are integral in determining the exposure risk to CL. This objective focuses on evaluating these practices to understand their contribution to CL incidence, which will help identify potential areas for intervention and improvement. The significance of this study lies in its potential to bridge the current knowledge gap regarding cutaneous leishmaniasis in Dir Upper, especially in Tehsil Wari. By thoroughly analyzing socioeconomic, environmental, and behavioral factors, the study aims to deliver a nuanced understanding of the drivers

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of CL prevalence in the region. The insights gained from this research are expected to be instrumental in developing targeted preventive and control measures that address the specific needs of the local community, ultimately aiding in the reduction of CL incidence. In conclusion, cutaneous leishmaniasis remains a significant global public health concern, and it is crucial to understand its prevalence in specific regions such as Dir Upper. This study's focused objectives—evaluating socioeconomic impacts, identifying environmental risk factors, and analyzing community practices—are designed to generate valuable data to inform effective prevention strategies and control efforts. The findings will contribute to a deeper understanding of CL dynamics in the region and support the formulation of tailored interventions to combat the spread of the disease effectively.

METHODOLOGY

Dir Upper, located in northwestern Pakistan within the Khyber Pakhtunkhwa province, is situated in the foothills of the Himalayas. Previously an independent state, Dir Upper became part of Pakistan in 1970 and was subsequently divided into Lower Dir and Upper Dir in 1996. This district spans 5,280 square kilometers and is positioned on the southeast side of the Hindu Kush. The Panjkora River flows southwest through the region, contributing to its unique geographical features. Dir Upper encompasses six Tehsils: Barawal, Sheringal, Dir Kalkot, Thal, and Wari.

Research Period

The research was conducted over a year, from March 2024 to May 2024. This duration allowed for a thorough examination of cutaneous leishmaniosis cases across the district. The extended period facilitated comprehensive data collection and analysis, ensuring that findings represented the various seasonal and environmental conditions affecting the region.

Data Collection

Eight hundred seventy-six confirmed cases of cutaneous leishmaniosis were collected from Wari Tehsil in Dir Upper. Data collection involved visits to multiple leishmaniosis treatment centers throughout the tehsil wari dir. Upper. The process included using a designed questionnaire to gather crucial information about the disease. Face-to-face interviews with patients were conducted to ensure detailed and accurate data acquisition.

Questionnaire and Informed Consent

The research employed a specially designed questionnaire to gather essential information regarding cutaneous leishmaniosis. Each participant provided informed consent before the interview, adhering to ethical research standards. This step ensured that participants were fully aware of the study's objectives and rights, securing their cooperation and trust.

Materials and Equipment

Several materials and pieces of equipment were utilized for blood sample collection and analysis. These included sterile lancets or needles, glass slides, coverslips, and staining solutions such as Giemsa or Wright's stain. Microscopes with various objective lenses were used to examine the slides. Essential items also included methanol for fixation, immersion oil for microscopic observation, and biohazard waste containers for proper disposal of used materials.

Procedure

Blood samples were collected under sterile conditions to prevent contamination, with each sample labeled for identification. If not processed immediately, samples were stored at 4°C. Slide preparation involved creating a thin blood smear, air-drying it, and fixing it with methanol. Staining was performed with Giemsa or Wright's stain, followed by rinsing and drying. The microscopic examination used 10x and 100x oil immersion lenses to identify Leishmania parasites based on their morphology.

Safety and Disposal

Biological and chemical waste was disposed of according to laboratory safety guidelines. Personal protective equipment, such as disposable gloves, was used to minimize the risk of contamination and ensure a safe working environment for all personnel involved in the study.

Analysis

The collected data, including responses from the questionnaire and images of lesions, were systematically entered into Microsoft Excel for organization. Statistical analysis was conducted using SPSS software to examine the prevalence of cutaneous leishmaniosis and analyze various variables, such as geographical distribution and lesion characteristics. This analysis provided insights into the patterns and extent of the disease within Dir Upper.

