Original Article

Risk Factors of Tuberculosis in Children

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Objective: To determine the frequency of known risk factors in confirmed cases of tuberculosis in children.

Study Design: Cross sectional study

Methodology: Children between 2 and 144 months with confirmed tuberculosis were enrolled in the study from outpatient and inpatient departments. Detailed information was taken regarding, history of contact, history of measles or whooping cough, house hold size, people sleeping in a room, socioeconomic and education status of parents, history of steroid use and urban & rural dwelling. Patients were examined for BCG scar and nutritional status.

Place and Duration: It was done at the Children Hospital Pakistan Institute of Medical Sciences, Islamabad from August 2006 to May 2007.

Materials and Methods: Children between 2 and 144 months with confirmed tuberculosis were enrolled in the study from outpatient and inpatient departments. Detailed information was taken regarding, history of contact, history of measles or whooping cough, house hold size, people sleeping in a room, socioeconomic and education status of parents, history of steroid use and urban & rural dwelling. Patients were examined for BCG scar and nutritional status.

Results: A total of 200 patients were evaluated. The mean age was 80 months, 160 (80%) patients had history of contact with TB case and 129 (69.5%) had no BCG scar. Illiteracy was found in 133 (66.5%) mothers and 73 (36.5%) fathers. One hundred and twenty three (61.5%) patients were residents of rural area and 102 (51.0%) belonged to poor background (income < Rs. 3000/month). One hundred three (51.5%) patients belonged to families where 5 or more people live in one room. Only 1% of patients belong to such families where 2 persons live in one room. One hundred (50%) children had grade III malnutrition, 48 (24.0%) had grade II malnutrition while 30 (15.0%) had grade I malnutrition. Out of total 200 cases, 27 (13.5%) had history of long term use of steroids, 86 (43.0%) had history of measles in near past while there was no history of whooping cough in any of patients.

Conclusion: Adult with TB disease spread TB to children. Family education especially the maternal education and vaccination with BCG are the two most important factors in preventing tuberculosis in children. Malnutrition, measles and steroid therapy are three important risk factors for development of tuberculosis in children.

Keywords: Risk factors, tuberculosis, children

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Introduction

Tuberculosis (TB) remains a major cause of morbidity and mortality worldwide.[1] Accurate global burden of childhood TB epidemic is scarce[2,3], but of the estimated 8.3 million new cases of TB reported globally in 2000, 11% were children.[3-5] However, the prevalence of TB varies greatly between countries and 75% of all diseased children reside in 22 high burden countries[2,5], Pakistan being one of the high burden countries for TB. In Pakistan approximately 5.7 million people suffer from TB[6], with 260000 new cases occurring every year.[7] The exact proportion of children with TB in Pakistan is unknown[8]. Overall the estimated proportion of children with TB is 3 to 13% of all TB cases.[9, 10] Only 5-10% of all infected children will acquire the disease.[8, 10] Majority of these infected children 80-90% will however add to the pool of people from whom future adult cases of TB will arise.[8, 10]

The basic cause of infection and disease caused by Mycobacterium tuberculosis and the ways of diagnosis

and management of TB are the same for children and adults.[11] TB is mainly spread via tiny aerosol droplets produced almost by an infectious source case.[5] Although children and adults are at equal risk to develop TB infection when exposed to a person with infectious TB, the children are substantially at greater risk for developing TB diseases especially miliary TB and tuberculosis meningitis.[11]

Factors that determine the risk of TB infection are more or less the same for children and adults.[12] The risk of infection following exposure depends on the severity of infectiousness of the source case together with the proximity and duration of contact[5]. The risk of progress to disease following primary infection is highest in very young children (less than 2 years).[13, 14] The risk is lowest in immune competent children aged 3-10 years but increases again if children develop primary infection after 10 years of age.[13, 14] Other important risk factors are; use of immunosuppressive drugs[15], lack of BCG vaccination[16,17], severe malnutrition[17], overcrowding[18] and measles.[1]

Since TB is a very common disease in Pakistan and children represent a large proportion of the pool from which cases will arise in the future. Moreover, there are limited data on the risk of infection in child population in developing countries, so knowledge about the risk of TB in children is of prime importance to evaluate the transmission of the infection in the community and to adapt TB control activities.

