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AN OVERVIEW OF THE ECONOMIC BURDEN EVALUATION OF TUBERCULOSIS IN ASIAN COUNTRIES

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ABSTRACT

Objectives: To summaries the state of knowledge on the economic burden evaluation of tuberculosis in Asian countries in order to propose and improve health and social policy.

Methods: A systematic literature search was conducted in PubMed, including journal articles reporting the cost of tuberculosis in Asian countries from 2000 to 2015. The search strategy was based on a broad combined search string (economic burden* OR cost* OR "cost of illness" [Mesh]) AND ("Tuberculosis" [Mesh] OR tuberculosis). Only studies that reported any costs of TB were retained. All costs were converted to 2015 USD in accordance with the PRISMA guidelines.

Results: Overall, thirteen articles were selected for the review. Thirteen articles included direct cost, eleven articles included indirect cost. The results showed the number of studies on the economic burden of tuberculosis is lower; the study also outlined the economic burden of tuberculosis in Asian countries. Overall, the economic burden of tuberculosis in Asian countries was in range of $76 to $1964.

Conclusions: The economic burden of tuberculosis in Asian countries was catastrophic. Tuberculosis leads to a significant economic burden for any countries. Tuberculosis has a substantial economic impact, and the lack of information on the cost of Tuberculosis in several countries highlights the need for further work in order to describe the global economic burden of Tuberculosis. Hence, the healthcare administration should suggest essential policies in order to control TB the best as well as reduce the economic burden of TB for the society.

KEYWORDS Tuberculosis, economic burden, cost of treatment.

1. Introduction

Tuberculosis (TB) is a combination of bacilli caused by respiratory tract-based chronic infectious diseases. Tuberculosis has been harmful to human health for thousands of years, and about 10,000 years ago in the Stone Age spine found on tuberculosis. In 1982, Knock found Mycobacterium tuberculosis under the microscope to determine the pathogen of tuberculosis. In 1921, Chalmette and Guerin cultivated attenuated Mycobacterium tuberculosis - BCG, which provided an effective biological agent for specific immunization of tuberculosis. In 1944 Waksman discovered chain toxins, creating a new era of tuberculosis chemotherapy. The implementation of the direct-observation (short-course) (DOTS) program under direct supervision has led to an effective control of the global epidemic of tuberculosis [1].

Tuberculosis epidemics are significantly different in different regions, 95% of tuberculosis patients and 98% of tuberculosis deaths occur in developing countries. According to the WHO Annual Report on Tuberculosis in 2015, the incidence of tuberculosis in sub-Saharan Africa is as high as 290/10 million. The world's 22 high tuberculosis accounts for 80% of the new cases, while Asia, India, China and India accounted for 40% of global tuberculosis cases [2].

Tuberculosis is one of the most common high mortality diseases. It has a significant financial burden on patients and society. Many countries have conducted a large number of studies to assess the economic burden of tuberculosis and have achieved different results. However, the same research is still less in Vietnam. Therefore, the purpose of this study is to outline the economic burden of tuberculosis in the world in order to propose and improve health and social policies.

2. METHOD

Study design

This study was conducted as a systematic review following the PRISMA guidelines [24] to explore the study methodology and the magnitude of the economic burden. The review focused on the economic burden of tuberculosis in Asian countries.

Search strategy

The PubMed database was searched for literature published in English from January 2000 to December 2015. The search strategy was based on a broad combined search string (economic burden* OR cost* OR "cost of illness" [Mesh]) AND ("Tuberculosis" [Mesh] OR tuberculosis).

Inclusion criteria

The selection of eligible articles was performed on the basis of the following inclusion criteria: the papers were original research and provided at least the direct medical cost of tuberculosis.

Exclusion criteria

Studies were excluded if they were not in the health sector or were not human subject research. Non-English full text or poster format, oral communications, or conference papers were not accepted in this review. The articles that show incomplete cost components (provide only drug cost and laboratory cost) or no specific cost of tuberculosis (cost of a group of diseases that includes tuberculosis), or are an economic evaluation study using secondary costing data were also excluded.

