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RESEARCH ARTICLE

Prevalence of Several Infectious Diseases in the District Dera Ismail Khan, Khyber Pakhtunkhwa, Pakistan

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Abstract:

***Background*:** Infectious diseases are the leading cause of death, especially in young children and particularly in underdeveloped countries. This cross-sectional study determined the prevalence of some common/major pathogenic diseases in the Dera Ismail Khan district.

***Materials and Methods*:** The two-year indoor data were obtained from the District Headquarters Hospital, Dera Ismail Khan.

***Results*:** Of the total 48093 cases, diarrhea/dysentery contributed to 59.1%, followed by enteric/typhoid (22.7%), pneumonia (9.6%), malaria (4.6%), extra-pulmonary tuberculosis (2.3%), and pulmonary tuberculosis (1.8%). May had the highest prevalence (16.0%), and February had the lowest (3.9%). Diarrhea/dysentery fever showed a higher prevalence compared to other infections, except enteric/typhoid in January and June. Diarrhea/dysentery and malaria revealed the highest prevalence of 19.6% and 17.1% in May, respectively. The combined prevalence of diarrhea/dysentery, enteric/typhoid, and pneumonia was 91.4% among the studied infectious diseases, indicating comparability in June. Enteric/typhoid demonstrated the highest prevalence in August (24.4%), pneumonia in June (23.5%), extra-pulmonary tuberculosis in March (65.4%), and pulmonary tuberculosis in November (26.2%). The overall disease rates increased steadily from February to March, peaking in May, with a relatively higher prevalence in April and from August through October and December.

***Conclusion*:** Gastrointestinal diseases contributed to 81.8% of the overall prevalence, followed by respiratory diseases (11.4%), while malaria and extra-pulmonary tuberculosis collectively resulted in 6.8%. Prevalence varied by month and season. This study helps inform the adoption of strategies to prevent and control infectious diseases in the study area.

Keywords: Prevalence, malaria, May, gastrointestinal diseases, months, seasons.

1. INTRODUCTION

Pathogenic organisms, including viruses, bacteria, protozoans, and fungi, cause infectious diseases in humans and other organisms, also known as communicable diseases. They are transmitted through direct contact, water, food, airborne droplets, body fluids, and vector organisms. Infectious diseases are among the leading causes of morbidity and mortality worldwide, resulting in more than 52 million deaths annually, and outbreaks of new and known diseases endangered 50% of the world's population [1]. Approximately 14 million deaths of children aged <5 years occur due to infectious diseases. These health issues negatively impact human well-being and productivity worldwide [2-3].

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One of the most common diseases in children is diarrhea [4-5]. Bacteria, including *Salmonella*, *Shigella*, and *Escherichia coli*, as well as parasites, and toxins cause food-borne diarrhea. Its symptoms include the loss of water and minerals from the body through loose or watery stools. High mortality due to diarrhea occurs in children less than 5 years of age in Pakistan, despite a decline in its incidence over the past few decades [6]. Rahmat *et al.* [7] recorded high annual mortality (74/1000 children) due to diarrhea in Pakistan. Bacteria, including *Shigella* and *Entamoeba histolytica*, cause dysentery, characterized by bloody diarrhea, intestinal discomfort, and dehydration. The disease is also foodborne. *S. typhi* causes another food-borne disease known as typhoid, characterized by diarrhea, high body temperature, and vomiting.

Malaria is caused by five species of Plasmodium, characterised by symptoms of high fever and shivering. The main Plasmodium species in Pakistan are *P. vivax* and *P. falciparum* [8-10]. Malaria is ranked the second major disease, resulting in about 4 million people affected in Pakistan annually [11]. Pneumonia is an airborne infection and inflammation of the lung alveoli, caused by *Streptococcus pneumonia,* characterized by symptoms including dry cough, chest pain, fever, and difficulty breathing. Pneumonia contributed the highest as the single cause of child death worldwide [12] and ranked second regarding morbidity and mortality of children in Pakistan [13]. It resulted in one-fourth of the overall deaths of children in Pakistan [12]. It accounted for the highest share in child mortality among children aged less than 5 years in Pakistan [14]. Children aged <5 years and adults affected by pneumonia are >0.5 million and 96,000, respectively, annually, in Pakistan [12].