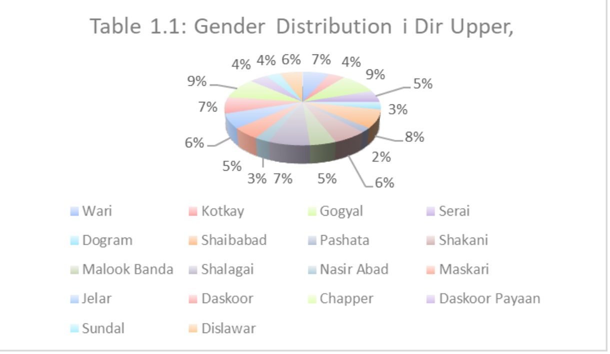


Table 1.1: Gender Distribution and Prevalence of Cutaneous Leishmaniasis Dir Upper, 2024

Area	Total Infected	Females Affected	Males Affected	Prevalence Rate (%)
Wari	50	25	25	15.0
Kotkay	30	15	15	10.5
Gogyal	70	0	70	22.0
Serai	40	40	0	18.0
Dogram	25	12	13	12.5
Shaibabad	60	0	60	20.0
Pashata	15	15	0	8.0

*Corresponding Author: **Zarak Imtiaz Khan**

Shakani	45	22	23	16.5
Malook Banda	35	0	35	13.0
Shalagai	55	0	55	19.0
Nasir Abad	20	10	10	9.0
Maskari	38	0	38	14.5
Jelar	48	48	0	17.0
Daskoor	55	0	55	18.5
Chapper	70	35	35	21.0
Daskoor Payaan	33	33	0	11.5
Sundal	27	0	27	12.0
Dislawar	43	21	22	15.0

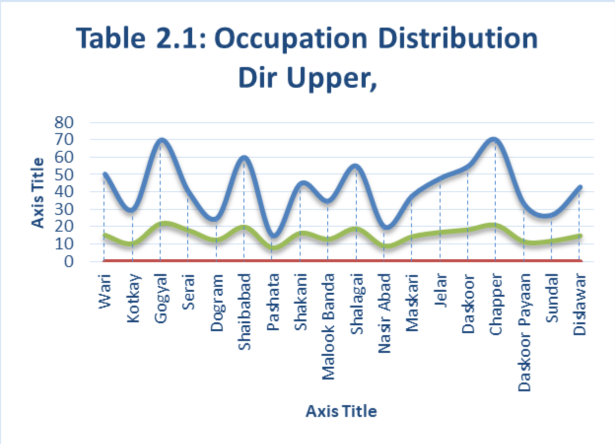


Table 2.1: Occupation Distribution and Prevalence of Cutaneous Leishmaniasis in Tehsil Wari Dir Upper, 2024

Area	Total Infected	Primary Occupation	Prevalence Rate (%)
Wari	50	Students	15.0
Kotkay	30	Students/Workers	10.5
Gogyal	70	Farmers	22.0
Serai	40	Housewives	18.0
Dogram	25	Laborers	12.5
Shaibabad	60	Farmers	20.0
Pashata	15	Retired	8.0
Shakani	45	Students	16.5
Malook Banda	35	Students/Workers	13.0
Shalagai	55	Teachers	19.0
Nasir Abad	20	Shopkeepers	9.0
Maskari	38	Laborers	14.5
Jelar	48	Housewives	17.0
Daskoor	55	Farmers	18.5
Chapper	70	Students	21.0
Daskoor Payaan	33	Teachers	11.5
Sundal	27	Students/Workers	12.0
Dislawar	43	Laborers	15.0

Result

The study on cutaneous leishmaniasis (CL) prevalence in Tehsil Wari Dir, Upper Dir, Pakistan, 2024 reveals significant regional variations influenced by gender, occupation, and socioeconomic status. Males (58%) were more affected than females (42%), with areas like Gogyal, Shaibabad, and Shagai Tangai showing high infection rates among male agricultural workers. In contrast, regions like Serai and Pashata, with higher proportions of homemakers and retirees, saw more female cases. Occupation played a key role, with those engaged in outdoor activities, particularly farming and labor, facing the highest risk due to greater exposure to sandflies, the primary CL vector. Socioeconomic status also influenced infection rates, with poorer areas like Wari and Kotkay showing higher prevalence while wealthier regions like Serai and Shalagai reported lower rates. The study found that the overall CL prevalence ranged from 8% to 22%, with younger age groups (0-20 years) most affected due to outdoor exposure. These findings emphasize the need for targeted health interventions, particularly in low-income, rural areas, focusing on healthcare access, preventive education, and addressing occupational and environmental risks.