3. RESULTS

The search from PubMed found 344 potential papers. We used a filter in PubMed to exclude articles that are not written in English (50 articles), that did not mention humans (3 articles) and were not original research (5 case reports and 87 review articles) and were conducted on Asian countries (another countries) (122 articles). The flow diagram describing the process of the systematic review is provided (figure 1). Of the remaining 77 papers, we excluded 27 articles after reviewing the titles because 12 articles were not conducted on tuberculosis and 15 articles did not include a primary costing study (just discussion or recommendations on tuberculosis and costs). 12 articles were excluded after reviewing the abstract

because 5 articles did not include a primary costing study and 7 articles did not present the specific cost of tuberculosis. Following this, 25 articles were excluded after reviewing the full text because 25 articles were not conducted on Asian countries. Finally, there were 13 papers included in this review.

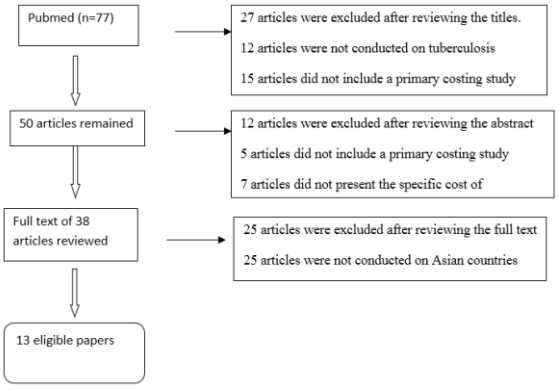

Figure 1: Flowchart of process of the systematic review

In Table 1, Tuberculosis studies were conducted in Asian countries, the main methodologies used in the study are retrospective (n=1; 7.7%), prospective (n=8; 61.5%) and retrospective and prospective (n=4; 30.8%). The results showed that pulmonary tuberculosis (PTB) (n= 5%, 38.5%) accounts for the highest rate followed by all tuberculosis (n=5, 38.5%), pulmonary tuberculosis and extra pulmonary tuberculosis (n=2, 15.4%) and Pulmonary tuberculosis; Extra-pulmonary tuberculosis and Re-treatment (n=1, 7.6%). The 13 articles were conducted for various lengths of time, included 11articles (84.6%) were conducted for less than one year of length, 2 article (15.4%) was conducted more than one year of length. 1 study (7.6%) were conducted for household perspectives, 2 studies were conducted for provider perspectives, 6 studies were conducted for patient perspectives, 3 studies were conducted for provider and patient perspectives, 1 study were conducted for household and patient perspectives. Regarding the sources of data, these included interviews (n=7, 53.8%), medical records (n=2, 15.4 %), medical records and interviews (n=3, 23.1%), hospital electronic databases and medical record (n=1, 7.7%). To provide data on the economic burden of tuberculosis, 2 studies (15.4%) calculated only direct cost, 11 studies (84.6%) calculated direct cost and indirect cost.

Table 1.General characteristics of studies

Characteristics		N	%	Characteristics		N	%
Study location	China	1		**Duration**	≤1 year	11	84.6
	India	4			>1 year	2	15.4
	Malaysia	2		**Type of cost**	Direct cost only	2	15.4
	Myanmar	1			Direct cost+ indirect cost	11	84.6
	Nepal	2		**Source of data**	Interview	7	53.8
	Yemen	1			Medical record and interview	3	23.1
	Tajikistan	1			Medical record	2	15.4
	Vietnam	1			Electronic database and medical record	1	7.7
Study design	Retrospective	1	7.7	**Perspective**	Provider	2	15.4
	Prospective	8	61.5		Household	1	7.6
	Retrospective + Prospective	4	30.8		Patient	6	46.1
Disease/ syndromes	All TB	5	38.5		Provider and patient	3	23.1
	PTB	5	38.5		Household and patient	1	7.6
	PTB, extra-PTB	2	15.4				
	PTB; extra-PTB and Re-treatment	1	7.6				