Mycobacterium tuberculosis causes airborne diseases, including pulmonary tuberculosis (PTB) and extrapulmonary tuberculosis (EPTB). The transmission of PTB occurs through breathing in air contaminated by the sneezing and coughing of PTB patients [15-17]. Infectious respiratory diseases contribute 20% to 30% of the children's deaths in Pakistan [18]. EPTB is tuberculosis of organs other than the lungs, including the visceral organs, bones, joints, meninges of the brain, skin, and eyes [19]. Tuberculosis (TB) is one of the top 10 major causes of global mortality.[20-21] Pakistan is among the top five high-burden TB countries, out of 30 listed by the World Health Organization [17, 22-24]. and accounted for 87% of TB cases worldwide [22, 25-26]. Pneumonia and tuberculosis are among the five major respiratory diseases, which contribute to 20% of global mortality [27]. Twenty infectious diseases contributed to a total of 13,666,263 cases in Pakistan during 2019 and 2022, with a decline in incidence observed during the pandemic period [1].

This study about the month- and season-based prevalence of several major/common infectious diseases is the first of its kind conducted in the District of Dera Ismail Khan (D.I. Khan). These findings help in designing effective interventions, such as improving awareness of disease prevalence, promoting hygiene, and implementing strategies like vaccination and anti-vector spray programs to decrease disease rates in the D.I. Khan district.

2. MATERIALS AND METHODS

2.1. Diagnosis

Laboratory tests/techniques are conducted to determine the cause of diseases using blood, urine, stool, mucus or other body fluids samples with the help of microscope or occasionally culturing the pathogens in the District Headquarters Hospital (DHQ), D.I. Khan.

2.2. Collection/Management of the Data

The two-year combined indoor patient data from December 2019 through November 2021 was obtained from the computer office (Admin) of DHQ, D.I. Khan. The data were sorted and were combined for the said period for each month.

2.3. Statistical Analysis

Pearson chi-square test was used to analyze the distribution of the frequencies of the diseases over the months and found significant (X-squared = 17131, df=55, p-value <0.0001) for the association between

diseases and months, followed by post hoc pairwise comparisons. Benjamini & Hochberg's [28]. method, at a level = 0.01, for adjusting the *p*-values for multiple comparisons was used. All months showed pairwise significant differences from each other ($p < 0.0001$).

2.4. Inclusion Criteria

The inclusion criteria were monthly/seasonal prevalence of several infectious diseases among indoor patients from December 2019 through November 2021 in DHQ hospital, D.I. Khan.

2.5. Exclusion Criteria/Limitations

The study is limited as it excluded the risk factors and sex-based prevalence of the studied diseases in the study area.

2.6. Ethical Committee Recommendation

The administrative staff of the DHQ Hospital, D.I. Khan approved the present study with reference No. 2606/MD-1, dated 17th June 2021.

3. RESULTS

3.1. Combined Diseases Prevalence

Overall aggregate data for two years demonstrated diarrhea/dysentery resulted in 59.1% of the overall prevalence of infectious diseases (Table **1**), followed by enteric/typhoid (22.7%), pneumonia (9.6%), malaria (4.6%), EPTB (2.3%), and PTB (1.8%). Overall, gastrointestinal diseases, including diarrhea/dysentery and enteric/typhoid, accounted for 81.8% compared to 18.2% by pneumonia, PTB, EPTB, and malaria. May resulted in 16.0%, followed by August (12.2%), September (10.0%), April (9.2%), October (9.1%), December (8.6%), June (7.6%), March (7.1%), July (6.0%), November (5.2%), January (5.0%), and February (3.9%). The overall prevalence of the diseases demonstrated a steady increase from February and reached a peak in May, followed decrease during June and July and increased in August, gradually decreased from September through November, and increased again in December.

Table 1. Monthly prevalence of several infectious diseases (indoor patient data) from December 2019 through November 2021.

Disease	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Diarrhea/Dysen	924	994	1888	3878	5577	1172	2441	2733	2565	2043	1587	2604	28406
Enteric/Typhoid	955	109	30	83	1358	1217	156	2673	1609	1454	295	997	10936
Pneumonia	254	486	612	308	346	1079	134	200	249	434	141	356	4599
Malaria	113	159	108	129	375	73	92	150	268	333	248	149	2197
Ext Pulm Tuber	98	97	714	0	6	65	53	6	26	22	2	3	1092
Pulm Tuber	64	49	67	38	43	39	20	92	82	96	226	47	863
Total	2408	1894	3419	4436	7705	3645	2896	5854	4799	4382	2499	4156	48093

Note: All months were pairwise statistically different from each other ($p < 0.0001$).

