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Research Article

Seasonality and Trend Analysis of Pulmonary Tuberculosis at St. Paul Hospital Millennium Medical College, Addis Ababa, Ethiopia

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Abstract

Background: Tuberculosis (TB) is a respiratory infectious disease caused by *Mycobacterium tuberculosis* which shows seasonality. However the situation is not well studied in poor setting countries like Ethiopia.

Objectives: To determine the seasonality and trend analysis of TB incidence at St. Paul Hospital Millennium medical college, Addis Ababa, Ethiopia.

Methods: A retrospective study was conducted by collecting data from laboratory log book at St. Paul Millennium medical college from December, 2011 to June 2015. Data was collected by using data collection sheet which contains code, age, sex, residence and TB test result by using convenience sampling technique from December 2015 to June 2016. The data was cleaned, edited, checked for completeness and entered into SPSS version 20 for analysis. The result was presented with tables accordingly.

Result: Out of a total of 471 (6%) sputum smear positive cases among a total of 7, 870, the highest cases 205 (2.6%) were reported during summer season. Out of a total of 471 (6%) sputum smear positive cases among a total of 7, 870, 266 (3.4%) cases were reported among females. Out of a total of 471 (6%) sputum smear positive cases among a total of 7, 870, the highest cases 111 (1.4%) were reported among the age group of 25 - 44 years.

Discussion: In this study, the seasonality of TB case notification with a peak in the Fourth season has been observed from the computed data. These results were observed to be more or less consistent for the whole study period.

Keywords: Trends; Seasonality; Time series; Tuberculosis; Ethiopia

Abbreviations

DOTS: Directly Observed Treatment-Short course; EPTB: Extra-Pulmonary Tuberculosis; HIV: Human Immunodeficiency Virus; PTB: Pulmonary Tuberculosis; TB: Tuberculosis; UK: United Kingdom; WHO: World Health Organization

Background

Introduction

Tuberculosis (TB) is a respiratory infectious disease caused by bacillus *Mycobacterium tuberculosis* and spreads through air droplets by sneezing and coughing of the infected person [1]. It is one of the biggest health challenges which the world is facing and is the second major cause of mortality, particularly in poor and low economic countries [2,3]. About one-third of the world's population has latent TB, people who are infected with TB bacteria have a lifetime risk of getting ill with TB of 10% (people with compromised immune systems have a much higher risk) and two third of people ill with TB will die without proper treatment. TB typically attacks the lungs (known as pulmonary TB), can also affect other parts of the body (known as extra-pulmonary TB) [4].

Globally, 8.6 million people developed TB throughout the world in 2012; 1.1 million (13%) were co infected with Human Immunodeficiency Virus (HIV) [5]. Throughout the world, 6.1 million cases of TB were registered to the national TB program, and of these, 5.7 million were newly diagnosed cases [6]. In WHO Global TB report, Ethiopia ranked 7th among 22 High Burden Countries and 3rd in Africa in 2011 [7,8]. Moreover, TB is one of the most important infectious diseases responsible as 3rd cause of hospital admission and the second top causes of death in Ethiopia [7,9].

It is a well-known fact that TB demonstrates seasonality. Seasonality of TB has been reported in many studies, such as in Kuwait, where the peak of case notification is in summer, in India with summer as the peak season, and in China where summer is the peak season. In Iran, a high number of TB cases were observed in spring and summer [10].

The review of various studies has shown a rise in TB case notification at the end of the winter and the start of summer [11]. The exact mechanism underlying this seasonality is not known, but it has been suggested that various environmental, social, and host-related risk factors such as temperature, humidity, rainfall, sunlight, indoor activity, crowding, pollution, immune suppression, and diagnostic delays are involved in TB seasonality, specially, in winter [12]. Various demographic and epidemiological factors have been

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Table 1: Season wise sputum smear status notification cases, 2011–2015.

Season of the year	Sputum Smear Status	Date of laboratory diagnosis in years					Total
		2011	2012	2013	2014	2015	
Autumn	Sputum smear positive	8	11	15	14	23	**71**
	Sputum smear Negative	152	309	225	466	457	1609
	Total	**160**	320	240	480	480	1680
Winter	Sputum smear positive	8	16	14	33	24	**95**
	Sputum smear Negative	352	344	306	407	458	1867
	Total	360	360	320	440	482	1962
Spring	Sputum smear positive	9	9	31	21	30	**100**
	Sputum smear Negative	351	391	209	379	408	1738
	Total	360	400	240	400	438	1838
Summer	Sputum smear positive	26	18	46	65	50	**205**
	Sputum smear Negative	254	342	664	415	510	2185
	Total	280	360	**710**	480	560	2390
Total	Sputum smear positive	51	54	106	133	127	**471**
	Sputum smear Negative	1109	1386	1404	1667	1833	**7399**
	Total	1160	1440	1510	1800	1960	**7870**

*Out of a total of 471(6%) sputum smear positive cases among a total of 7, 870 reported sputum smear cases, the highest cases 205(2.6%) were reported during Summer season.

characterized that explain the trend and seasonality of TB [13,14].

