

## Scoring system for the diagnosis of tuberculosis in indigenous children and adolescents under 15 years of age in the state of Mato Grosso do Sul, Brazil\*

Diagnóstico da tuberculose em indígenas menores de quinze anos por meio de um sistema de pontuação em Mato Grosso do Sul

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### Abstract

**Objective:** To evaluate the process of diagnosing pulmonary tuberculosis in smear-negative indigenous children and adolescents under 15 years of age with the modified Brazilian National Ministry of Health Scoring System (mBNMH-SS). **Methods:** This was a retrospective descriptive study involving 49 indigenous patients under 15 years of age with tuberculosis, treated between 2007 and 2010 in the state of Mato Grosso do Sul, Brazil. **Results:** Of the 49 patients, 27 (56%) were under 5 years of age, 33 (67%) had symptoms suggestive of tuberculosis, 24 (49%) were underweight, and 36 (73.5%) had been BCG vaccinated. The tuberculin skin test was positive in 28 patients (57%), 18 (64%) of whom had an induration  $\geq 10$  mm. Chest X-rays were performed in 37 (76%) of the patients, 31 (84%) of whom had only one chest X-ray taken. Among those 37 patients, the radiological findings were suggestive of tuberculosis in 16 (43%), infiltration/condensation in 10 (27%), and normal in 4 (11%). The Indigenous Health Care Teams made the diagnosis in 31 (63%) of the cases, using the original BNMH-SS in only 14 (45%). We calculated the mBNMH-SS scores for 30 (61%) of the 49 patients. Among the 30 cases scored, a diagnosis of tuberculosis was found to be highly likely, possible, and unlikely in 16 (53%), 11 (37%), and 3 (10%), respectively. **Conclusions:** The proportion of highly likely and possible diagnoses was consistent with the standard proportion of cases diagnosed by the teams (90%), demonstrating the epidemiological applicability of the mBNMH-SS for the diagnosis of pulmonary tuberculosis in the indigenous population, within the scenario of the health care provided.

**Keywords:** Tuberculosis, pulmonary/diagnosis; Health services, indigenous/standards; Health services, indigenous/organization & administration.

### Resumo

**Objetivo:** Avaliar o processo diagnóstico da tuberculose pulmonar em indígenas menores de 15 anos, por meio do Sistema de Pontuação do Ministério da Saúde Modificado (SP-MSm), em crianças e adolescentes com resultados negativos na baciloscopia. **Métodos:** Estudo descritivo retrospectivo de 49 casos de tuberculose em indígenas menores de 15 anos no estado do Mato Grosso do Sul entre 2007 e 2010. **Resultados:** Dos 49 pacientes, 27 (56%) eram menores de 5 anos, 33 (67%) apresentavam sintomas sugestivos de tuberculose, 24 (49%) tinham baixo peso, e 36 (73,5%) haviam sido vacinados com BCG. O teste tuberculínico foi reator em 28 pacientes (57%). Dentre esses, 18 (64%) apresentaram endurecimento  $\geq 10$  mm. Foram realizadas radiografias de tórax em 37 pacientes (76%), sendo que 31 (84%) fizeram apenas um exame. Desses 37 pacientes, os achados radiológicos eram sugestivos de tuberculose em 16 (43%), de infiltrado/condensação em 10 (27%) e normais em 4 (11%). As Equipes de Saúde Indígena foram responsáveis pelo diagnóstico em 31 (63%) dos casos, mas o SP-MS original só foi utilizado em 14 (45%). Os escores do SP-MSm foram determinados em 30 pacientes (61%). Dos 30 casos pontuados, os resultados dos escores indicaram diagnóstico de tuberculose muito provável, possível e pouco provável em 16 (53%), 11 (37%) e 3 (10%), respectivamente. **Conclusões:** A proporção de diagnóstico muito provável e possível foi concordante com o diagnóstico padrão do serviço (90%), evidenciando a aplicabilidade epidemiológica do SP-MSm para o diagnóstico da tuberculose pulmonar em indígenas, de forma compatível com a realidade do serviço de saúde prestado.

**Descritores:** Tuberculose pulmonar/diagnóstico; Serviços de saúde do indígena/normas; Serviços de saúde do indígena/organização & administração.