3.2. Relative Percentage Prevalence of the Diseases Over Months

The combined average indoor data for two years (December 2019 through November 2021) revealed diarrhea/dysentery resulted in the highest prevalence (Table **1**, Fig. **1**) of 19.6% in May over months, followed by April (13.7%), August (9.6%), December (9.2%), September (9.0%), July (8.6%), October (7.2%), March (6.6%), November (5.6%) and the remaining months showed ≤ 4.1%. Enteric/typhoid showed 24.4% prevalence in August, followed by September (14.7%), October (13.3%), May (12.4%),

June (11.1%), December (9.1%), and January (8.7%), and the remaining months showed ≤ 2.8% prevalence. Pneumonia contributed 23.5% share in June, followed by March (13.3%), February (10.6%), October (9.4%), December (7.7%), May (7.5%), April (6.7%), January (5.5%), September (5.4%), and the remaining months ≤4.3%. Malaria revealed a prevalence of 17.1% in May, followed by October (15.2%), September (12.2%), November (11.3%), February (7.2%), each August and December (6.8%), April (5.9%), and January (5.1%), while March, July, and June showed malaria prevalence ranging from 3.3% to 4.9%. PTB resulted in 26.2% prevalence in November, followed by October (11.1%), August (10.7%), September (9.5%), March (7.8%), January (7.4%), February (5.7%), December (5.5%), May (5%), each April and June (approx. 4.5%), and July (2.3%). EPTB showed 65.4% prevalence in March, followed by January and February (each approx. 8.9%), June (6%), and July (4.9%) with all other months having ≤ 2.4% prevalence.

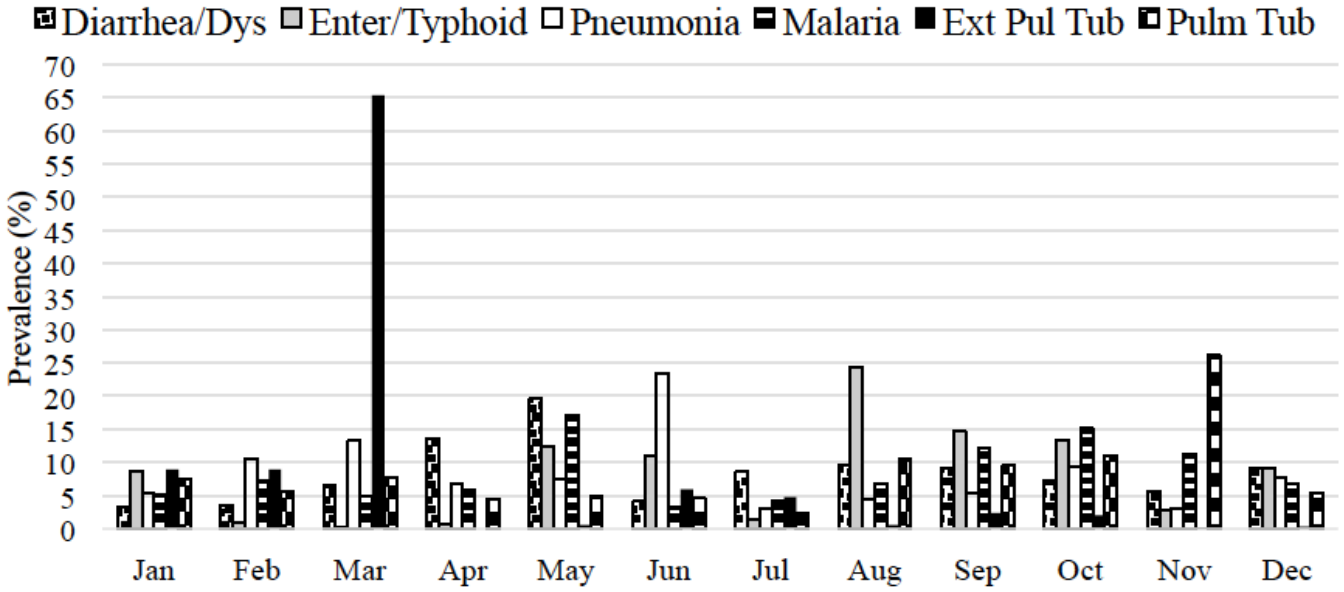

Figure 1. Percentage relative prevalence of several pathogenic diseases over months in D.I. Khan.