One dominant hypothesis in the literature suggests that spring surges in tuberculosis result from increased activation of latent tuberculosis due to late winter nadirs in vitamin D [15], an immune regulator synthesized in sun-exposed skin that enhances cellular immunity against *Mycobacterium tuberculosis in vitro* [16]. An alternative hypothesis proposes that spring time peaks in tuberculosis diagnosis are due to increased transmission of tuberculosis rather than an increase in activation of latent disease, perhaps due to wintertime indoor crowding [17,18].

TB case notification has been reported with different peaks in different seasons, such as in South Africa where it peaks from winter to early spring [19], in the UK and Hong Kong where summer is the peak season [19,20], and in Spain and Japan, where the maximum numbers of cases were reported in summer and autumn [21,22].

Statement of the problem

Despite Tuberculosis (TB) being a long-standing, worldwide disease the global burden of disease attributable to TB continues to be a major public health concern. In 2013 alone there were an estimated 9.0 million new cases of TB worldwide and 1.5 million deaths attributable to TB, 80% of which were occurring from 22 High-Burden Countries (HBCs) [23].

In 2012, the incidence of TB were 8.6 million globally, equivalent to 122 cases per 10,000 population. The estimated prevalence of TB were 12 million, equivalent to 169 cases per 100,000 population. The deaths from TB were estimated 1.3 million, equivalent to 18 cases per 100,000 population. Most TB cases and deaths occur in

Table 2: Sex-wise sputum smear status notification cases, 2011–2015.

Sex of the patient	Sputum Smear Status	Date of laboratory diagnosis in years					Total
		2011	2012	2013	2014	2015	
Male	Sputum smear positive	28	21	56	70	30	205
	Sputum smear Negative	597	717	533	639	830	3316
	Total	625	738	589	709	860	3521
Female	Sputum smear positive	23	33	50	63	97	266
	Sputum smear Negative	512	669	871	1028	1003	4083
	Total	535	702	921	1091	1100	**4349**
Total	Sputum smear positive	51	54	106	133	127	**471(6%)**
	Sputum smear Negative	1109	1386	1404	1667	1833	**7399((94%)**
	Total	1160	1440	1510	1800	1960	**7870**

*Out of a total of 471(6%) sputum smear positive cases among a total of 7, 870 reported sputum smear cases, 266(3.4%) cases were reported among females.

men, but the burden of TB is also high among women and children. South-East Asia and Western Pacific Regions accounted for 58% of the world's TB cases and India and China had the largest number of cases representing 26% and 12% of the global total respectively [24]. In 2012, the TB notification cases in Hong Kong was 4858, or a notification rate of 67.9 per 100,000 population. The number of TB deaths were 199 and the corresponding TB mortality rate was 2.8 per 100,000 population. TB is still a major infectious disease, accounting for 0.5% of the total registered deaths in Hong Kong [25].

Globally, the trend of TB incidence, prevalence and mortality rate was descending of all categories and the trend of TB treatment successes and detection rates is growing. However, there was still a long way to reach the goal of "TB Stop Strategy" conducted by WHO [24,26]. The incidence rate was relatively stable from 1990 to 2001, and then it started to fall until 2013. The number of TB case notifications per 100,000 populations in the diagnosis and notification was relatively stable between 1990 and 2000, rose sharply from 2000 to 2008, and then began to decline slowly [24]. Besides, the declining trend of mortality rates was faster than that of incidence rates of TB [27].

The seasonal pattern of TB has been observed in many countries, including Spain, United Kingdom, India and so on [17,19,21]. Also, the pattern can be seen in some cities like Birmingham in United Kingdom and Delhi in India [26,28]. Different studies show different results of the questions of if the seasonality of TB varies with latitude, sex, age and various disease forms of TB [26,29,30]. Vitamin D deficiency, sunlight, other respiratory diseases, delay of diagnosis and indoor activities are the possible reasons of seasonality of TB. However, these questions related to seasonality of TB remain controversial [21,28,31].

