Original Article

Prevalence of tuberculosis among children in North Sudan: Are we only seeing the tip of the iceberg?

Wadie M. Elmadhooun, Elmuntasir Taha Salah[1], Sufian K. Noor[2], Sarra O. Bushara[2], Ekhlas O. Ahmed[3], Hamdan Mustafa[4], Amel A. Sulaiman[5], Mohamed H. Ahmed[6]

Department of Pathology, Nile Valley University, Atbara, [1]Department of Paediatrics and Child Health, National Ribat University, Khartoum, [2]Department of Medicine, Nile Valley University, Atbara, [3]National Tuberculosis Control Program, State Ministry of Health, River Nile State, Atbara, [4]National Tuberculosis Control Program, Federal Ministry of Health, Khartoum, Sudan, [5]Department of Community Medicine, Nile Valley University, Atbara, [6]Department of Medicine, Melton Keynes University Hospital NHS Foundation Trust, Melton Keynes, Buckinghamshire, UK

Address for correspondence:
Dr. Mohamed H. Ahmed, Department of Medicine, Milton Keynes University Hospital Foundation Trust, Milton Keynes, Buckinghamshire, UK. E-mail: elziber@yahoo.com

Abstract

Introduction: Tuberculosis (TB) is a significant cause of morbidity and mortality among children. The vague symptoms, the uncertain diagnostic tests and lack of adequate awareness among families all contributed in masking the actual prevalence of the disease. The objective of this study was to describe the epidemiology of childhood TB in River Nile State (RNS), North Sudan. **Methods:** All registered cases of TB aged 15 years and below, at the 13 management units in RNS during 3 years, 2011–2013 were included. The records included epidemiological, clinical, and microbiological data. **Results:** Out of the 1221 total TB notified cases, children were 187 (15.3%); almost equally distributed across the 3 years of the study period. Males were 56.7%. Most of the cases (89.9%) were newly diagnosed; among them, pulmonary TB (PTB) constituted 61.5%. Sputum specimen was tested in 59.4% (111/187) of cases, and only 15.3% (17/111) of specimens were sputum smear positive for new cases. The cure rate was (76.5%), and the treatment success rate was (88.2%). The death rate was 6.1% among PTB cases and 5.6% among extra-pulmonary cases. All the 20 (10.7%) children tested for HIV were negative. **Conclusion:** TB is under-reported in RNS and treatment outcomes are sub-optimal. Strategies to identify the active case-detection among children are recommended.

Key words: Childhood tuberculosis, River Nile State, Sudan

INTRODUCTION

Tuberculosis (TB) is one of the major infections affecting children worldwide.[1] It causes significant morbidity and mortality, especially in infants and young children. However, accurate information on the extent and distribution of disease in children is not available for most of the world.[1,2] Factors such as overcrowding, poverty, and the HIV epidemic have all contributed to the resurgence of TB globally.[2] Indeed, the highest rates of TB occur in resource-poor countries.[3]

Sudan alone carries 11–15% of the TB burden in the Eastern Mediterranean Region of the World Health Organization (WHO).[4] The estimated incidence of new TB cases in 2010 was 119/100,000 populations, and the estimated

Access this article online	
Quick Response Code:	Website: www.jnsbm.org
	DOI: 10.4103/0976-9668.198359

How to cite this article: Elmadhooun WM, Salah ET, Noor SK, Bushara SO, Ahmed EO, Mustafa H, *et al*. Ahmed MH. Prevalence of tuberculosis among children in North Sudan: Are we only seeing the tip of the iceberg?. J Nat Sc Biol Med 2017;8:114-8.

prevalence was 209/100,000 causing an overall death rate of 24/100,000 annually.[4] The exact number of deaths among children is not known, but its important to emphasize that TB is an important disease affecting child survival.[5]

The natural history and clinical expression of infection of TB differ substantially in children compared with adults.[6] It is difficult to confirm the diagnosis of TB by current microbiological methods. Even in industrialized countries, the triad of a positive tuberculin skin test, radiographic and/or clinical manifestations consistent with TB, and establishing a recent link to a known infectious case of TB is the "gold standard" for diagnosis.[7]

Furthermore, poor ascertainment and reporting of cases of TB prevent accurate estimation of the global burden of disease among children. While overdiagnosis is a possibility, the majority of cases is not diagnosed, especially where children with TB can access services only through referral hospitals.[8] It is important to mention that TB in young children indicates recent infection rather than secondary reactivation.[1-8]

The aim of this work was to describe the epidemiology of TB among children in RNS, North Sudan; we believe that, in low-resource settings, such as our country, epidemiological data can be used to monitor TB transmission in the community and to evaluate the effectiveness of the National TB Control programme.

