Epidemiological analysis of tuberculosis trends in Ethiopia: 2000-2009

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ÖZET

Etiyopya'da tüberküloz seyrinin epidemiyolojik analizi: 2000-2009

Tüberküloz uzun süreden bu yana Etiyopya'da morbidite ve mortalitenin başlıca nedenlerinden birisidir. Bu nedenle Etiyopya Sağlık Bakanlığı ve paydaşları bütün güçleriyle bu sağlık problemine yöneldiler. Bu çabalar arasında tüberküloz programları için iyi geliştirilmiş bir HMIS oldu. Etiyopya'da tüberkülozun gidiş yönü ve epidemiyolojik olarak ilgili faktörler yeterli araştırılmamıştı. Bu çalışmanın amacı 2000-2009 arasında on yıllık dönemde Etiyopya'da tüberkülozun epidemiyolojik seyrini incelemekti. Mekansal, zamansal, hastalık tipi ve cinsiyet açısından seyri araştırıldı. Zaman serisi çalışma dizaynı Etiyopya'da on yıllık tüberküloz seyrinin incelenmesinde kullanıldı. Sağlık Bakanlığı kaynaklarından elde edilen 2000-2009 dönemine ait verilerden 10 tane anahtar belirteç saptandı. Tüberkülozun anahtar göstergelerindeki seyri incelemek için beş adet tabakalı değişken kullanıldı. Göstergelerin verileri beş basamaklı bir analizden geçti: Kümeleşme, hesaplama, özetleme, grafikler ve model uyumu. Etiyopya'da tüberkülozun insidansı yıllık olarak 100.000'de beş yeni olgu hızında artmaktadır. On yıllık süreçte hastalık kentlerde zirai-ekolojik alanları daha fazla etkilemiştir. Ekstrapulmoner tüberküloz ve yayma negatif tüberküloz oranları çalışma süresince hafif bir artış göstermiştir. On yıllık çalışma süresinde erkeklerin orantısız olarak etkilendiği saptanmıştır. Diğer taraftan olgu saptama oranı ve tedavi başarı oranı yıllık olarak %0.5 oranında artış göstermektedir.

Anahtar Kelimeler: *Tüberküloz, Etiyopya, trend analizi.*

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SUMMARY

Epidemiological analysis of tuberculosis trends in Ethiopia: 2000-2009

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Tuberculosis has been one the major causes of morbidity and mortality in Ethiopia for long. Accordingly, the Ethiopian Ministry of Health and its stakeholders have their unreserved and integrated efforts on this health problem. Among these efforts was the well developed HMIS for tuberculosis programs. However, the direction to where tuberculosis in Ethiopia is heading hasn't been well analyzed and unpackaged by epidemiologically relevant factors. The overall aim of this study was to examine the epidemiological trends of tuberculosis in Ethiopia for the ten-year period from 2000-2009. The trends were investigated from spatial, temporal, disease type and gender perspectives. A time-series study design was applied to analyze the ten-year trends of tuberculosis in Ethiopia. Data on ten-key indicators for the period of 2000-2009 was obtained from the Ministry of Health public documents. Five stratifying variables were used to analyze the trends in the key tuberculosis indicators. The data on the indicators have undergone five stages of analysis: aggregation, computation, summarization, graphics and model fitting. The incidence rate of tuberculosis is increasing in Ethiopia at a rate of 5 new tuberculosis cases per 100.000 populations per year. Urban agro-ecological zones have been more affected by the disease throughout the ten-year period. Extra-pulmonary rate and smear-negativity has shown a modest increment during the study period. Masculine gender was also disproportionately affected by tuberculosis during the ten-year study period. On the other hand case detection rate and treatment success rate are found to be increasing at a rate of 0.5% per year

Key Words: *Tuberculosis, Ethiopia, trend-analysis.*

In 2008, there were an estimated 9.4 (range, 8.9-9.9 million) million incident cases (equivalent to 139 cases per 100.000 population) of tuberculosis (TB) globally (1). This is an increase from the 9.3 million TB cases estimated to have occurred in 2007, as slow reductions in incidence rates per capita continue to be outweighed by increases in population (1). Estimates of the number of cases broken down by age and sex are being prepared by an expert group as part of an update to the Global Burden of Disease study (Lopez, 2006) due to be published in 2010 (2). Provisional analyses indicate that women account for an estimated 3.6 million cases (range, 3.4-3.8 million).

