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Factors Contributing to Low Tuberculosis Detection Rates among Children Accessing Health Services in Selected Public Sector Health Facilities in Zimbabwe

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Abstract

Introduction: Zimbabwe is one of 8 African countries with high per capita incidence of TB, TB/HIV and multi-drug resistant TB. Zimbabwe experienced a proportionate decline in childhood TB contribution to all notifications from 9% in 2011 to 5% in 2017.

Methodology: Analytical cross-sectional study was conducted in 20 public sector health facilities. Data were collected from healthcare workers (HCWs) using structured questionnaires, interview guide for health managers and data abstraction tool for childhood TB data in registers. Protocol received ethical approval and written informed consent was obtained from participants.

Results: Eighty-one HCWs and 18 managers were interviewed; data for 21,791 children were abstracted. About 3.1% of children were screened for TB, and 63.2% of presumptive TB children had TB diagnostic tests. A majority (71.9%) of TB tests were conducted on the Gen Xpert MTB Rif platform. Thirty-one out of 335 children with TB tests were diagnosed with TB, and 93.5% were initiated on treatment. Seven facilities offered TB testing, 5 had TB guidelines and 5 had pediatric TB job aides. Five out of 7 microscopes and 4/7 GeneXpert machines were functional. About 64.1% of HCWs had childhood TB training, 51% had ever received mentorship on childhood TB management, 53.1% had ever collected childhood TB diagnosis specimen and 23.3% had ever initiated children on TB treatment.

Discussion: Childhood TB screening and diagnosis was suboptimal, and this was a result of low healthcare worker capacity, shortage and breakdown of TB diagnostic machines and weak TB diagnostic sample transportation system.

Keywords: ***Factors, Childhood, Tuberculosis, Detection, Diagnosis, Zimbabwe.***

Introduction

Tuberculosis (TB) is the leading cause of mortality from a single infectious agent (WHO, 2018), and the leading cause of death among people living with HIV (Gupta R.K. et al, 2015; Wait C.J. et al, 2011). Approximately 10 million people had TB in 2017, and 1 million were children below 15 years of age. TB is the leading infectious cause of morbidity and mortality among children (Martinez et al, 2018; Jenkins H.E. et al, 2014; Dodd P.J. et al, 2016). In 2017, an estimated 1.3 million HIV negative and 300 000 HIV positive people died of TB (WHO, 2018). About 26% of the global TB cases in 2015 were from the African region (WHO, 2018), and about 70% of all people living with HIV/TB co-infection are in sub-Sharan Africa (UNAIDS, 2018). Although HIV testing and ART coverage among TB patients has significantly improved in Sothern Africa with coverages above 80% and 90% respectively (WHO, 2018; Chimbindi et al, 2015), the average rate of decline in TB mortality has been slowest in the African region (2.2% per year) since 2010.

Zimbabwe is one of the eight countries in Africa that appear in all three World Health Organization (WHO) lists of top 30 countries with high per capita incidence of TB, TB/HIV and Multi – Drug Resistant TB (MDR-TB) (Zimbabwe TB report, 2018). The estimated TB incidence rate in 2015 was 242 cases per 100 000 people, and there were 8, 000 deaths attributed to TB alone (TB prevalence survey, 2014). TB in Zimbabwe is fueled by high HIV prevalence, estimated to be 14.6% among adults aged 15-64 years (ZIMPHIA, 2015-16). HIV is known to make the diagnosis of TB more difficult, and TB

is the leading cause of death among people living with HIV (PLHIV) (Gupta R.K. et al, 2015). Children are at high risk of developing severe and disseminated forms of TB (WHO, 2018).

Childhood TB diagnosis depends on an assessment of available evidence from history of exposure, clinical examination and relevant investigations. Key risk factors for TB in children include household or other close contact with a pulmonary TB patient, age less than 5 years, HIV infection, severe malnutrition and recent measles infection. Zimbabwe national guidelines recommend that All children presenting to health facilities should be screened for TB using a symptom enquiry, history of contact with an individual with TB and a nutritional assessment. All children with a positive symptom enquiry and/or who are under nourished and/or have a positive history of contact with TB and an abnormal chest X-ray should have a specimen obtained and tested for TB using the Xpert MTB/Rif or Ultra assay (Zimbabwe TB guidelines, 2019). Xpert MTB/Rif assay has a high sensitivity and specificity for TB and provides information on rifampicin susceptibility (MSF, 2014). A positive Tuberculin Skin Test (TST) is useful to support diagnosis of TB in children with suggestive clinical features who have a negative bacteriologic test for TB or who cannot produce sputum (Zimbabwe TB guidelines, 2019).

