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# Paediatric Tuberculosis in Bhopal, Madhya Pradesh, India: DOTS, Diagnosis, and Determinants

Emma Klein

*SIT Graduate Institute - Study Abroad*

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# Paediatric Tuberculosis in Bhopal, Madhya Pradesh, India: DOTS, Diagnosis, and Determinants

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India: Public Health, Policy Advocacy, and Community

Spring 2016

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## **Glossary of Acronyms**

AIIMS: All-India Institute of Medical Sciences

ANM: Auxillary Nurse Midwife

ATT: Anti-Tuberculosis Therapy

BCG: Bacille Camille-Guerin

CB-NAAT: Cartridge-Based Nucleic Acid Amplification Test

DMC: Designated Microscopy Center

DTC: District Tuberculosis Center

DOTS: Directly Observed Treatment Short-Course

DTO: District Tuberculosis Officer

HIV: Human Immunodeficiency Virus

JPH: Jay Prakash Hospital

MDR: Multiply Drug Resistant

MO: Medical Officer

MP: Madhya Pradesh

RNTCP: Revised National Tuberculosis Control Programme

SEAR: South-East Asia Region

TB: Tuberculosis

TBHV: Tuberculosis Health Visitor

TU: Tuberculosis Unit

WHO: World Health Organization

## **Abstract**

Tuberculosis (TB) is one of the world's largest public health challenges, and it has a disproportionate impact on India. In children, TB is a serious but understudied illness due to the complexity of case-notification and relative lack of public health importance. This study took place over the course of one month in Bhopal, Madhya Pradesh, India. In a mixed method study consisting of 53 quantitative patient interviews and qualitative interviews with healthcare providers, social determinants of TB in this setting were investigated as well as challenges faced at all stages of healthcare delivery. Malnutrition and housing were the most severe determinants of paediatric TB, though socioeconomic status, age, and household contacts also played a role. Diagnosis continues to be a challenge for healthcare providers. Overall, DOTS and the RNTCP is an effective public health program to address paediatric TB, but to reduce incidence interventions on determinants need to be prioritized.

## Introduction

### Global and Indian Status of Paediatric TB

Tuberculosis (TB) is counted among HIV and malaria as one of the world's most severe infectious public health challenges. TB is caused by bacteria of genus *Mycobacteria*, usually *M. tuberculosis*, and usually results in pulmonary disease, whose symptoms include chronic cough, fever, and weight loss. The burden of TB lies disproportionately on low- and middle-income countries, with 22 high-burden countries responsible for over 70% of TB cases worldwide<sup>1</sup>. The South-East Asia region (SEAR) accounts for an estimated 38% of the global TB incidence; nearly two-thirds of these cases are from India<sup>2</sup>. India has the highest burden of TB of any nation, due to its huge population and development status. However, it performs slightly above average in terms of incidence, prevalence, and mortality rates in the SEAR, which attests to the efficacy of the RNTCP despite the scale of the problem. An estimated 10% of India's TB caseload occurs in paediatric patients, due to its young population, which is defined by the WHO as TB occurring in persons between 0-14 years of age. Though paediatric TB is often neglected in national and international academic work, policy, and awareness campaigns, several improvements are underway to improve case-detection and care for children with TB in India. In Madhya Pradesh, the site of this study, 1,00,034 cases of TB were registered for treatment in 2015, a case-notification rate of 131 per lakh population. Of these, 8,395 or 10% were paediatric patients<sup>3</sup>.

In India, several policies are in place by the RNTCP to address paediatric TB. The most well-known and widely used of these strategies is the broad implementation of the

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<sup>1</sup> Swaminathan 2010.

<sup>2</sup> WHO 2015.

<sup>3</sup> India, Ministry of Health and Family Welfare, 2015.

Bacille Camille-Guerin (BCG) vaccine. This is an immunization delivered to children throughout India at birth, with estimated 91% coverage<sup>4</sup>. The BCG vaccine does not prevent all forms of TB; instead, it protects children from severe, highly disseminated forms of TB such as tubercular meningitis. It reduces mortality from paediatric TB but has little impact on public health indicators such as incidence and prevalence. As children age, the RNTCP recommends chemoprophylaxis to all children who are less than 6 years of age or are immunocompromised and have a known contact with TB as a preventative measure. For treatment, government clinics have pre-packaged boxes of drugs, incremented by weight, which are provided for children with a TB diagnosis. This allows for 4 weight categories, incremented by 6kg, for children of weights up to 30kg, at which point adult treatment is recommended. Children are treated under Directly Observed Treatment Short-course (DOTS) protocol as are adults; however in paediatric patients the mothers can be trained as DOTS providers to reduce strain on the family and ensure quality care for the child. If this is undesirable, the community DOTS providers, often ASHAs or other community health workers, are also trained to address paediatric TB cases. If convenient and desired by the family, the DOTS providers are able to deliver the anti-tuberculosis therapy (ATT) to the family's home.

Despite these policies, the country still faces significant challenges in addressing paediatric TB. Though estimates for the burden of paediatric case burden are around 10% of all TB in India, only about 6% of reported TB cases are paediatric. This ratio hasn't changed for the past several years, indicating both systemic underreporting and a lack of improvement. It's likely that many of these cases are handled in the private sector, but

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<sup>4</sup> UNICEF, 2015.



integration into government reporting services has been slow. Swaminathan and Sachdeva identify seven key issues pertaining to childhood TB in India: integration of TB services with the general health system, training of medical professionals, improving diagnosis, screening of high-risk children, contact screening and chemoprophylaxis, treatment, and drug-resistance<sup>5</sup>. The first two points, integration and training, will help to extend coverage for TB to children who may not have access to TB centers or specialists. Paediatricians are almost always the first medical professional to encounter sick children, so it is imperative that they are trained in identification and diagnosis of paediatric TB. In addition ANMs and ASHAs could play an important role in expanding identification and treatment of impoverished children who have TB. Surprisingly, not all children in malnutrition wards are screened for TB despite the increased risk, which could be a key area for improvement. Diagnosis in India has been vastly improved since the introduction of cartridge-based nucleic acid amplification test (CB-NAAT), a fast molecular biology diagnostic tool whose use has expanded in India in the past few years. This not only speeds diagnosis, it is also able to identify some of the resistance genes allowing for rapid detection of MDR strains. This technology has been prioritized for paediatric cases. Access to this tool is limited to tertiary-level care providers, so a continued expansion of the use of this technology as well as training on laboratory sanitation techniques is imperative. Chemoprophylaxis is an area in which India can improve, as 35-70% of eligible children did not receive this preventive treatment<sup>6</sup>. Notably, none of the efforts mentioned in Swaminathan and Sachdeva's article mention social determinants, beyond family contacts. General improvement and expansion

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<sup>5</sup> Swaminathan 2015.

<sup>6</sup> Swaminathan 2015.

of India's public health sector would likely address many of the missing paediatric TB cases.