Most of the estimated number of cases in 2008 occurred in Asia (55%) and Africa (30%), with small proportions of cases in the Eastern Mediterranean Region (7%), the European Region (5%) and the Region of the Americas (3%). The 22 high-burden countries (High-Burden Countries, defined as the countries that rank first to 22nd in terms of absolute numbers of cases and which have received particular attention at the global level since 2000) account for 80% of all estimated cases worldwide. The five countries that rank first to fifth in terms of total numbers of incident cases in 2008 are India (1.6-2.4 million), China (1.0-1.6 million), South Africa (0.38-0.57 million), Nigeria (0.37-0.55 million) and Indonesia (0.34-0.52 million). India and China alone account for an estimated 35% of TB cases worldwide [World Health Organization (WHO), 2009] (3).

Ethiopia has a total population of about 74 million with 86.2% living in the agrarian regions [Oromiya, Amhara, Southern Nations Nationalities and Peoples Region (SNNR) and Tigray regions]. The rest 9.2% and 4.6% live in the pastoralist (Gambella, Somali, Benshangul-Gumuz and Afar regions) and urban (Addis Ababa, Diredawa and Hareri) (Central statistical authority,

2007) (4). Ethiopia ranks seventh among the world's 22 high-burden TB countries. According to the WHO's Global TB Report 2008, the country had an estimated 306.330 TB cases in 2006, with an estimated incidence rate of 379 cases per 100.000 population (WHO 2008) (1).

The Stop TB Strategy is the approach recommended by WHO to reduce the burden of TB in line with global targets set for 2015 (WHO, 2006) (5). The Stop TB Partnership's Global Plan to Stop TB, 2006-2015 (hereafter the Global Plan) sets out the scale at which the interventions included in the Stop TB Strategy need to be implemented to achieve the 2015 targets (WHO, 2006) (5). WHO developed the directly observed treatment short-course (DOTS) strategy as the internationally recommended approach to TB control in the mid-1990s. DOTS is also the foundation of the Stop TB Strategy, which was launched by WHO in 2006 to guide TB control efforts during the period 2006-2015. The start of WHO efforts to systematically monitor progress in TB control on an annual basis in 1995 coincided with global promotion and expansion of the DOTS strategy (WHO 2009) (6).

The data that have been compiled 1995–2009 allow an assessment of the achievements of TB control between 1995 and 2008. During this period, 36 million patients have been successfully treated in DOTS programs. This has averted millions of deaths-at least 2 million but possibly as many as 6 million compared with what would have occurred had DOTS not been implemented (WHO, 2009) (3).

Ethiopia's National Tuberculosis and Leprosy Control Program (NTLCP) began to implement DOTS (the internationally recommended strategy for TB control) in two zones in 1991, and, in 2006, DOTS coverage reached 100 percent of the population where health services had adopted the strategy. TB treatment is integrated into general health services, although only 40 percent of Ethiopia's population has true access to DOTS. The DOTS detection rate remains low, at 27 percent, compared with the WHO target of 70 percent detection. The limited diagnostic capacity for TB in the country remains a challenge to improving case detection rates. The treatment success rate is close to the 85 percent target set by WHO; after falling from 80 percent in 2000 to 70 percent in 2003, it has since risen to 78 percent in 2006.

The number of TB cases is likely to increase as Ethiopia's HIV/AIDS epidemic expands; among the 2.6 percent of TB patients tested for HIV, 40 percent are HIV positive. The level of multidrug-resistant (MDR) TB among new TB cases is estimated at 1.6 percent; 4.964 cases of MDR-TB were reported in 2007.

Though such data are reported to describe the situation of TB in Ethiopia, information about the Epidemiological trends of TB by place (regions), person (type of TB, sex, age) and time (within 10 years) is minimal. That is to indicate that having summary figures for the country and analyzing such values will provide information about the country as a whole. However, detailed and disaggregated level of trend analysis is important to uncover the existing facts within the country. In light of this, the purpose of this study is to examine the epidemiological trends of TB in Ethiopia for the period of 10 years (2000-2009). Such analysis would help in guiding the programming of TB interventions to critical focal areas.

MATERIALS and METHODS

Study Area and Period

This trend analysis describes findings for the whole country, Ethiopia, as well as by agro-ecological zones, administrative regions and gender for the period of 2000-2009.