TB=tuberculosis, PTB=pulmonary tuberculosis; extra PTB=extra-pulmonary tuberculosis

Table 2 and Table 3 show study design and measurement of costs. 11 articles used an incidence-based approach in the study, 2 articles used a comprehensive approach in the study. Regarding the cost calculation method, the bottom-up approach was used in most studies (n=10; 76.9%), the top down approach was used in one studies. The other studies did not mention the approach. For the estimation of direct medical costs, it included personnel cost; physician, and other health care provider fee (n=7), drug and medical supplies cost (n=12), investigation or diagnostic tests (n=9), hospital bed-day costs (n=0). The five studies did not report detail of direct medical cost components. In general, most studies (n=6) estimated the personnel cost using cost at charge, followed by direct measurement (n=1). Unit cost applied in the calculation of drug and medical supplies costs were cost at charge (n=7), direct measurement (n=5). Cost at charge (n=6) was the most commonly used unit cost for investigation cost, followed by direct measurement (n=3). Two studies did not report detail of unit cost for investigation cost. A total of 11 studies estimated the direct non-medical cost covering meal (n=11), transportation (n=11), accommodation (n=1). 10 studies that estimated travel and meal costs, direct measurement of actual expenditure was applied. These indirect costs were estimated based on real lost income (n=11).

Table 2.Study design

Country	Author, year	Study design	Disease/syndromes	Patients	Duration	Currency
China	Pan HQ,2013 [19]	Prospective	PTB	Inpatient and outpatient: aged >15 years	17 months	2011 CNY
India	Muniyandi M, 2005 [17]	Prospective	All TB	Inpatient, outpatient : aged >15 years	5 months	2000 Rs
India	Anathakrishnan R, 2012 [1]	Prospective	PTB, extra-PTB	Inpatient, outpatient : aged >15 years	3 months	2007 Rs
India	John K R, 2009 [6]	Prospective	PTB	Inpatient, outpatient: aged >18 years	3 months	2008 US$
India	Muniyandi M ,2006[16]	Retrospective	All TB	outpatient	1 year	2002 Rs; US$
Malaysia	Elamin E I, 2008 [4]	Retrospective and prospective	All TB	Inpatient: aged>15 years	10 months	2003 US$
Malaysia	Atif M, 2014 [2]	Prospective	PTB	Inpatient :aged>18 years	12 months	2011 MYR, US$
Myanmar	Lönnroth K, 2007 [13]	Retrospective and prospective	PTB, extra-PTB, re-treatment	Inpatient: aged>0 year	10 months	2005 , Kyat

Nepal	Karki DK,2007 [8]	Retrospective and prospective	All TB	Inpatient	9 months	2002, US$
Nepal	Gurung G N, 2012 [5]	Retrospective and prospective	PTB	Inpatient	11 months	2009 US$
Yemen	Othman G Q, 2012 [18]	Prospective	PTB and extra-PTB	inpatient	18 months	2009, US$
Tajikistan	Aye R, 2010 [3]	Prospective	PTB	Inpatient	4 months	2007,PPP, US$
Vietnam	Mauch V, 2013 [14]	Prospective	All TB	Outpatient ; aged >15 years	1 years	2009, US$

