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Climatic Variables and Intestinal Parasitosis Transmission Dynamics in Jimma Town, South West Ethiopia: An Ecological Retrospective Study

Ayalew Jejaw[1*], Ahmed Zeynudin[2], Tariku Belay[3]

[1]Department of Biomedical Science, College of Health Sciences, Mizan Tepi Univesrsity, Mizan Teferi, Ethiopia

[2, 3]Department of Medical Laboratory Sciences and Pathology, College of Public Health and Medical Sciences, Jimma University, Jimma, Ethiopia

Abstract: ***Background**: Intestinal parasites cause considerable morbidity and mortality. Variability of climatic factors is important determinants for transmission of parasitic infections. This study was aimed at assessing trends of intestinal parasites and their correlations with climatic variables in Jimma town, South west Ethiopia. **Methodology**: Ecological retrospective study was conducted by reviewing six years (from January 01/2006-December 30/2011) laboratory records of intestinal parasites from all Public health facilities, and meteorological variables from Jimma branch of national metrology agency of the town. Descriptive statistics, Time series and Spearman correlation analysis were used during data analysis. **Results**: During the six years period, there was a significant reduction (p=0.037) in overall prevalence of intestinal parasites and the highest (43.4%) being in 2006 and the lowest (31.8%) in 2011. Within these years; ten types of intestinal parasites were isolated and the predominant parasite detected was* **Ascaris lumbricoides** *(11.6%) followed by* **Giardia lamblia** *(9.4%) and* **Entamoeba histolytica** *(5.9%). Spearman correlation analysis indicated that monthly total rainfall was positively correlated with* **Giardia lamblia** *(r=0.87, p=0.001) and* **Entamoeba histolytica** *(r = 0.699, p = 0.027). On the other hand, none of the climatic variables were significantly correlated with any intestinal helmenthosis. **Conclusion**: Although prevalence of intestinal parasitosis showed significant reduction within the six years; they are still a health problem in the study area and imply that more coordinated efforts should be paid for further declination. Cases of intestinal protozoa infections might be affected by rainfall pattern and during rainy season preventing and controlling measures should be undertaken.*

Keywords: Intestinal parasites, Month, Season, Meteorological parameters, Jimma, Ethiopia

1. Introduction

Intestinal parasitic infections (IPIs) are major health problems globally and have been described as constituting the greatest single worldwide cause of illness, particularly in developing and the most deprived communities of the world. In addition to causing morbidity and mortality, intestinal helminths and protozoan parasites have a negative impact on growth and development of children [1-3].

Intestinal helminths alone had high global prevalence, of which *A.lumbricoides, T.trichiura*, and hookworms are the most widespread species affecting over 1.2 billion, 795 million and 740 million people worldwide, respectively [4-6]. In addition to helminths, there are worldwide intestinal protozoa infections. *G.lamblia*, which is a waterborne parasite, is a frequent cause of diarrhea and affects approximately 200 million people worldwide [7, 8]. Amoebiasis is among the leading cause of death from parasitic diseases worldwide. It is estimated that approximately 50 million people of the worldwide suffer from invasive amoebic infection each year which results 40-100 thousand deaths annually [9].

The epidemiology of intestinal parasitic infections varies in different parts of the world. Climatic factors combined with poverty, malnutrition, personal and environmental hygiene, high population density, unavailability of potable water, low health status, and other factors provide optimum conditions for the growth, transmission of the parasites and increase the probability of exposure to such infections [10].

Climatic variables vary along with time in the majority of habitats; tending to induce regular cyclic fluctuations in the prevalence and intensity of parasitic infections [11-13]. Changes in temperature, precipitation, and runoff water play an important regulating role in the distribution, transmission and developmental success of intestinal parasitic organisms. This is due to the fact that most intestinal nematodes and protozoan parasitic infections involve a direct life cycle, i.e host-soil-host interaction [14]. It is therefore; very likely that short to long-term climatic variability could lead to consistent changes in IPIs rates.

Ethiopia is one of the tropical countries where intestinal parasitoses are major public health problems. Although the distributions of such infections in Ethiopia are cosmopolitan, studies showed that their prevalence varies from place to place.