Study Design

This study is a time-series analysis of the epidemiological trends of TB by geographic characteristics (agro-ecological zones, and administrative regions), Disease characteristics (Pulmonary/extra-pulmonary, smear-positive/smear-negative, first-time/re-treatment) and temporal factors (yearly for the ten year period). A combination of these characteristics is used in most of the analysis.

Source of Data

The data source for this study is the Federal Ministry of Health of Ethiopia. Annual reports from Health Facilities are compiled and sent to the Mi-

nistry of Health through Regional Health Bureaus. The Ministry of Health keeps a database of these reports and publishes it in the Health and Health related indicators on annual basis. All of the input data used in this study are also publicly available in Health and Health related indicators of Ethiopia.

Sample and Sampling

As a complete set of data was available only for the year 2000-2009, a ten year analysis of trends was chosen. The number of trend variables analyzed in this study is limited within the scope of the availability of data in the reports.

Indicator Variables

In this study ten major indicators were used. These indicators were also disaggregated by different stratifying variables.

1. Number of total new TB cases per 100.000 population per year,

2. Number of new pulmonary TB (PTB) cases per 100.000 population per year,

3. Number of extra-pulmonary TB (EPTB) cases per 100.000 population per year,

4. Number of smear-positive PTB (PTB+) cases per 100.000 population per year,

5. Number of smear-negative PTB (PTB-) cases per 100.000 population per year,

6. Number of re-treatment TB cases per 1000 TB cases per year,

7. Proportion of TB cases with extra-pulmonary for of TB per year,

8. Proportion of PTB- cases per year,

9. Proportion of female PTB+ cases per year,

10. Case detection rate and Treatment Success rate.

Trend-Analysis Variables

The trends of the indicator variables are analyzed based on the following main trend-analysis variables:

1. Time in years from 2000-2009,

2. Agro-ecological zones: Agrarian, Pastoralist and Urban zones,

3. Administrative regions: nine regions and two city administrations,

4. Form of Tuberculosis: PTB/EPTB, PTB+/PTB-First-time/re-treatment,

5. Gender: Male and Female PTB+.

Data Analysis and İnterpretation

The data from the Ministry of Health documents is imported to and processed using Ms-excel software program. The analysis of the epidemiological trends followed the following steps:

1. Indicator values presented separately for administrative regions were summed up to agro-ecological zones,

2. Rates/proportions were computed by dividing those indicator values with the respective population sizes/denominator for each specific year,

3. The trends in the rates/proportions were displayed using graphics, bar graphs and line graphs for the different analysis variables,

4. When appropriate numeric summaries were used to describe the nature of the trend in the specific trend variable,

5. Model fitting was tried to find the best model/trend-line equation that could best represent the nature of the data (using R^2).

Ethical Issues

This study has used publicly available data of the Ministry of Health of Ethiopia. Besides, there was a direct participation of TB focal persons in the Ministry of Health in the undertaking of this study. Moreover, the data considered in this study and presentation of the findings is only at the aggregated level.

RESULTS

General Tuberculosis Trends

New TB cases per 100.000 populations per year: During the ten-year study period, the total number of new TB cases per year has increased from 85.226 to 145.602. The net increment in the total number of TB cases per year during the study period was thus 60.376 cases. This is an increment of 71% of the initial annual number of new cases. This crude increment

was on average of about 6000 new cases per year. Therefore, the average percentage increase in the total number of new TB cases per year in the country was about 7%. The crude increase of the total number of new TB cases per year follow a linear trend with the following model with R^2= 0.941.

Y= 6209.3x + 82535

As to the incidence of TB, total number of new TB cases per 100.000 populations per year, there was an increase from 150 per 100.000 to 200 per 100.000 populations per year (p= 0.99). Further look in to this increase shows that there is a total increment of 33% (50 new TB cases per 100.000 population per year) and an average annual increment of 3.3% (5 new TB cases per 100.000 population per year). The overall incidence of TB has increased by one-third during the ten-year study period. The causes of the increment of TB incidence in Ethiopia may be an improvement in the case detection rate and/or actual increment in the number of new TB cases. Whether this overall increment in the incidence of TB is due to actual increment in the number of TB cases or improvements in case detection needs further investigation. The trends in the incidence may also be seen from the perspective of trends in HIV prevalence (Figure 1).