Table 3.Measurement of cost

Author, year	Perspective	Approach	Cost component			Data collection method	Unit cost for valuing			Travel, meal	Time cost
			Direct medical cost	Direct non-medical cost	Indirect cost		Personnel	Drug and medical supplies	investigation		
Pan HQ,2013 [19]	Patient	Incidence, bottom up	D	M,T,A	CT	Interview	–	Direct measurement	–	Direct measurement	Real lost income
Muniyandi M, 2005 [17]	Patient	Incidence, bottom up	D	M,T,	CT	Interview	-	Direct measurement	No detail	Direct measurement	Real lost income
Anathakrishnan R, 2012 [1]	Patient	Incidence, bottom up	D,I	M,T,A	CT	Interview	-	Direct measurement	Direct measurement	Direct measurement	Real lost income
John K R, 2009 [6]	Patient	Incidence, bottom up	D,I	M,T,A	CT	Interview	-	Direct measurement	Direct measurement	Direct measurement	Real lost income
Muniyandi M [16]	Provider	Incidence , top down	P,D,I	-	-	Electronic database, medical record	Cost at charge	Cost at charge	Cost at charge	-	-
Elamin E I, 2008 [4]	Provider, patient	Incidence, bottom up	P,D,I	M,T,A	CT	medical record, Interview	direct measurement	direct measurement	direct measurement	direct measurement	Real lost income
Atif M, 2014 [2]	Provider, patient	Incidence, bottom up	P,D,I	M,T,A	CT	Medical record	Cost at charge	Cost at charge	Cost at charge	Cost at charge	Real lost income
Lönnroth K, 2007 [13]	patient	Incidence, bottom up	D,I	M,T,A	CT	Medical record	-	Cost at charge	-	Cost at charge	Real lost income
Karki DK,2007 [8]	Provider cost	Comprehensive	P,D,I	-	-	Medical record, interview	Cost at charge	Cost at charge	Cost at charge	-	-
Gurung G N, 2012 [5]	Household ; patient	Comprehensive	P,D,I	M,T,A	CT	interview	No detail	No detail	No detail	No detail	Real lost income
Othman G Q, 2012 [18]	Patient , Provider	Incidence , bottom up	P,D,I	M,T,A	CT	Medical record, interview	Cost at charge	Cost at charge	Cost at charge	Cost at charge	Real lost income
Aye R, 2010 [3]	Household	Incidence, bottom up	P,D,I	M,T,A	CT	Interview	Cost at charge	Cost at charge	Cost at charge	Cost at charge	Real lost income
Mauch V, 2013 [14]	Patient	Incidence, bottom up	D,I	M,T,A	CT	Interview	Cost at charge	Cost at charge	Cost at charge	Cost at charge	Real lost income

-=not included, P=Personnel cost, physician and other health care provider fee, D=Drug and medical supplies cost, I= Investigation or diagnostic test, B= hospital bed-day costs, M=meal cost, T=transportation cost, A= accommodation cost; CT= caregiver time.

Table 4.Average cost of tuberculosis

Country	Author, year	Direct cost	Indirect cost	Total cost/case	Direct cost in 2015 US$	Indirect cost in 2015 US$	Total cost/ case in 2015 US$	Sensitivity analysis
China	Pan HQ,2013 [19]	1086 CNY	2615.2 CNY	2183 CNY	189	455	380	Multi-way
India	Muniyandi M, 2005 [17]	1101 Rs	1776 Rs	2776 Rs	65	106	164	No report
India	Anathakrishnan R, 2012 [1]	1071 Rs	2140 Rs	3211 Rs	48	95	143	Multi- way
India	John K R, 2009 [6]	34.91 US$	526.87 US$	562.66	64	966	1032	Multi-way
India	Muniyandi M ,2006[16]	30-43 US$	-	30-43 US$	76-108	-	76-108	No report
Malaysia	Elamin E I, 2008 [4]	797.62 US$	118.98 US$	916.4 US$	1072	160	1232	No report
Malaysia	Atif M, 2014 [2]	469.43 US$	257.83 US$	727.26 US$	513	282	795	Multi-way
Myanmar	Lönnroth K, 2007 [13]	23168 Kyat	14188 Kyat	37356Kyat	68	42	110	No report
Nepal	Karki DK,2007 [8]	89.6	-	89.6	239	-	239	No report
Nepal	Gurung G N, 2012 [5]	212.16	114.46	326.62	354	191	544	

Yemen	Othman G Q, 2012 [18]	385.2	124	509.2	675	217	892	No report
Tajikistan	Aye R, 2010 [3]	396	657	1053	738	1225	1964	No report
Vietnam	Mauch V, 2013 [14]	30	728	758	47	1148	1196	No report

Table 4 show average cost of tuberculosis.

