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DEVELOPING 'COMMUNITY TB HEALTH' A STATISTICAL MODEL FOR RANKING OF DISTRICTS TB PROGRAMME PERFORMANCE IN RAJASTHAN, INDIA

Community Medicine

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ABSTRACT

OBJECTIVES: Ranking of areas has been in use to attract attention of decision makers, and users. India is one among top 20 high TB burden countries. Measures of ranking the geographical areas based on overall scenario of tuberculosis burden, care, and therapeutic effectiveness are hardly available in medical literature. Objectives of the study were (1) To develop a statistical model 'Community TB health' incorporating TB programme indicators selectively and (2) to apply this model in ranking the districts TB programme performance.

METHODS Annual reports of Revised National Tuberculosis Control Programme (RNTCP) from 2011-2014 were reviewed. Retrospective epidemiological study was undertaken. A statistical model 'community TB health' has been developed incorporating selective RNTCP indicators based on their significance in tuberculosis health in community.

RESULTS The model summarises 9 RNTCP indicators describing four separate aspects of the programme i.e. magnitude of ongoing transmission of TB, case detection rates, treatment effectiveness and drug sensitivity profile. Study identified worst and best performing districts on the basis of ranking by 'community TB health' score. The study also highlights the clustering of best and worst districts in studied years.

CONCLUSIONS A statistical model 'Community TB health' has been developed utilizing RNTCP indicators from different aspects of programme. Developed model can be used in ranking geographical areas for community TB health.

KEYWORDS

Tuberculosis, Awareness, India, Statistical model

INTRODUCTION

Ranking the geographical areas by various attributes has been in use to attract attention of decision makers, programmers, users and general public.[1-4] Ranking of countries have been made on the basis of health attribute.[5] Health basis ranking of geographical areas has been made up to much smaller, county level. The Robert Wood Johnson Foundation in collaboration with the University of Wisconsin Population Health Institute brings about annual county health rankings of all the counties of various states of United Sates since year 2010.[6,7]

Global tuberculosis report 2017 rank India as one among top 20 countries with high TB burden.[8] This ranking is based on total number of diagnosed cases of tuberculosis in country. Central TB Division (CTD), Directorate General of Health Services, Ministry of Health and Family welfare, Government of India receives information on tuberculosis case-finding, their management, sputum conversion and treatment outcome for patients registered under Revised National Tuberculosis Control Program (RNTCP) from all of its 35 states and union territories. CTD publishes annual performance reports of this information for all the states and districts thereof but without ranking.[9] Measures of ranking the geographical areas based on overall scenario of tuberculosis burden, care, and therapeutic effectiveness are hardly available in medical literature. Rajasthan is the largest state of India in regard to geographical area.[10] The objectives of this study were to develop a statistical model of community TB health, based on data of RNTCP and to rank various districts of Rajasthan utilizing this model.

METHODS

Setting: Study was carried out in Rajasthan, the largest state of India located on western side of country. Its geographical area is 342,239 Km^2. It shares 10.4% in total land area of country. Rajasthan is currently divided in to 34 districts for administrative purposes.[11]

Study design: Retrospective secondary data based epidemiological study

Ethics Ethical approval was not required, because it was a retrospective secondary data based study.

Data source: CTD publishes annual status reports of the RNTCP. Annual reports of the years 2011, 2012, 2013, and 2014 were accessed from the website.[12]

Vital indicators

Rajasthan state is having yearly data on 35 RNTCP indicators for all its districts. These indicators convey vital information of ongoing TB transmission, incidence rate of various types of TB, treatment success rates, sputum smear conversion rates etc.

Statistical model 'Community TB Health'

All the available 35 RNTCP indicators were studied in regard to the valuable information these convey about TB in community. A statistical model has been developed which comprised of 4 separate aspects of community health in reference to TB. These 4 separate aspects are (1) *ongoing transmission*; (2) *Case detection*; (3) *treatment*; and (4) *drug sensitivity* (Fig.1). To represent these 4 separate aspects of tuberculosis and its programme in community, 9 RNTCP indicators were selected on the basis of vital information these convey (Table: 1).

