AN OVERVIEW AND MAPPING OF CHILDHOOD TUBERCULOSIS: PREVALENCE, SCIENTIFIC PRODUCTION AND CITATION ANALYSIS

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Summary

Aim: The study aimed to analyze publications in the field of “pediatric tuberculosis” and associate them with regional Tuberculosis (TB) profile.

Methods: A schematic analysis of scientific production in the field of pediatric tuberculosis between 1990 and 2010 using ISI web of science was carried out. Terms used for searches were each as a combination of “Mycobacterium Tuberculosis”, or “Tuberculos*” and “Child”, or “Infant”, or “New born”, or “Neonatal”, or “Adolescent”, or “Pediatric”. Features including year of publication, citation per year, country of origin, funding state, contributing university, language, leading journals and authors, and highly cited articles, main journal publishing these articles were taken into account.

Results: The search retrieved 3417 articles (of 4559 total) with an almost gradual annually progressive pattern from 20 (in 1990) to 302 (in 2009) which have been cited totally 48459 times and 14.18 times per article. The greatest contribution originated from United States of America (25.11%) followed by South Africa (12.17%), and England (11.18%). Interestingly, 82.4% of all South African articles were from Stellenbosch University and Cape Town University on contrary.

Conclusions: International Journal of Tuberculosis and Lung Disease ranked as the first with regard to the number of articles and Lancet with regard to the number of highly cited articles. Developing countries excluding South Africa despite their high prevalence scarcely contribute to the field and USA is the leading country in the field. [Indian J Tuberc 2013; 60: ]

Key words: Citation, Tuberculosis, Pediatric, Bibliometric.

INTRODUCTION

Tuberculosis (TB) is primarily a pulmonary disease transmitted via respiratory route which has caused human suffering and death for centuries.1,2 Although it was identified by Robert Koch in 1882, it is still a global health challenge.3,4 Based on published reports, over eight million people annually become infected by TB 3,5 and more than 50 million people will die of TB between 1998 and 2020.3 The global epidemiology of TB is poorly documented,7,8 though approximately 95% of all cases take place in developing countries1,9 where HIV infection presents as a challenge to TB control.10

The extent of childhood tuberculosis is unknown which may be due to the difficult accurate diagnosis, inadequate health information systems in developing countries, and the negligence by tuberculosis control authorities.11-14 However, the overall prevalence of infection in the 0-14 year age group is estimated to be 8.6–10%.15 The risk of developing disease has been estimated to be 24% in children 1–5 years of age, and unfortunately as high as 43-50% in infants less than a year of age.7,16

An urgent step towards better diagnosis and epidemiological data acquisition in this regard seems to be a global obligation; otherwise, childhood tuberculosis remains an ‘invisible’ entity. Since resurgence of tuberculosis after decades of consistently declining incidence in 1990, case notifications in children have been increasing steadily.16,17 Much efforts have also been made on tuberculosis therapeutic and diagnostic18,19 methods.

As the diagnosis and control of childhood tuberculosis is fundamentally different from adult one,20 and infected children are reservoirs for adult cases,21 addressing different aspects of TB in children
is an important health care related issue which deserves the global attention. Nevertheless, this attention has not yet been viewed by a scientometric scale to reveal meticulous details regarding its contributors. Our study aimed to analyze the 1990-to-2010-interval publications in the field of “pediatric tuberculosis” and correlate them with corresponding regional TB prevalence.

MATERIAL AND METHODS

The current descriptive study targeted a schematic view of scientific map in the field of pediatric tuberculosis. We used ISI web of science (http://www.isiknowledge.com) as our database to carry out our analysis in January 2010. Terms used for the searches were chosen in accordance with Medical Subject Heading (Mesh) which is used to index PubMed© contents. Twelve terms were used for our searches. Each term composed of a combination from “Mycobacterium Tuberculosis”, or “Tuberculos*” and “Child”, or “Infant”, or “New born”, or “Neonatal”, or “Adolescent”, or “Pediatric”. The query was done with all 12 mentioned terms for the intended period of 1990 to 2010. The study merely includes articles among all other retrieved documents such as reviews, proceeding papers, letters, editorial material, meeting abstracts, notes, reprints, corrections, news items, book reviews, and additions.

