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Risk Factors Contributing to the Incidence of Intestinal Protozoa in District Swat.

By

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Abstract

Swat, Khyber Pakhtunkhwa (KP), based on data from two camps over six months. Key factors examined include gender, age, socioeconomic status, and travel history. In Camp 1 (Aug 2022-Jan 2023) and Camp 2 (Feb-Jul 2023), males were more affected, comprising 62.50% and 57.14% of infections, respectively. Males showed higher infection rates during the early months, gradually declining. Females had fewer infections but also experienced a steady decrease in prevalence. Children aged 0-15 years were the most affected, accounting for 35.45% of infections in Camp 1 and 36.88% in Camp 2, reflecting their higher vulnerability. Adults aged 16-30 were the next most affected, while older adults (45+) showed lower infection rates, possibly due to better hygiene practices or reduced exposure. Low-income individuals were disproportionately affected, making up 47.45% of infections in Camp 1 and 53.75% in Camp 2. This group's greater vulnerability is linked to limited clean water and sanitation access. Middle-income individuals also faced significant infection rates, while high-income individuals had the lowest prevalence. Local transmission was the primary source of infections, accounting for 48.61% in Camp 1 and 55.00% in Camp 2. Regional transmission followed, while national and international travel contributed minimally, suggesting that most infections were acquired locally due to sanitation and hygiene challenges. The study highlights the complex interplay of gender, age, socioeconomic status, and travel history in the spread of intestinal protozoa in District Swat. Effective interventions should focus on improving sanitation, water access, and health education, particularly for vulnerable groups such as children and low-income populations. Enhanced surveillance and targeted prevention measures are essential to control the local transmission of protozoal infections.

Keywords: Intestinal protozoa,

Introduction

1.1 Background and Justification

Parasitology, a key field in Zoology, focuses on the relationships between hosts and parasites, including parasitism, mutualism, commensalism, and phoresies. Parasitism is a non-mutual relationship where one organism (the parasite) benefits at the expense of another (the host). Parasites are widespread, affecting all life forms, and are classified as either ectoparasites (living on the host's surface) or endoparasites (living inside the host). In humans, parasitic infections have been known for centuries, particularly in tropical and subtropical regions, where they remain common (Solomon et al., 2014; Bush et al., 2001).

Intestinal Pathogenic Parasites (IPP) colonize the gastrointestinal tract and are major agents of gastroenteritis globally. The disease burden is significant in developing countries, especially among children. Around 3.5 billion people are affected by IPP worldwide, primarily due to factors

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like poverty, population density, inadequate hygiene, and limited access to safe water (Okyay et al., 2004; Hotez et al., 2004). IPP is transmitted through contaminated food, water, soil, and close contact with infected animals or humans, causing a spectrum of symptoms from dysentery to cognitive impairment in children (Rodriguez-Morales et al., 2006). Acute Gastrointestinal Illnesses (AGI), primarily caused by IPP, result in significant mortality, especially among children in developing nations. WHO estimates 2.2 million annual deaths from diarrhea, with Pakistan reporting 20-30% of deaths in children under five linked to diarrhea (WHO, 2002; Habib et al., 2013). AGI management remains costly, with high morbidity rates even in developed countries due to prolonged infections (Fleury et al., 2009). Major contributing factors include contaminated food/water, heavy rainfall, poor hygiene, and overcrowding. Thus, improving water safety and sanitation is essential for controlling IPP spread (Panagiotis et al., 2007).