### Social Determinants of Tuberculosis

Despite its historical connotation as a disease of poverty, current WHO guidelines rely almost entirely on medical techniques to prevent TB. This is contradictory to historical example; in Europe, sanitation and housing programs in cities led to the decline of TB incidence long before the innovation of pharmaceutical interventions<sup>7</sup>. These strictly medical interventions are mirrored in India's RNTCP, whose TB control activities rely mainly on DOTS treatment. Though implementation of DOTS has been effective in treating ill patients and reducing prevalence of TB worldwide, incidence rates are stagnant, illuminating the need to address the underlying social factors that contribute to disease. At the global level, social determinants of TB can be separated into two broad classifications: differential access to quality diagnosis, treatment and care; and differential risk of TB exposure, infection and progression to disease<sup>8</sup>. The former category includes social factors such as poverty, stigma, low awareness and education, financial and structural barriers such as poor geographical coverage and low government health expenditure, and unequal distribution of and access to social welfare programs. The second category includes poverty, poor or nonexistent housing, urbanization, unhealthy lifestyle, and co-morbidities including HIV, malnutrition, and non-communicable diseases. This split in social determinants of disease conveniently mirrors agencies that should be responsible for addressing each set of determinants – the first category handled by national tuberculosis

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<sup>7</sup> Lonnoth 2009.

<sup>8</sup> Rasanathan 2011.

programs (in India, RNTCP) and the second category by broader Ministry of Health and social welfare ministries.

Though it has long been assumed that “...the epidemiology of childhood tuberculosis follows that in adults,”<sup>9</sup> there is emerging evidence that greater research needs to be done on determinants in children for effective interventions at that level. Little of the literature on social determinants mentions children or women, and this neglect is something that must be addressed. Children are at higher risk for malnutrition than adults and it affects their immune systems much more severely, so this determinant needs greater attention in paediatric populations. Additionally, household and community crowding and proximity to infectious adults have greater impact on children due to their inability to travel far from their homes. Because of this, indoor air pollution may have a larger impact on children as well. However, none of this is as well-established as in adult populations, and “more studies are needed in low-income countries to examine specific risk factors for TB in children.”<sup>10</sup>

### Field Study Objectives

This study aims to discover the status of paediatric tuberculosis in Bhopal, Madhya Pradesh, India. It aims to illuminate the factors that increase children’s vulnerability to TB infection and reduce their access to treatment. Social determinants of TB are well-studied, but much of the existing literature excludes paediatric patients. Children are a particularly vulnerable segment of society so it is especially important to put a strong focus on their health. In addition, the TB status of children is a good indicator of community health, so fully understanding childhood TB will lead to generally improved TB prevention in a system with effective contact-tracing. This study will contribute to the body of knowledge

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<sup>9</sup> Kabra 2004.

<sup>10</sup> Nelson 2004.

regarding root causes of TB in children such that community-level interventions can be more effective. With this purpose in mind, this study will also investigate current interventions with respect to paediatric TB in Bhopal and in MP. In short, this study aims to answer the following questions: Which factors contribute most significantly to paediatric TB in Bhopal, and how could they be best addressed? What are the greatest challenges for effective diagnosis, treatment, and prevention of paediatric TB? Where are the gaps in coverage of intervention on behalf of paediatric TB patients and how could those be addressed?

## Methodology

### **Setting**

Madhya Pradesh is the second largest state and is situated in central India. Bhopal district is centrally located within this state, with population of 2.53 million and is predominantly urban, holding the city of Bhopal, capital of Madhya Pradesh. RNTCP infrastructure in Bhopal district includes one District TB Centre (DTC), five sub-district level programme management units (Tuberculosis Units - TU) and 27 designated microscopic centres (DMCs) for sputum acid-fast bacilli examination. Among 27 DMCs, 6 are located in medical colleges, 1 in district level hospital and 20 in primary/secondary level health centres. Each DMC is staffed by a tuberculosis health visitor (TBHV) whose job involves registering patients and overseeing the DOTS program in his/her DMC. The treatment of individual patients is supervised by DOT providers, usually community health workers trained in the DOTS regimen, to ensure appropriate and complete treatment. They act as link between the formal health system and the community for treatment of TB; they are expected to provide supervision for the treatment duration and counselling services, as well as facilitate scheduled sputum examination and screening of household contacts of an

index case if needed. In addition, in the treatment of paediatric TB the mother of the patients is permitted to register as a DOT provider for her child, in order to ease the burden on the family and ensure high-quality care for the child. Patients are referred to the DOTS program for treatment by physicians after diagnosis of TB. In paediatric patients, the referring physician is a paediatrician, usually from the government healthcare system though private sector participation in RNTCP is increasing in Bhopal district.

This study was conducted over a span of four weeks in two Bhopal district TUs: Jay Prakash Hospital (JPH) and District Tuberculosis Center (DTC). These two TUs are both urban and include a combined 13 DMCs, at which the study was conducted. The study population was all paediatric TB patients registered in these two TUs in the first quarter of 2016. This totaled 63 registered patients. With permission from DTO Dr. Manoj Verma and cooperation with TBHVs at each DMC, information was gathered about the study population. In addition, qualitative interviews were conducted with select patients, DOT providers, TBHVs, doctors, and other relevant health-sector employees in the areas covered by the selected TUs.

### **Study Design**

The quantitative portion of this study relies on questionnaire responses from the families of paediatric patients from the study population. This questionnaire is attached as Appendix 1. This is meant to probe for demographic information about the patients and their families correlated to known social determinants of TB in adults and children. Basic information regarding the child's illness as well as experiences with and accessibility to government services will also be collected. Lacking a control population, this study will instead rely on knowledge from previous literature and public census data for

comparisons. These interviews largely occurred at the DMCs at which patients were registered. Patients were requested to come to the DMC by the TBHV, where informed consent was obtained and the interview was conducted in Hindi. Some interviews were conducted at the patients' homes, escorted by a DOT provider and with permission from the family. This was not widely attempted out of respect for the privacy of patients and their families. A select number of interviews were conducted over the phone for patients who were otherwise unreachable in order to increase the yield. A total of 53 patients were interviewed for the quantitative portion of this study.

The interview respondents are the escorts of the patients to the DMC on the date on which that interview was conducted. Usually, this was the parents of a patient. Sometimes, a patient was accompanied by another family member, such as an older sibling, aunt, uncle, or grandparent. A handful of patients were escorted by community health workers or other third parties. Some responses to the questionnaire were obtained directly from the RNTCP registration card of patients. Most notably, patient's weight was sometimes from the most recent addition to their registration card, sometimes taken at the time of the interview on an available scale, and sometimes estimated by the parents. This was variable depending on DMC, since easy access to the card was only available in some areas. All responses are subject to the knowledge and biases of the respondents; in particular reports of TB contacts in the household and community and income are highly subject to bias.

In addition, this quantitative data is supplemented by qualitative data taken from in-depth interviews and personal observations. Some families were identified for further questioning during the questionnaire process based on their apparent knowledge, interest,

and willingness to share on the topic of their child's illness. These families were asked to participate in a longer, in-depth interview with open-ended questions probing their experiences with their child's illness, including challenges in accessing diagnosis and treatment services, financial and social barriers to care, and narratives of how the illness has affected their family. The interview guide for families of patients can be found in Appendix 2. This is intended to show the personal and human challenges faced by paediatric TB patients and their families, as well as illuminate knowledge about the illness. In-depth interviews were conducted with 1 pulmonologist, 3 paediatricians, 1 medical officer (MO), 3 TBHVs, 1 DOT provider, and 1 private pharmacist. These interviews focused on the challenges faced in adequate case-finding, diagnosis, and treatment, including adherence, from the medical perspective, as well as public health challenges faced by health workers. This interview guide for healthcare providers can be found in Appendix 3. Medical professionals should be able to illuminate any particular challenges in dealing with paediatric TB that the researcher may have overlooked, as well as providing information about interventions currently prescribed by the Revised National Tuberculosis Control Program (RNTCP). The integration of the knowledge of medical professionals with the experiences of the patients is intended to give a complete snapshot of the challenges in addressing paediatric TB in Bhopal.