Overall number of related publications besides further aspects like annual publications, annual citations per paper, language, leading countries, first authors, most contributing journals, highly cited per paper, institutional affiliations, and collaboration were retrieved from ISI Web of Sciences. The collaboration of two countries defined as the total number of articles which composed of at least one author originates from each country regardless of their order and presence of other countries. We also took $h$ index into account. The $h$-index reported is defined if at least $h$ papers each have been cited at least $h$ times. Other bibliometric measures to assess individual scientific achievements were total number of published articles and total number citations. The Journal’s impact factor reflects journals’ scientific merits and standing in a specific field.

Data regarding regional TB profile including total number of new TB cases in Children less than 15 years’ old and total number of new TB cases in 2009 were extracted from WHO country-based report available at http://www.who.int/tb/country/data/profiles.

RESULTS

Our query returned 3417 articles (of 4559 total items including reviews, proceeding papers, letters, editorial material, meeting abstracts, notes, reprints, corrections, news items, book reviews, and additions).

These 3417 articles were examined thoroughly from versatile view point, as stated in subsequent sub-headings.

Annual published articles

The distribution of annual publications over time span is depicted in figure 1 which is roughly reflective of an almost gradual annually progressive pattern (excluding 1996-7, 1999-2000, 2000-1, and 2009-10 intervals) with sharpest upsurges being 2005-6 interval followed by 1990-1 and 1991-2. Although the most productive year is 2009 with published 302 articles, there would be possibility of change in the number of 2010-published articles if the study was carried out later.

Citation over time

These articles have been totally cited 48,459 times where the average citation per article for the past 20 years has been 14.18.

Countries’ production distribution

These 3417 articles originated from 129 countries among which United States of America with over one fourth of articles followed by South Africa with 416 articles and England with 382 articles have been the most productive ones.

Countries with over 100 articles in the time span are analyzed from different standpoints as
CHILDHOOD TUBERCULOSIS MAPPING

Looking from the perspective of citation per article, Switzerland has preceded others including USA (the most productive country) by a total citation per article of at least over two times of the rest; however, from the perspectives of h index and total citation per year, USA has still preserved its first rank (Table 1).

Since there is no unanimous country specific epidemiological data regarding pediatric TB prevalence, to examine the possible association between amount of regional pediatric tuberculosis cases and the extent of scientific production in the field, we used total number of new TB cases in children less than 15 years, reported to WHO in 2009.

Table 1: Countries’ pediatric tuberculosis related articles production: Total number of articles, total citations per article, citations per year, and h index in ISI Web of Sciences between 1990-2010 in association with countries’ total number of new TB cases (total, and under 15 years’ old)

<table>
<thead>
<tr>
<th>Country</th>
<th>Total article (% total)</th>
<th>Total Citations</th>
<th>Citations per Article</th>
<th>Citations per Year</th>
<th>h Index</th>
<th>Total &lt; 15 y*</th>
<th>Total New*</th>
<th>Ratio &lt; 15/T</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>858 (25.11%)</td>
<td>21289</td>
<td>24.81</td>
<td>967.68</td>
<td>62</td>
<td>639</td>
<td>11545</td>
<td>5.53%</td>
</tr>
<tr>
<td>South Africa</td>
<td>416 (12.17%)</td>
<td>5404</td>
<td>12.99</td>
<td>245.64</td>
<td>36</td>
<td>49825</td>
<td>340066</td>
<td>14.65</td>
</tr>
<tr>
<td>England</td>
<td>382 (11.18%)</td>
<td>9021</td>
<td>23.62</td>
<td>429.57</td>
<td>45</td>
<td>339</td>
<td>7008</td>
<td>4.83%</td>
</tr>
<tr>
<td>India</td>
<td>308 (9.01%)</td>
<td>2285</td>
<td>7.42</td>
<td>103.86</td>
<td>23</td>
<td>13577</td>
<td>1243552</td>
<td>1.09%</td>
</tr>
<tr>
<td>France</td>
<td>232 (6.79%)</td>
<td>3126</td>
<td>13.47</td>
<td>142.09</td>
<td>25</td>
<td>107</td>
<td>2890</td>
<td>3.7%</td>
</tr>
<tr>
<td>Turkey</td>
<td>147 (4.30%)</td>
<td>954</td>
<td>6.49</td>
<td>50.21</td>
<td>13</td>
<td>940</td>
<td>15943</td>
<td>5.89%</td>
</tr>
<tr>
<td>Germany</td>
<td>130 (3.80%)</td>
<td>1496</td>
<td>11.51</td>
<td>74.8</td>
<td>21</td>
<td>114</td>
<td>3545</td>
<td>3.21%</td>
</tr>
<tr>
<td>Netherlands</td>
<td>116 (3.39%)</td>
<td>2196</td>
<td>18.93</td>
<td>104.57</td>
<td>22</td>
<td>57</td>
<td>1094</td>
<td>5.2%</td>
</tr>
<tr>
<td>Canada</td>
<td>106 (3.10%)</td>
<td>1876</td>
<td>17.7</td>
<td>89.33</td>
<td>23</td>
<td>86</td>
<td>1447</td>
<td>5.94%</td>
</tr>
<tr>
<td>Switzerland</td>
<td>106 (3.10%)</td>
<td>5502</td>
<td>51.91</td>
<td>250.09</td>
<td>26</td>
<td>16</td>
<td>333</td>
<td>4.8%</td>
</tr>
</tbody>
</table>