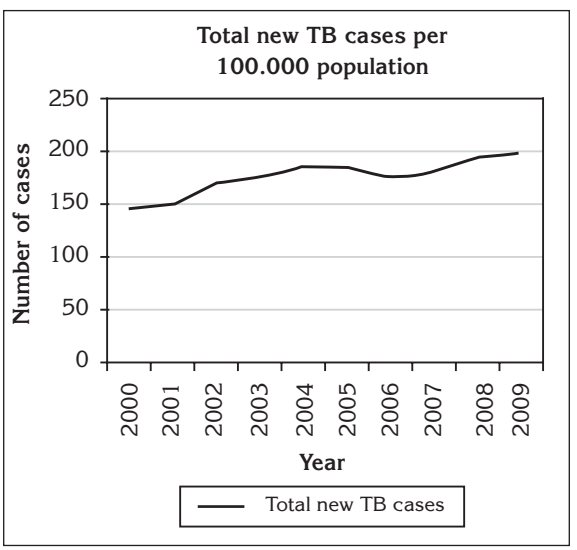

Figure 1. The ten-year incidence of TB (2000-2009).

PTB and EPTB cases per 100.000 populations per year: In the overall trends of TB in Ethiopia, both PTB and EPTB incidences were increasing proportionally. The incidence of PTB has increased from 100 (in 2000) to 130 (in 2009) per 100.000 population per year (p= 0.97). On the other hand, the incidence of EPTB has increased from 50 (in 2000) to 70 (in 2009) new TB cases per 100.000 population per year. It is evident from these figures that the rate of increment is lower for EPTB (2 new cases per 100.000 population per year) as compared to PTB (3 new cases per 100.000 population per year) (Figure 2).

PTB+ and PTB- cases per 100.000 populations per year: Analysis of the trends of the incidence of PTB+ and PTB- over the last 10 years in Ethiopia shows that there were reversals in 2001(at 50 new TB cases per 100.000 population per year) and 2005 (at 60 new TB cases per 100.000 populations per year). During the recent years, the incidence of PTB- remained to be higher than the incidence of PTB+. Based on the 2009 estimates, the incidence of PTB- was 70 new TB cases per 100.000 populations per year while that of smear-positive was 60 new TB cases per 100.000 populations per year (Figure 3).

Re-treatment cases per 1000 TB cases: During the study period, the number of re-treatment cases has increased from 1808 to 3322 (by 84%). This indicates that the number of re-treatment cases grow by 8.4% while the number of new TB cases grow by 7.1%. Thus, there is 1.3% excess

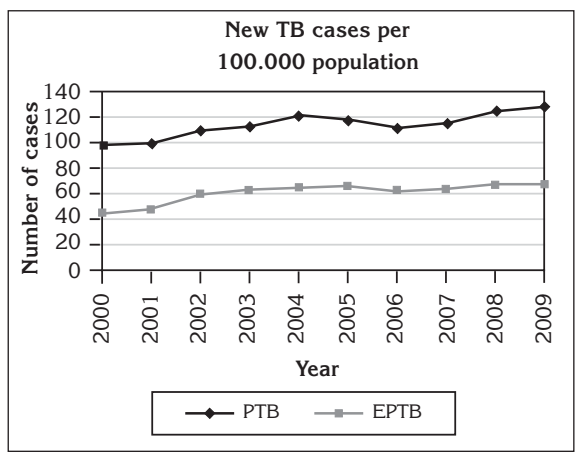

Figure 2. The incidence of pulmonary and extra-pulmonary TB (2000-2009).

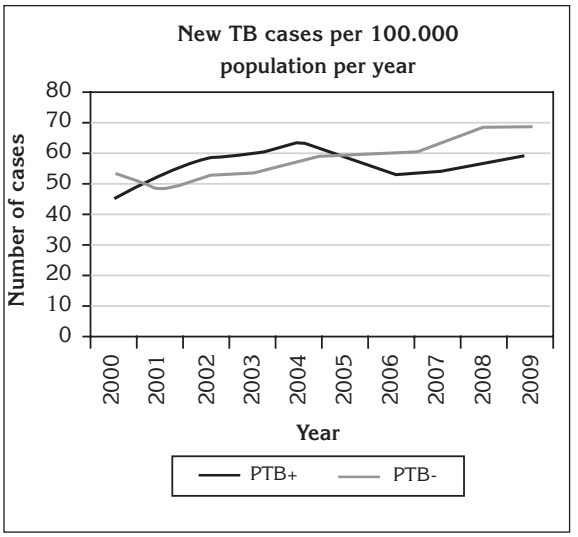

Figure 3. Incidence of smear-positive and smear negative PTB cases (2000-2009).

increase in the number of re-treatment cases. The growth in the number of re-treatment cases can be best described by the following linear trend-line equation with R^2= 0.82.