1.2 Driving Forces of Parasitic Infection

Environmental contamination is vital in transmitting protozoan parasites, mainly through water, soil, and food. Parasites can enter human systems by ingesting transmissive stages such as cysts or spores. Transmission is exceptionally high in areas with poor sanitation, affecting nearly two-thirds of the global population in developing countries (Mirdha & Samantray, 2002). Environmental Route of Transmission: Key factors include the number of infected hosts, environmental sanitation, socioeconomic conditions, and agricultural practices (Bahrami et al., 2018). Waterborne Transmission: Contaminated water is a significant route for IPP, impacting drinking supplies, food production, and irrigation. Transported water can introduce parasites into new regions, contaminating fresh and marine water sources (Wordemann et al., 2006; Munoz-Antoli et al., 2014). Foodborne Transmission: Fruits and vegetables contaminated at any stage (production, transport, or preparation) can carry parasites. The complex water-food chain enables fecal material to act as a vehicle for parasitic spread, heightening transmission risks (Vaillant et al., 2005). IPP remains a significant public health challenge in South Asia, affecting Pakistan, India, and Bangladesh. Although commonly linked with developing regions, IPP poses significant risks in developed countries (Liu et al., 2012).

1.3 Protozoan Parasites

Protozoa are microscopic, single-celled organisms capable of surviving in diverse host environments. They can reproduce in the host, and many rely on oral-fecal transmission, affecting various vertebrates and some invertebrates (Neva & Brown, 1994).

1.3.1 Entamoeba histolytica

Entamoeba histolytica, responsible for amebiasis, infects approximately 50 million people annually and has a high mortality rate of 55,000 deaths each year (Ham, 2020). The parasite has a biphasic life cycle consisting of infectious cysts and pathogenic trophozoites. Transmission occurs via the fecal-oral route, disproportionately impacting low-income communities where sanitation is inadequate (Haque et al., 2003).

Diagnosis: Diagnosis methods include microscopy, serology, antigen detection, and PCR. Microscopy alone is unreliable due to the misidentification of related species. Antigen detection, especially the TechLab test, is practical for distinguishing E. histolytica from similar non-pathogenic species. PCR offers high sensitivity, particularly in resource-rich settings, though it is costly (Singh et al., 2009).

Treatment: Standard treatment for amebiasis includes metronidazole or other nitroimidazole derivatives, often combined with luminal agents such as paromomycin to target intestinal cysts. Alternative treatments like nitazoxanide are being explored, especially for cases with antimicrobial resistance (Blessmann et al., 2003; Preisig et al., 2021).

1.3.2 Giardia lamblia

Giardia lamblia, or Giardia intestinalis, is a flagellated protozoan causing giardiasis, a diarrheal disease. It affects various mammals and is recognized as zoonotic, allowing animal-to-human transmission (Ryan & Caccio, 2013). Giardia has a simple life cycle with cysts (infective) and trophozoites (active). Transmission occurs primarily through contaminated food, water and direct contact with infected animals (Kalavani et al., 2024). Symptoms: Giardia infection symptoms range from mild to severe, including diarrhea, bloating, and malabsorption. Chronic cases in children may lead to growth retardation and cognitive deficits (Cernikova & Hehl, 2018). Treatment: Nitroheterocyclic drugs such as secnidazole and tinidazole are effective treatments, exploiting Giardia's unique metabolic pathways. Drug resistance is a growing concern, prompting research into alternative treatments, including

MATERIALS AND METHODS

1. Study Overview

The study, conducted between August 2022 and December 2023, aimed to assess the health conditions and disease prevalence in the Muhajir camps. Camp 1 (August 2022 to January 2023) and Camp 2 (February 2023 to July 2023) were carried out in two distinct phases. Data was collected from 1,388 individuals residing in the camps throughout these two camps. The data collection process was structured and rigorous, capturing various health-related information. The goal was to assess seasonal trends, identify key health issues, and provide actionable insights into the needs of this vulnerable population. The study was designed as a cross-sectional analysis, sampling individuals from various public and private health facilities within the Muhajir communities.

2. Data Collection

The data collection methodology utilized a structured questionnaire to capture demographic, clinical, and environmental information. The questionnaire was divided into several sections to ensure a thorough understanding of the factors influencing health conditions. It began by gathering Patient Demographics, including essential details such as name, age, sex, nationality, and address. The clinical data

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focused on documenting lesions' number, type, location, and duration, which helped assess the severity and extent of health conditions among the participants. Social and environmental factors were also examined, including occupation, travel history, and family history of diseases, as well as housing characteristics like construction materials and proximity to vegetation. Household data collected information on domestic animals, clothing worn during sleep, sewage systems, and typical indoor and outdoor activities, all contributing to understanding the broader health factors.