3.3. Percentage Month-Based Relative Prevalence

The combined average indoor data for two years demonstrated diarrhea/dysentery contributed 87.4% (Fig. **2**) prevalence in April relative to other diseases, followed by July (84.3%), May (72.4%), November (63.5%), December (62.7%), March (55.2%), September (53.5%), February (52.5%), August (46.7%), October (46.6%), January (38.4%), and June (32.2%). Enteric/typhoid contributed a relative prevalence of 45.7% in August, followed by January (39.7%), September (33.5%), June (33.4%), October (33.2%), December (24%), and May (17.6%). While February to March, July, and November demonstrated a ≤11.8% prevalence of enteric/typhoid. Pneumonia led to a 29.6% relative share in June, followed by February (25.7%), March (17.9%), January (10.6%), October (9.9%), December (8.6%), and April (6.9%), and the remaining months led to ≤5.6% of the relative prevalence. Malaria contributed 9.9% relative prevalence in November, followed by February (8.4%), October (7.6%), September (5.6%), May (4.9%), January (4.7%), December (3.6%), March and July (3.2%), April (2.9%), August (2.6%), and June (2%). EPTB demonstrated relative prevalence (20.9%) in March, followed by February (5.1%) and January (4.1%). The remaining months showed ≤1.8% relative prevalence of EPTB. PTB resulted in 9% relative prevalence in November, followed by January (2.7%), February (2.6%), October (2.2%), and March (2%), while the remaining months revealed ≤1.7% relative prevalence.

3.4. Seasonality of the Diseases

Diarrhea/dysentery showed a steady increase in prevalence from spring to early summer (March through May), with the highest prevalence in early summer in May (Table **1**, Fig. **1**). Enteric/Typhoid showed higher prevalence in early summer and late summer/early autumn (August through October).

Pneumonia showed the highest prevalence in mid-summer (June), followed by spring. Malaria prevalence peaks in early summer, remained relatively high from late summer through late autumn and early winter (October and November), and reached its lowest point during mid-summer. EPTB and PTB showed the highest prevalence in early spring and late autumn/early winter, respectively.

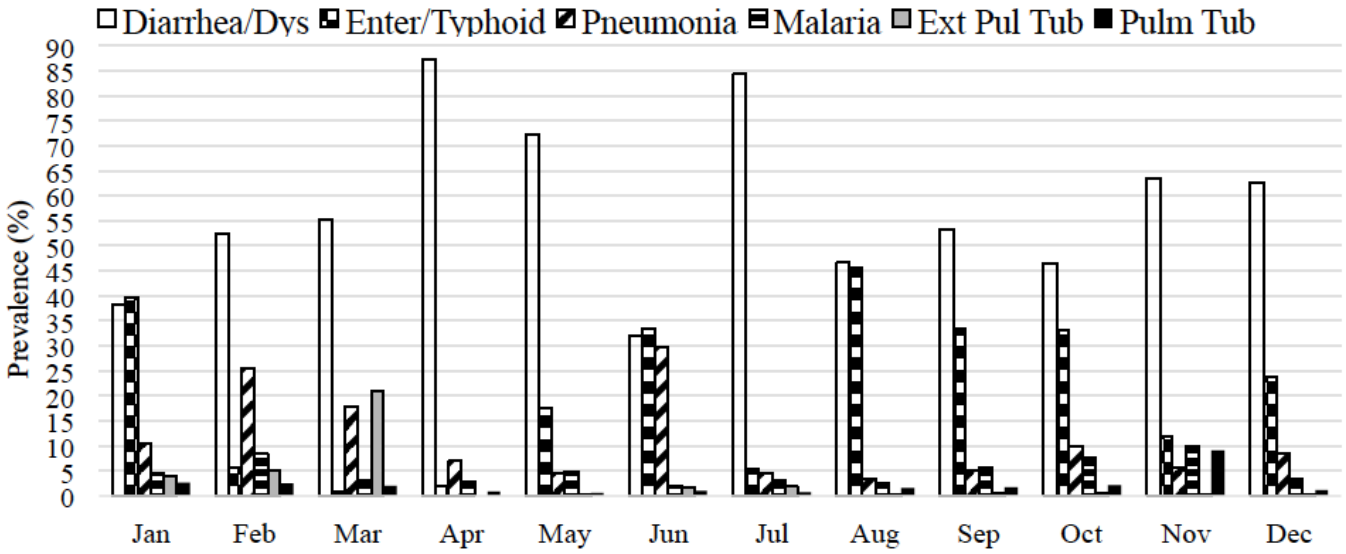

Figure 2. Percentage month based relative prevalence of several pathogenic diseases in D.I. Khan.