METHODS

Settings

River Nile State (RNS) lies in North Sudan, (32–36° N and 16–22° E), covering an area of 124,000 km^2, and the population is about 1,250,000 composed of different ethnic groups. The most important cities are Ed Damer, Atbara, Shendi, Berber and Abu Hamad. There are seven working TB Management Units (TBMUs), integrated within the general health system and distributed over the seven localities of the state, staffed with medical and nursing personnel, and social workers. TBMUs are the institutions where suspected TB patients are diagnosed and treated.

Data collection tools

Data were collected from the TB records, at the TBMUs. The records included the following epidemiological, clinical, and microbiological data: Name, age, sex, residence, centre of diagnosis and management, referral source, date of presentation, site of the disease, signs and symptoms with duration, whether new or re-treatment case, sputum microscopy tests initially and periodically, other diagnostic methods, treatment category, time of sputum conversion, treatment outcomes, and HIV status. In RNS, TB is diagnosed using a combination of a patient history, physical examination, and diagnostic tests, including sputum microscopy, chest X-ray, and tissue samples.

Data analysis

A descriptive analysis for the selected variables was performed using SPSS computer program version 20.0 (IBM Statistics, Chicago, IL). The frequency distribution of the different variables and the percentages of cases with data on these variables was calculated. Age was characterized by mean and standard deviation. $P < 0.05$ was considered statistically significant for comparing proportions.

Ethical issues

Ethical approval was obtained from the Ethical Committee of the Faculty of Medicine and Health Sciences, Nile Valley University.

RESULTS

During the 3-year period of study, 187 children (15 years and below) were registered in the records of the TB control program in RNS, out of the 1221 total cases during the same period, representing (15.3%). Almost equal number of cases were diagnosed every year, 62, 60, 65 in the years 2011, 2012, and 2013, respectively. This distribution gives a rough case notification rate of 5/100000 population. Males constituted 56.7% with a male to female ratio of 1.3:1. Seven TMBUs cases were diagnosed. However, most cases in this study, 53.5% (100/187) were diagnosed in Atbara center [Table 1]. Concerning the type of patients at the start of treatment,

Table 1: Sociodemographic characteristics of registered children with tuberculosis in River Nile State, Sudan 2011-2013 (*n*=187)

Characteristic	Variable	*n*	Percentage
Sex	Male	106	56.7
	Female	81	43.3
Age group (years)	<1	13	7.0
	1-2	42	22.5
	>2-<5	32	17.1
	5-10	53	28.3
	>10	47	25.1
Residence by locality	Atbara	37	19.8
	Eldamer	62	33.2
	Berber	46	24.6
	Shendi	33	17.6
	Abu Hamad	9	4.8
TBMU center	Atbara Teaching Hospital	100	53.5
	Eldamar Hospital	14	7.5
	Berber Hospital	29	15.5
	Abu Hamad Hospital	6	3.2
	Kaboushia Hospital	3	1.6
	Alketyab Hospital	4	2.1
	Shendi Hospital	31	16.6

TBMU: Tuberculosis management unit

89.9% (168/187) were new TB cases, 3.2% (6/187) were relapses, and only one case (0.5%) was a defaulter [Table 2].

Pulmonary TB (PTB) cases were 61.5% (115/187) and extra-pulmonary cases were 38.5% (72/187).

The total number of children tested for sputum were 59.4% (111/187); among them, only 15.3% (17/111) were sputum smear-positive new cases and 84.7% (94/111) were new sputum smear-negative cases.

The treatment outcome for children was displayed in Table 3. However, due to the limited number of new sputum smear-positive cases, all indicators of the control program were sub-optimal. When considering the WHO indicators for the assessment of the control program outcomes that takes into account only new sputum smear-positive cases as a denominator; the cure rate was (76.5%), and the treatment success rate was (88.2%). For comparison, when considering the whole cohort of PTB cases, the cure rate was 12.2%, and treatment completion rate was 63.5%.