## **Social Determinants of Paediatric TB**

### Background Data

All participants in this study were of 18 years of age and consented to be interviewed for the purpose of this work. A total of 53 patients' families were interviewed

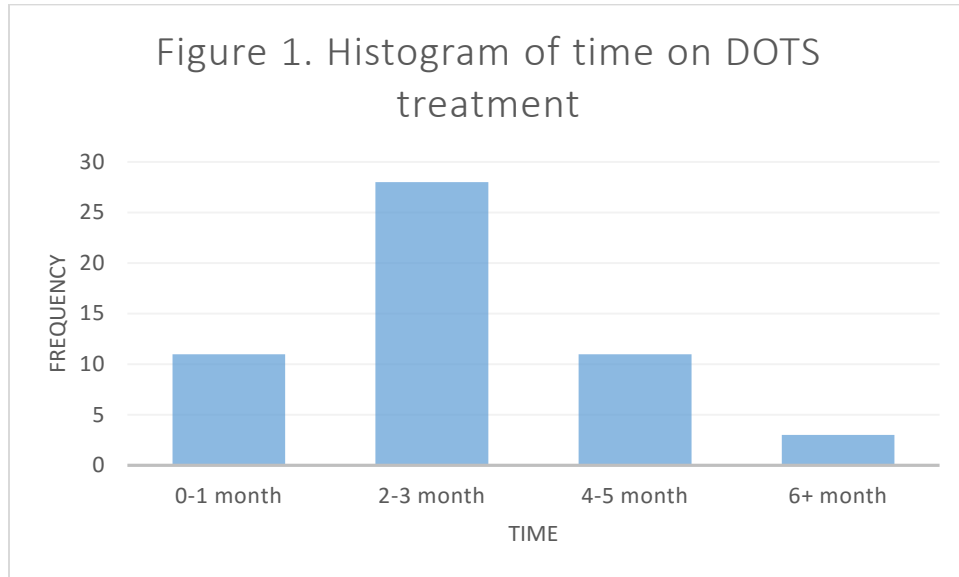
between 18 April and 7 May 2016. The patients were spread across 13 DMCs in Bhopal city. All were undergoing treatment under the RNTCP and were within the purview of the government healthcare system. Most patients were undergoing category I treatment under DOTS, which is for newly registered patients. A few patients were taking category II treatment, which is for relapse, treatment failure, or other cases where the first course did not work.

Since this study is focused on paediatric TB, it was imperative to focus on all types of TB disease. TB is classified into two general types: pulmonary and extrapulmonary, depending on the location of infection. Children are much more susceptible to extrapulmonary disease than adults. In this study, 60% (32/53) patients had extrapulmonary TB and 40% (21/53) had pulmonary TB. Data on smear-positive or smear-negative status was not collected. Of the extrapulmonary cases, lymph node TB was the most common location, though Koch's abdomen and nervous system infections were also relatively frequent.

All patients were currently undergoing DOTS treatment, but were at different stages in the process. Category I DOTS protocol is divided into two phases: the 2-month intensive phase is followed by the 4-month continuation phase. The drug regimen is different between phases: the intensive phase involves thrice weekly doses of rifampicin, isoniazid, pyrazinamide, and ethambutol, while the continuation phase is a daily dose of medication, either rifampicin and isoniazid (3x weekly) or pyridoxine (4x weekly). Treatment may last longer than 6 months when desired results are not achieved within the time frame. A



summary of the time on which patients had been receiving DOTS treatment can be found in Figure 1.



Most patients in this study had completed the intensive phase (here denoted by the 0-1 month bin on the histogram) and proceeded into the continuation phase. This data is subject to error due to estimates on the part of the parents when exact dates were not obtained from medical documents.

### Age and Gender

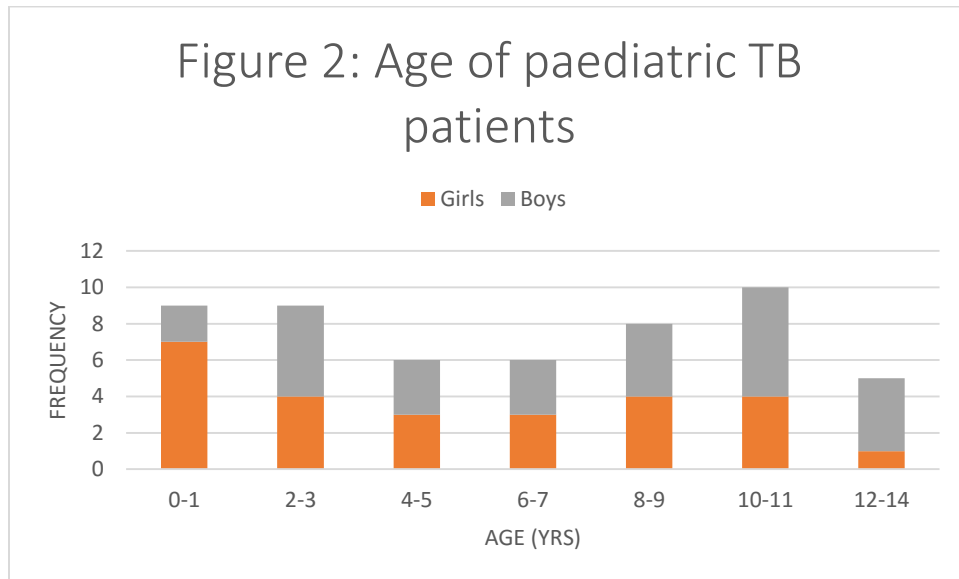
To analyze if there is a gender bias in the treatment of paediatric TB in Bhopal, the gender breakdown of the study sample was analyzed. Of the 53 patients in the study, 26 were female and 27 were male. The sex ratio of Bhopal district is 920 women to 1000 men<sup>11</sup>. There is no significant difference between the population of Bhopal and the sample in the study, thus there is no gender bias in the RNTCP in Bhopal district.

The risk of developing TB disease after infection is age-dependent. From Swaminathan and Rekha 2010: "Young age and HIV infection are the most important risk

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<sup>11</sup> Bhopal District: Census 2011.

factors for severe or disseminated disease; the risk of disease progression decreases during childhood, is least at 5–10 years of age, and increases again during adolescence<sup>12</sup>.” The age and gender breakdown of the study sample is visible in Figure 2.