4. DISCUSSION

The COVID-19 pandemic, from 2019–2021, introduced significant confounding factors in data on in-door patient reporting and health-seeking behaviors, severely disrupting healthcare services. Infectious disease epidemics are driven by a combination of several factors, including high population density, lack of safe water, inadequate sanitation, low socio-economic status, and insufficient immunization [29]. Furthermore, ambient temperature is a key factors in disease transmission [30]. The density of vectors also performs a key role in the transmission of pathogens causing infectious diseases.

The present study indicated season-wise and month-wise variations in the prevalence of several common pathogenic diseases in District D.I. Khan (Table **1**). The data pooled over all diseases indicated the highest prevalence (Table **1**) in May (16.0%), followed by August (12.2%), September (10%), April (9.2%), October (9.1%), December (8.6%), and February (3.9%). The rising temperature, and increase in the population of flies/mosquitoes in D.I. Khan, play a key role in increasing the prevalence of the diseases from March to May, with a peak in May (Table **1**). Comparatively lower temperatures in January reduced the survival, breeding rates, and activity of vector insects. This resulted in the lowest prevalence of the disease in February in the present study. The aggregated data showed diarrhea/dysentery resulted in the highest prevalence, followed by enteric/typhoid (Table **1**) and both contributed 81.8% of the overall prevalence of studied diseases in D.I. Khan, demonstrating that unhygienic conditions, including unhygienic drinking as well as feeding to the babies, and an abundance of flies are major risks for transmitting the disease in the study area is confirmed by Rehmat *et al.* [7] who concluded that the higher prevalence of diarrhea among children in Pakistan is mainly because of drinking unhygienic water. Pneumonia and diarrhea revealed distinct seasonal variations, and climatic conditions, including temperature, rainfall, humidity, and pathogen, commonly determine the transmission patterns [31-34].

Previous research on the season-wise and month-wise prevalence of diarrhea/dysentery, typhoid, and extrapulmonary tuberculosis is not available in Pakistan. Most of the previous studies deal with the sex and age-wise prevalence of diarrhea and pneumonia in Pakistan and abroad. Similarly, Mirza *et al.* [35] investigated the prevalence of several intestinal parasites in D.I. Khan. Other than seasonality studies on EPTB are available [19, 24, 36].

The highest occurrence of diarrhea/dysentery (Table **1**, Fig. **1**) in late spring/early summer (April-May) was supported by previous studies on gastroenteritis reported in children of 15 years or less in Bannu (Pakistan), which demonstrated April showed the highest prevalence, followed by May [37]. The highest number of enteric/typhoid cases was recorded in August, and relatively lower rates were recorded from February to April, with the lowest in March, as supported by Bukhari *et al.* [38] who found a higher prevalence of typhoid from April to June and lower rates from January to March (winter/spring) in Taxila (Pakistan) and surrounding areas.

Pneumonia showed a relatively higher prevalence from early winter through mid-summer (Table **1**, Fig. **1**) and during September and October (autumn). Pneumonia showed peak prevalence in June. In contrast, Sharif *et al.* [39] determined the prevalence of pneumonia based on sex and age and found the highest prevalence of the disease in the winter in Pakistan.

The peak pneumonia reported in June in the present study, in contrast to the traditional winter months, is due to the fact of high heat, dust storms, particulate matter (PM2.5) inhalation, and often unhygienic living conditions, malnutrition, lack of vaccinations, and poor breastfeeding in D.I Khan or may be due to many cases of severe COVID-19 in 2020-2021 that were misdiagnosed and reported as viral pneumonia.

EPTB and PTB showed early spring (March) and early winter (November) as the peak months of prevalence, respectively, in D.I. Khan. However, in contrast, Khan [40] reported that lower respiratory tract infections (LRTIs) showed the highest prevalence in February (17.9%) and the lowest in May (5.5%). In addition, PTB revealed relatively higher prevalence during August to October, which was supported by Khan [40], who also reported higher prevalence of LRTIs during February-April and October-November in Bannu. Moreover, Khan [41] also supported the present result and found relatively higher PTB cases during February-July (late winter to mid-summer) and September-October (late summer to early autumn) in Bannu. Further supported by Khan [26], who recorded the highest prevalence of PTB in September (late summer) and the lowest in July (mid-summer) and November (autumn) in Serai Naurang (Lakki Marwat). Nevertheless, in contrast, Khaliq *et al.* [17] reported seasonal variation, as the peak prevalence of tuberculosis was during April–June in Lahore.