3. Data Assessment

In addition to demographic and clinical data, a significant focus of the study was understanding the social and environmental factors that may influence the prevalence of diseases in the Muhajir camps. This included gathering data on the types of housing, such as construction materials for walls and ceilings, which could influence the spread of infections. Vegetation near houses was noted, as this could impact exposure to vectors like insects. Data on occupations and travel history helped identify possible links to diseases brought into the camps from outside. The household data provided a further understanding of the domestic environment, including the number and species of domestic animals (which can be sources of zoonotic diseases), the use of insect repellents, and the presence of sanitation systems. These insights contributed to a holistic understanding of health risks in the camps.

4. Ethical Considerations

A key component of the study was assessing health behaviors that may impact the incidence of diseases. This included questions about sleeping habits, such as whether individuals slept on the ground or used impregnated bed nets, which are critical for preventing insect-borne diseases. The use of insecticides and insect repellents was also recorded, as these can play a significant role in controlling the spread of vector-borne diseases. Additionally, information was gathered about prior treatments for conditions, which helped assess the effectiveness of past health interventions. Ethical considerations were a priority, with all participants providing informed consent before participating. The study ensured that all data were collected and handled with confidentiality, and photographic documentation of lesions was taken with participants' consent to further assist in clinical assessments.

5. Laboratory Work:

In parallel to the survey data, the study included a laboratory component focused on intestinal infections. A total of 576 fecal samples were collected from individuals presenting symptoms of diarrhea or gastrointestinal illness. These samples were collected in sterile, pre-labeled containers and preserved in 5% formalin for transport to the laboratories at DHQ Hospital Timergara. Each sample was carefully examined to identify intestinal parasites or pathogens causing the symptoms. Demographic data such as age, sex, and the seasonal timing of sample collection were recorded to evaluate trends in infection rates across different seasons and demographic groups. These laboratory examinations were essential for understanding the prevalence of parasitic infections within the population and linking seasonal and demographic factors to infection rates.

6. Data Analysis

Once the data were collected, they were systematically processed and analyzed using descriptive statistics to identify patterns and trends. The data were organized by age, gender, seasonal periods, and geographic location to assess seasonal fluctuations and determine which demographics were at higher risk for infection. The prevalence of intestinal protozoal infections was evaluated using percentile values to highlight which groups were most affected by specific diseases. By identifying these seasonal and demographic trends, the study provided crucial insights into the health needs of the Muhajir camps, enabling public health authorities to target interventions during high-risk seasons. Using SPSS software for data analysis helped ensure the findings were statistically sound and reliable, offering a solid foundation for future public health planning and interventions in the camp populations.

Results

In the period between February 2023 and July 2023, the data from Camp 2 highlights various aspects of the prevalence of infection within different sectors, categories, and groups. In Sector A, the infected individuals were divided by gender, with 400 males (57.14%) and 297 females (42.86%) affected. The monthly distribution for males shows that the prevalence was highest in February, with 120 cases (30%), gradually decreasing each month, reaching 25 cases (6.25%) by July. For females, the monthly distribution followed a similar trend, with 85 females (28.62%) infected in February, dropping to 12 (4.06%) in July. The total monthly distribution for both males and females add up to 100% for each gender, with males representing a larger share.

The age group distribution reveals that 36.88% of the infected individuals were children aged 0-15 years, while the 16-30 years age group comprised 20.52% of the total infections. The 31-45 years group accounted for 24.53%, and individuals over 45 years made up 18.07% of the cases. In total, there were 697 infected individuals across all age groups.

Regarding socio-economic status, the majority of the infected individuals in Sector A were from low-income backgrounds, comprising 53.75% of the total, followed by 30% from middle-income households and 16.25% from high-income households.