Materials and Methods

This cross sectional study was done at the Pediatric Department, Children Hospital, Pakistan Institute of Medical Sciences (PIMS), Islamabad from August 2006 to May 2007. A total of 200 children aged 2 months to 12 years diagnosed of both pulmonary and extra pulmonary TB were enrolled. Children having congenital lung or heart diseases and immunodeficiency diseases were excluded. After taking informed consent children were enrolled from both inpatient and outpatient departments. TB was diagnosed using "Pakistan Pediatric Association Scoring Chart". Only those children who had score of seven or more were considered confirmed TB patients. Patients were evaluated for risk factors of tuberculosis. Children demographic features like weight and height were used to find out nutritional status on the basis of Gomez classification of malnutrition. Both arms were examined to see presence or absence of BCG scar. Detailed information were asked from parents about the risk factors of TB in the child, including any history of close contact with TB patient, history of measles or whooping cough to the child in the past, long-term use of steroids, house hold size and number of the people sleeping in a room, socio-economic status of the family, education of the parents and urban or rural dwelling. History of close contact with TB case was considered when there was history of Close contact with an AFB smear positive adult TB patient, mostly exposed at home. The family, who's monthly income was less than 3000/month, was considered low socio-economic status. If the number of people sleeping per room was more than 3, then this was considered overcrowding. Malnutrition was classified according to the Gomez classification. In this classification weight was assessed at various ages by standard weight charts. If weight was less than<90% of expected weight for that age then child was considered malnourished.

a. Grade I: if weight was 75-90% of expected weight

b. Grade II: if the weight was 60-74% of the expected weight

c. Grade III: If the weight was below 60% of expected weight

Diagnosis of TB was based on "Pakistan Pediatric Association Scoring chart for the diagnosis of TB in children"[11], which depend largely on clinical examination, history of close contact with an adult TB case, chest X-ray and tuberculin testing. Children having score of seven or more were considered confirmed TB patient. A specifically designed proforma was used to record all the patient information.

Statistical Considerations: A sample of 200 patients was assumed for the study. Convenience sampling technique was used. Data was entered and analyzed using SPSS software. The means and standard deviations were calculated for continuous study variables such as age, weight, height. Frequencies and percentages were calculated for categorical variables like gender, parent's education, history of contact with TB case, nutritional status, past history of measles or whooping cough, long-term use of steroids, presence or absence of BCG scar, overcrowding, urban/rural residence and socio-economic status of the patients.

Results

During the study period of nine months from August 2006 to May 2007 a total of 200 cases of confirmed tuberculosis were enrolled for evaluation of risk factors. The mean age of patients was 80 months ranging from 24 to 144 months. In our study majority of the children 85.5% were between 2 and 10 years while a small proportion of 2.5% were under two years of age while another 12% were above 10 years of age. The mean weight of study patients was 17.9 $\pm$ 6.2 kilogram while mean height was 110.6 $\pm$ 16.1 cm. Both genders

were almost equally affected with 49% males and 51% female proportions. (Table I)

Table I: Baseline characteristics of study patients (n = 200)

	Number	%age
Gender		
Male	102	51%
Female	98	49%
Age categories (mon)		
< 24	5	2.5%
25-120	171	85.5%
> 120	24	12.0%
Age (mon)		
Mean ± SD	80.0 ± 30.4	
Range	24 – 144	
Weight (kilograms)		
Mean ± SD	17.9 ± 6.2	
Range (min – max)	6 – 46	
Height (cms)		
Mean ± SD	110.6 ± 16.1	
Range (min – max)	28 – 197	

As far as the educational status of parents was concerned in this study 36.5% fathers and 66.5% of the mothers were illiterate, 39% fathers were having up to middle education while almost 25% were matriculate or above. In mothers 27.5% were having up to middle education while 6% had matric or above education. It was found out that mother's illiteracy was positively associated with TB (p-value = <0.001). (Table II)

Out of the 200 study population 123 (61.5%) belonged to rural areas while 77 (38.5%) were from urban area. In 129 (64.5%) cases there was no BCG scar which was significantly associated with TB (p-value = <0.001). Similarly past history of close contact with adult TB patient 160 (80.0%) was also significantly associated with TB (p-value = <0.001). Mean duration of contact was 47.3 months.