Y= 149.79x + 1847.1

Based on the above equation the total number of re-treatment cases increases by 150 every year. However, when one looks in to the number of re-treatment cases per 1000 TB cases per year, the net increment during the study period was only 3 (from 20 in 2000 to 23 in 2009) retreatment cases per 1000 TB cases per year with a maximum value of about 27 retreatment cases per 1000 TB cases in 2006 (Figure 4).

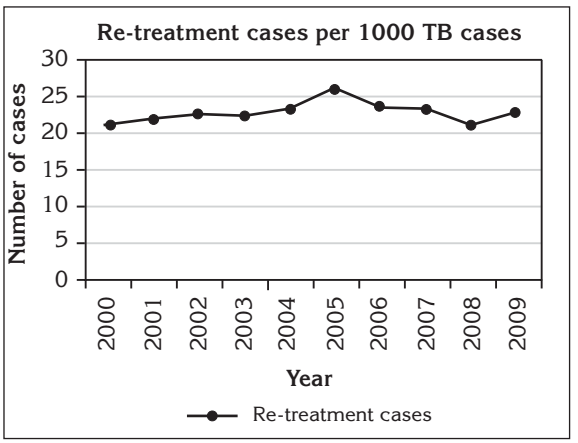

Figure 4.Re-treatment cases per 1000 TB cases per year (2000-2009).

Trends in Tuberculosis Incidence by Agro-Ecological Zones

Trends at agro-ecological zones: As shown in Figure 5 the urban areas (Addis Ababa, Dire Dawa and Harari) have the highest number of new TB cases per 100.000 population per year compared to the Agrarian and Pastoralist regions. Agrarian communities (Oromiya, Amhara, SNNPR and Tigray) have the next TB incidence followed by the pastoralist communities (Afar, Benshangul-Gumuz, Gambella and Somali) which have overall incidence below the national level (Figure 5).

Trends in agrarian communities: The total number of New TB cases is generally increasing in Oromiya, Amhara and SNNP regions. The number of New TB cases has stabilized in Tigray. Compared to the national level and the rest of the agrarian regions, Tigray has higher TB incidence (Figure 6).

Trends in pastoralist communities: As it is displayed in the figure below, Gambella has reported higher incidence of TB throughout the ten-year period. Though highly variable Afar had an overall trend of higher than the national figure. Benshangul-Gumuz and Somali regions have TB incidence lower than the national figure (Figure 7).

Trends in urban communities: As indicated earlier, urban communities in Ethiopia have higher incidence of TB compared to other regions. A comparison within the urban administrative regions shows that Dire Dawa used to have highest incidence till 2007. Recently, the incidence of TB in Harari is the highest (Figure 8).

Trends by Extra-Pulmonary Nature

Proportion of TB cases with extra-pulmonary form of TB: As displayed in Figure 9, the proportion of EPTB cases shows a lower level trend for pastoralist communities. The trend of this variable is also less than the national trend for urban communities too. The agrarian regions bear a larger proportion of EPTB cases as compared to other zones (Figure 9).

Trends of Tuberculosis by Smear Negativity

The trend-line for proportion of PTB- cases is at a higher level for the urban zones compared to