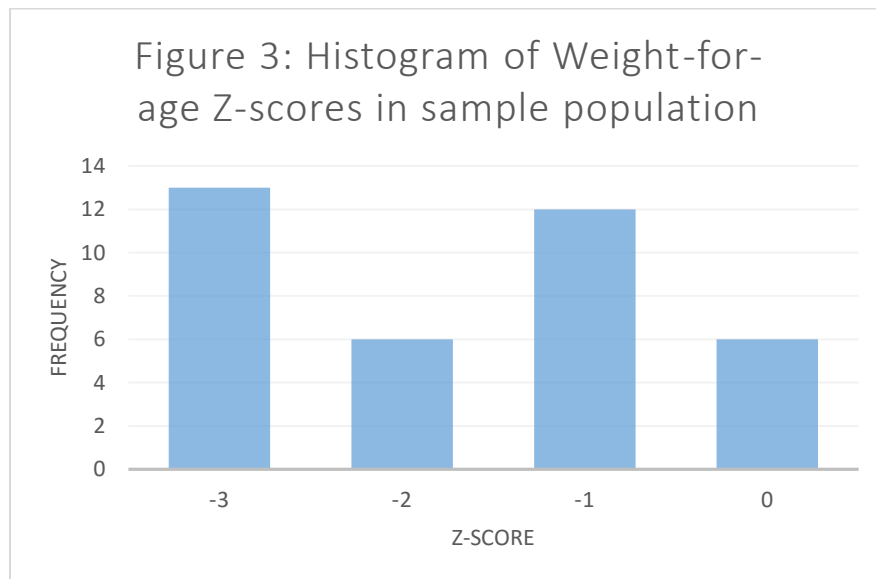
To some extent, the expected trend as outlined by Swaminathan and Rekha is seen in the data. There is a higher number of very young cases in comparison to those in the 4-7 age range. However, cases increase before adolescence and drop off once patients become preteens. This premature rise in case frequency with respect to age could be due to an increased ability of slightly older children to communicate their symptoms to their parents in comparison to their younger peers. The drop-off in adolescent case frequency could be due to a greater awareness of stigma as children age, especially in girls, who are underrepresented in the oldest age bracket.

### Malnutrition

In an attempt to gauge the prevalence of malnutrition in the paediatric TB population in Bhopal, age and weight at the time of diagnosis were collected for all patients

<sup>12</sup> Swaminathan 2010.

surveyed. Using WHO weight-for-age tables, Z-scores were assigned to all patients 10 years of age or younger, a total of 37 patients<sup>13</sup>. These Z-scores were integers and did not exceed an absolute value of 3. Since date of birth was not taken, and the age in months of the child was unavailable, the integer age of each child was used with the WHO field tables. The results are displayed in Figure 3.



The mean z-score among surveyed paediatric TB patients was -1.70 and the standard deviation was 1.11. This is significantly different from an expected distribution where the mean is 0 ( $p < 0.01$ , 1-tailed z-test). Though weight-for-age is by no means a comprehensive measure of nutritional status, this indicates a strong bias toward children who are undernourished in the paediatric TB population of Bhopal. According to the WHO, this is worrisome not just for the sample that is undernourished but indicates population-scale interventions are necessary<sup>14</sup>. 2.3% of the population is expected to have a Z-score of

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<sup>13</sup> WHO Child Growth Standards.

<sup>14</sup> WHO, Global Database on Child Growth and Malnutrition.

less than -2, meaning that it is possible some of this sample population is not truly undernourished. However, with 44% of the population having Z-scores of this magnitude, the WHO would classify the severity of malnutrition as “very high” by the weight-for-age indicator. Taken all together, this indicates that malnutrition is a highly significant comorbidity for TB in Bhopal district.

Weight at the time of interview was also collected. One symptom of tuberculosis is weight loss, so in malnourished children, TB can exacerbate the problem. Treatment under DOTS is expected to increase the weight of the child in question. The weight of each child in the sample at the time of diagnosis and at the time of interview was compared in a paired t-test. The weight at the time of interview was found to be significantly higher ( $p < 0.01$ ) than at the time of diagnosis by an average of 1.2 kg. Given that the time since diagnosis was different for each child, with an average of around 2.5 months, this indicates significant improvement in nutritional status with tuberculosis treatment.

Bhopal district is working to improve TB case detection in malnourished children. Paediatricians screen patients who come to nutrition rehabilitation centers (NRCs) for TB, especially children resistant to gaining weight when in the hospital and on a proper diet. Several of the patients included in this study were referred to the RNTCP from the NRC after treatment for malnutrition, especially patients 2 years of age or younger. This is especially effective in identifying infants and toddlers with pulmonary TB, as its symptoms are usually less severe and less likely to warrant a doctor’s visit. The efficacy of these cross-referrals could be improved if a greater age range was eligible for treatment at the NRC and if malnutrition services and screenings were more widely available and utilized.

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## Household Contact

One of the most common and well-known risk factors for paediatric TB is the presence of a sputum-positive adult patient within the same household. This is why chemoprophylaxis is available through the RNTCP in Bhopal district for all children 6 years of age or younger with sputum-positive household contacts<sup>15</sup>. However, this is not always provided or taken regularly by the children. Additionally, children older than 6 are not offered chemoprophylaxis at all. To gauge the prevalence of known household and community contacts, the patients were asked 3 questions: Does anyone in your family have TB? Does anyone in your family have chronic cough? Do any neighbors or community members have TB or chronic cough? The results are aggregated in Table 1.

*Table 1: Reported contacts of paediatric TB patients*

<b>Classification</b>	<b>Known Household Contact</b>	<b>Possible Household Contact</b>	<b>Known Community Contact</b>	<b>Household + Community Contact</b>	<b>No Known Contact</b>
<i>Count</i>	15	2	5	2	29
<i>Percentage</i>	28%	4%	9%	4%	55%

This totals to 45% of the study sample having some kind of known contact.

Paediatricians at AIIMS Bhopal reported that out of every 5 TB patients, 2-3 would have a traceable contact<sup>16</sup>. This aligns with the data found in this study. In addition, underreporting is very likely due to the social stigma associated with TB. People are not likely to know the TB status of their neighbors; healthcare providers generally agreed that when there is no traceable contact a new case of paediatric TB is due to a community member whose illness is not public knowledge. Additionally, many are reluctant to admit,

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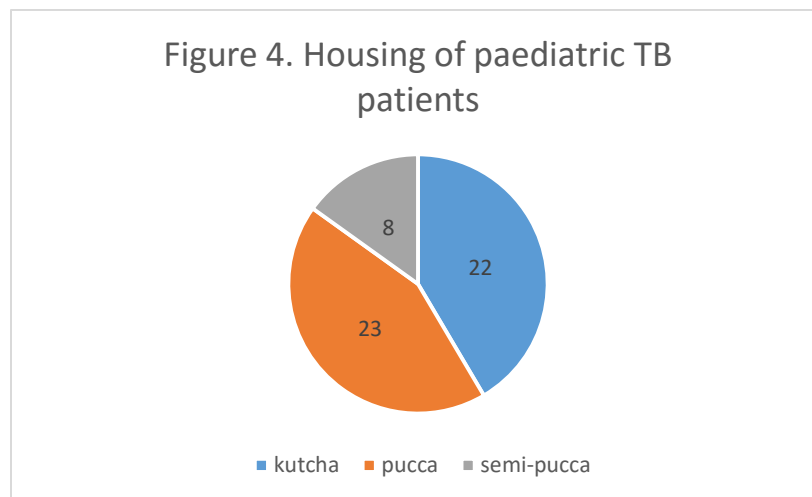
<sup>15</sup> MO, JK Hospital, 2016.

<sup>16</sup> Bhatt 2016.

even to the researcher, that there is TB in their family. Accounting for these two factors would likely boost the total number of paediatric TB cases in this study with contacts.

