



## Control measures to trace $\leq 15$ -year-old contacts of index cases of active pulmonary tuberculosis

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### ABSTRACT

This was descriptive study carried out in a medium-sized Brazilian city. In  $\leq 15$ -year-old contacts of index cases of active pulmonary tuberculosis, we assessed compliance with the Brazilian national guidelines for tuberculosis control. We interviewed 43 contacts and their legal guardians. Approximately 80% of the contacts were not assessed by the municipal public health care system, and only 21% underwent tuberculin skin testing. The results obtained with the Chi-square Automatic Interaction Detector method suggest that health care teams have a biased attitude toward assessing such contacts and underscore the need for training health professionals regarding tuberculosis control programs.

**Keywords:** Tuberculosis, pulmonary epidemiology, Tuberculosis, pulmonary prevention and control; Contact tracing.

Assessment of contacts is one of the essential steps in tuberculosis control programs, and its purpose is to diagnose or rule out latent infection or active tuberculosis in such individuals.<sup>(1)</sup>

In Brazil, activities that health care facilities should employ to assess contacts are described in the Brazilian National Ministry of Health guidelines for tuberculosis control.<sup>(1)</sup> In those guidelines, this assessment involves five steps, namely invitation for contacts to come to the health care facility for assessment, interview by the health care team, tuberculin skin testing, chest X-ray, and, when necessary, prescription of treatment for latent tuberculosis infection (LTBI) or, if appropriate, for active tuberculosis.<sup>(1)</sup>

Despite the strategic importance of such measures, compliance rates are low (up to approximately 60%) in Brazil,<sup>(2,3)</sup> whereas, in developed countries, the aforementioned surveillance and control measures reach approximately 90% of individuals.<sup>(4)</sup>

The objective of the present study was to assess compliance with the steps applicable to  $\leq 15$ -year-old contacts of index cases of active pulmonary tuberculosis.

This was a descriptive study carried out in a medium-sized city in the central-western portion of the Brazilian state of Minas Gerais. Minas Gerais is the second most populous Brazilian state, as well as being the third most important economically; the city under study serves as a regional hub for health care for 55 cities and had,

between 2007 and 2010, an average resident population of 213,501.<sup>(5)</sup>

The inclusion criteria for contacts were as follows: being  $\leq 15$  years of age; living in the city under study; and being a contact of a case of active tuberculosis reported between January of 2007 and December of 2010, according to the Brazilian Case Registry Database. The index cases were located by means of the addresses available on the tuberculosis reporting and investigation forms that feed the database.

Data on contacts were collected in December of 2010 by administering a structured coding instrument, at a home visit; by determining, through a review of the municipal health information system, over a period of up to two years after the index cases had been reported, whether or not tuberculin skin testing and chest X-ray were performed; and by assessing prescription of and adherence to treatment for LTBI, through a review of dispensing records for isoniazid.

The statistical analysis included descriptive tests and bivariate and multivariate analyses in which the response variable was compliance or noncompliance with the steps in the assessment of contacts, as determined by the Chi-square Automatic Interaction Detector (CHAID) algorithm,<sup>(6)</sup> with cross-validation of results of 10 subsamples, a maximum of 10 nodes, and 5 cases in the child node. Pearson's chi-square test with Bonferroni's adjustment was used for between-node separation. Explanatory variables

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were degree of contact and family relationship between contacts and the index case, gender, number of rooms in the index case's house, and number of residents in the household. For the analysis of the second step (interview by the health care team), we included, in addition to the aforementioned variables, home visits (yes/no) and invitation for contacts to come to the health care facility.

The research project and its written informed consent form were submitted to and approved by the Human Research Ethics Committee of the *Hospital São João de Deus*—the only such committee in the city at the time the study was conducted— Protocol no. 63/2011.

Between January of 2007 and December of 2010, 135 cases of tuberculosis were reported, of which 54

(40%) consisted of patients with active pulmonary tuberculosis and who therefore were eligible for the study. We excluded 11 patients (20.4%) because there was no record of their addresses, 18 (34.2%) because they did not meet the inclusion criteria—13 (24.0%) because they had no ≤ 15-year-old contacts at the time of diagnosis and 5 (9.2%) because they lived in other cities—and 2 (3.7%) because they declined to participate in the study. There thus remained 21 index cases (38.9%), who were revisited between July of 2011 and February of 2013 and through whom 43 contacts who met the inclusion criteria were identified.

Table 1 presents the general characteristics of the study population.