Figure 1: Published articles related to pediatric tuberculosis: Total number in ISI Web of Sciences between 1990-2010.
and its ratio to total number of new TB cases in 2009 (figure 2). However, a discrepancy is evident between the extent of publication and the expense of pediatric tuberculosis cases. Although, the wealth of new pediatric TB cases might have been involved in scientific productions of South Africa, it seems USA’s productions are much more independent of TB cases.

**Funding state**

In the time period of our study, a few articles had stated their funding state; however, among indexed funding agents, National Institute of Health has contributed the most to the field by supporting 35 articles. The utmost indexed funding agents mostly originate from USA where also most articles in the field arose from. However, if we reassessed the total funded USA’s articles along the high volume of produced articles, then it would no longer seem significant.

**Contributing universities’ distribution**

The query returned 501 universities where at least three authors/co-authors of the published articles in the time span affiliate to. However, Stellenbosch University followed by Cape Town University, both in South Africa, has got the first rank in this respect and they cumulatively have been involved in 82.4% (343 out of 416) of all South African publications. On contrary, published articles from USA should have been distributed more uniformly within the country, as evidenced by the few number USA universities in the list of major productive universities.

**Applied languages**

Most articles (91.31%) of the field in the time span were published in English; however, other ISI Web of Sciences indexed languages were respectively French (4.54%), German (1.49%), Spanish (1.49%), Portuguese (0.47%), Italian (0.18%), Russian (0.15%), Turkish (0.15%), and finally Croatian (0.09%).

**Leading journals**

Looking at the analysis from the aspect of publishing journals revealed 385 journals with at least two articles in the time span. However, majority of the articles have been published in *International Journal of tuberculosis and Lung Disease* (235 articles), *Pediatric Infectious Disease Journal* (165 articles), and *pediatrics* (78 articles). *International Journal of Tuberculosis and Lung Disease*.
**Journal of tuberculosis and Lung Disease** in spite of being more scope specific than pediatric specific, has got the first rank in the time span (Table 2).

**Leading authors**

We found that 501 people coauthored at least three articles between 1990 and 2010. However, most top composing authors/coauthors are from South African and mostly affiliated to Stellenbosch University. Simon Hendrick Schaaf and Nulda Beyers both affiliated to Stellenbosch University have got the most top H index of 24, though Nulda Beyers total article counts is relatively lower (Table 3).

**Highly cited articles**

Our analysis regarding highly cited articles between 1990 and 2010 returned 50 articles which have been cited over 100 times in the ISI Web of Sciences between 1990-2010 in association with journal impact factor (IF)

<table>
<thead>
<tr>
<th>Journal</th>
<th>Articles Count (% total)</th>
<th>IF</th>
</tr>
</thead>
<tbody>
<tr>
<td>International Journal of tuberculosis and Lung Disease</td>
<td>235 (6.88%)</td>
<td>2.548</td>
</tr>
<tr>
<td>Pediatric Infectious Disease Journal</td>
<td>165 (4.83%)</td>
<td>2.854</td>
</tr>
<tr>
<td>Pediatrics</td>
<td>78 (2.28%)</td>
<td>4.687</td>
</tr>
<tr>
<td>Clinical Infectious Diseases</td>
<td>63 (1.84%)</td>
<td>8.195</td>
</tr>
<tr>
<td>Archives of Disease in Childhood</td>
<td>54 (1.58%)</td>
<td>2.657</td>
</tr>
<tr>
<td>Journal of Tropical Pediatrics</td>
<td>53 (1.55%)</td>
<td>1.224</td>
</tr>
<tr>
<td>Tubercle and Lung Disease</td>
<td>51 (1.49%)</td>
<td>1.186</td>
</tr>
</tbody>
</table>