### Housing and Cooking

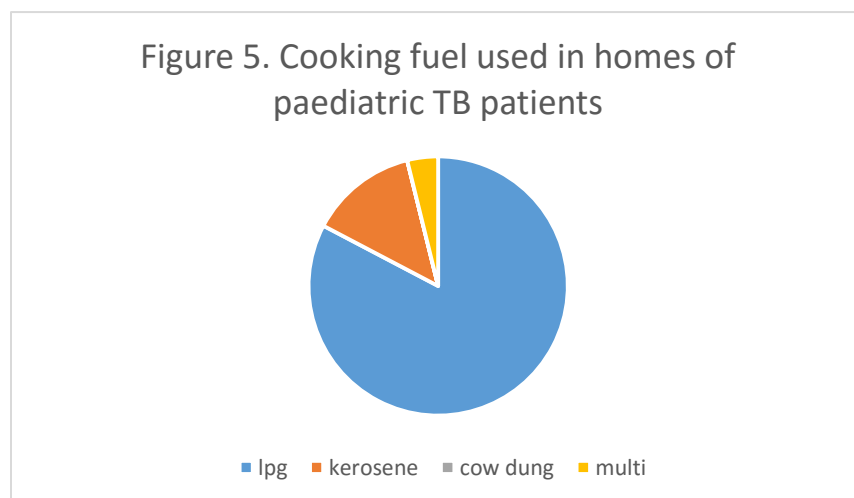
Two main types of housing are prevalent in India, called kutcha and pucca. A pucca house could be translated to a permanent house in English; it is made of high-quality materials including floor, walls, and roof. Kutcha homes are made of thatch, mud, and other such materials. Homes made with a mixture of materials are called semi-pucca. Housing is an important determinant of tuberculosis because of its respiratory mode of transmission. A poorly ventilated home increases the chance of TB transmission. In addition, knowledge about the type of home in which someone resides gives evidence by proxy of the type of community in which they live. Communities with mainly kutcha homes tend to be more crowded, slum-type areas where rates of TB are high. The self-reported housing type of study participants is found in Figure 4.



Approximately equal numbers of paediatric TB patients surveyed in this study live in kutcha and pucca homes. However, in urban communities in Madhya Pradesh, 93.2% of

homes are pucca and only 1.2% are kutcha<sup>17</sup>. By this standard, a huge proportion of paediatric TB patients live in low-quality housing, with a statistically significant difference ( $p < 0.01$ , chi-squared test). Poor housing is a highly significant determinant in the landscape of paediatric TB in Bhopal. This provides strong evidence that further action on determinants is necessary to adequately prevent TB. No part of the RNTCP acts to improve the housing in which TB patients live, yet it is clearly a highly influential factor.

Cooking fuel is also a determinant of tuberculosis. Indoor air pollution creates stress on the lungs and thus increases likelihood of TB disease. Three types of cooking fuel are common in India, listed here in order of cleanliness for the lungs: LPG (gas), kerosene, and cow dung. To gauge the effect of indoor air pollution due to cooking as a determinant of paediatric TB, the fuel preferred by each family was collected. The majority of families use LPG, which indicates that cooking fuel is not a very important determinant of paediatric TB in Bhopal. Full results can be found in Figure 5.

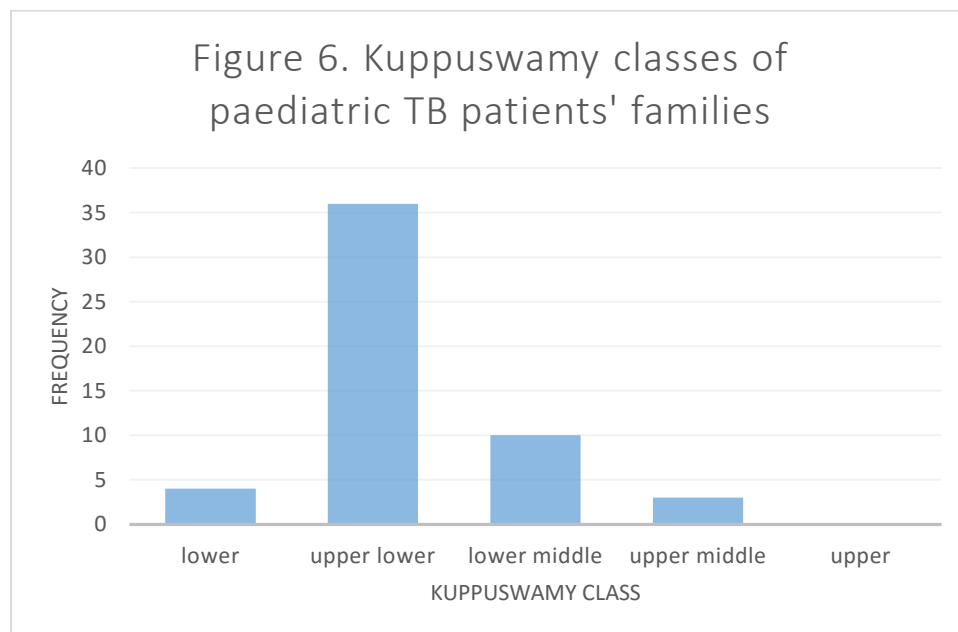


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<sup>17</sup> India, Ministry of Statistics and Programme Implementation, 2015.

## Socioeconomic Status

To analyze the socioeconomic status of patients of paediatric TB, information on household occupation, education, and income was collected. This was all self-reported by the escort of the child to the DOTS center and is subject to bias. In cases where the educational attainment differed between the mother and father, an approximate average was used as the household score, with more emphasis on the education of the primary wage earner. When both parents were employed in different-status jobs, an in-between score was given, with emphasis on the higher-status job. This information was consolidated into a Kuppuswamy score for each family. In this system, a numerical value is assigned to a household based upon each of the categories previously mentioned<sup>18</sup>. When added, the score acts as an indicator of socioeconomic status. Income scores were calculated for this study using real-time data and an online calculator<sup>19</sup>. The results can be seen in Figure 6.



<sup>18</sup> Sharma R. Kuppuswamy's socioeconomic status scale - revision for 2011 and formula for real-time updating. *Indian J Pediatr* 2012;79(7):961-2

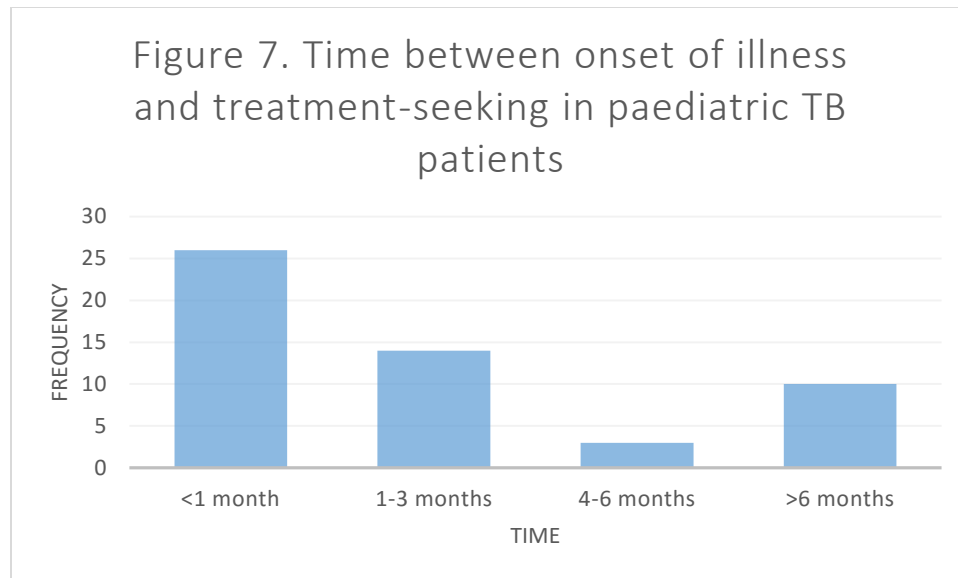
<sup>19</sup> Sharma R. Online interactive calculator for real-time update of the Kuppuswamy's socioeconomic status scale. Available from: [www.scaleupdate.weebly.com](http://www.scaleupdate.weebly.com) (Accessed on 2016 May 08)



Kuppuswamy is only an approximate indicator of socioeconomic status, however this data provides a baseline snapshot of class disparities in paediatric TB in Bhopal. The mean Kuppuswamy score was 8.9 with standard deviation 3.4; the median was 8. TB is well-known as a disease of the poor and that is confirmed by these results, where the vast majority of patients fall into the “upper lower” class. Most surprising is the low level of lower-class patients. This could be due to a lack of awareness amongst the poorest about paediatric TB, or a lack of access to government services. Possibly the upper lower class patients have improved literacy and are more able to miss work than the lower class patients. In addition, some paediatric TB cases are handled by the private healthcare system, but the class breakdown of these patients is unknown.