Zimbabwe is failing to meet the WHO recommended target of 10-15% of total TB notifications being children below 15 years of age. Zimbabwe experienced a proportionate decline in the contribution of childhood TB notifications to overall country burden from 9% in 2011 to 5% in 2017 (Zimbabwe TB report, 2018). The low childhood TB detection rates results in underdiagnoses, negative outcomes, increased transmission and high TB prevalence rates (TB prevalence survey, 2014). We explored factors contributing to low childhood TB detection rates among children accessing health services in public sector health facilities in Zimbabwe. Understanding these factors is critical in the design and implementation of childhood TB prevention and management programs, thereby contributing to achievement of national targets in line with the global End TB Strategy (WHO, 2015).

Methods

Study design

An analytical cross-sectional study was conducted in selected public sector health facilities in Zimbabwe. Study participants consisted of healthcare workers (HCWs) in the selected facilities, health managers at provincial and district levels and children aged 0 to 14 years who presented to study sites between 1 January and 31 December 2019 and whose records of clinical services they received were documented in facility registers.

Selection of study setting

The study was conducted in 20 public sector health facilities with high TB notifications across 4 districts. Multi-stage stratified sampling was used to select districts and health facilities.

Sample size determination

Assuming the proportion of healthcare workers confident in collecting non-sputum TB diagnosis specimens in children of 5%, Epi-Info (StatCalc) Version 7 was used to calculate the sample size using the following formula:

Large population sample size: $n= z^2 * p*(1-p)/e^2$

Where n = the sample size required, z = 1.96, p = 0.05 and e = precision = 0.05; the sample size was 73 healthcare workers.

Sampling techniques

All 62 health districts in Zimbabwe were stratified into 3 categories namely urban, rural and boarder areas; only Harare and Bulawayo were considered as urban districts given their large populations. One district was randomly selected from each stratum using the lottery method; a fourth urban district was purposively selected. Health facilities were stratified into two strata namely primary level and referral. One referral and 4 primary level facilities with the highest number of childhood TB notifications in 2018 were purposively selected from each stratum across 3 districts; 2 referral and 3 primary level facilities were selected in the 4th district. All children aged 0 to 14 years who presented at health facilities between 1 January and 31 December 2019 and whose records of TB screening, diagnosis and treatment services they received were documented in registers were selected. All healthcare workers i.e. nurses,

medical doctors, laboratory scientists/technicians, pharmacists and environmental health officers within study facilities and found on duty on the day of data collection were purposively selected. Health managers at provincial and district levels directly involved in the TB program were purposively selected.

Data collection tools, methods and Processes

A structured questionnaire and interview guide were used to collect data from HCWs and health managers respectively; all interviews were conducted at the participants' workstation. A data abstraction tool was used to collect TB screening, diagnosis and treatment services uptake data from facility-level registers.

Inclusion and Exclusion criteria

Table 1. Inclusion and exclusion criteria by participant type

Study participant	Inclusion criteria	Exclusion criteria
Children	All children aged 0 to 14 years presenting at study sites between 1 January and 31 December 2019 and with age and date of clinic visit documented in health facility registers	Clients presenting to study sites without documented age and / or date of clinic visit
Healthcare workers	Healthcare workers working in entry points where children are managed and found on duty on the day of data collection	HCWs working in other departments where children are not managed
Health managers	Provincial and district managers directly involved in TB program management and coordination	Provincial and district health managers not directly involved in TB program management and coordination

Data Analysis

We used Epi Info (Version 7) package to analyse quantitative data from questionnaires and TB management data abstracted from facility registers, generating proportions and measures of central tendency. Responses to open ended questions were recoded as appropriate and analysed quantitatively.