Of the total, 100 (50.0%) children had grade III malnutrition; though it seems a significant proportion but statistically it was found out to be non-significant. Eighty six (43.0%) had history of measles while none of the patients had history of whooping cough. Twenty seven (13.5%) patients had history of using steroids for more than 2 weeks with mean duration of usage 10.3 months. In our study population 103 (51.5%) children were living in a condition where five or more people were sleeping in one room. (Table III)

Out of the 200 study population 123 (61.5%) belonged to rural areas while 77 (38.5%) were from urban area. In 129 (65.0%) cases there was no BCG scar. Similarly 160 (80.0%) had past history of close contact with adult TB patient. Mean duration of contact was 47.3 months.

Table II: Educational factors associated with tuberculosis in the study (n = 200)

	Illiterate	Literate	p-value
Father's education	73 (36.5%)	127 (63.5%)	<0.001
Mother's education	133 (66.5%)	67 (33.5%)	<0.001

Of the total, 100 (50.0%) children had grade III malnutrition. Eighty six (43.0%) had history of measles while none of the patients had history of whooping cough. Twenty seven (13.5%) patients had history of using steroids for more than 2 weeks with mean duration of usage 10.3 months. In our study population 103 (51.5%) children were living in a condition where five or more people were sleeping in one room.

Table III: Risk factors associated with tuberculosis in the study (n = 200)

	Yes	No	p-value
No BCG immunization	129 (64.5%)	71 (35.5%)	<0.001
History of contact with TB patient	160 (80.0%)	40 (20.0%)	<0.001
Grade III malnutrition	100 (50.0%)	100 (50.0%)	0.92
History of measles	86 (43.0%)	114 (57.0%)	0.06
Low socio economic status	102 (51.0%)	98 (49.0%)	0.76
Five or more people sleeping in same room	103 (51.5%)	97 (48.5%)	0.61

Discussion

Tuberculosis is one of the commonest infectious diseases in children.[11] As infected children represent large proportion of the pool from which cases will arise in future, so knowledge about the risk factors that influence TB in children is of prime importance.

In our study out of 200 TB patients, 171 (85.5%) were between 2 and 10 years, only 5 (2.5%) were below 2 years while 24 (12.0%) were above 10 years of age. Marais BJ et al reported that the highest risk of TB disease is in very young age (< 2 years) and the lowest risk is between 3 and 10 years but it increases again above 10 years of age.[13] Rie AV et al from South Africa have reported that 25-49% of their children were

between 0-4 years and 7-12% were between the age of 5-14 years.[19] The difference between these studies and our study can be explained by the fact that our study is not community based but hospital based study. Majority of the children in our study also had TB before two years of age as well but they were undiagnosed in community. History of contact with an adult TB patient is the commonest risk factor for TB in children. Our results show that 80% of our study population had history of close contact with TB case. These findings are comparable to other studies from America[20], Botswana[21] and Brazil[22] in which contact with an individual with TB came out as the strongest risk factor for TB infection. However, our figure is high compared to other reports.[12, 16, 20] Saiman L et al[20] from America had reported the history of contact with TB case in 24% of children. Lienhardt C et al from West Africa and Singh M et al from India have reported the history of contact with TB case in 41% and 38.5% respectively[12, 16]. This difference can be explained by the high intensity of the exposure as well as the high infectivity of the individual with TB in our study. The mean duration of contact with TB case was 47.3 month i.e. prolonged duration of contact and also there is high geographic proximity of the individual with TB at nigh time. Both of these factors are in favour of high value of this study.