### Health-Seeking Behavior

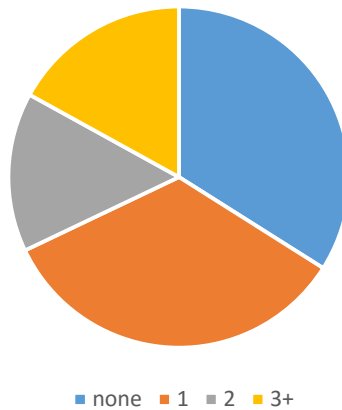
In order to be included in this study, each patient had to access the government healthcare system in Bhopal. This process is not always straightforward and involves many steps, including recognizing illness, going to a doctor, waiting for a diagnosis, and referral to the nearest DOT center. To complement the data on determinants, data was gathered on some basic health-seeking behaviors of paediatric TB patients and their families in order to assess the challenges they may have faced. First, patients’ families were asked how long the patient was sick before seeking treatment. Results are presented in Figure 7.



This data is self-reported and may be skewed toward shorter periods of time, which is a bias towards good caregiving. Some of the patients who fall into the “less than 1 month” category were victims of acute TB disease such as meningitis, and due to the severity of the symptoms, visited the hospital quickly. Other patients in this category include patients referred from the NRC who were not showing symptoms noticeable to the parents but were detected by medical professionals. With these caveats, most patients visited a doctor within one month of noticing illness, which demonstrates a good level of education about symptoms. In addition, this question was difficult to translate and not worded very clearly, so this time may include time spent with private doctors for treatment for some patients, especially for those greater than 6 months. Many of those patients reported a time in years.

To attempt to understand the behavior of patients and private healthcare providers in the context of paediatric TB, patients’ families were asked if they had been to private doctors before they were enrolled in DOTS. Private and public collaboration on TB has not always been strong, but for effective treatment, prevention, and reporting, the private sector needs to work closely with the RNTCP. Results are in Figure 8.

Figure 8. Private doctors visited before seeking government healthcare for paediatric TB



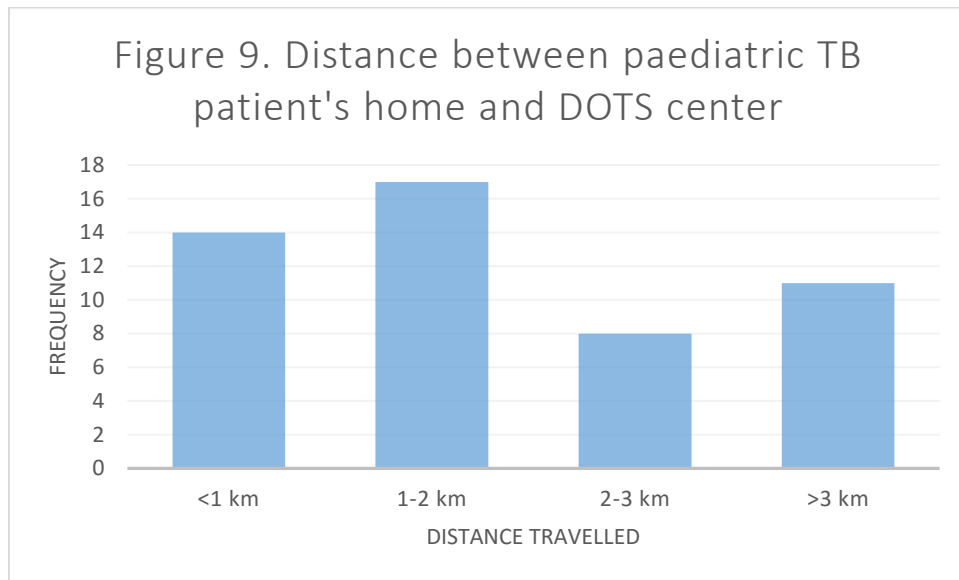
In this sample, approximately 2/3 of patients did not go to a private doctor or only saw one before they were referred or changed their mind. The survey format of this study was not able to explore the patient's reasons for choosing private doctors or for changing their doctors. However, doctors at AIIMS noted that private doctors are becoming more cooperative with the government on paediatric TB in recent years and are more likely to refer patients to RNTCP DOTS centers<sup>20</sup>. The high number of patients who saw only a single private doctor compared to those who saw more supports the conclusion that the private sector is working relatively well with the government, though no conclusion can be drawn about the change over time.

Another possible barrier to treatment is the distance a patient is required to travel to get medicine. In treatment of paediatric TB with DOTS through RNTCP, the family of the patient has 3 options: they can travel to the DOTS center to receive treatment, they can have treatment delivered to their home by the DOTS provider, or the mother can be trained

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<sup>20</sup> Bhatt, 2016.

as a DOTS provider for her child. The distance is an important factor because the further away and more inconvenient the DOTS center is, the less likely a patient is to go receive treatment. Travelling costs money and the more time the appointment take, the more hours of work are lost. A summary of the distances can be found in Figure 9.



That said, most patients lived relatively close to their DOTS centers. The mean distance was 1.7 km with standard deviation 1.5 km. This distance is easily travelled by bike or auto and can be walked if necessary. Some patients did not know how far this distance was. Though it wasn't specifically asked, in this study 20% of patients reported that the treatment was delivered to their home by the DOTS provider. The mean distance to this subset of patient's homes was 1.8 km, and this difference is not statistically significant ( $p=0.43$ , 2-sample t-test). This low rate is partially due to the lack of question on the questionnaire but also due to stigma. Families who do not want their neighbors to know their child has TB do not want a DOTS provider visiting their home three times a week.

Community awareness and decreasing stigma would ease the burden on families with children with TB.

## **Healthcare Provider Challenges**

### Diagnosis of Paediatric TB

Diagnosis of paediatric TB provides the biggest barrier to effective reporting of paediatric cases. Even with modern technology, it is extremely difficult to produce an accurate diagnosis of paediatric patients. In developed countries, use of the tuberculin skin test (TST or Mantoux's test) for TB diagnosis is standard practice, but in India and other developing countries where the BCG vaccine is used, this test is not as useful<sup>21</sup>. It can only identify that a patient has been exposed to TB but not whether the current disease is in fact TB. Instead, in adults, the standard diagnostic procedure of TB in endemic countries relies on sputum analysis. This leads to the common classifications of smear-positive or smear-negative, which is dependent on the presence of TB bacilli in the sputum. However, children are usually not able to produce sputum for this test, and the diagnostic categories used in adult TB cases are not useful in children. This leads to a complicated diagnostic formula for paediatric TB involving contact tracing, symptom analysis, and response to standard antibiotic therapy. In addition, paediatric patients are more likely to have extrapulmonary TB than adults, which further complicates diagnosis. In practice, a wide variety of diagnostic tests are used, especially in extrapulmonary illness. New methods using molecular biology and other techniques are in development, but even where these are promising, they are tested in adults and not paediatric patients. One of the foremost

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<sup>21</sup> Nelson 2004.

challenges in treating paediatric TB is effective and rapid diagnosis, especially when drug resistance is suspected.