Method of scoring and ranking:

Some of the selected RNTCP indicators are expressed as proportions and others as rates. Even rates are expressed with different denominator units. So these indicators were standardized. The absolute values of these indicators were transformed into 'z' scores for each of the districts in Rajasthan for every year. These 'z' score indicate relative position of district with respect to the average value of the concerned RNTCP indicator in Rajasthan. This 'Z' score was derived by using the formula given below: -

$$Z\ score = \frac{(\text{Value of RNTCP indicator in district} - \text{Average value of RNTCP indicator in Rajasthan})}{(\text{Standard deviation of values of RNTCP indicator in all the districts of Rajasthan})}$$

The values of all the selected RNTCP indicators are then expressed in same metric, wherein average value of indicator in Rajasthan is 0 and standard deviation is 1. A positive value of 'z' score in any district indicates that the value of indicator in concerned district is higher than the average value of that indicator in Rajasthan. A negative value of 'z' score in any district indicates that the value of indicator in concerned district is lower than the average value of that indicator in Rajasthan. Higher 'z' score values of 4 out of 9 selected RNTCP indicators viz. (1) *% of paediatric cases out of all new cases,* (2) *Annual new smear positive case notification rate*, (3) *Annual smear positive case detection rate (from PMR)*, & (4) *Annual total case notification rate*, indicates poorer community TB health. Remaining 5 RNTCP indicators (suspects' examination rate, 2 separate treatment success rates and 2 separate sputum conversion rates) are desirable indicators, wherein higher values indicates better community TB health. Values of 'z' score of these 5 remaining desirable indicators were multiplied by -1, so that in case of each of the total 9 considered RNTCP indicators, higher 'z' score indicated poorer community TB health. To take account of the inter-district variability of 'z' scores of these 9 indicators, a weight score (co-efficient of variation) was derived for each indicator separately for studied years. Calculated weight score was then

multiplied in 'z' score of the indicator. These calculated values of 'z' scores multiplied by weight scores were then sum up to give rise the final score of 'community TB health'. Higher score of 'community TB health' reflected poorer community TB health status. This score was then sorted in descending order. Highest value reflected worst district and lowest value reflected best district in the considered year.

Analysis: Community TB health score was calculated and sorted to derive ranking of each district in state for separate years. Pattern of ranks of districts between studied years was checked for consistency by deriving Pearson's Co-efficient of correlation (r).

RESULTS

Table I lists selected 9 indicators along with the reasons governing choice of selection. Fig I depicts the structure of statistical model with respect to the considered 4 separate aspects of tuberculosis disease and TB programme in community. The aspect '*ongoing transmission*' was represented by 2 RNTCP indicators namely '*% of paediatric cases out of all new cases*' and '*Annual new smear positive case notification rate*'. The aspect '*case detection*' was represented by 3 indicators namely '*Suspects examined per smear positive case diagnosed*', '*Annual smear positive case detection rate (from PMR)*', and '*Annual total case notification rate*'. Third aspect '*treatment effectiveness*' was represented by 2 indicators namely '*treatment success rate of new smear positive patients*' and '*treatment success rate among smear positive previously treated cases*'. The fourth considered aspect '*drug sensitivity*' was represented by 2 indicators namely '*3 month conversion rate of new smear positive patients*' and '*3 month conversion rate of retreatment patients*'. Table II elaborates on the calculated weight scores of selected 9 RNTCP indicators for years 2011-2014 separately. Small inter-district variation was observed in 'z' scores of indicators representing '*drug sensitivity*' and '*treatment effectiveness*' aspects of programme. Indicator '*3 month conversion rate of new smear positive patients*' varied from 1.46% to 1.7% in these years. Indicator '*treatment success rate of new smear positive patients*' varied from 2.32% to 3.92% in these years. Indicators representing '*case detection*' and '*ongoing transmission*' aspects of programme varied moderately. Indicator '*Annual smear positive case detection rate (from PMR)*' representing '*case detection*' aspect of programme varied from 34.26% to 43.63% across the districts in studied years. Similarly indicator '*% of paediatric cases out of all new cases*' representing '*transmission*' aspect of programme varied from 33.4% to 37.61% across the districts in these years. Table III elaborates on the districts of Rajasthan with their ranking with respect to the 'community TB health' score in years 2011-2014 separately. District with rank 1 in each year reflects highest community TB health score and poorest overall TB health scenario in particular year. District with bottom rank reflects lowest community TB health score and best TB health scenario in particular year. Among studied 4 years separately, district Udaipur consistently scored top with poorest community TB health among all districts. District 'Tonk' consistently remained one among top 5 districts in studied 4 years. District 'Ajmer' & 'Bhilwara' got one among top five positions in 3 out of the 4 studied years.

Similarly, among bottom 5 districts with best community TB health in studied 4 years, districts 'Barmer' & 'Jaisalmer' consistently scored one among bottom five districts. Concordance analysis to check for variations in ranks of studied districts across years 2011-2014 showed consistency in model. The values of Pearson's correlation coefficient in analysing ranks of studied districts between years 2011-2012, 2012-2013 & 2013-2014 were 0.948.3, 0.94671 & 0.94775 respectively.