The correlation between maternal literacy and childhood morbidity and mortality is well known. Our study confirms this correlation between paternal education and development of tuberculosis. In our study 36.5% fathers and 66.5% mothers were illiterate, 13.5% of fathers and 3.5% of mothers were matric and 5.0% father and only 1.55 mothers were having graduate education. Our data highlights two important points. First is that maternal education is more important than paternal education in preventing TB in children. Second is that more is the education of parents, lesser will be the chances of acquiring TB in their children. Data from South Africa have shown a similar trend as reported by Rie AV et al.[19] Lienhardt C et al from Gambia, West Africa have found similar results[12]. Education is important factor as it determines the socio-economic status of a person and thus the ability to afford healthy environments and understanding of the disease. With a higher education level the parents are more likely to understand the importance of screening their children for possible infection with M. tuberculosis, so that prophylaxis can be given before disease occurs. Moreover, educated parents give anti-tuberculous drugs regularly and complete the course at time. Thus their children recover completely without any complication of tuberculosis.

BCG vaccine activates host cell mediated immunity to mycobacterial antigens and prevents infection or progression to disease if a subsequent infection with M. tuberculosis occurs. Most important effect of BCG is to limit serious disseminated tuberculosis especially miliary TB and TBM.[11] The present study shows that among the 200 children only 35.5%had BCG scar while 64.5% had no BCG scar. These results are almost consistent with data from some other studies.[12, 17] Lienhardt C et al from West Africa reported that out of 176 children with BCG scar only 21% had acquired TB while 79% children had not developed TB[12]. In Pakistan Khan GQ et al have shown that out of 100 children with tuberculosis 76 were vaccinated while 24 were not vaccinated[23]. Similarly the prevalence of infection was estimated at 11.8% among children without BCG scar and 10.6% among children with BCG scar in a study conducted in India by Chadha et al.[24] This difference may be due to the presence of those risk factors (immunodeficiency, leukemia and lymphoma) in their study which are not included in our study.

Measles have been reported as a risk factor for tuberculosis in children[25]. In our study 86 (43.0%) children had past history of measles. Hussey G has also reported similar results.[25] Measles weakens cell mediated immunity and often an old TB focus is reactivated and a child develops a TB disease. Moreover, measles also causes protein calorie malnutrition and thus malnourished children are more prone to TB infection.

Socioeconomic conditions have traditionally been cited as risk factors for developing TB[26]. The present study demonstrates direct relationship between TB infection and overcrowding. Our results show that as the number of people sleeping/room increases there are more chances of acquiring tuberculosis infection. In the present study among 200 patients 103 (51.5%) were belonging to such families where > 4 individuals were sleeping/room while 67 (33.5%) were belonging to such families where 4 individuals were sleeping/room. Studies in Bronx, New York have also showed a significant relation between the percentage of people living in crowded conditions and childhood TB.[26]

Our study also demonstrates correlation between malnutrition and development of TB. Out of the 200 cases 50% had grade III malnutrition, 24% had grade II

malnutrition and 15% had grade I malnutrition only 11% had no malnutrition. Our findings suggest that more severe the malnutrition more will be the chances of acquiring TB. Data from Pakistan and India have shown a similar trend as reported by Khan GQ et al[23] and Chadha et al[24] respectively.

Our study also demonstrates that TB is more common in children living in rural areas as compared to urban areas. Out of 200 patients 61.5% were from rural areas. Our results are comparable to studies conducted in South Arfica[19] and West Africa[12]. People in rural areas have poor knowledge about nature of TB. Children are usually not vaccinated with BCG. Moreover, all the family members are usually sleeping in a common room i.e. there is overcrowding and thus there are more and more chances of spread and transmission of tuberculosis in these children.

As per our study findings it can be concluded that in most of the cases children always get tuberculosis from infectious adult TB cases. Family education especially the maternal education is one of the most important factors to prevent TB in children and thus control TB in community. BCG vaccination is second most important factor in preventing TB in children. Protein calorie malnutrition, measles and steroid therapy are three other risk factors for TB in children. TB is more common in rural areas as compared to urban areas. More studies are needed on different aspects of TB in children.

Conclusion

Adult with TB disease spread TB to children. Family education especially the maternal education and vaccination with BCG are the two most important factors in preventing tuberculosis in children. Malnutrition, measles and steroid therapy are three important risk factors for development of tuberculosis in children.

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