Paediatricians at AIIMS shed some light on their diagnostic process for paediatric TB. All 3 interviewed called the process difficult and each highlighted different challenges. These interviews confirmed the literature about the difficulty of sputum production. The alternative to this procedure is gastric lavage, but Dr. Shiv Dubey, paediatrics resident at AIIMS Bhopal, emphasized that it is less than ideal as a substitute due to its low sensitivity of 30%<sup>22</sup>. Notably, all three doctors answered exclusively in response to the diagnosis of pulmonary TB, and did not provide information on extrapulmonary until prompted by the researcher. Diagnosis of extrapulmonary TB is also challenging because of the wide range of presentations it can have. Key symptoms include vague and general problems like weight loss or inability to gain weight and fever, according to Dr. Nena Shrivastava, paediatrics resident at AIIMS Bhopal<sup>23</sup>. A wide variety of diagnostic procedures are used including x-ray, ultrasound, and biopsy, and there is increased suspicion when a known contact exists. This was demonstrated in the quantitative interviews of patients, who reported diagnostic procedures ranging from Montauk's test and the very generic "blood" test to ultrasounds and cerebrospinal fluid analyses (in the case of meningitis). Because AIIMS is a prestigious medical college, there is also access to a new molecular diagnostic technique called CB-NAAT. This is used in adult patients primarily for drug susceptibility testing but has moderate efficacy as a diagnostic technology for paediatric patients. Dr. Girish Bhatt, associate professor of paediatrics at AIIMS Bhopal, says that they use this

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<sup>22</sup> Dubey, Personal Interview, 2016.

<sup>23</sup> Shrivastava, Personal Interview, 2016.

technology in cases of high suspicion<sup>24</sup>. However, caution needs to be exercised in relying upon this technology for diagnosis, despite its immense power. Because TB is so common in India, and because sanitary laboratory practices are not often followed rigorously, contamination of samples is easy and can contribute to false positive diagnoses, according to associate professor of pulmonology at AIIMS Bhopal Dr. Alkeesh Khurana<sup>25</sup>. Ultimately, many patients are diagnosed after their illness does not respond to ordinary antibiotic treatment.

Diagnosis provides an interesting stage for interaction with the private sector. Because many private doctors are limited by resources, Dr. Girish notes that they sometimes refer patients to AIIMS when they have difficulty in diagnosis. This is especially pronounced with the availability of the CB-NAAT test<sup>26</sup>. According to Dr. Alkeesh, the private sector's involvement in TB control activities has improved in recent years. He says:

*"...when I joined [pulmonology, 12 years ago] the private sector was reluctant to collaborate with the public sector due to some issues like financial issues or lack of trust with the policies, but I think the RNTCP in India has now broadly incorporated private sector also... The government has deliberately involved private sector more in the last 10 years to make them an integral part of this program. I have seen in the private sector doctors who, instead of prescribing ATT daily non-DOTS, they are referring [TB patients] to the DOTS centres."*

This increased involvement of the private sector in TB control activities is extremely helpful for patients. Though there is still a long ways to go, this seems to be a huge step forward for public-private partnerships in TB care in India.

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<sup>24</sup> Bhatt, Personal Interview, 2016.

<sup>25</sup> Khurana, Personal Interview, 2016.

<sup>26</sup> Bhatt 2016.

## Treatment of Paediatric TB

Treatment of paediatric TB can be problematic. When a child is suspected to have TB, they are prescribed treatment through DOTS, just like an adult patient. In Bhopal, the option of having the mother be a DOTS provider for the child allows flexibility for the family and more individualized care for the child. When the mother is willing and able to be an effective DOTS provider, this option removes the need for the family to travel thrice weekly to the DOTS center, as the mother will keep the box of drugs. Several of the doctors interviewed mentioned the financial burden of the lost wages and transit to the hospital, but this action can greatly reduce these costs<sup>27</sup>. Generally, interviewed subjects spoke well of the RNTCP, nobody doubted its efficacy or coverage in either adults or children.

The only complaint about treatment of paediatric TB from medical professionals had to do with the drugs. Drug dosages for paediatric patients are extrapolated from adult data and are often not accurate for a child's metabolism<sup>28</sup>. This leads to higher rates of treatment failure in children than adults in general. In addition, when paediatric patients do get MDR-TB, the second-line drugs are not well formulated for children, which makes treating this difficult disease even trickier. Another huge concern is the administration of drugs to paediatric patients. The current DOTS formulations provided by the RNTCP are simple pills that need to be swallowed. However, it is challenging to get children to take these drugs, and dispersible tablets or liquid delivery would be much preferred<sup>29</sup>. Private pharmacists offer dispersible ATT to paediatric patients, but this is not the RNTCP recommended formulation nor is it subject to DOTS. Additionally, there are challenges

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<sup>27</sup> Bhatt 2016, Shrivastava 2016.

<sup>28</sup> Swaminathan 2010.

<sup>29</sup> Khurana 2016.



when patients have adverse reactions to drugs. Though rare, especially in children, patients sometimes require individualized ATT due to allergies or other problems<sup>30</sup>. This is very challenging to administer through DOTS because the preset drug regimens do not allow flexibility.

### Prevention of Paediatric TB

Prevention of TB in paediatric patients relies on two main medical interventions: the Bacille Camille-Guerin (BCG) vaccine and chemoprophylaxis. The BCG vaccine is given to every infant at birth in India, and coverage is upwards of 90%<sup>31</sup>. However, BCG vaccination does not prevent all TB infection but only reduces incidence of severe disseminated forms of the disease. It significantly reduces mortality from paediatric TB infection but does not prevent all childhood illness. As stated in Nelson 2004, "...a strategy of BCG vaccination at birth alone will not adequately reduce the burden of childhood TB."<sup>32</sup> This was confirmed by findings in Bhopal. At least one child in the sample had received the BCG vaccine and still suffered from TB meningitis because the protection only lasted one year. The sheer number of paediatric patients in Bhopal indicates that BCG is not effective in true prevention of paediatric TB.

Additionally, chemoprophylaxis, or preventative pharmaceuticals, is recommended to all children less than 6 years of age with a household member with active TB infection. It is critically important to verify that the child does not have TB infection at the time of prescription, since only a single drug is given<sup>33</sup>. Unscrupulousness can result in drug resistance. Importantly, most paediatric TB cases can be traced to household contacts, so

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<sup>30</sup> Shrivastava, 2016.

<sup>31</sup> Swaminathan 2015.

<sup>32</sup> Nelson 2004.

<sup>33</sup> Singh, Personal Interview, 2016.

effective implementation of this preventative measure could vastly reduce the burden of paediatric TB. Despite this recommendation, and despite access to chemoprophylaxis through the RNTCP DOTS centers, not all patients recommended to take chemoprophylaxis actually did, especially for the full 6 months. In addition, though few cases less than 6 in the quantitative survey had household contacts, several of the older children did. The RNTCP might benefit from broadening the age range to which chemoprophylaxis is accessible.