The death rate was 6.1% among PTB cases and 5.6% among extra-pulmonary cases [Table 3]. All 20 (10.7%) children tested for HIV were negative.

DISCUSSION

TB is one of the greatest challenges for all health authorities across the globe. In this study, among the 1221 total cases of TB reported in RNS, children were 187 (15.3%). It is to be mentioned that globally, the WHO estimated the prevalence of childhood TB is around 6% of total cases.[9] Our finding is higher than the reported global burden of TB in children. For instance, among the 4,452,860 new cases reported in 2010 by the 22 countries with the highest burden of TB, only 157,135, (3.5%) (range, 0.1–15.0%), of the cases were children. There is general agreement in literature that the best estimates suggest that children account for approximately 11% of the burden of disease from TB.[1,7] In addition, it is estimated that only 50% of cases of childhood TB was notified to the National Control programmes. This low notification rate was attributed to many factors, including the nonspecific symptoms in children, the uncertain diagnosis, poor accessibility to health facilities, poverty, and unawareness among families.[10] It is plausible to suggest that these same factors are also contributing to the high incidence of childhood TB expected in Sudan and to the low reporting rate as well.

To overcome this obstacle, the WHO launched the "roadmap for childhood TB" to improve case-detection, diagnosis, and treatment outcome, and also advocates for better commitment and accountability at all levels of the health system and the community.[11] In this context, active case finding activities of proven yield included:

Table 2: The clinical characteristics of children with tuberculosis in River Nile State, Sudan 2011-2013 (*n*=187)

Characteristic	Variable	*n*	Percentage
Type of patient at start of treatment	New TB case	168	89.8
	Relapse	6	3.2
	Transferred	3	1.6
	Defaulter	1	0.5
	Other types*	9	4.8
Site of TB involvement	Pulmonary	115	61.5
	Extra-pulmonary	72	38.5
Sputum positive for AFB (for PTB cases)		23	12.3
Symptom	Cough	102	54.5
	Fever and sweating	115	61.5
	Chest pain	1	0.5
	Loss of weight	26	13.9
	Diarrhea	18	9.6
	Lymphadenopathy	21	11.2
	Cold abscess	3	1.6
	Other symptoms+	23	12.3
Duration of symptoms	<1 week	7	3.7
	2 weeks	19	10.2
	3 weeks	16	8.6
	1 month	57	30.5
	6 weeks	11	5.9
	2 months	40	21.4
	3 months	21	11.2
	1 year	8	4.3
	>1 year	8	4.3

*Other types include: (1) Symptomatic cases, sputum negative, has been previously treated; (2) patients not known treated or unknown outcome, or returned to treatment from PTB negative or extra-pulmonary TB, +Other symptoms include: Discharging sinus, abdominal pain general ill-health, etc., AFB: Acid fast *Bacilli*, PTB: Pulmonary TB, TB: Tuberculosis

Table 3: Treatment outcome of children with tuberculosis in River Nile State, Sudan 2011-2013 (*n*=187)

Characteristic	Variable	*n*	Percentage
Treatment outcome for the new smear-positive pulmonary TB cases (*n*=17) based on WHO criteria	Cure	13	76.5
	Completed treatment	2	11.8
	Treatment success rate	15	88.2
	Default	1	5.9
	Transferred	1	5.9
Treatment outcome for the whole study group of TB cases (*n*=187)			
Pulmonary TB cases (*n*=115)	Cure	14	12.2
	Completed treatment	73	63.5
	Died	7	6.1
	Default	17	14.8
	Transferred	4	3.5
Extra-pulmonary TB cases (*n*=72)	Cure	0	0
	Completed treatment	54	75
	Died	4	5.6
	Default	7	9.7
	Transferred	7	9.7

TB: Tuberculosis, WHO: World Health Organization

Household contact screening, private-public mix services, mobile health chest maps, community home-based care visits, and screening of children at school in addition to safe motherhood health services.[10]

It is to be mentioned that age *per se* has an important impact in the natural history of disease progression. For instance, in our study, children < 2 years were minority (7.6%) when compared to those more than 5 years (45%). This finding has been attributed to the natural history of TB in children which differs substantially in the two age groups.[12] Primary infection before 2 years of age frequently progresses to serious disease within the first 12 months without significant prior symptoms. Whereas primary infection between 2 and 10 years of age rarely progresses to serious disease, and such progression was associated with significant clinical symptoms. In children aged more than 3 years, the presence of symptoms represented a high chance to establish a clinical diagnosis before serious disease progression. Primary infection after 10 years of age frequently progresses to adult-type disease.[13]