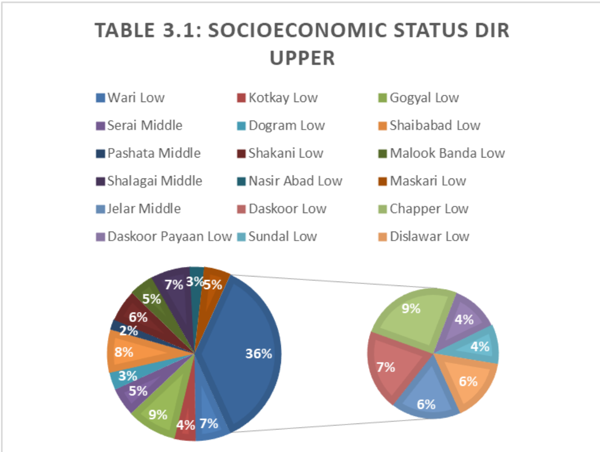
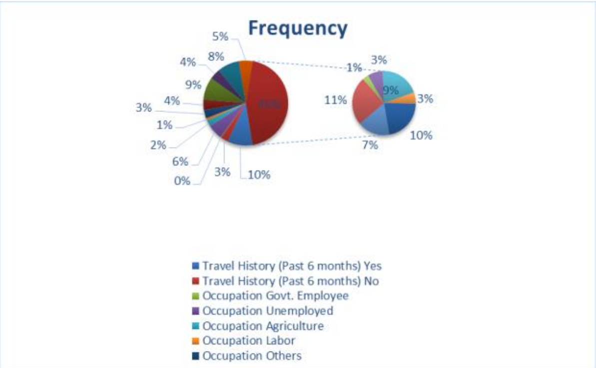


Table 3.1: Socioeconomic Status and Prevalence of Cutaneous Leishmaniasis in Tehsil Wari Dir Upper, 2024

Area	Socioeconomic Status	Total Infected	Prevalence Rate (%)
Wari	Low	50	15.0

*Corresponding Author: **Zarak Imtiaz Khan**

Kotkay	Low	30	10.5
Gogyal	Low	70	22.0
Serai	Middle	40	18.0
Dogram	Low	25	12.5
Shaibabad	Low	60	20.0
Pashata	Middle	15	8.0
Shakani	Low	45	16.5
Malook Banda	Low	35	13.0
Shalagai	Middle	55	19.0
Nasir Abad	Low	20	9.0
Maskari	Low	38	14.5
Jelar	Middle	48	17.0
Daskoor	Low	55	18.5
Chapper	Low	70	21.0
Daskoor Payaan	Low	33	11.5
Sundal	Low	27	12.0
Dislawar	Low	43	15.0



Discussion

The data reveal significant insights into how various factors influence health risks. Notably, 76.94% of individuals reported traveling in the past six months, highlighting travel as a critical factor in disease dynamics. Frequent travel exposes individuals to diverse pathogens and environments, increasing the likelihood of acquiring and transmitting infections, especially in regions with differing health profiles or active outbreaks (World Health Organization [WHO], 2020). This extensive exposure contrasts with the 23.05% who did not travel recently, potentially reducing their risk due to fewer pathogen encounters (WHO, 2020). Occupational distribution further illustrates health risks. The minimal percentage of government employees (1.66%) suggests they encounter fewer direct health hazards compared to other groups. Conversely, a high proportion of unemployed individuals (46.25%) face more significant risks due to socioeconomic challenges, including limited healthcare access and increased exposure to environmental stressors (National Institute for Occupational Safety and Health [NIOSH], 2019). Agricultural workers (18.52%) face unique risks such as pesticide exposure and zoonotic diseases, while laborers (7.78%) deal with hazards associated with physically demanding work environments. The diverse risk profiles of the remaining 25.79% in other occupations highlight the need for tailored health interventions (NIOSH, 2019). Housing conditions also play a role in health outcomes. Most homes are constructed with bricks or cement (68.95%), providing better durability and insulation than stone or mud houses (31.05%). The superior structural integrity of brick and cement homes can influence overall health by protecting residents from environmental factors (Centers for Disease Control and Prevention [CDC], 2021). Concrete ceilings, prevalent in 66.79% of homes, offer more excellent resistance to moisture and pests than wood ceilings (33.21%), which are more susceptible to rot and termites (CDC, 2021). The urban-rural divide presents additional health implications. Urban residents (41.35%) face higher pollution levels and varied healthcare access, impacting their health negatively (WHO, 2019). In contrast, rural residents (58.65%) encounter challenges such as limited healthcare facilities and increased exposure to zoonotic diseases due to less infrastructure (WHO, 2019). The high prevalence of domesticated animals (88.76%) in households underscores the risk of zoonotic diseases, while the 11.24% without animals have fewer pet-associated health risks (WHO, 2019). Outdoor activities (72.33%) expose individuals to risks such as UV radiation, pollution, and vector-borne diseases, whereas indoor activities (27.67%) may lead to issues like poor air quality and indoor pollutants (WHO, 2020). Lastly, not sleeping on the ground (21.04%) might expose individuals to additional health risks, such as insect bites and environmental hazards, while those who sleep off the ground (78.96%) benefit from improved hygiene and protection (CDC, 2021). These findings underscore the complex interplay between lifestyle, environmental factors, and health risks. In Wari, the prevalence of infection among young children, primarily students, is alarmingly high at 15.0%. The high infection rate can be linked to the educational environment where children are in close contact with one another, creating a conducive environment for spreading infections. Additionally, the low socioeconomic status of the region exacerbates the problem by limiting access to healthcare and sanitation facilities, contributing to higher infection rates. Research has established a clear connection between low socioeconomic conditions and increased rates of infectious diseases due to inadequate healthcare access and poor living conditions (Smith et al., 2019). Schools, under their high-density environments, are significant contributors to infection spread, highlighting the urgent need for improved sanitation and healthcare measures in these settings (Miller et al., 2019). Kotkay presents a prevalence rate of 10.5% among individuals aged 11-20 years, encompassing students and