Permission and ethical considerations

The study protocol was reviewed and approved by the Medical Research Council of Zimbabwe (MRCZ/A/2581), and permission was sought and granted by the MOHCC head office, as well as provincial, district and health facility managers. Written informed consent was obtained from all participants, and a waiver of consent was obtained for accessing client records during abstraction of data on childhood TB management.

Results

We enrolled 81 healthcare workers and 18 health managers; 21, 791 children aged 0 to 14 years accessed health services during the period under review of which 56.8% were below 5 years of age, 21.5% were aged 5 to 9 years, and 21.6% were aged 10 to 14 years. A total of 1,166 (5.1%) children had TB data recorded in facility registers. Overall, 27.4% of children with TB data recorded were HIV positive and 36.5% had no documented HIV status. A total of 684 (3.1%) out the 21,791 children who accessed health services were screened for TB. The proportion of children below 5 years, aged 5 to 9 years and those aged 10 to 14 years who were screened was 0.8%, 5.2% and 7.3% respectively. TB screening was significantly higher at referral facilities (6.9%) compared to primary level facilities (1.7%), $p<0.05$.

A total of 530 (77.4%) out of 684 children screened for TB had symptoms presumptive of TB. Sixty-three percent (335/530) of children with presumptive TB had diagnostic

investigations. The proportion of presumptive TB children below 5 years, aged 5 to 9 years and those aged 10 to 14 years who had TB diagnostic tests was 51.2%, 55.8% and 71.4% respectively. About 71.9% (241/335) of TB diagnostic tests were conducted on the Gen Xpert MTB RIF platform and 17.9% were smear microscopy (Figure 1). A total of 31 (9.3%) children with TB diagnostic investigations tested positive. The overall TB positivity rate for Gen Xpert across all age groups was 10.8%, and smear microcopy was 3.3%. Ninety-three percent (29/31) of children diagnosed with TB were initiated on treatment. TB treatment outcomes for 17 out of the 26 eligible children were evaluated; 10 had completed treatment, 4 were cured and 3 died(Figure 2).