Peak malaria occurred in May (early summer), followed by October (autumn), and lowest in June (Table **1**, Fig. **1**). This may be the reason the population of mosquitoes also increased rapidly in the same periods. Ahmad *et al.* [42] recorded the peak malaria in October and found the lowest in June in Dir Lower. Malaria transmission occurs throughout the year, yet peak months are from July to November after the rains [43-44]. Malaria reached its peak in May and decreased in June (Table **1**), which was supported by Bashir *et al.* [10] who found the lowest rate of malaria in February, a steady increase up to May, and then again decreased in June in D.I. Khan. While, in contrast, Khan [45] reported malaria steadily increased from April through August, with a peak in August (20% cases), but was lowest in February (2.1%) in Lakki Marwat.

The EPTB revealed the peak prevalence in March (65.4%), followed by approximately 9% each in January and February (Fig. **1**). Sufficient literature is not available on the EPTB. The EPTB contributed to 20% of all notified TB cases [24]. Lin *et al.* [46] investigated and found 766 patients of TB, including EPTB 102 (13.3%) and PTB 664 (86.7%) in Taiwan; 19.6% of patients were found with mixed cases of EPTB and PTB. Rashid *et al.* [47] reported pneumonia prevalence (63.5%), meningitis (20%), acute watery diarrhea (8.5%), enteric fever (4%), malaria (2%), and tuberculosis (2%) in Lahore.

Seasonal/monthly anomalies in the pattern of diseases in the present study, compared to previous studies, may be due to the COVID-19 pandemic, and or harsh seasonal and hygienic conditions and pollution in the study area. Moreover, the focus of treatment was shifted comparatively more to COVID-19 in the health centers, as well as many people preferred not to go for medical checkup to health facilities during the study period in order to avoid contact with COVID-19 patients in the study area.

CONCLUSIONS

Both month-wise and seasonal-wise variations in the prevalence of diseases occurred in the study area. Diarrhea/dysentery demonstrated increased prevalence during March-May (from spring through early

summer) and showed relatively higher prevalence during July-December compared to January and February (mid and late winter). Enteric/Typhoid showed relatively higher prevalence during May-June (summer) as well as August through October (late summer/early autumn), and relatively lower during February-April (late winter/spring). Pneumonia showed the highest prevalence in June (mid-summer), followed by March (spring), and February/October (late winter/early autumn), indicating that seasonal changes play an important role in the disease prevalence. Malaria showed the highest prevalence in May (early summer) and relatively higher prevalence during late summer through autumn (September through November). Extrapulmonary tuberculosis and pulmonary tuberculosis revealed the highest prevalence in March (spring) and November (late autumn/early winter), respectively. The poor sanitation system, the unsafe drinking water, as well as taking unhygienic food, and the high temperature, and high density of vector insects mainly contributed to the prevalence of diseases in the study area.

RECOMMENDATIONS

Awareness of diseases, educating and vaccinating the public, and improving hygiene can help reduce the prevalence of diseases [30]. The present study provides useful information to the local health authority to introduce a strategy including specific interventions directly linked to the peak month of May, such as targeted indoor residual spraying of all households in early April to control vectors of diseases, distributing long-lasting insecticidal nets, and implementing larviciding in known mosquito breeding sites in March/April. Other options are 1) bottle feeding should be avoided and mother feeding should be adopted, 2) patients' stool and phlegm should be disposed of, and the patient should be isolated, 5) a hygienic way of life including hand washing with sanitizer, covered/boiled food, and drinking should be adopted, 6) using facemask, 7) vaccination, and 7) use of oral rehydration therapy.

LIST OF ABBREVIATIONS

PTB = Pulmonary Tuberculosis

EPTB = Extrapulmonary Tuberculosis

TB = Tuberculosis

D.I.Khan = Dera Ismail Khan

DHQ = District Headquarters Hospital

CONSENT FOR PUBLICATION

Not applicable

FUNDING

None

CONFLICT OF INTEREST

None

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