**Table 3:** Authors with most pediatric tuberculosis related articles: Total number as index in ISI Web of Sciences between 1990-2010 along their affiliation and topic related H index

<table>
<thead>
<tr>
<th>Authors</th>
<th>Record Count</th>
<th>H Index</th>
<th>Affiliation</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simon Hendrick Schaaf</td>
<td>89 (2.60%)</td>
<td>24</td>
<td>Stellenbosch University</td>
<td>South Africa</td>
</tr>
<tr>
<td>Nulda Beyers</td>
<td>64 (1.87%)</td>
<td>24</td>
<td>Stellenbosch University</td>
<td>South Africa</td>
</tr>
<tr>
<td>Peter Roderick Donald</td>
<td>61 (1.79%)</td>
<td>22</td>
<td>Stellenbosch University</td>
<td>South Africa</td>
</tr>
<tr>
<td>Robert P. Gie</td>
<td>59 (1.73%)</td>
<td>23</td>
<td>Stellenbosch University</td>
<td>South Africa</td>
</tr>
<tr>
<td>Ben J Marais</td>
<td>59 (1.73%)</td>
<td>23</td>
<td>Stellenbosch University</td>
<td>South Africa</td>
</tr>
<tr>
<td>Anneke C. Hesseling</td>
<td>59 (1.73%)</td>
<td>23</td>
<td>Stellenbosch University</td>
<td>South Africa</td>
</tr>
<tr>
<td>Savvas Andronikou</td>
<td>30 (0.88%)</td>
<td>8</td>
<td>University of Cape Town</td>
<td>South Africa</td>
</tr>
<tr>
<td>Jeffrey R. Starke</td>
<td>30 (0.88%)</td>
<td>15</td>
<td>University of Texas</td>
<td>USA</td>
</tr>
<tr>
<td>Mark Fredric Cotton</td>
<td>22 (0.64%)</td>
<td>11</td>
<td>Stellenbosch University</td>
<td>South Africa</td>
</tr>
<tr>
<td>Jean Laurent Casanova</td>
<td>21 (0.61%)</td>
<td>12</td>
<td>St. Giles Laboratory</td>
<td>France</td>
</tr>
<tr>
<td>Gregory Hussey</td>
<td>21 (0.61%)</td>
<td>9</td>
<td>Stellenbosch University</td>
<td>South Africa</td>
</tr>
<tr>
<td>Klaus Magdorf</td>
<td>20 (0.59%)</td>
<td>4</td>
<td>CharitéUniversitätsmedizin</td>
<td>Germany</td>
</tr>
</tbody>
</table>
Indian Journal of Tuberculosis Sciences. The *Lancet* with 11 highly cited articles, 4743 citations over time and 431.18 citations per paper has got the first rank. We also calculated H/T ratio to find out what was the proportion of published articles in each journal which have been highly cited over the time span. Nevertheless, table 4 outlines journals with at least two highly cited papers in the field of pediatric TB during the time span.

Analysis of these highly cited papers in respect of published years disclosed that excluding 2008-2010 intervals which have got lesser chances of being cited over 100 times, one highly cited article each year is at least published every year. However, 1997 with seven highly cited articles and subsequently 2002 with six highly cited articles headed the rest. To retrieve the share of collaboration upon accomplishment of these highly cited articles, we extracted them from ISI Web of Science. The countries’ collaboration ranged from two to 13 and totally 23 highly cited articles were cooperative ones. Since 2000, a greater proportion of each year highly cited articles have been cooperative ones.

Out of 129 countries involved in production of the pediatric tuberculosis related articles, only 31

**Table 4: Journals with at least two pediatric tuberculosis related highly cited articles: Total number as index in ISI Web of Sciences between 1990 and 2010 along journal IF**

![Figure 3: Countries’ highly cited pediatric tuberculosis related articles along their cooperative highly cited articles: Total number in ISI Web of Sciences between 1990-2010](image)

Indian Journal of Tuberculosis
had taken part in collaboration resulting in publication of a highly cited article. However, these countries’ total highly cited articles along cooperative highly cited articles are depicted in figure 3.

During the time span, a few countries like Egypt, Italy, and Netherlands have not yet been involved in collaboration resulting in publication of a highly cited article; On contrary, most of the England highly cited articles are cooperative, the most prevalent method among other countries. However, most of the American highly cited articles are non-cooperative (15 out of 24).