Figures and tables

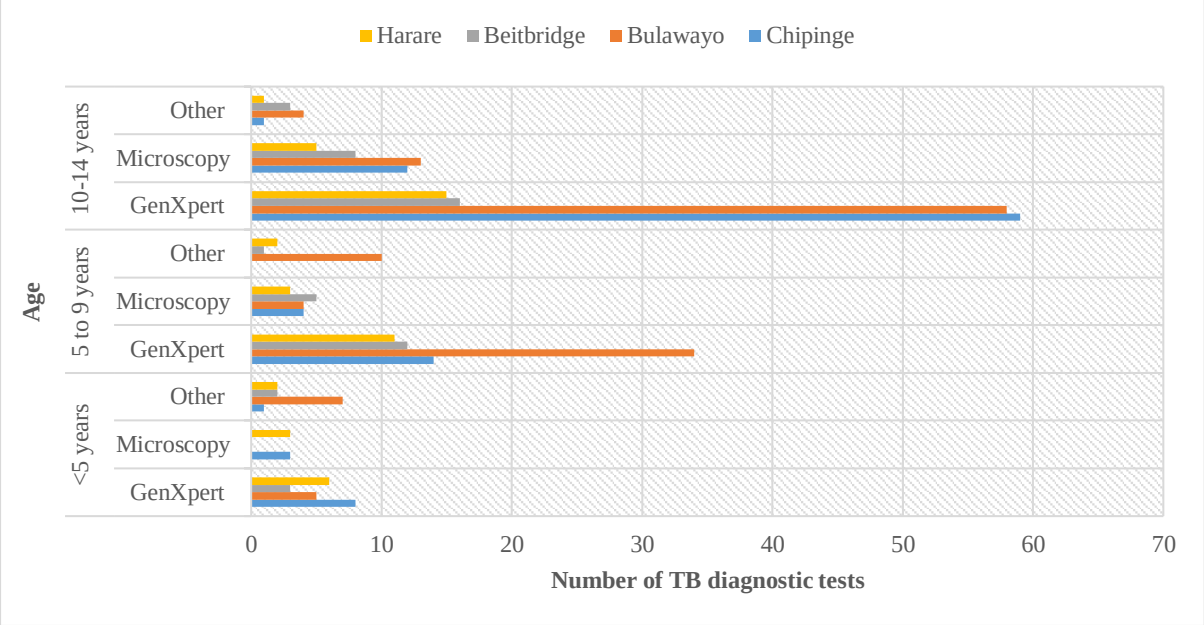

Figure 1. Distribution of TB diagnostic tests by age and district

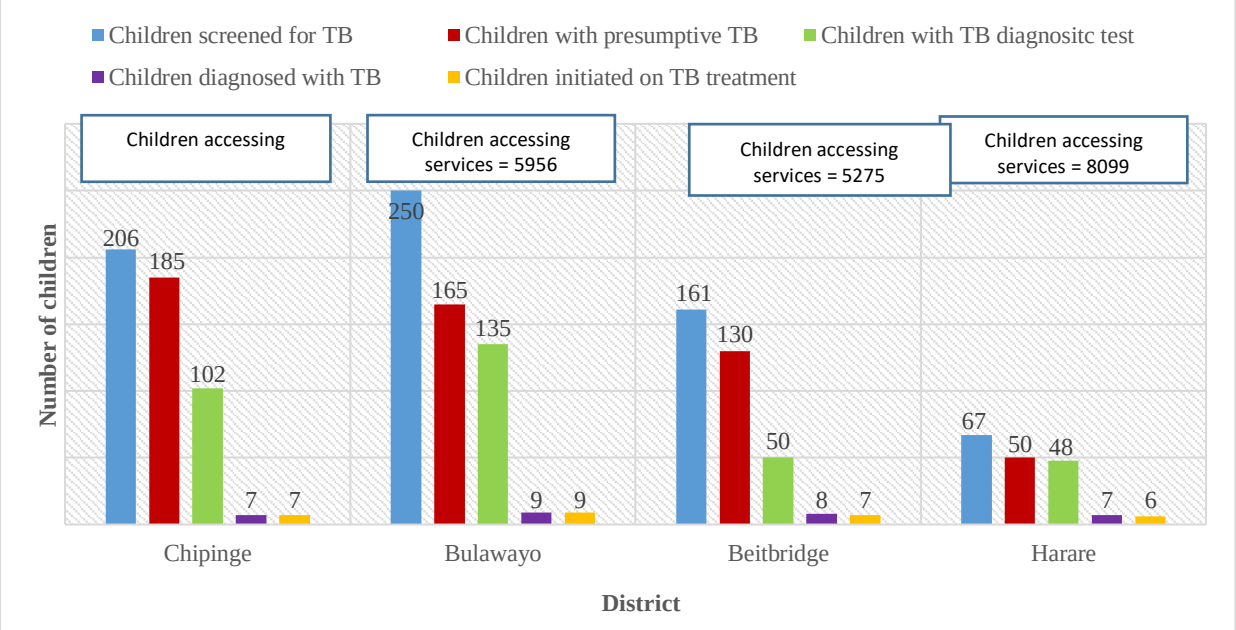

Figure 2. Childhood TB screening, diagnosis and treatment cascade

All 20 study sites offered TB screening, TB treatment, TB preventive services, contact tracing and community follow up of defaulters; 7 facilities offered on-site TB diagnostic testing. Eleven out of 20 study sites had a TB focal person, 9 had a TB committee, all 20 sites had TB infection control policy, 5 had 2019 TB management guidelines and 5 had pediatric TB job aides. Seven out of 20 sites had a microscope for TB diagnosis and 5 were functional, 7 facilities had GeneXpert MTB/Rif machines and 4 were functional, and 5 facilities had functional digital X-ray machines. About 98.7% of HCWs reported that HIV positive children were screened for TB, and 20.9% reported that children paid for chest X-ray. About 85.2% of HCWs reported having first line fixed dose combination TB medicines for children. Ninety percent of HCWs reported that their facilities offered TB preventive therapy (TPT), and of these 84.5% offered 6 months of Isoniazid (INH) and 35 (47.9%) offered 3 months of Rifampicin and Isoniazid (3RH). Ninety-two percent of HCWs had standard TB registers, 95.1% had TB symptom screening tool.