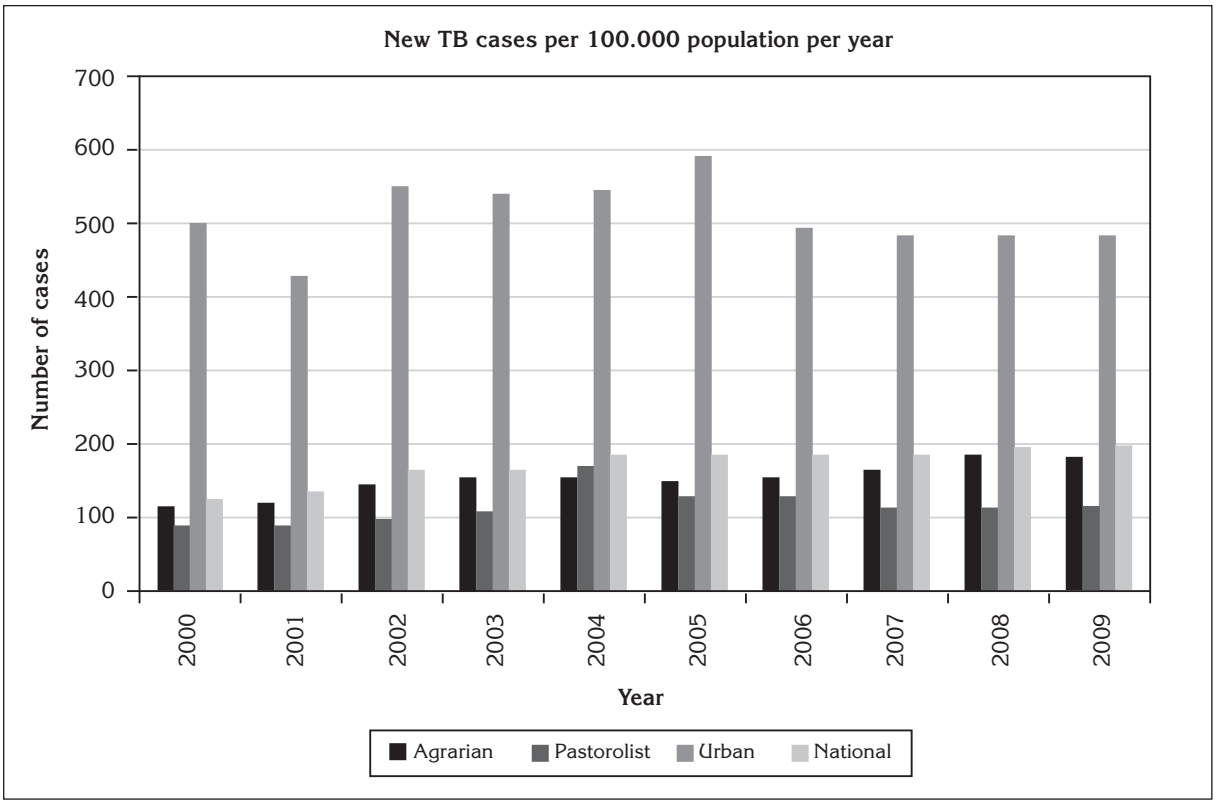

Figure 5. The incidence of tuberculosis by agro-ecological zones (2000-2009).

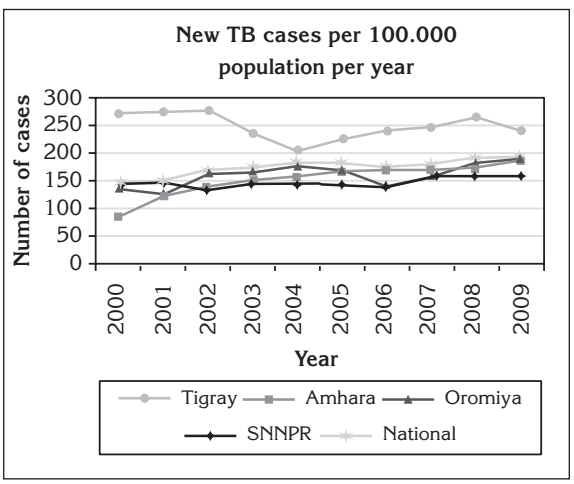

Figure 6. The incidence of TB in agrarian administrative regions (2000-2009).

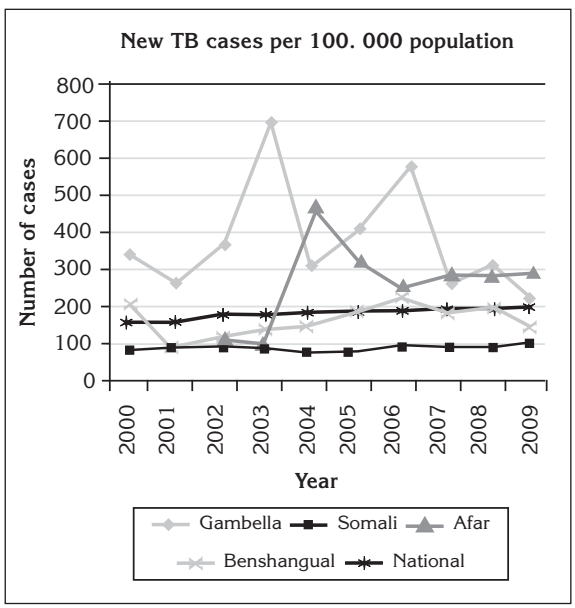

Figure 7. The incidence of TB in pastoralist administrative regions (2000-2009).

other agro-ecological zones. The trend of smear-negativity is actually lower for pastoralist communities (Figure 10).