A significant barrier to proper prevention of paediatric TB in Bhopal is the continued stigma against TB. One of the most effective methods to prevent TB is contact tracing – tracking down those who new TB patients are in close contact with and screening for TB. Currently, the RNTCP is not involved in active case screening. However, the stigma against TB makes it incredibly challenging for medical professionals to track down individuals with active TB disease, even if they were able to. For this study, which focused on known TB patients, the researcher had to ask about chronic cough instead of using the word “tuberculosis” for some interviewees to admit to having TB in their household. Without patients’ willingness to cooperate, any public health system intervention is doomed to fail. Additionally, improved education and awareness of TB is required. In Bhopal, the DOTS centers organize World TB Day events and hold monthly meetings where new patients can meet with old patients to learn about TB. The community is definitely working towards improved TB awareness, though there is a long way to go, especially with paediatric TB.

Every healthcare professional spoken to for this study spoke highly of DOTS and the RNTCP. Most patients were satisfied with their treatment under the RNTCP as well. Patient

suggestions include more staff, staff who work their full hours (9am-5pm instead of the closing at 1 or 2pm that is standard), and increased advertising on TV and radio. Evidence supports this assessment of both patients and medical professionals: TB prevalence in India has declined quite rapidly in the past 10-15 years, since the inception of the RNTCP<sup>34</sup>. The RNTCP is working phenomenally well in a resource-limited setting; but to truly reduce paediatric TB incidence, action must be taken on the social determinants.

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<sup>34</sup> World Health Organization. Regional Office for South-East Asia. Tuberculosis Control in the South-East Asia Region: Annual Report 2015. Web. 28 Mar. 2016.

## **Conclusions**

This study has illuminated the relative importance of various social determinants of paediatric TB in Bhopal. Malnutrition plays a huge role in tuberculosis infection in children, with the study sample weighing significantly less than WHO standards. Because TB and malnutrition each exacerbate the other, this is a critical finding of the study and target for action. Additionally, poor housing plays a significant role in paediatric TB infection. Significantly higher numbers of paediatric TB patients reside in impermanent housing than the general population of Bhopal. Socioeconomic status, the presence of household contacts, and age also play a role. Healthcare providers face significant obstacles in diagnosis, but the doctors included in this study were very aware of the problems and their possible solutions. Overall, despite a highly regarded government DOTS program, social determinants analysis reveals severe disparities in healthcare among some segments of the young population.

### **Limitations**

This study was limited to certain areas of Bhopal district and cannot be generalized. The quantitative portion of the study was based upon voluntary participation and does not represent a random sample of paediatric TB cases in Bhopal. A sample size of 53 is not large enough to draw any firm conclusions. Additionally, the doctors interviewed all worked at AIIMS, a prestigious medical school. Their knowledge is likely greater than the average doctor treating TB, and they do not represent a common standard of knowledge. Hindi translations may not be completely accurate.

### **Recommendations for Further Study**

Because paediatric TB is so understudied, there is lots of space for further study in the topic. This study chose not to focus on the prominent issues of TB/HIV coinfection and

MDR-TB due to time and sensitivity concerns, but both would be valid and interesting subjects to explore in a paediatric context. Paediatric TB and malnutrition is a fascinating set of co-morbidities whose high significance merits more study. Operational research could be conducted on the use of either chemoprophylaxis or BCG vaccine, i.e. investigating whether these interventions are used where they are supposed to be. Lastly, research not on paediatric TB, but on TB's effects on the family could be of value. For example, does a parent's TB increase the likelihood that his/her child drops out of school? Do children suffer worse non-TB health outcomes?

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# Appendices

## Appendix 1

### Questionnaire for Paediatric TB Patients

1. TB Reg no/ lab no:
2. Age:
3. Sex:
4. Is your child in school?
  - a. If yes, which standard?
  - b. If no, because of disease?
5. Weight at diagnosis:
6. Present weight:
7. Pulmonary or extrapulmonary?
8. How was the TB diagnosed?
  - a. Clinical
  - b. Sputum
  - c. Gastric Lavage
  - d. other
9. How long was your child sick before seeking treatment?
  - a. <1 month
  - b. 1-3 months
  - c. 3-6 months
  - d. >6 months
10. Did you see a private doctor before going to the government system?
  - a. If yes, how many?
11. How many kilometers do you have to travel to get your child's treatment?
  - a. <3
  - b. 3-6
  - c. >6
12. For how long has your child been taking the medicine?
  - a. 0-2 months
  - b. 2-4 months
  - c. 4-6 months
  - d. >6 months
13. Does anyone else in your family or relatives have a TB diagnosis?
  - a. If yes, was the child offered chemoprophylaxis?
14. Does anyone in your family/relatives have chronic cough?
15. Do others in your community have TB or chronic cough, as far as you know?
16. What housing do you live in?
  - a. Kuccha
  - b. Pukka
  - c. Semi-kuccha



17. What fuel do you use to cook food?
  - a. LPG
  - b. Kerosene
  - c. Cow dung
  - d. others
18. What is your monthly income?
  - a. Above 10000
  - b. 5000-10000
  - c. 2500-5000
  - d. 1000-2500
  - e. Less than 1000
19. What is your education level?
  - a. Professional or honours
  - b. Graduate or Post-graduate
  - c. Intermediate or Post-High school diploma
  - d. High school certificate
  - e. Middle school certificate
  - f. Primary school certificate
  - g. Illiterate
20. What is your occupation?
  - a. Profession
  - b. Semi-profession
  - c. Clerical, Shop owner, farmer
  - d. Skilled worker
  - e. Semi-skilled worker
  - f. Unskilled worker
  - g. Unemployed
21. Do you have a BPL card?

## Appendix 2

### **Interview Guide on Pediatric TB: Patient's Families**

1. Has your child ever had to miss treatment? Why?
2. How do the drugs affect your child?
3. How has your life changed since your child's diagnosis? What challenges has your child's illness caused in your life?
4. What did you know about TB before your child's diagnosis? What have you learned? What do you wish you knew?
5. Does your child face stigma in your community? What does that look like?
6. What could the government do better to reach other children with TB?
7. Tell me about your community. Do you like living here? What are the upsides and downsides? How is the health of people who live here?

## Appendix 3

### **Interview Guide on Pediatric TB: Health care providers**

1. What is your name? What is your job title?
2. How frequently do you treat children with TB?
3. How do you diagnose children with TB? What is the most difficult part about diagnosing children with TB?
4. How are pediatric TB patients referred to you/to whom do you refer suspected TB cases? Do you coordinate with health care providers from other departments (pediatrics, malnutrition, etc.)?
5. In your experience, do most pediatric TB cases come from household contacts?
  - a. If no, from where?
6. How easily available is chemoprophylaxis? Do you recommend it to all adults with children seeking TB treatment?
7. What burdens does having a child with TB place on his/her parents? Are the parents still able to work?
8. What do you tell the parents of the child who is diagnosed with TB?
9. How is adherence in pediatric patients? How is MDR/XDR handled differently in pediatric patients?
10. What is awareness of pediatric TB like in the community? What is being done to address it? Do children face stigma?
11. What role is played by the private sector in treatment of pediatric TB? Do you think they are effective? How can they be more effective?
12. What do you think are the strengths and weaknesses of the RNTCP in addressing pediatric TB?