Sixty-four percent of HCWs had received childhood TB training; all of these were trained in TB screening using symptom tool, TB treatment initiation, TB notification and community follow up of treatment defaulters; only 26.9% of HCWs were trained on conducting fine needle aspiration, 59.6% on conducting naso-pharyngeal aspiration, 48.1% on interpreting radiologic films and 69.2% on conducting sputum induction. Fifty-one percent of HCWs had ever received mentorship on provision of childhood TB services, and 72% reported that provision of childhood TB services required additional resources including more HCWs, fuel for TB diagnostic sample transportation, airtime for follow up of patients, incentives for community health workers, current registers and TB forms, pediatric TB diagnostic consumables, job aides, and regular supportive visits from district team (Table 2).

Table 2. Capacity building of healthcare workers for TB management (N=81)

Variable		**Frequency n (%)**
Ever been trained in childhood TB management		52(64.1)
Date of last training in childhood TB management (N=52)	In the last 6 months	37(71.1)
	6 -12 months ago	3(5.7)
	More than 12 months ago	10(19.2)
Aspects of childhood TB management trained on (N=52)	TB screening using symptom tool	52(100)
	Clinical diagnosis of TB	51(98.1)
	Collection of diagnostic specimens using gastric lavage	50(96.2)
	Conducting naso-pharyngeal aspiration	31(59.6)
	Conducting fine-needle aspiration	14(26.9)
	Sputum induction	36(69.2)
	Interpretation of radiologic films	25(48.1)
	TB treatment initiation	52(100)
	Management of TB medicines side effects	50(96.2)
	TB notification	52(100)
	Community follow up of treatment defaulters	52(100)
Ever received mentorship on provision of childhood TB services		42(51.8)
Frequency of mentorship visits (N=42)	Once per month	19(45.2)
	Once per quarter	12(28.5)
	Once every 6 months	1(2.3)
	Other	4(9.5)

	No response	6(14.2)
Ever been involved in training of other health service providers in the provision of childhood TB services		29(35.8)
Health service providers trained (N=29)	Medical doctors	2(6.8)
	Nurses	21(72.4)
	Pharmacists	1(3.4)
	Laboratory scientists/technicians	4(13.7)
	Environmental health officers/technicians	3(10.3)
	Primary Care Counsellors	12(41.3)
	Community health workers	20(68.9)
	Peer educators	1(3.4)
Provision of childhood TB services at this facility require additional resources		59(72.8)

Nearly all (98.7%) HCWs correctly reported that TB was caused by Mycobacteria Tuberculosis, 2.4% correctly reported that TB was transmitted through coughing droplets, and 98.7% wrongly reported that TB was transmitted through shaking hands. Nearly all (98.7%) HCWs correctly cited weight loss, persistent cough for 2 or more weeks and night sweats as TB symptoms. Only 49.4% of HCWs correctly reported that covering mouth when coughing/sneezing prevented spread of TB, and about 46.9% and 44.4% correctly reported that working in crowded and dusty places increased chances of TB infection respectively. Only 35.5% correctly reported that HIV infection increased the risk of developing active TB disease, and 48.1% correctly reported that TB was curable. About 53.1% of HCWs had ever collected a childhood TB diagnosis specimen, and 95.3% of these had collected a sputum, 37.2% had collected a gastric aspirate and only 1 (2.3%) had conducted a fine needle aspirate. Most (92.6%) HCWs had confidence in collecting sputum from older children, 71.6% were however not confident in conducting gastric lavage, 93.8% were not confident in conducting fine needle aspiration and interpreting radiology images. Only 23.3% of HCWs had ever initiated a child on TB treatment (Table 3).

Table 3. Healthcare worker competency in childhood TB screening and diagnosis (N=81)

Variable		**Frequency n(%)**
Ever collected a TB diagnosis specimen from children		43(53.1)
TB diagnosis sample collected (N=43)	Sputum	41(95.3)
	Gastric aspirate	16(37.2)
	Nasopharyngeal aspirate	2(4.6)
	Fine-needle aspirate	1(2.3)
How confident are you in collecting sputum from older children	Not confident	6(7.4)
	Confident	19(23.5)
	Very confident and can teach others	56(69.1)
How confident are you in conducting gastric lavage in children	Not confident	58(71.6)
	Confident	13(16.1)
	Very confident and can teach others	10(12.3)
How confident are you in conducting fine-needle aspiration in children	Not confident	76(93.8)
	Confident	4(4.9)
	Very confident and can teach others	1(1.2)
How confident are you in conducting naso-pharyngeal aspiration in children	Not confident	65(80.2)
	Confident	11(13.5)
	Very confident and can teach others	5(6.2)
	Not confident	76(93.8)