Changes have been observed in the epidemiology of same species of some infections in areas with different altitudes [15]. Generally in Ethiopia, particularly in Jimma town a few studies have been done to determine the prevalence of different parasitic infections. However, there is statistically significant inter- monthly and inter- seasonal variations of meteorological variables in the town [16]; there is a lack of understanding as far as their transmission dynamics is concerned at different time scales in relation to meteorological variables; This study was, therefore, initiated to assess the trend of intestinal parasitosis and their patterns of correlation with meteorological factors over the last six years.

2. Methods

2.1 Study Area

The study was conducted in Jimma town which is located 350 kms south west of Addis Ababa (the capital city of Ethiopia). It is located at an average altitude of 1780 meters above sea level with geographical coordinates of approximately 7°41' N latitude and 36° 50'E longitude. It lies in the climatic zone locally known as 'Woyna Dega' (areas located between 1,500 - 2,400 m above sea level) which is considered ideal for agriculture as well as human settlement. The town is generally characterized by warm climate with mean annual maximum temperature of 30°C and mean annual minimum temperature of 14°C. The annual rainfall ranges from 1138 to 1690 mm. Maximum precipitation occurs during the three months period, June to August, with minimum rainfall in December and January. The town is divided in to 13 administrative districts. According to the central statistical agency (CSA) of 2007, the total population of the town is 130,254. During the study period, there were one public hospital and three health centres and several private clinics in the town.

2.2 Study Design

An ecological retrospective study was conducted to determine the correlation between meteorological variables and intestinal parasitosis over six years (from January 01/2006-December 30/2011) period.

2.3 Data Collection

The parasitological data was collected from all public health facilities in Jimma Town. For this, six-year (from January 01/2006- December 30/2011) laboratory records of intestinal parasites in three health centers and one public hospital were reviewed retrospectively. We did not extract data from privates due to their improper result documentation. Both positive and negative samples were included in the analysis.

A single stool samples were collected per participant using clean cup container. Then wet smear was prepared using normal saline (0.85%) within 30 minutes of sample collection. Each slide was examined under 10x and 40x microscopic objectives by experienced laboratory professionals. These microscopically confirmed cases were documented on laboratory registration format of each health institutions. Accordingly, the extracted data include: 1) date of stool examination; 2) total number of patients who were requested for stool examination 3) result of the stool examination and 4) species of intestinal parasites isolated. Moreover, the six year's metrological data were retrieved from Jimma branch of the National Meteorological Agency. The extracted variables include: daily minimum, maximum, mean temperature, daily total rainfall and daily average relative humidity.

2.4 Data Analysis

Monthly and annual meteorological parameters; minimum average temperature, maximum average temperature, average temperature, total rainfall, and average relative humidity were calculated by Ms-excel. Finally, the data was analyzed by using SPSS-16 software. Time series analysis was used in order to clearly observe trends of intestinal parasitic infections and metrological parameters at different time scales illustrative. Spearman correlation analysis was used to determine the pattern of correlation between meteorological variables and occurrence of intestinal parasites.

2.5 Ethical Clearance

Ethical clearance was obtained from the Institute of Research and Community Support of Jimma University. Permission was sought from the medical directors of the health institutions.

3. Results

3.1 Annual trends of intestinal parasites in Jimma town, (2006-2011)

During the six years period (2006-2011); a total of 69,782 stool specimens were examined from patients who visited the health facilities of Jimma town. Out of these, 25198 (36.1%) were infected by at least one species of intestinal parasites. There was significant overall reduction ($p=0.037$) in the positivity rate for intestinal parasites and the highest (43.4%) being in 2006 and the lowest (31.8%) in 2011 (Figure 1).