Trends of Tuberculosis by Gender

In general, the number of male PTB+ cases remained higher than that of the female correspondent throughout the study period. The proportion of female PTB+ cases was higher for urban communities and lower for pastoralist com-

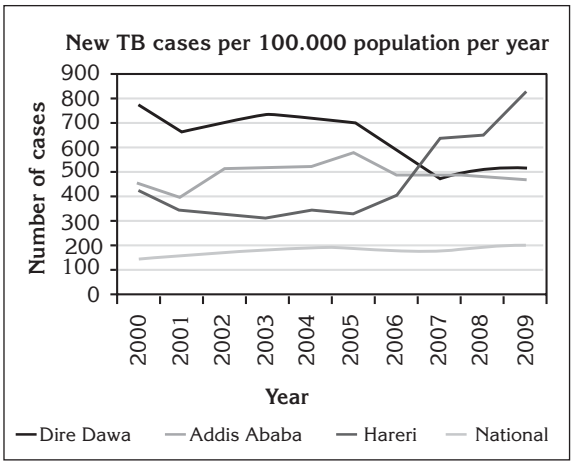

Figure 8. The incidence of TB in Urban administrative regions (2000-2009).

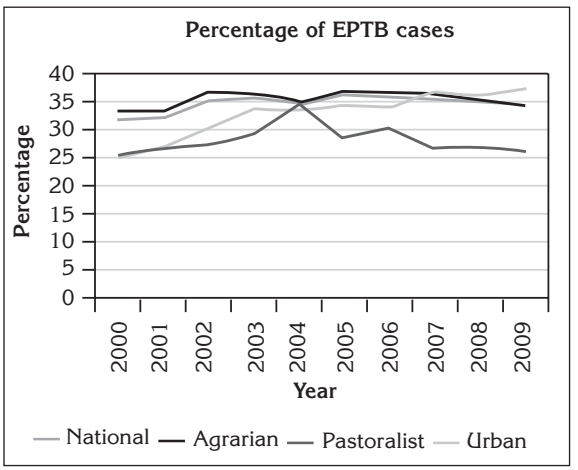

Figure 9. Intrapulmonary rate of TB by agro-ecological zones (2000-2009).

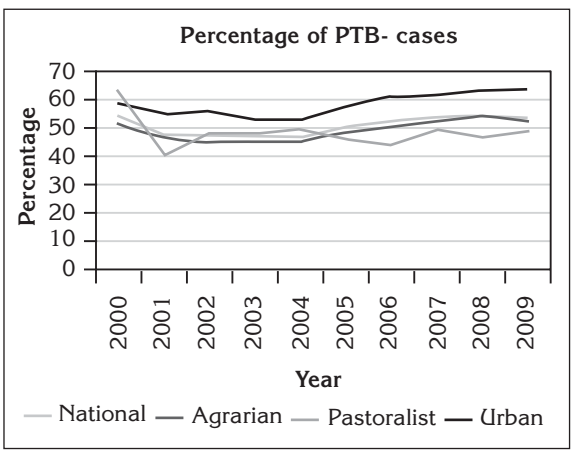

Figure 10. Smear-negativity rate of PTB by agro-ecological zones (2000-2009).

munities. The trendlines of the agrarian and national values for this indicator are overlapping. It is also evident that the trend-lines for proportion of female PTB- cases are converging to a single point, the national figure. This shows that the disparity in the proportion of female TB cases among the three agro-ecological zones is decreasing (Figure 11).

Trends in Case Detection and Treatment Success Rate

During the study period, the case detection rate for TB has improved from 44% to 49% of the estimated TB cases. During the same period the treatment success rate has improved from 80% to 84% of the detected cases. There is almost a proportional improvement of case detection rate and treatment success rate with an average increment of about 0.5% per year.