How confident are you in interpreting radiography images in children?	Confident	4(4.9)
	Very confident and can teach others	1(1.2)
How confident are you in interpreting GenXpert MTB/Rif results in children?	Not confident	66(81.4)
	Confident	12(14.8)
	Very confident and can teach others	3(3.7)
Ever initiated a child on TB treatment		36(23.3)

A total of 13 out the 18 health managers had ever received training in childhood TB management. Twelve managers reported that all their health facilities offered childhood TB screening; 3 managers mentioned lack of HCW training as the reason why some facilities did not offer the service. Eight managers reported that some of their facilities did not offer clinical diagnosis of childhood TB; 3 of them mentioned lack of training and confidence of HCWs as the reasons. Only 7 out of the 18 managers reported that all their facilities offer TB diagnostic testing services, with shortage of testing machines (7) and machine breakdown (5) being cited as the major reasons why most sites did not offer the service. Six out of the 18 managers reported that TB diagnosis specimen transportation from peripheral facilities to testing laboratories was not working well; broken down motorcycles, inadequate fuel and staff shortage contributed to dysfunctional sample transportation system. Most managers recommended HCW training (16), structured mentorship (16) and availing symptom screening tools (15) to improve childhood TB screening. Most managers recommended improving supply chain management of TB diagnostic testing consumables (17) and training of ancillary staff (16) in order to improve TB diagnostic testing. Almost all (17) managers recommended HCW training and regular mentorship in order to improve childhood TB treatment initiation.

TB screening among children accessing health services was very low, with only 3.1% of children having been screened. TB screening is the entry point to care and management of TB and should therefore be optimized in all health facility entry points. TB screening was lowest among children below 5 years of age (0.8%) and highest among older children aged 10 to 14 years (7.3%). This indicates that TB screening among younger children was not prioritized by HCWs, and therefore represent missed opportunities for diagnosis of childhood TB. Children below 5 years of age are at increased risk of developing severe and disseminated forms of TB, often with poor treatment success rates and high mortality rates. A study conducted in southern Ethiopia in 2015 showed that under-five children diagnosed with TB had low treatment success rates and high mortality rates (Dangisso et al, 2015). Similarly, a study conducted in Kenya showed that age less than 5 years was one of the major risk factors for mortality among TB patients (Onyango et al, 2018).

TB diagnostic investigations among children presumed to have TB was suboptimal, with an overall uptake percentage of 63.2%, with children below 5 years contributing the least number of those with diagnostic investigations (11.9%). These results are consistent with findings from a study conducted in public health facilities in Kersa District, south west Ethiopia which found that 35.2% of TB suspects did not have requests for microscopic examination of sputum smear (Dabaro et al, 2017). Similarly, a study conducted in Kenya found that only 15% of presumptive TB children had TB diagnostic investigations (Oliwa et al, 2019). The low proportion of younger children with diagnostic tests was largely a result of lack of healthcare worker expertise and confidence in collecting diagnostic specimens such as naso-gastric aspirates, naso-pharyngeal aspirates or induced sputum. These results are similar to findings from a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis conducted in 2016, which cited limited healthcare worker capacity for screening and diagnosis of childhood TB as one of the factors contributing to low childhood TB detection in Zimbabwe (Zimbabwe TB guidelines, 2016-2020). Similarly, a study conducted in south west Ethiopia found that shortage of trained healthcare providers was one of the major factors for low TB case identification (Dabaro et al, 2017). Some of the factors which contributed to low diagnostic rates include unavailability and breakdown of TB testing machines, and shortage of fuel and

broken-down motorbikes which affected diagnostic sample transportation. Unavailability of TB guidelines and job aides meant that HCWs did not have reference materials for childhood TB management. Most TB tests were on the Gen Xpert MTB RIF platform, in line with national guidelines. Patients paid for chest X-rays and this was a bottleneck to childhood TB diagnosis given that most caregivers cannot afford.