(A) Step 1

Invitation from any type of health care facility

Cat	%	n
Yes	55.81	24
No	44.19	19
Total	(100.00)	43

Number of rooms in the residence  
P-value = 0.0006; Chi-square = 11.8824; df=1

Up to six rooms

Cat	%	n
Yes	76.92	20
No	23.08	6
Total	(60.47)	26

Six rooms or more

Cat	%	n
Yes	23.53	4
No	76.47	13
Total	(39.53)	17

(B) Step 2

Interview by the health care team

Cat	%	n
Yes	34.88	15
No	65.12	28
Total	(100.00)	43

Invitation from any type of health care facility  
P-value = 0.0000; Chi-square = 18.2366; df=1

Yes

Cat	%	n
Yes	62.50	15
No	37.50	9
Total	(55.81)	24

No

Cat	%	n
Yes	0.00	0
No	100.00	19
Total	(44.19)	19

Duration of contact  
P-value = 0.0054; Chi-square = 7.7257; df=1

Up to 8 weeks

Cat	%	n
Yes	85.71	12
No	14.29	2
Total	(32.56)	14

More than 8 weeks

Cat	%	n
Yes	30.00	3
No	70.00	7
Total	(23.26)	10

(C) Step 3

PPD testing performed

Cat	%	n
Yes	20.93	9
No	79.07	34
Total	(100.00)	43

Contact was physician assessed  
p-value = 0.0000; Chi-square = 22.2265; df = 1

Yes

Cat	%	n
Yes	77.78	7
No	22.22	2
Total	(20.93)	9

No

Cat	%	n
Yes	5.88	2
No	94.12	32
Total	(79.07)	34

Interview by the health care team

p-value = 0.0151; Chi-square = 5.9028; df = 1

Yes

Cat	%	n
Yes	22.22	2
No	77.78	7
Total	(20.93)	9

No

Cat	%	n
Yes	0.00	0
No	100.00	25
Total	(58.14)	25

**Figure 1.** Multivariate analysis of factors influencing access to clinical and therapeutic resources by ≤ 15-year-old contacts of cases of active pulmonary tuberculosis between 2007 and 2010. Cat.: category; and df: degrees of freedom.

**Table 1.** Descriptive characteristics of ≤ 15-year-old contacts of index cases of active pulmonary tuberculosis.<sup>a</sup>

Characteristic	N = 43	Invitation from the PHC team to be assessed for health status		p*
		Invited (n = 24)	Not invited (n = 19)	
<b>Sociodemographic</b>				
Male gender	22 (51.2)	12 (50.0)	10 (52.6)	> 0.05
Age at interview <sup>b</sup>	10.2 (8.3-12.5)	10.5 (8.6-12.7)	10.0 (7.6-12.2)	> 0.05
Knowing how to read or write	35 (81.4)	20 (83.3)	15 (78.9)	> 0.05
<b>Residence type</b>				
Owned	32 (74.4)	17 (70.8)	15 (78.9)	
Rented	10 (23.3)	7 (29.2)	3 (15.8)	
Borrowed	1 (2.3)	-	1 (5.3)	
<b>Number of rooms</b>				
Up to four	3 (7.0)	2 (8.3)	1 (5.3)	0.01
Five	13 (30.2)	9 (37.5)	4 (21.1)	
Six	10 (23.3)	9 (37.5)	1 (5.3)	
Seven or more	17 (39.5)	4 (16.7)	13 (68.4)	
<b>Number of residents in the household</b>				
Up to four	14 (32.6)	11 (45.8)	3 (15.8)	< 0.01
Five or more	28 (65.1)	12 (40.0)	16 (85.2)	
No response	1 (2.3)	1 (4.2)	-	
<b>Sanitation status</b>				
Piped, treated water	43 (100.0)	24 (100.0)	19 (100.0)	> 0.05
Sewage collection system	38 (88.4)	20 (83.3)	18 (94.7)	> 0.05
Garbage collection	43 (100.0)	24 (100.0)	19 (100.0)	> 0.05
<b>Contact with the index case</b>				
<b>Frequency of contact</b>				
Daily	25 (58.1)	15 (62.5)	10 (52.6)	> 0.05
Residence	20 (80.0)	13 (86.7)	7 (70.0)	
Same lot	5 (20.0)	2 (13.3)	3 (30.0)	
Infrequent	18 (41.9)	9 (37.5)	9 (47.4)	
<b>Duration of contact</b>				
≤ 2 weeks	12 (27.9)	9 (37.5)	3 (15.8)	< 0.01
3-10 weeks	14 (32.6)	9 (37.5)	5 (26.3)	
> 10 weeks	17 (39.5)	5 (24.0)	11 (57.9)	
<b>Degree of family relationship with the index case</b>				
Grandchild	16 (37.2)	11 (45.8)	5 (26.3)	0.03
Child	12 (27.9)	8 (33.8)	4 (21.1)	
Nephew/niece	12 (27.9)	2 (8.3)	10 (52.6)	
Other	2 (4.7)	2 (8.3)	-	
Sibling	1 (2.3)	1 (4.2)	-	
<b>PHC received by contacts</b>				
<b>Type of health care facility</b>				
Family health care clinic	8 (18.6)	5 (20.8)	3 (15.8)	> 0.05
Primary health care clinic	35 (81.4)	19 (79.2)	16 (84.2)	
<b>Preventive activities</b>				
<b>BCG vaccination</b>				
First vaccination	42 (97.7)	23 (95.8)	19 (100.0)	> 0.05
Revaccination	1 (2.3)	1 (4.2)	-	
<b>Invitation from the PHC team to be assessed for health status</b>				
Invitation accepted	15 (62.5)	15 (62.5)	-	< 0.01
Home visit	7 (43.8)	7 (46.7)	-	0.01
Assessment by the physician <sup>c</sup>	9 (56.2)	8 (53.3)	1 (100.0)	0.03
Underwent tuberculin skin testing	9 (20.9)	8 (33.3)	1 (5.3)	0.03
Underwent chest X-ray	5 (11.6)	4 (16.7)	1 (5.3)	> 0.05
Underwent chemoprophylaxis	1 (14.3)	1 (4.2)	-	> 0.05