DISCUSSION

As stated earlier, there was an increase in the number of new TB cases from 150 per 100.000 to 200 per 100.000 populations per year during the study period (2000-2009). This is against ones' expectation of decrease in the incidence of TB following the advancements of the interventions and the expansion of the services. However, whether this is due to the improvement in the case detection rate or actual increment in the number of new TB cases needs further analysis. If the increase in the incidence is real, the effect of HIV/AIDS would possibly be the contributing cause.

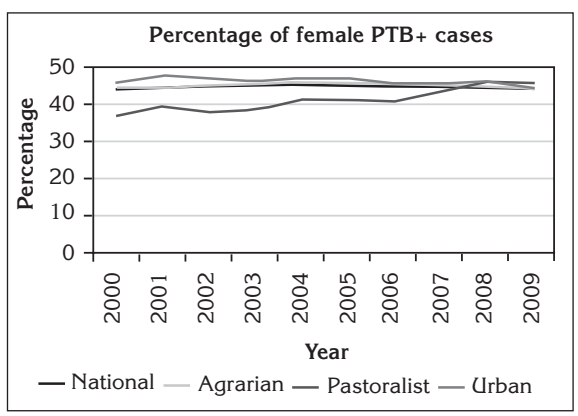

Figure 11. Trends in proportion of female smear-positive PTB cases (2000-2009).

The main conclusion that TB incidence is increasing confounds the possible effects of HIV (and other factors) with improvements in case finding. The additional finding that men are disproportionately affected by TB may represent the truth, but this observation made from routine data may also be confounded by the way in which men and women make use of health services.

On the other hand, the number of re-treatment TB cases has increased by 84% of the initial value during the study period. Corresponding to the overall increment in the number of new TB cases, the increment in the number of the re-treatment would be due to the effect of the increasing pattern of the HIV/AIDS symptomatic levels of stage of the disease. However, such increments in the number of re-treatment cases needs further investigation to rule out loose follow up of the treatment of the TB cases in Health Facilities.

As indicated in the results section, urban agro-ecological zones were found to be the most affected areas followed by agrarian areas. This finding is in-line with the fact that urban areas are more crowded as compared with agrarian and pastoralist communities. This overcrowding results in more rapid transmission of the disease from the patient to the healthy person. On the other hand, the pastoralist communities have larger geographic coverage and less densely populated areas. These natures of the agro-ecological zones have resulted in wide differences in the incidence of TB during the study period. Despite these, urban areas used to have more access to TB treatment services.

With regard to extra-pulmonary nature of TB, agrarian communities were more affected than the other regions. Though the difference is not significant, the difference it might be related to prevalence of HIV/AIDS in those regions. Similarly, smear-negativity was highest for urban areas. The smear-negativity issue would be related to the quality of laboratory tests for TB.

In contrary to the expectation that more females would be affected by TB, this study revealed that males were consistently more affected by TB throughout the study period. It is still true that females are more affected by HIV/AIDS as compared to males. Explaining such opposite findings could be related to disparities in accessing health services particularly in rural areas. It is a general fact that females have less access to health services in general and emergency maternal health services in particular. Hence the high incidence in males is possibly due to better health seeking behavior and access to health services among males.

The case detection rate and treatment success rates are improving at an annual rate of 0.5%. The case detection rate is much lower than the expected MDG target, which is about 84% (WHO, 2009). Though better, treatment success rate need to be improved to 87% among smear-positive cases to meet the millennium development goals. The Ministry of Health and its partners should thus strengthen their efforts on improving access to and quality of TB prevention and control services in Ethiopia.

This study is based entirely on the review and analysis of TB statistics collected and compiled from Health Facilities through the Health Management information system (HMIS). It will be possible to come up with better results if one can include TB related information from communities. An improvement in the HMIS should also be taken in to account in interpreting the findings.

Conclusions

The incidence rate of TB is increasing in Ethiopia at a rate of 5 new TB cases per 100.000 population per year. Urban agro-ecological zones have been more affected by the disease throughout the ten-year period. Extra-pulmonary rate and smear-negativity has shown a modest increment during the study period. Masculine gender was also disproportionately affected by TB during the ten-year study period.

Conflict of Interest

None detected

Disclaimer

The ideas reflected in this paper are solely the ideas of the authors and don't necessarily reflect the opinions of their organizations.

Authors Contribution

Both authors, Tilahun Nigatu and Mulu Abraha, Contributed equally from the inception to the manuscript preparation of this article

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