**DISCUSSION**

Current study aimed to review the scientific production in the field of pediatric tuberculosis between 1990 and 2010. Different foci are explained in prior section; however, it seems that generally scientific production has been progressing since 1990 when a global concern arose regarding resurgence of tuberculosis after decades of consistently declining incidence. After World Health Organization Tuberculosis Unit special study to determine the nature and magnitude of global tuberculosis in 1989/1990, a study which yielded to WHO call on an urgent need to develop control and elimination strategies,5 we have witnessed two sharp rises of published articles in subsequent two intervals of 1990-1 and 1991-2. Since the WHO declaration of a “global tuberculosis emergency” in 1993, wealth of publications have been addressing different aspects of tuberculosis like its burden, management, and control but adult disease has got the most attention, nevertheless; pediatric tuberculosis share is also steadily progressive as evident yearly growth in published articles. In 2006, world attention was captured by an extremely lethal outbreak in Tugela Ferry, a rural settlement of KwaZulu Natal, South Africa following which World Health Organization Global Task Force on Extensively Drug Resistant TB (XDR-TB) altered XDR-TB definition in October 2006.25 This event coincided with the most significant upsurge of published articles in the past 20 years in 2005-6.

Between 1990 and 2010, over one fourth of the production in the field took place in USA despite its relatively low yearly new cases in children less than 15 years. Remarkably, during the mentioned period, the contribution of USA, South Africa, and UK have been nearly equivalent to the rest of the World. On the other hand, Switzerland articles, despite having a low frequency of 3.1%, have been cited over two times of the rest during the time period. However, USA, South Africa, and UK, irrespective of order, also preserve the pattern of their precedence over the others in the aspects of sated funders and contributing universities but in the aspect of total highly cited articles Switzerland has substituted South Africa.

Among 501 involved indexed institutions in the field, South African universities, especially Stellenbosch University, have had significantly high amount of publications per university during the time span of 1990 to 2010. The motivation for this great volume of research in this region may not follow similar lines of other areas, since high prevalence of HIV in this region not only exacerbates the TB disasters but also emerged to new manifestation of TB such as congenital and neonatal TB which are increasing as a result of the rising prevalence of TB in young women and mothers.10

Almost all articles, despite their versatile originalities, were published in English language. Journals with paramount productions have a broad range of IF from 0.406 to 30.758; however, over one of fourth of articles in the field during 1990-2010 were published by only 11 journals among which two have totally had 13 highly cited articles, i.e. cited over 100 times.

It seems that those articles published in “Science” (IF: 29.747) and “The New England Journal of Medicine” (IF: 47.05) have been credited the most since 100% of “Science” published articles and 50% “The New England Journal of Medicine” published articles have become highly cited between 1990 and 2010; however, two factors at least should be taken into account: Firstly, a few articles were published in both journals. Secondly, these journals have got high impact factors which might be to some extent explanatory of our finding.
It is worthwhile to emphasise on this point that only 40% of highly cited articles were published between 2000 and 2010, but it seems that the real frequency is much higher; lack of any highly cited papers since 2008 might be a clue to this assumption. Furthermore, a general trend of more cooperative highly cited articles since 2000 is noted in this analysis, though USA with half of highly cited papers during the period, has been less cooperative with other countries.

Authors with utmost articles in the field of pediatric tuberculosis are mostly affiliates of Stellenbosch University in South Africa. However, we found two following effective factors: First and foremost, the prevalence of tuberculosis in the region is significantly high. Last but not the least, most of the South African articles (343 out of total 416) during 1990-2010 were produced by Stellenbosch and Cape Town Universities in South Africa. Nevertheless, any of their articles have not yet been highly cited and the only South African highly cited article co-author is not among these leading ones. Most South African leading authors in the field of pediatric TB have got a topic specific H index which is relatively much higher than a few non-South African leading authors.

In conclusion, we have found that although pediatric tuberculosis is of discrepant geographic range and most cases take place in developing countries, it draws a wide research interest in 129 countries. However, the central publishing country is USA. Unfortunately, excluding South Africa, developing countries scarcely contribute to the field despite their high prevalence. Finally, although the number of publications and the scientific interest in pediatric tuberculosis have increased rapidly in recent years, it deserves to remind that TB in children is an important health care related issue which mandates the global attention.

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