The data also highlights the origin of the infection in Sector A, with 55% of cases linked to local transmission. Regional, national, and international travel contributed to smaller proportions of the infections, with regional travel accounting for 22.5%, national for 15%, and international travel for 7.5%.

This comprehensive breakdown provides a clear overview of infection trends by gender, age group, socio-economic status, and the origins of the infections within the camp during the specified period.

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Table.1 Diarrheal Disease Burden in Risk Factors Contributing to the Incidence of Intestinal Protozoa in District Swat Kp.

Camp	Sector	Parameter	Category	Month	Infected Individuals	Prevalence (%)
Camp 1 (Aug 2022 - Jan 2023)	Sector A	Gender	Males	-	432	62.50%
	Sector B		Females	-	259	37.50%
Monthly Distribution (Males)				August	135	31.25%
				September	110	25.46%
				October	70	16.20%
				November	50	11.57%
				December	30	6.94%
				January	20	4.63%
Total Monthly (Males)				-	432	100%
Monthly Distribution (Females)	Sector B			August	90	34.75%
				September	70	27.03%
				October	40	15.44%
				November	25	9.65%
				December	15	5.79%
				January	9	3.47%
Total Monthly (Females)				-	259	100%
Age Group Distribution	Sector C	Age Group	0-15 years	-	245	35.45%
	Sector D		16-30 years	-	138	20.00%
	Sector E		31-45 years	-	184	26.63%
	Sector F		>45 years	-	124	17.92%
Total Age Group				-	691	100%
Socio-Economic Status	Sector A	Status	Low Income	-	205	47.45%
			Middle Income	-	160	37.04%
			High Income	-	67	15.51%

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Travel History	Sector A	Infection Origin	Local	-	210	48.61%
			Regional	-	115	26.62%
			National	-	70	16.20%
			International	-	37	8.56%

Table 2. Comprehensive Analysis of Infection Dynamics in Camp 2: Gender, Age, Socio-Economic, and Travel Impact District Swat Kp.

Camp	Sector	Parameter	Category	Month	Infected Individuals	Prevalence (%)
Camp 2 (Feb 2023 - Jul 2023)	Sector A	Gender	Males	-	400	57.14%
	Sector B		Females	-	297	42.86%
Monthly Distribution (Males)				February	120	30.00%
				March	95	23.75%
				April	60	15.00%
				May	50	12.50%
				June	30	7.50%
				July	25	6.25%
Total Monthly (Males)				-	400	100%
Monthly Distribution (Females)	Sector B			February	85	28.62%
				March	75	25.25%
				April	50	16.84%
				May	35	11.76%
				June	25	8.42%
				July	12	4.06%
Total Monthly (Females)				-	297	100%
Age Group Distribution	Sector C	Age Group	0-15 years	-	257	36.88%
	Sector D		16-30 years	-	143	20.52%
	Sector E		31-45 years	-	171	24.53%
	Sector F		>45 years	-	126	18.07%
Total Age Group				-	697	100%
Socio-Economic Status	Sector A	Status	Low Income	-	215	53.75%
			Middle Income	-	120	30.00%
			High Income	-	65	16.25%
Travel History	Sector A	Infection Origin	Local	-	220	55.00%
			Regional	-	90	22.50%
			National	-	60	15.00%