From 2000 to 2015, many Asian countries have studied the economic burden of tuberculosis, including China, India, Malaysia, Myanmar, Nepal, Yemen and Vietnam. Research perspectives included provider, patient, household perspectives. Regarding the provider perspective, five studies estimated the cost of TB accounted for a range of $ 76 to $355.65 (2015 value) [2, 3,4, 8, 16], in which the average provider sector cost of treatment for a TB per patient was $325.35 ($355.65; 2015 value) in Malaysia[2], $ 189.5 ($254.76-2015 value) in Malaysia[4], $89.6 ($239-2015 value) in Nepal[8], $30-43 ($76-108 -2015 value) in India [16] and $34 ($59.6-2015 value) for pulmonary TB and $38.8 ($68-2015 value) for extra-pulmonary in Yemen [18].

According to different research perspective have different types of costs. Various costs (included direct costs and indirect costs) were conducted. All studies provided the value of direct cost. The costs were in range of $ 47to $ 1072 (2015 value) [4,14]. In addition, the indirect cost was also an interesting issue in China [19], India [17,1,6], Malaysia [4,2],Myanmar [14], Nepal [5], Yemen [18], Tajikistan [3], and Vietnam [14], in which the indirect cost were in range of $ 42 to $1225 (2015 value) [3,13] .Thus, the total costs(included direct cost and indirect cost) were in range of $76 to $1964 (2015 value) [3,16], in which the total economic burden of tuberculosis in Tajikistan is the highest at $1964[3] and the total economic burden of tuberculosis in India is the lowest at $76[16]. This study shows that the economic burden of TB in different countries is different, because of the different frequency regimens diseases.

For the calculation of indirect economic burden to be divided into different angles: the angle of family and social point of view. From a family perspective, indirect economic burden of disease and loss of working time because of the economic losses caused by; from a social perspective, the economic burden is indirect economic burden of disease on society caused. In Tajikistan, the economic burden of TB is up to $ 1225 in Myanmar is the lowest at $ 42.

Tuberculosis has a significant economic burden on any country. Therefore, health care management should be made an essential social policy that try to control tuberculosis and reduce the economic burden of TB.

4. DISCUSSION AND CONCLUSION

Many studies were found by searching with keywords in the Pub Med database, but only 4% of the articles met the selection criteria. Although many studies used the keywords "cost" or "economic burden" in the discussion or recommendations, they were not primary economic research. Thus, these studies were excluded.

Most of the papers did not provide information on sensitivity analysis and the perspective of the costing study that are essential in an economic study. This affects the quality of the studies. In cost of illness studies, the cost components are the direct medical cost, direct non-medical cost and indirect cost. However, most studies covered only the direct medical cost. Therefore, there is a limitation to the demonstrating of the economic burden incurred by society. This is because of the difficulty of collecting direct non-medical costs and indirect costs from patient or caregiver interviews.

This study has reviewed articles published during the years 2000 – 2015, of which four articles were conducted in India, two articles were conducted in Malaysia, and two articles were conducted in Nepal, in Myanmar, in Yemen, in Vietnam.

The results show a wide range of cost estimates due to country-specific differences in disease management, hospital admission, patient age, patient types (inpatient or outpatient), and the economic and healthcare systems in each country. For example, the costs of TB conducted in Yemen were higher than in Malaysia. For the provider perspective, the costs in Nepal [8] were higher than India [16]. Thus, the total costs (included direct cost and indirect cost) were in range of $76 to $1964 (2015 value) [3, 16], in which the total economic burden of tuberculosis in Tajikistan is the highest at $1964[3] and the total economic burden of tuberculosis in India is the lowest at $76[16].

The review shows that the economic burden of Tuberculosis in Asian countries is high. The results from this study should be used to forecast the cost of treatment, improve budget management. Tuberculosis has a significant economic impact because of its high prevalence. The lack of recent direct or indirect cost estimates in several countries highlights the need for further work in examining the global economic burden of Tuberculosis.

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