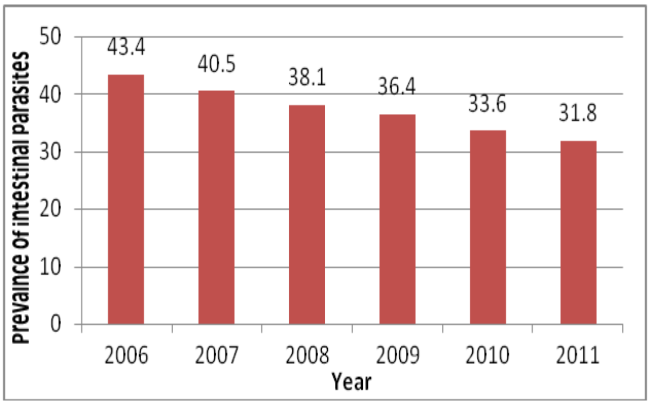

Figure 1: Annual trend of prevalence of intestinal parasites documented in the public health facilities from 2006-2011, in Jimma Town, Ethiopia

Ten types intestinal parasites were isolated within the six years period; *i.e A.lumbricoides=11.6%, G.lamblia=9.4%, E.histolytica/dispar=5.9%*

T.trichiura=3.4%, Hookworm=2.2%, H.nana=1.8%, S.stercoralis=.6%, S.mansoni=.6%, Taenia spp=.6%, E.vermicularis=.1%, (Table 1).

Table 1: Annual trend of IPIs prevalence from 2006-2011, Jimma town, Ethiopia

Year		***2006***	***2007***	***2008***	***2009***	***2010***	***2011***	***Total***
Total samples/year		9391	8055	6912	11809	13665	19950	69782
Types of parasites n (%)	*Al*	1331 (14.2)	974 (12.1)	848 (12.3)	1385 (11.7)	1389 (10.2)	2136 (10.7)	8063 (11.6)
	Gl	869 (9.3)	825 (10.2)	561 (8.1)	1132 (9.6)	1175 (8.6)	2000 (10)	6562 (9.4)
	Eh	670 (7.1)	593 (7.4)	521 (7.5)	733 (6.2)	719 (5.2)	864 (4.3)	4100 (5.9)
	Tt	477 (5.1)	358 (4.4)	266 (3.8)	394 (3.3)	492 (3.6)	393 (2)	2380 (3.4)
	Hw	331 (3.5)	195 (2.4)	161 (2.3)	245 (2)	318 (2.3)	283 (1.4)	1533 (2.2)
	Hn	175 (1.9)	171 (2.1)	155 (2.2)	176 (1.5)	236 (1.7)	325 (1.6)	1238 (1.8)
	Ts	96 (1)	58 (.7)	43 (.6)	46 (.4)	84 (.6)	92 (.4)	419 (.6)
	Sm	40 (.4)	21 (.26)	22 (.3)	73 (.6)	84 (.6)	188 (.9)	428 (.6)
	Ss	78 (.8)	65 (.8)	58 (.8)	96 (.8)	71 (.5)	51 (.2)	419 (.6)
	Ev	3 (.03)	1 (.01)	1 (.01)	14 (.1)	19 (.1)	18 (.1)	56 (.1)
Total positive samples/year, n (%)		4070 (43.4)	3261 (40.5)	2636 (38.1)	4294 (36.4)	4587 (33.6)	6350 (31.8)	25198 (36.1)

Al=A.lumbricoides, Gl=G.lamblia, Eh=E.histolytica,Tt= T.trichiura,Hw= Hookworm,Hn= *H.nana,Ts= Taenia spp,Sm= S.mansoni,Ss= S.stercoralis,Ev= E.vermicularis*

3.2 Monthly Distribution of Intestinal Parasitic Infections

Although there was no significant difference (p>0.05) in the distribution of total prevalence of intestinal parasites in each months of the six years period; intestinal protozoan parasites showed significant monthly fluctuation (*E.histolytica*, P = 0.035, *G.lamblia* , P = 0.047) and their peak prevalence's were observed in June in most of the years (Figure 2).