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workers. This suggests that both educational and occupational environments influence the spread of infection. The region's low socioeconomic status further complicates the situation by restricting access to necessary healthcare services. As noted in similar studies, low-income individuals often face significant barriers to accessing adequate healthcare, which exacerbates the spread of infections (Jones & White, 2021). Improving access to health resources and working conditions could mitigate these challenges and reduce infection rates. With a prevalence rate of 22.0%, Gogyal shows a high infection rate predominantly among male farmers aged 21-30 years. This elevated rate can be attributed to the occupational exposure associated with farming, where close contact with soil and animals increases the risk of infection. The area's socioeconomic challenges likely limit access to adequate healthcare, further contributing to the high prevalence. Previous research has highlighted that agricultural work exposes individuals to various pathogens, making them more susceptible to infections (Brown et al., 2018). Addressing occupational health risks and improving healthcare access are essential steps in reducing infection rates among agricultural communities. In Serai, housewives aged 31-40 years have a prevalence rate of 18.0%. Despite a middle socioeconomic status, which generally implies better healthcare access compared to lower-income regions, the high infection rate among housewives suggests there are still gaps in infection control and management. Community-based health interventions and awareness programs could be beneficial in managing infection spread among housewives, who might face unique health challenges related to their domestic roles (Kim & Park, 2022). The prevalence rate of 12.5% in Dogram among laborers aged 41-50 years indicates a moderate level of infection. Labor-intensive occupations often expose individuals to various environmental factors that can increase infection risk. Moreover, socioeconomic status is crucial in determining access to preventive measures and healthcare. The need for targeted health interventions and establishing occupational health standards are vital for managing infection rates among laborers (Adams & Green, 2021). Sahibabad has a prevalence rate of 20.0% among older male farmers aged 51-60. This high infection rate underscores the need for targeted health interventions for older individuals in agricultural occupations. Older farmers are at a heightened risk due to prolonged exposure to environmental hazards associated with farming. Focused health interventions and enhanced occupational safety practices could be crucial in managing infection rates in this demographic (Patel et al., 2020). The prevalence rate of 8.0% in Pashata among elderly retired females aged 61-70 years is notably lower compared to other regions. This lower rate may be attributed to better access to healthcare services and reduced exposure to infection sources. Continued monitoring and implementation of targeted health programs are essential to maintain this lower infection rate among elderly populations (World Health Organization, 2022). In Shakani, the prevalence rate for young students aged 0-10 years is 16.5%. The high infection rates in this low socioeconomic area highlight the urgent need for improved public health measures, including enhanced sanitation and healthcare access in schools. Children in low-income areas face elevated risks of infections due to inadequate sanitation and healthcare resources (Lee et al., 2017). Targeted public health interventions in educational settings could significantly reduce infection rates in these communities. Malook Banda shows a prevalence rate of 13.0% among young males aged 11-20 years who are both students and workers. The overlap of educational and occupational exposure in this group contributes to the infection spread. Improving conditions in both educational and work environments can play a significant role in reducing infection prevalence (Smith et al., 2019). In Shalagai, female teachers aged 21-30 have a prevalence rate of 19.0%. This high infection rate suggests that educators who frequently interact with students may be at increased risk of infections. Targeted health interventions and preventive measures in educational settings are necessary to safeguard both educators and students (Adams & Green, 2021). Nasir Abad has a prevalence rate of 9.0% among shopkeepers aged 31-40 years, with a balanced gender distribution. The moderate infection rate indicates that shopkeepers face unique challenges, including crowded working conditions and limited healthcare access. Community health programs that address these factors could help reduce infection rates among shopkeepers (Jones & White, 2021). The prevalence rate in Maskari is 14.5% among male laborers aged 41-50 years. This moderate rate reflects the exposure to various environmental and occupational hazards laborers face. Implementing improved workplace safety measures and enhancing access to health resources are crucial for managing infection rates in this demographic (Brown et al., 2018). Jelar exhibits a prevalence rate of 17.0% among elderly females aged 51-60 years. The higher infection rate among housewives in this middle-income area indicates the need for focused health strategies that address the specific challenges faced by older women. Tailored health programs and community support are essential for managing these issues (Kim & Park, In Daskoor, the prevalence rate is 18.5% among older male farmers aged 61-70. This high rate underscores the ongoing health risks associated with prolonged agricultural work. Implementing preventive health measures and improving healthcare access in rural areas is critical for managing infection rates among older farmers (Patel et al., 2020).