To our knowledge, no study has described the seasonality of TB and Trend analysis at St. Paul Millennium Medical College. Therefore, the present study will reveal the seasonality and Trend analysis of TB in the study area [32-40].

Significance of the study

The study of seasonality and the trend pattern of TB are very

important to find out the major risk factors involved in the spread of the disease and to plan the strategies to control the prevention of the disease. It is also important to identify possible seasonal pattern in the disease incidence, the knowledge of which may be used to predict the future magnitude of the health problem, to develop an effective public health program, and to set objectives and utilize available resources more effectively.

Objective

General objective

To determine the seasonality and trend of tuberculosis over the past five years among patients who were diagnosed at St. Paul Hospital Millennium Medical College.

Specific objective

To determine the seasonal variation of tuberculosis in the study area

To determine the trend of smear positive PTB among different ages, sex and living area

Hypothesis: The peak TB notification in this study area was not be different from the study conducted in Kuwait, India, China, Hong Kong, UK, which is reported during summer season [19,20].

Materials and Methods

Study area/setting

The study was conducted at St. Paul Hospital Millennium Medical College. St. Paul Hospital is found in Addis Ababa, capital city of Ethiopia. It is teaching and referral Hospital located western part of Addis Ababa, Gulelle sub-city, Woreda 9, House No 461. The hospital is built by Emperor Haileselassie in 1969 with the help of the German Evangelical church aimed to serve the poor. A Millennium medical college was started in 2007. It is teaching centre for Medicine. The Hospital serves an average of 700 Patients daily including private wing. The Hospital has 340 beds. The laboratory gives service on average 300 patients daily including private wing. The reason for selection of the study site was its accessibility, and this laboratory has implemented Laboratory Information System (LIS) and has to assess trend and seasonality of tuberculosis documents [41].

Study design

A Five year Retrospective study design was conducted between December 2015 to June 2016 at St. Paul Hospital Millennium Medical College to determine the seasonality and trend of Tuberculosis.

Study period

The study was carried out from December 2015 to June 2016.

Population

Source population: All patients who were examined for TB for the last five years.

Study population: Patients with complete demographic and laboratory data.

Inclusion and exclusion criteria

Inclusion Criteria: Patient with complete demographic and laboratory data.

Exclusion criteria: Patients with other chronic illnesses like Cancer, Diabetes Mellitus.

Table 3: Age wise sputum smear status notification of cases, 2011–2015.

Age in years	Sputum Smear Status	Date of laboratory diagnosis in years					Total
		2011	2012	2013	2014	2015	
0-14	Sputum smear positive	3	4	7	9	14	**37**
	Sputum smear Negative	56	72	55	73	125	381
	Total	59	76	62	82	139	418
15-24	Sputum smear positive	7	9	29	11	18	**74**
	Sputum smear Negative	114	235	393	380	379	1501
	Total	121	244	422	391	397	1575
25-34	Sputum smear positive	7	10	32	29	33	**111**
	Sputum smear Negative	231	248	214	310	321	1324
	Total	238	258	246	339	354	1435
35-44	Sputum smear positive	8	12	13	42	36	**111**
	Sputum smear Negative	214	293	349	400	378	1634
	Total	222	305	362	442	414	1745
45-54	Sputum smear positive	13	9	23	17	21	**83**
	Sputum smear Negative	244	299	261	351	350	1505
	Total	257	308	284	368	371	1588
55-64	Sputum smear positive	8	7	1	25	3	**44**
	Sputum smear Negative	168	161	125	149	198	801
	Total	176	168	126	174	201	845
65 or Greater	Sputum smear positive	5	3	1	0	2	**11**
	Sputum smear Negative	82	78	7	4	82	253
	Total	87	81	8	4	84	264
Total	Sputum smear positive	51	54	106	133	127	**471**
	Sputum smear Negative	1109	1386	1404	1667	1833	**7399**
	Total	1160	1440	1510	1800	1960	**7870**

*Out of a total of 471(6%) sputum smear positive cases among a total of 7, 870 reported sputum smear cases, the highest cases 111(1.4%) were reported among the age group of 25-44 years.

Sample size and sampling technique

Sample size: All available data that fulfil inclusion criteria from 2011 to 2015 was used.

Sampling technique: Convenient sampling method was used by using available data of patients recorded on the laboratory log book.

Study variables

Dependent variable

Prevalence of TB among different age and sex group

Number of TB cases notified

Independent variable

Age

Sex

Data collection

Data collection procedure: Data was collected by using data collection sheet which contains code, age, sex, residence, and AFB smear result from laboratory log book after the actual permission from DRERC (Department of Research and Ethics Review Committee).