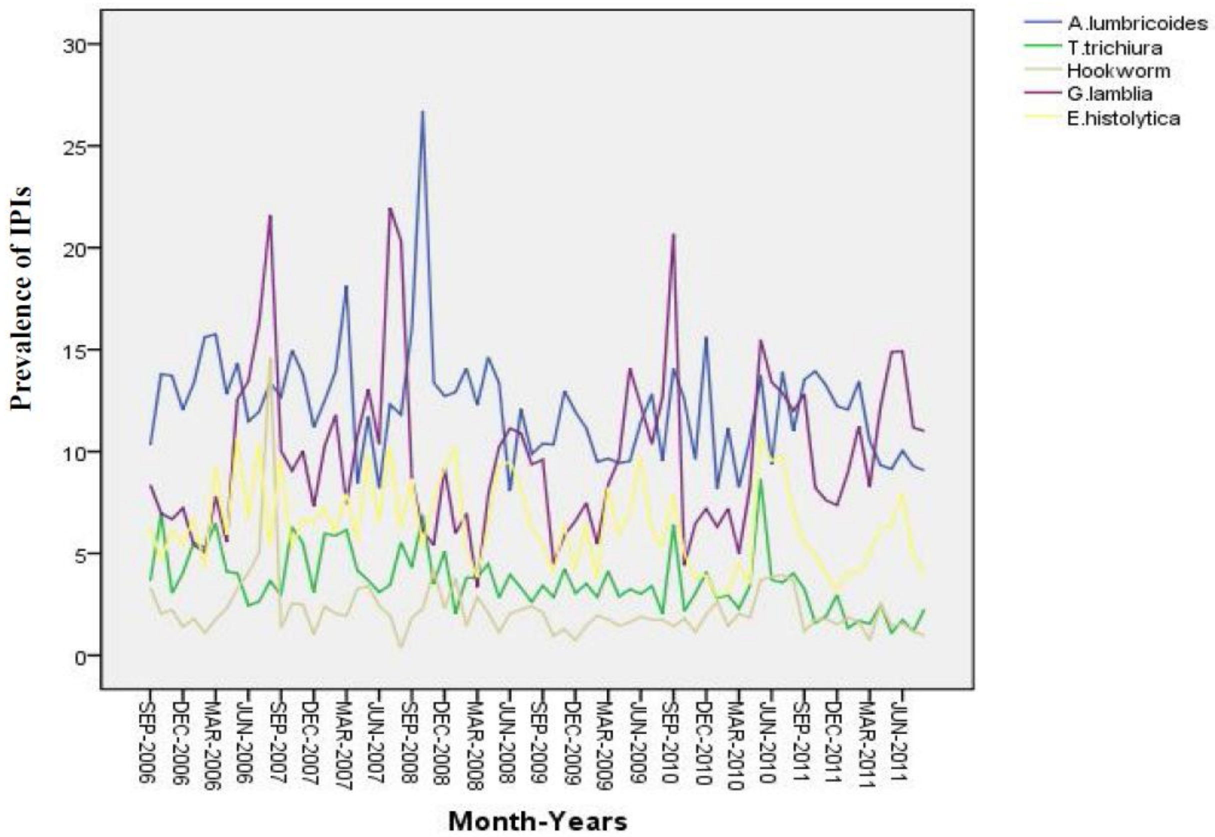

Figure 2: Monthly prevalence of the first top five species of IPIs from 2006-2011, in Jimma town, Ethiopia

3.3 Meteorological variables in Jimma Town, Ethiopia (2006-2011)

As it is shown on figure 3; annual trends of meteorological parameters did not show statistically significant variation (P = 0.06). On the other hand, statistically significant (p = 0.025) inter monthly variations among meteorological variables were noted.

The towns' annual mean temperature ranged from 19.87 °C in 2011 to 20.32°C in 2006 and slight fluctuating trend of temperature throughout the years of 2006 to 2011 was observed. But relatively high fluctuating trend of rainfall was reported through the years 2006 to 2011. The maximum total annual rainfall was observed in 2006 (1862.4 mm) and the minimum total annual rainfall was observed in 2007 (1416.2 mm).In the last six years annual average relative humidity showed some fluctuating trend that ranges from 54.90% in 2008 to 61.43% in 2010.