Overall treatment initiation among children was high (93.5%). Interventions to improve TB management should therefore target screening, and collection and testing of specimens from all presumptive TB children. Ascertainment of TB treatment outcomes was suboptimal, and might result in children continuing to take TB medicines beyond the recommended treatment periods. TB preventive therapy (TPT) services were almost universally available, and some facilities offered 3 months of Rifampicin and Isoniazid, one of the shorter, safer and affordable TPT regimens recommended by the WHO (WHO, 2020).

Slightly over 60% of HCW had received childhood TB management training, posing a challenge given the high staff rotation and attrition in Zimbabwe's public health sector. A majority of HCWs were not trained in collection of non-sputum samples, and this is likely a result of some clinical policies; these procedures have traditionally been reserved for medical doctors so nurses and other HCWs were not prioritized with trainings. Training of nurses will enable task shifting from doctors, decentralization of services and optimization of childhood TB diagnosis. Slightly over half of HCWs had received mentorship on childhood TB management. Clinical mentorship is one of the capacity building initiatives recommended by MOHCC. A study conducted in 2015 found a significant improvement in skills and expertise of nurse mentees for ART initiation after going through a structured clinical mentorship program (Muchedzi et al, 2015). Such an approach, if replicated for TB management, may result in improved childhood TB detection.

Overall HCWs were knowledgeable about causes of TB, however only 2.4% reported that TB was transmitted through coughing droplets, and 98.7% reported that TB was transmitted through shaking hands. Understanding the correct mode of transmission is important as it is the basis for instituting prevention measures within facilities and communities. HCWs are often the only reliable source of information about TB prevention, diagnosis and treatment especially in remote rural communities. Less than 40% of HCWs correctly reported that having HIV infection increased the risk of developing active TB disease. This is worrying as TB is the major cause of mortality among PLHIV, more so in Zimbabwe where up to 80% of TB patients are co-infected with HIV. Only 48.1% of HCWs correctly reported that TB was curable; this is concerning as misinformed communities (from HCWs) may perpetuate stigma and discrimination of those diagnosed with TB. It also affects overall management of TB patients, especially correct ascertainment and documentation of treatment outcomes. Most HCWs were not confident in collecting non-sputum TB diagnosis specimens; HCWs are more likely to conduct clinical procedures they are confident to perform, implying that younger children who have challenges expectorating sputum were less likely to have TB diagnostic samples collected. Slightly over 50% of HCWs had ever collected a childhood TB diagnosis specimen, and more than 75% had never initiated children on TB treatment; demonstrating gaps in childhood TB diagnosis and treatment. These findings are similar to those from a study conducted in Botswana in 2017, which showed that poor healthcare worker knowledge about TB and limited diagnostics at health facilities were major barriers to childhood TB diagnosis (Arscott-Mills T et al, 2017).

Conclusion

This study revealed that TB screening and diagnosis among children accessing health services at public sector facilities was very low, and children below 5 years of age had the lowest TB screening and diagnosis rates, despite this age group contributing most of the children presenting to health facilities. HIV testing among children with presumptive TB symptoms was suboptimal, with 36% of them having no documented HIV status. Availability of TB diagnostic testing services and infrastructure was suboptimal, with most health facilities not offering on-site TB diagnostic testing coupled with a weak TB diagnosis sample transportation system between peripheral facilities and testing laboratories. Provision of TB diagnosis services followed the national TB management

guidelines, with most diagnostic tests conducted on the Gene Xpert MTB Rif platform. Although the Zimbabwe national TB control guidelines recommend that all TB services should be offered free of charge in public sector facilities, patients paid for chest X-rays and this contributed to low TB diagnosis among children. There were high TB treatment initiation rates among children diagnosed with TB, but suboptimal ascertainment of childhood TB treatment outcomes.

Most healthcare workers had suboptimal knowledge about the modes of TB transmission and TB preventive measures. In addition, HCWs had suboptimal capacity to screen for and collect TB diagnostic samples among children, and this was largely a result of a substantial proportion of them not receiving training and mentorship in childhood TB management. Provision of childhood TB diagnostic services was negatively affected by low healthcare worker capacity, shortage and breakdown of TB diagnostic machines, weak TB diagnostic sample transportation system, and unavailability of TB management guidelines, standard operating procedures and job aides.

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