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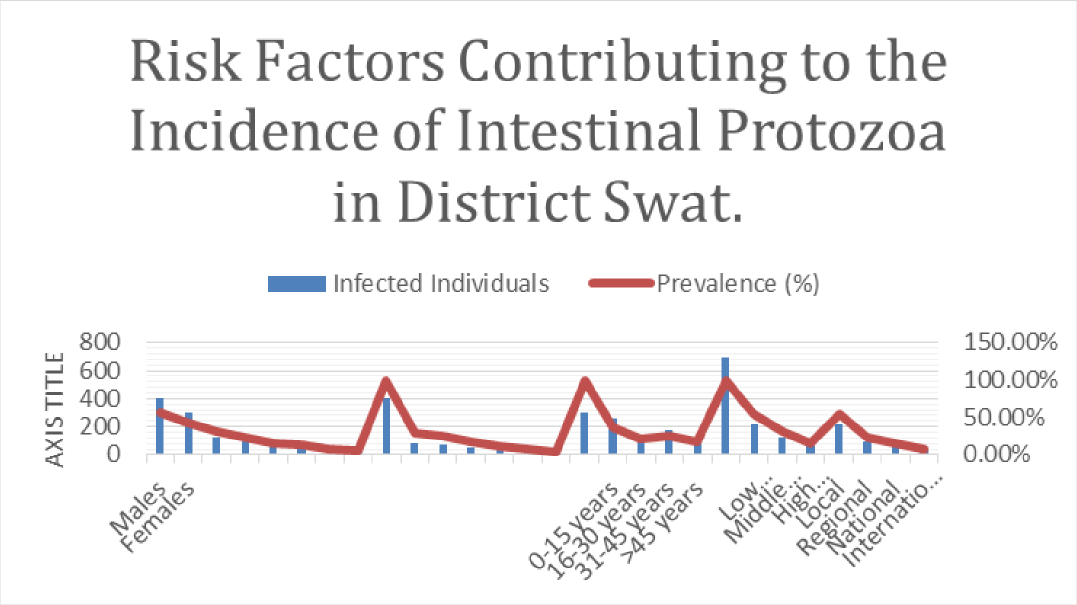
			International	-	30	7.50%



Discussion

In 2023, the prevalence of Protozoa cases displayed a notable decline compared to previous years. This reduction suggests the potential effectiveness of intervention strategies, improved water treatment, and heightened public awareness. Factors such as the establishment of better sanitation facilities and the influence of environmental policies could have contributed to the observed decrease. Compared to the spike in 2022, attributed to both catch-up effects post-pandemic and adverse environmental factors, the 2023 data may reflect improvements in community health education, preventative measures, and infrastructure. However, while the overall case numbers have decreased, the gender distribution in infection rates continues to show a pattern, with males exhibiting higher prevalence than females. This gender-based trend aligns with previous research, including Ulhaq et al., 2021, indicating that males may have higher exposure or susceptibility, possibly due to differences in outdoor activity levels or hygiene practices. Our findings align with seasonal trends observed by Bahrami et al., 2018, highlighting a peak in Protozoa cases during the summer months and a notable decrease during winter. This seasonal oscillation underscores the influence of environmental factors, such as temperature and humidity, which may facilitate protozoa transmission in warmer conditions.

Conclusion

The study over three years (2021-2023) identifies a distinct seasonal and annual pattern in Protozoa prevalence, with significant fluctuations influenced by environmental and social factors. Entamoeba histolytica remained dominant throughout the years, followed by Giardia lamblia. The seasonal peak in Protozoa cases during summer and higher rates among males and younger individuals suggest that socioeconomic factors, such as access to clean water, sanitation, and hygiene practices, play crucial roles in transmission dynamics. These findings highlight the need for targeted interventions and public awareness campaigns to address the root causes of Protozoa infections.

Recommendations

Strengthening Control Measures: Develop and enforce policies to prevent parasitic infestations, focusing on hygiene and sanitation. Public Awareness Campaigns: Implement educational programs at the community level to raise awareness about Protozoa, their transmission, and prevention, focusing on hand hygiene and clean drinking water. Targeted Health Initiatives: Introduce health initiatives in vulnerable areas, such as villages, schools, and colleges, to promote prevention, early detection, and timely treatment of Protozoa infections. Sanitation Infrastructure Improvement: To reduce contamination sources, prioritize upgrading sanitation facilities, including water and sewerage systems, especially in rural and low-income areas. Further Research: Conduct additional studies to explore the underlying risk factors for Protozoa transmission and refine evidence-based prevention strategies. Potentially, examine the impact of climate on seasonal variation in infection rates.

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