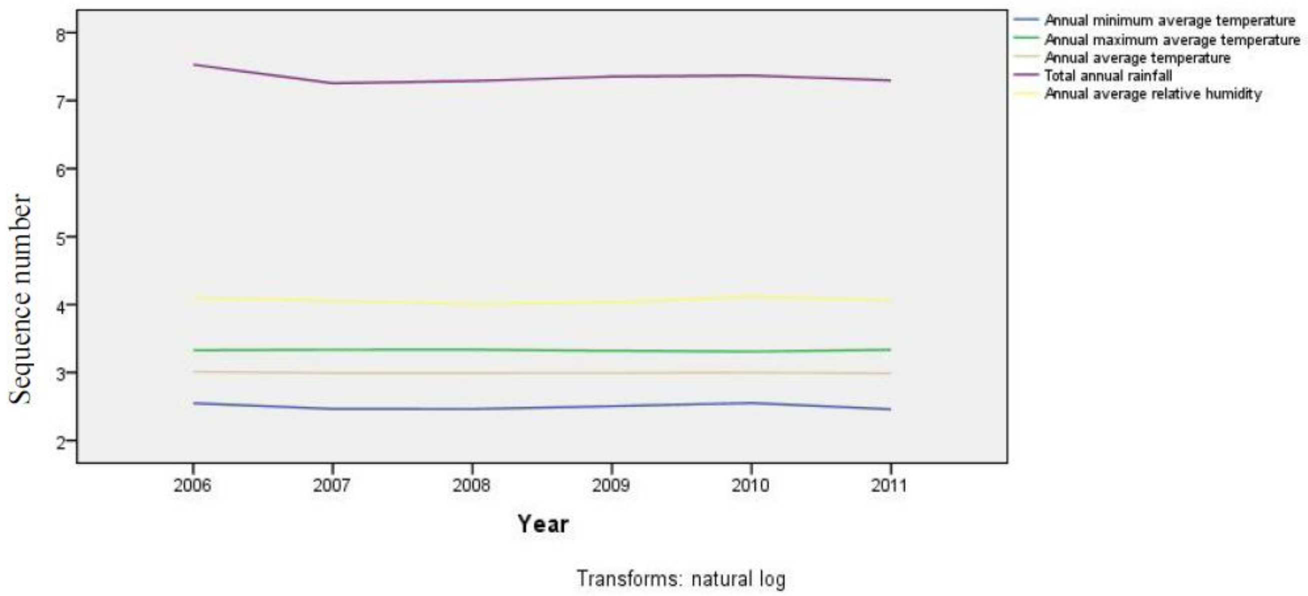

Figure 3: Annual trends meteorological parameters from 2006-2011, in Jimma town, SW Ethiopia

3.4 Annual Correlations of IPIs and Meteorological Variables

Although a significant annual fluctuation of IPIs prevalence was observed, annual meteorological factors showed insignificant annual variability within the last six years in the study area and no significant correlation with total annual prevalence of IPIs was observed (Table 2).

Table 1: Annual Correlations of IPIs and meteorological variables from 2006-2011, in Jimma town, Ethiopia

Meteorological variables	Correlation coefficient	P-value
Annual min average T	-0.010	0.985
Annual max average T	0.431	0.394
Annual average T	0.387	0.449
Annual total Rf	0.208	0.692
Annual average Rh	-0.031	0.954

Note: T=temperature, Rf=Rain fall, Rh = Relative humidity, min=minimum, max=maximum

3.5 Monthly Correlations of IPIs and Meteorological Variables

Only intestinal protozoan infections had correlations with one metrological parameter. Both *G.lambilia* and *E.histolytica* had a significant positive correlation (p<0.05) with total monthly rain fall (Table 3).

Table 3: Monthly Correlations of the top five intestinal parasites and meteorological variables from 2006-2011, in Jimma town, Ethiopia

Meteorological variables	Type of parasites/Correlation coefficients				
	Eh	*Gl*	*Al*	*Tt*	*Hw*
Monthly min average T	0.249	0.554	-.270	-.139	.200
Monthly max average T	-0.097	-0.321	.349	.243	.316
Monthly average T	0-.316	-0.246	.225	.085	.371
Monthly total Rf	0.699*	0.87*	-.203	-.516	-.049
Monthly average Rh	0.219	0.552	-.324	-.226	-.091