Data quality assurance: During data collection the data collected was cleaned, edited checked for completeness, clarity and consistency by the PI on daily bases. Data was computerized using double data entry to minimize transcription errors.

Statistical data analysis

Data was coded and double entered by principal investigators into SPSS version 20 for data checking, cleaning, and analysis, to determine the seasonal variation. Descriptive analyses and frequency table was computed as appropriate. The result was presented with tables accordingly.

Ethical consideration

Ethical clearance to conduct the study was obtained from the Research Ethics Review Committee at the Department of Medical Laboratory Sciences, Addis Ababa University. Permission will also obtain from St. Paul Hospital Millennium Medical College where the study was conducted. In addition, all the information obtained from laboratory logbook was strictly kept confidential and was not accessible to any third party and privacy of the study population was respected and kept as will. Moreover, to ensure confidentiality the name of the study subjects was not written on the data collection format or any written material concerning the research or in discussions of the research project instead code is used as identification number which is known only by the principal investigator of the study and all the information obtained was stored in a safe place that no one save the researchers can access.

Result dissemination

The findings of the study were forwarded to the Department of Medical Laboratory Science, College of Health Science, School of Allied Health Science, Addis Ababa University. The findings were presented to St. Paul Hospital Millennium Medical College staffs and Managers. We were also proposing to submit the study for publication in various Medical Journals.

Results

The study period from 2011–2015 constituted 20 seasons during which a total of 7,870 suspected Pulmonary TB cases were registered. The average number of cases notified/season was 393.5. The annual number of cases varied over the period of the study, with a maximum of 1960 in 2015 and a minimum of 1160 in 2011. Increasing trends of 10% of TB cases were observed. Within the calendar year, the maximum number of patients was observed in the fourth season of 2013 (710 cases) and the minimum of cases was observed in the first season of 2011 (160 cases), as shown in Table 1. In general, the maximum number of cases was reported in summer, then winter. More cases were reported among females than males as shown in Table 2. When grouped into similar age groups, males predominated at the age of 65 or < years (male to female ratio of 1.15). In the rest of the age groups, the incidence predominated in females as shown in Table 3.

Discussion

In this study, as one can observe from the computed data the seasonality of peak TB case notification were during the Fourth season. These results were observed to be more or less consistent for the whole study period. Similar results have already been shown in different studies in the UK [19] and Hong Kong [4], where TB cases notification was high in summer. In developing countries such as Ethiopia, the TB incidence rate is quite high in rural populations as compared to urban populations, because of poor healthcare facilities and unawareness, which may account for seasonal variation in case notification [44]. A rise in TB notification in summer is basically influenced by the winter season, mainly because of two reasons. In winter, overcrowding, indoor pollution, and vitamin D deficiency increase the probability of duration of contact with infection. This probability is increased when other seasonal infections like flu, pneumonia, asthma, fever, etc. reduce immunity, which increases the susceptibility to the infection if exposed to an infected person [45]. Secondly, mycobacteria are slow growing and take 7 - 8 weeks to proliferate and show symptoms in favorable conditions [46]. Hence, at the onset of spring and with the rise in temperature in summer, the TB case notification increases. It is believed that in winter, symptoms of TB may possibly not be seen immediately after becoming infected, but when summer approaches and the temperature increases, the bacterium starts proliferating and growing with positive symptoms of the infection. It has been generally observed that, during summer most of infected people seek healthcare assistance, which results in increased case notification. It is also possible that all infected individuals may not be notified, so it is important to find infected and exposed persons to control the spread of infection [47]. In the present study, it was also observed that at the age of 65 or < years, more cases were reported among males than females (M: F ratio 0.81), which matches well with the previous findings [44]. At present, it is not fully understood why TB notification has been observed to be high among females in Ethiopia, but this is an important epidemiological finding from the point of view of public healthcare. Inequitable access to healthcare facilities and reporting biases are not the only reason for observed differences in case notifications and there are genuine gender differences in the biology and epidemiology of TB.

Conclusion/Recommendation

The increments of TB cases in summer clearly show that temperature has a direct relationship with the increasing rate of infection, which is shown by the seasonality of the disease in the study area. These results showed that transmission of the disease was higher in winter and the infection notification was higher in summer. Investigation of risk factors responsible for increased transmission of the disease during winter months can help to control the spread of the infection. In general clinicians need to educate people on health issues. Healthcare facilities should be improved for timely diagnosis, treatment, and prevention of the disease.

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