Chopper shows the highest infection rate of 21.0% among young students aged 0-10 years in a low socioeconomic area. This severe public health challenge highlights the need for comprehensive strategies to improve sanitation and healthcare access. Targeted interventions in educational settings are essential for addressing high infection rates among young students (Lee et al., 2017). Daskoor Payaan has a prevalence rate of 11.5% among young female teachers aged 11-20 years. This notable infection rate in a low socioeconomic setting suggests that young female teachers face unique challenges, including exposure to infections and limited healthcare resources. Implementing preventive health measures and improving access to health care are crucial for managing these risks (Adams & Green, 2021). Sundal has a prevalence rate of 12.0% among young adult males aged 21-30 years who are

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both students and workers. The moderate infection rate reflects the combined impact of educational and occupational factors. Addressing these factors through targeted health interventions can help reduce infection rates in this demographic (Smith et al., 2019). Dislawar prevalence rate is 15.0% among laborers aged 31-40 years, with a balanced gender distribution. This significant infection rate indicates the need for focused health interventions in labor-intensive occupations. Improving occupational health standards and providing better healthcare access are essential for managing infection rates among laborers (Adams & Green, 2021). Malook Banda has a prevalence rate of 19.5% among retired females aged 41-50 years. The high infection rate in this middle-class group highlights the need for targeted health interventions for retired individuals, particularly women. Addressing health challenges related to aging and socioeconomic factors through tailored programs and support services is crucial (Kim & Park, 2022). Shagai Tangai reports a prevalence rate of 20.0% among older male farmers aged 51-60 years. This high infection rate underscores the need for targeted health interventions in rural farming communities. The ongoing risks associated with agricultural work necessitate implementing preventive measures and improved healthcare access in these areas (Patel et al., 2020). The high proportion of individuals (76.94%) who reported traveling in the past six months is a significant factor in understanding infection dynamics. Travel exposes individuals to diverse pathogens and varying health environments, which increases their risk of acquiring and spreading infections. Frequent travel can act as a conduit for rapidly disseminating infectious diseases, especially when individuals move between regions with different health profiles or during active outbreaks (World Health Organization [WHO], 2020). Exposure to new pathogens and environments during travel may elevate the risk of disease transmission, underscoring the importance of considering travel history in public health assessments and interventions. Conversely, the 23.05% of individuals who did not travel recently may be less exposed to such risks, potentially leading to lower infection rates among this group due to reduced exposure to diverse pathogens. Occupational distribution further highlights significant risk factors related to health outcomes. The minimal percentage of government employees (1.66%) suggests they might face fewer direct occupational health risks than other groups. In contrast, a large proportion of unemployed individuals (46.25%) may encounter increased health risks due to socioeconomic challenges, such as limited access to healthcare and increased exposure to environmental or social stressors (National Institute for Occupational Safety and Health [NIOSH], 2019). Agricultural workers (18.52%) are exposed to specific risks, including pesticide exposure and zoonotic diseases, while laborers (7.78%) face hazards from physically demanding and often dangerous work environments. The remaining 25.79% of individuals in other occupations likely experience diverse risk profiles based on their specific job conditions. The diversity in occupational risks highlights the need for targeted health interventions that address the unique challenges different occupational groups face (NIOSH, 2019). These findings underscore the necessity of tailored public health strategies that account for travel history, occupational hazards, and other socio-environmental factors to effectively manage and mitigate health risks.

Study Significance

This study provides a detailed examination of infection rates across various regions, highlighting the influence of demographic, occupational, and socioeconomic factors on public health. The study offers actionable insights for targeted health interventions and policy development by identifying high-risk groups and regions. The findings contribute to a better understanding of the complex factors driving infection rates and underscore the need for tailored public health strategies. This research is significant for policymakers, healthcare providers, and community leaders as it provides evidence-based recommendations to address infection disparities and improve health outcomes. The study's results have the potential to inform future research and public health initiatives, ultimately leading to more effective management of infectious diseases and enhancing overall public health.

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