Note: T=temperature, Rf=Rain fall, Rh = Relative humidity, min=minimum, max=maximum, Eh= *E.histolytica* , Gl= *G. lamblia, Al= A.lumbricoides, Tt= T. trichuria, Hw* = Hookworm

*Statistically significant

4. Discussions

The proportion of patients positive for intestinal parasites decreased significantly (P = 0.037) from 43.34% in 2006 to 31.83% in 2011. Thus, the health extension workers provide health information at household level to create awareness and improve skills in dealing with avoidable diseases. According to the information obtained from Jimma Town Health Office, the urban health extension workers are involved in school water, sanitation and hygiene and awareness creation at household level to access health services, among others. As a result of introduction of the program, primary health care coverage of the country has improved [17].

Over the past six years cumulative annual prevalence of IPIs was found to be 36.1%. It is nearly similar with previous retrospective finding reported from Palestine (37.12%) [18]. On the other hand, the overall prevalence is higher than the previous reports from Gaza (29.77%) [19] and Saudi Arabia (2.3%) [20]. These differences might be attributed to the differences in local climatic factors and in employing the various health interventional activities like deworming, environmental sanitation, personal and food hygiene against diarrheal diseases prevention and control strategies.

During the six years period, total prevalence of IPIs didn't show significant monthly fluctuation. Similarly, no significant seasonal fluctuation of IPIs was observed in this study, even though the maximum and minimum peak prevalence was observed in summer and winter season, respectively. This is consistent with the finding from Gaza [19], which showed no significant seasonal variation of IPIs. On the contrary, this finding contradicts with other previous study conducted in Jordan [21] which showed significant seasonal variation in the prevalence of IPIs. This variation might be attributed to local climatic factor difference and other factors.

Iintestinal helminthic infections didn't have any significant correlation with all meteorological variables at any time scales and this contradicts to what have been suggested by different investigators from Uganda [22] in which they concluded that rainfall and relative humidity had a positive correlation. On the other hand, there was a negative correlation with temperature.

Intestinal protozoan infections had correlations with some measured meteorological variables in the study area. Monthly prevalence of Giardiasis was positively correlated with total monthly rain fall. This is comparable with the finding undertaken in New Zealand [23], but it is contradictory to the study conducted in KwaZulu-Natal populations [24]. Similarly, *E.histolytica* had a significant positive correlation with rainfall. This is inconsistent with the finding from Sivas [25]. All this variation could be due to difference in local climatic condition in elsewhere and here in the study area.

During this study the significant correlation between rainfall and intestinal protozoan infections suggested that total monthly rain fall could be one of the most significant factors that could correlated with IPIs dynamics in the study area. This can be due to the fact that rain fall pattern would enhance contamination and transportation of the infective stages of intestinal parasites from one area to another area. Similarly, this was noted by other researchers and runoff water which can result from heavy rainfall is capable of transporting parasitic and other pathogens; and contaminating drinking water sources increasing the risk of human exposure and infection. Increased levels of faucal contamination in water sources are common during heavy rain seasons and increased rates of diarrheal diseases [26].

The following limitation was considered when interpreting the results. A single stool sample and direct microscopy is not sensitive test during light infections, and did not enable us to include other opportunistic intestinal parasites as their detection requires staining procedures.

5. Conclusion

Despite there was a remarkable significant reduction of IPIs over the six years; 36.1 % annual average prevalence rate of such infections is still high and implies that more coordinated efforts should be paid for further declination. *Entamoeba histolytica* and *Giardia lamblia* infections showed oscillation with rain fall parameter. Thus, cases of intestinal protozoa infections might be affected by climatic variables and during rainy season preventing and controlling measures should be undertaken.

6. Competing Interests

We declare that we do not have any conflict of interests.

7. Authors' Contributions

AJ conceived the study, involved in the study design, data analysis and drafted the manuscript. TB and AZ involved in the design, supervised data collection, participated in data analysis and critically reviewed the manuscript. All authors read and approved the final manuscript.

8. Authors' Information

All authors are academicians. AJ has MSc in medical parasitology. TB is an assistant professor in medical parasitoloy. AZ is an associate professor in Medical parasitlogy.

9. Acknowledgements

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