PHC: primary health care. <sup>a</sup>Values expressed as n (%), except where otherwise indicated. <sup>b</sup>Values expressed as median (interquartile range). <sup>c</sup>One contact who was not invited for assessment sought the physician by itself. Therefore, the total number of assessments performed by the PHC team was 16 rather than 15. \*Pearson's chi-square test with Bonferroni's adjustment.

Of the 43 contacts, all had received BCG vaccination, 22 (51.2%) were male, 40 (93.0%) lived with five or more persons in the household, 25 (58.1%) had frequent contact with the index case, and 25 (58.1%) reported a family income of up to two times the national minimum wage.

Figure 1 contains the decision tree for the first three steps in the assessment of contacts. In it, the lack of invitation for contacts to come to the health care facility (in 44.2%; Figure 1A) is of note, as are the lack of interview by the health care team (in 65.1%; Figure 1B) and the lack of tuberculin skin testing (in 79.1%; Figure 1C). In addition, invitation for contacts to come to the health care facility was found to be associated only with number of rooms in the house (a proxy for socioeconomic status), the invitation being made mostly to those living in houses with fewer rooms (76.9%; Figure 1A). No statistical significance was found for either degree of contact or type of health care facility where care was provided.

Whether an interview would be conducted with contacts and their families was determined by contacts having been instructed to come to the health care facility and by duration of contact. Only 24 contacts (55.8%; Figure 1A) were invited to come to the health care facility, whereas, among these, the attendance rate was 62.5%.

The most significant variable ( $p < 0.0001$ ) in determining whether a contact would undergo tuberculin skin testing was medical assessment, i.e., 77.8% of those who were assessed by a physician underwent such testing, which denotes that assessment of contacts was centered on only one professional. In cases in which the contact was not assessed by a physician, the second explanatory variable was interview by the health care team (Figure 1B).

The last two steps in the assessment of contacts were not included in the decision tree because they were not performed for all contacts; they are recommended based on the results obtained in the previous assessment step, i.e., whether a contact will undergo chest X-ray is dependent on tuberculin skin testing results, and whether a contact will receive treatment for LTBI or active tuberculosis is dependent both on chest X-ray findings and tuberculin skin testing results.

Treatment for LTBI should have been recommended to at least 2 of the contacts; however, only 1 of them (2.3%) received such treatment and for only about 30 days.

Our review of the literature found no studies on assessment of contacts in which the CHAID method was used, this method being a strategy for statistical

analysis that allows the identification of critical points in each step in the investigation of such individuals.

As shown in the present study, assessment of contacts revealed that compliance rates were lower than desirable. A study conducted in the state of Mato Grosso, Brazil, reported that 60.5% of the contacts younger than 15 years were investigated, and that the proportion of contacts investigated was 40.0% higher among those exposed to active cases, being higher than that found in the present study.<sup>(3)</sup> In the city of São José do Rio Preto, Brazil, 63.1% of the contacts were assessed by the municipal health care system in 2002.<sup>(2)</sup> Nearly the reverse of this situation is found in developed countries; there, the proportion of contacts who are investigated ranges from 80% to 90%, as is the case in the USA and in the Netherlands.<sup>(4,7)</sup>

It is possible that biases occurred in the approach to contacts. One such bias is that only the low socioeconomic conditions of the contacts (perceived perhaps because of the size of the houses, given that approximately 60% had six rooms at most; Table 1) would favor the transmission of tuberculosis. However, in the present study, this was not observed, since only 11.6% of the contacts lived with more than five people in houses with up to six rooms. Another such bias is that the health professionals seem to have assumed that the risk of developing the disease would be higher among those 60% (Table 1) whose duration of exposure to the active source case had occurred within the first 10 weeks than would among those whose duration was greater than 10 weeks ( $p < 0.01$ ). In other words, these professionals believed that, if contacts had not contracted tuberculosis up to that time, they would not develop the disease in the future. This perception is completely wrong. In addition, the present study found that assessment of contacts was physician-centered, contrary to the Brazilian National Tuberculosis Control Program guidelines, which strongly encourage the participation of all health professionals.<sup>(2)</sup>

In conclusion, the present study underscores the urgent need for training primary health care teams on how to approach contacts appropriately, especially those who are exposed to patients with active tuberculosis.

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