In this study, cough was reported in 54.5% while fever and sweating were reported in 61.5%. It has been stated that with airway involvement, the usual presenting symptom is a persistent, nonremitting cough that is unresponsive to the treatment for the likely alternative causes.[13] Clinical signs are often subtle, and no diagnostic scoring system has been adequately verified.[14]

The duration of symptoms varies, but most cases (96.3%) run a chronic coarse (more than 2 weeks) before establishing diagnosis while only (3.7%) were diagnosed within 1 week duration. This delay could be explained by the natural history of TB and both the variations in susceptibility to disease and the diverse spectrum of clinical manifestations observed in children due to the sequence of events that follows primary infection with *Mycobacterium tuberculosis*.[13]

Microscopical examination of sputum for bacteriologic confirmation was only used in (27.3%) of the studied children; this could be due to the difficulty of collecting spontaneously produced sputum in children. In addition, a gastric aspiration that needs training, and hospital setting was not feasible at the diagnostic centers in our settings. DOTS/STOP TB strategies have been effective epidemiological tools in targeting sputum smear-positive cases in adults. However, children deemed to be ignored as they are unable to produce sputum. Therefore, children contribute very little to transmission within communities.[15-17]

Chest radiography was used in 44.9% of cases as X-ray has always been highly suggestive of a diagnosis of PTB but it depends on technical quality and facilities which are major challenges in developing countries. Another investigation used in the studied children was fine-needle aspiration biopsy, which was used in (5.9%). This technique was proven useful in children with a peripheral lymph-node mass.[18,19]

In our study, we identified PTB in 61.5% of the cases while the remaining 38.5% were extra-PTB. This percentage is less than that reported in South Africa, 76.7% for pulmonary and 25% for extra-thoracic TB while in the USA 73.6% was PTB and 18.7% were extra-PTB.[20,21] These variations may be attributed to disease prevalence as well as the availability of methods of early diagnosis and early notification. Furthermore, many studies highlighted the difficulty in confirmation of the disease in children that resulted in poor reporting, especially in endemic areas with limited resources.[22,23] This poor reporting has been identified as a major factor contributing to the poor treatment indicators.[8]

The outcome of treatment in this study was generally sub-optimal. For the new smear-positive pulmonary cases, the cure rate and treatment completion rate were 76.5% and 88.2% respectively. However, due to the scarcity of new smear-positive cases among children, we also calculated the treatment outcome for the whole cohort, i.e., all cases underwent sputum testing as a denominator and not only the new cases. By doing so, the cure rate and treatment completion rate dropped to 12.2% and 63.5%, respectively.

Despite the fact that children with TB respond well to and tolerate the same basic treatment regimens as used for adults,[7] the situation is sub-optimal in our settings. This was evidenced by the fewer number of children achieving required treatment targets. Here, poor compliance with treatment may constitute a contributing factor.

This study has some limitations. The cross-sectional design may reflect only temporal associations. In addition, a health facility-based study is another limitation that may not allow generalizations to be made about the exact situation in the community. However, with the limited resources in our setting, other alternative ways to survey the community are not feasible. It is possible to consider the small sample size as one limitation of this study; however, this was the total number of cases notified to the control program during study period. It is well reported in literature that diagnosis of TB in children is an ambiguous area[15,23] in addition to problems of data recording in TB registries at TBMUs. Despite these limitations, we assume that this study is the first

of its kind in Sudan, reflecting the epidemiology of childhood TB with special emphasis on the assessment indicators of the control program of DOTS/STOP TB strategies. We recommend further studies to explore the whole picture in our country, hopefully, using "intensified case-detection" strategies.

CONCLUSION

The epidemiology of childhood TB in RNS as in many other developing countries is masked by many factors that result in low case-detection rate, poor ascertainment of diagnosis, and sub-optimal treatment outcome.

Acknowledgment

we are thankful to the Swiss Embassy for financing this work. Our thanks are extended to the administrators and statisticians at the State Ministry of Health, RNS for their collaboration.

Financial support and sponsorship

This study was partially funded by the Swiss Embassy in Khartoum, Small Action Fund 2013.

Conflicts of interest

There are no conflicts of interest.

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