Fig. II depicts the geographical locations of various studied districts in maps of Rajasthan separately for studied years 2011-2014. Districts have been colour coded with respect to the community TB health scores. Districts with top 5 and bottom 5 community TB health scores have been colour coded in red and green respectively. Other remaining districts with community TB health scores between top and bottom five have been colour coded as white. It is evident from the Fig.2 that districts adjoining western boundary of state along Pakistan and Gujarat border are consistently showing best community TB health scenario. Districts located in the eastern or south-eastern part of state are showing poorest community TB health scenario. Remaining districts with intermediate community TB health score are scattered in whole of Rajasthan, with shifting from one category to another in some of the cases.

DISCUSSION

The values of RNTCP indicators vary from year to year and from one district to another. One district with best desirable value of one RNTCP indicator may or may not be having equal desirable values of other RNTCP indicator. It then becomes difficult to judge which district is overall better than other one. Health ranking model summarising health outcomes and determinants demonstrates overall differences in geographical areas with respect to health. It raises awareness on the factors influencing overall health status and stimulates community health improvement efforts. Human instinct to compete with peers undermines the philosophy of ranking.[7] County health ranking has served as a catalyst to enhance the healthy actions by the community.[6] A composite indicator developed to monitor performance of RNTCP programme in India allows few districts to have equal value of indicator so hindering ranking of these districts.[12,13] This study has developed a quantitative comprehensive indicator which can exclusively rank districts without overlapping based on the value of a continuous quantitative indicator.

The statistical model developed in this study summarises 9 RNTCP indicators describing four separate aspects of the programme. These indicators highlight valuable information about magnitude of ongoing transmission of TB, case detection rates, treatment effectiveness and drug sensitivity in the geographical areas. The model showed consistency in ranks of studied districts across the four studied years 2011-2014. The values of Pearson's correlation coefficient analyzing ranks between studied years were consistently more than 0.94. Inter – district variability in z scores of indicators justified computing the weight score on yearly basis. The study also highlights the clustering of best and worst districts on community TB health score in studied years. There can be some local factors responsible for this clustering which need to be explored.

This study developed the statistical model of community TB health for drawing attention of district TB officers, physicians, politicians and public at large. Ranking the districts of Rajasthan will hopefully raise awareness and enhance competition among peers for securing better ranks in future by improving considered RNTCP indicators.

Conclusions

This study developed a statistical model of community TB health score by summarizing 9 RNTCP indicators representing different aspects of programme. Ranking of districts of Rajasthan with community TB health score will raise awareness among programmers and public for enhancing efforts for improvement in rank and community TB health scenario.

Limitation of study It is a secondary data based analytical epidemiological study wherein author did not had any control in collection of data. Ranking is purely based on differences in absolute values of RNTCP indicators. Differences in values of indicators may or may not be statistically significant. Factual status of performance of RNTCP can be assessed by evaluation of the RNTCP programme using input, process, output and outcome indicators.

Conflict of Interest None declared
Source of funding None declared

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Table I: Selected RNTCP indicators and the reasons of their selection in statistical model

Sr. No.	RNTCP * indicator	Reason of selection
1.	Suspects examined per smear positive case diagnosed	Indicator showing programme efforts for detecting smear positive cases
2.	Annual smear positive case detection rate (from PMR)	Indicator reflecting the rate of detection of infectious cases of TB in community
3.	Annual total case notification rate	Indicator reflecting the rate of notification of all types of cases of TB in community
4.	Annual new smear positive case notification rate	Indicator reflecting the rate of notification of infectious cases of TB in community

5.	% of paediatric cases out of all new cases	Paediatric cases of TB are suggestive of recent transmission of tuberculosis in community
6.	3 month conversion rate of new smear positive patients in %	Sputum conversion reflects drug sensitivity profile among new smear positive patients in community
7.	3 month conversion rate of retreatment patients in %	This indicator reflects drug sensitivity profile among retreatment patients of TB in community
8.	Treatment success rate of new smear positive patients	This indicator is a measure of overall therapeutic effectiveness in new smear positive patients
9.	Treatment success rate among smear positive previously treated cases in %	This indicator is a measure of overall therapeutic effectiveness in smear positive previously treated patients

*Revised National Tuberculosis Control Programme

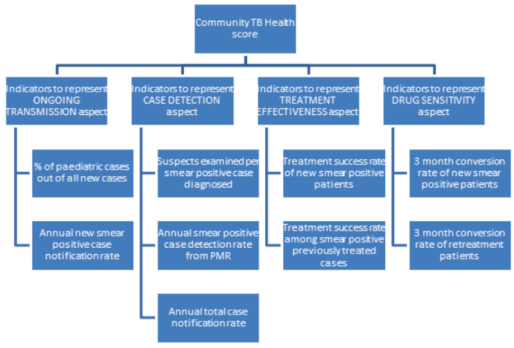

Fig. I: Statistical model for ranking of community TB health – a composite score

Table II: Weight score assigned to selected RNTCP indicators in years 2011-2014

Indicator	Weight score (%)			
	2011	2012	2013	2014
Suspects examined per smear positive case diagnosed	27.45	27.8	29.17	29.07
Annual smear positive case detection rate (from PMR)	34.26	38.45	39.07	43.63
Annual total case notification rate	23.31	25.27	26.39	29.81
Annual new smear positive case notification rate	27.57	27.55	32.37	39.47
% of paediatric cases out of all new cases	37.61	35.18	33.4	35.43
3 month conversion rate of new smear positive patients	1.46	1.7	1.64	1.53
3 month conversion rate of retreatment patients	5.03	6.37	6.51	7.4
Treatment success rate of new smear positive patients	2.32	3.92	2.52	2.78
Treatment success rate among smear positive previously treated cases	6.21	11.75	7.38	6.64

Table III: Districts and their ranks with respect to community TB health score in Rajasthan, 2011-2014

Community TB Health Score	Rank	Year 2011	Year 2012	Year 2013	Year 2014
Highest score & worst TB health	1.	Udaipur	Udaipur	Udaipur	Udaipur
	2.	'Tonk'	Bhilwara	Tonk	Tonk
	3.	Bhilwara	Tonk	Bhilwara	Dungarpur
	4.	Ajmer	Ajmer	Banswara	Banswara
	5.	Dungarpur	Dungarpur	Dungarpur	Ajmer
	6.	Dhaulpur	Jaipur	Dhaulpur	Bhilwara
	7.	Banswara	Dhaulpur	Ajmer	Baran
	8.	Hanumangarh	Baran	Hanumangarh	Dhaulpur
	9.	Jaipur	Banswara	Baran	Jaipur
	10.	Baran	Jaipur DTC II	Pratapgarh	Hanumangarh
	11.	Kota	Hanumangarh	Jaipur	Pratapgarh
	12.	Sirohi	Rajsamand	Kota	Jhalawar
	13.	Jhalawar	Kota	Rajsamand	Sawai Madhopur
	14.	Karauli	Sirohi	Sawai Madhopur	Kota
	15.	Rajsamand	Bikaner	Bundi	Rajsamand
	16.	Bikaner	Sawai Madhopur	Jaipur DTC II	Alwar
	17.	Sawai Madhopur	Bundi	Churu	Bikaner
	18.	Churu	Jhalawar	Jhunjhunun	Jaipur DTC II
	19.	Jhunjhunun	Churu	Chittaurgarh	Chittaurgarh
	20.	Bundi	Chittaurgarh	Jhalawar	Jhunjhunun
	21.	Ganganagar	Bharatpur	Bikaner	Karauli
	22.	Pali	Karauli	Bharatpur	Churu
	23.	Chittaurgarh	Jhunjhunun	Karauli	Bharatpur
	24.	Jalore	Ganganagar	Alwar	Sirohi
	25.	Bharatpur	Alwar	Sirohi	Bundi
	26.	Alwar	Nagaur	Ganganagar	Ganganagar
	27.	Jodhpur	Sikar	Nagaur	Nagaur
	28.	Nagaur	Dausa	Jodhpur	Jodhpur
	29.	Dausa	Pali	Sikar	Pali
	30.	Sikar	Jalore	Jalore	Sikar
	31.	Barmer	Jodhpur	Dausa	Dausa
	32.	Jaisalmer	Barmer	Pali	Jalore
Lowest score & best TB health	33.	-	Jaisalmer	Jaisalmer	Barmer
	34.	-	-	Barmer	Jaisalmer

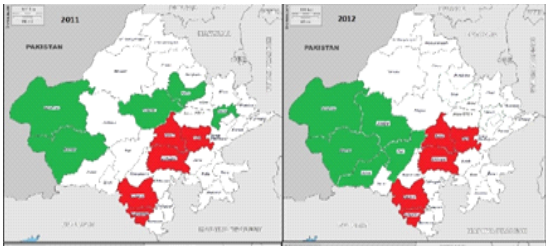

Fig. II: Geographical location of districts as per their community TB health score, Rajasthan, 2011-2014

Note: - Top five districts with highest community TB health score or poorest TB health scenario are colour coded as Red; bottom five districts with lowest community TB health score or best TB health scenario are coded as green and rest of the districts as white.

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