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## Introduction

Historically, tuberculosis has significantly contributed to the reduction in the indigenous population size in Brazil and remains a major cause of morbidity and mortality, although specific treatment is available.<sup>(1)</sup> The prevalence of tuberculosis in indigenous children and adolescents under 15 years of age in the state of Mato Grosso do Sul, which was 40% in 2001,<sup>(2)</sup> decreased to 20.4% between 2000 and 2006.<sup>(3)</sup> Although this is a significant reduction, this prevalence is in contrast to the percentage of tuberculosis cases expected for children and adolescents under 15 years of age in the general Brazilian population (5%).<sup>(4)</sup> In addition to this epidemiological profile, there is the diagnostic challenge posed by this age group, given that it is difficult to obtain sputum samples, the disease is characteristically paucibacillary,<sup>(5)</sup> and the clinical and radiological findings are nonspecific.<sup>(6)</sup> The difficulty in obtaining bacteriological confirmation is related to the fact that sputum or gastric lavage culture positivity rates are low, ranging from 30 to 40%.<sup>(6)</sup> Gastric lavage, despite being the ancillary test of choice for diagnostic confirmation in specific cases, requires that the child be hospitalized for three days or be taken to the facility on three consecutive days in order to undergo the procedure.<sup>(7)</sup> In order to overcome the problem of diagnosing tuberculosis in children, combinations of clinical characteristics, history of contact with adult active tuberculosis, tuberculin skin test (TST) results, and radiological findings have been evaluated. Various scoring systems, which assign different weights to these variables, have been developed.<sup>(8,9)</sup> Although their validation is limited by the lack of a gold standard for comparison, these systems have played an important role in diagnostic screening.<sup>(10)</sup> Diagnostic, clinical, and radiological criteria, as well as TST results, are still recommended, given that, in the short term, there is little prospect of devising a standard diagnostic method, which involves culture, microscopy, PCR, or serological tests, widely available to children.<sup>(11)</sup> Since 2002, the Brazilian National Ministry of Health (NMH) has officially recommended a scoring system for the diagnosis of pulmonary tuberculosis in smear-negative children and adolescents.<sup>(12)</sup> This scoring system was adjusted in 2010,<sup>(13)</sup> and its sensitivity and specificity are 88.9% and 86.5%, respectively.<sup>(6)</sup> The objective of the present study was to evaluate the process

of diagnosing pulmonary tuberculosis in smear-negative indigenous children and adolescents under 15 years of age with the Brazilian NMH Scoring System. Considering the limitations of its applicability in this population, because of operational aspects inherent to the health care system, the authors adjusted the numerical values assigned to some of the scoring system variables and applied the modified Brazilian NMH Scoring System for the diagnosis of pulmonary tuberculosis as a new proposal for use in the assessment of indigenous children and adolescents.

## Methods

This was a retrospective descriptive study of the diagnostic process in 49 indigenous patients under 15 years of age with tuberculosis who were treated between 2007 and 2010 and who resided in indigenous villages in the state of Mato Grosso do Sul. The cases were reported and treated by the *Equipes de Saúde Indígena* (ESI, Indigenous Health Care Teams) of the *Distrito Sanitário Especial Indígena de Mato Grosso do Sul* (DSEI-MS, Special Indigenous Health District of Mato Grosso do Sul), which is affiliated with the Special Department of Indigenous Health, in accordance with guidelines of the *Programa Nacional de Controle da Tuberculose do MS* (PNCT/MS, Brazilian National Tuberculosis Control Program of the Brazilian NMH).<sup>(14)</sup> We chose non-probability, convenience sampling, which is recommended because this was a homogeneous population and because of its operational ease.<sup>(15)</sup> The population was selected on the criterion of cases reported in the DSEI-MS base clinics with the highest incidence of tuberculosis, all of which were located in the south of the state. The records (medical charts and case registries) made available by the ESI of the DSEI-MS were analyzed for epidemiological, clinical, and radiological characteristics, as well as data regarding nutritional status, BCG vaccination, and TST results, all of which are used by the Brazilian NMH Scoring System (Chart 1).<sup>(13)</sup> We retrospectively applied the Brazilian NMH Scoring System to the cases studied. However, changes were made to the numerical values assigned to the variable *chest X-ray findings*. The Brazilian NMH Scoring System<sup>(13)</sup> presupposes that a second chest X-ray will be taken to assess progression of imaging findings and therefore determine the score for this variable. Since this procedure is operationally

**Chart 1** – Brazilian National Ministry of Health Scoring System for the diagnosis of pulmonary tuberculosis in smear-negative children and adolescents, Brazil, 2011.

Clinical manifestations	Points
Fever or symptoms such as cough, adynamia, expectoration, weight loss, and sweating for more than 2 weeks	+15
No symptoms or symptoms for less than 2 weeks	0
Respiratory infection that improved with antibiotics for common pathogens or without antibiotics	-10
<b>Chest X-ray findings</b>	
Hilar lymphadenopathy or miliary pattern	+15
Condensation or infiltration (with or without cavitation) for more than 2 weeks, remaining unchanged	+15
Condensation or infiltration (with or without cavitation) for more than 2 weeks, worsening or not improving with antibiotics for common pathogens	+15
Condensation or infiltration of any type for less than 2 weeks	+5
Normal	-5
<b>History of contact with adult tuberculosis</b>	
Close contact in the last 2 years	+10
Occasional or no contact	0
<b>Tuberculin skin test results</b>	
Induration $\geq$ 5 mm in patients who have not been BCG vaccinated, or who were BCG vaccinated 2 or more years earlier, or who are immunocompromised	+15
Induration $\geq$ 10 mm in patients who were BCG vaccinated 2 or more years earlier	+15
Induration from 0 to 4 mm	0
<b>Nutritional status</b>	
Severe malnutrition	+5
Normal nutritional status or no severe malnutrition	0

Result interpretation: highly likely diagnosis: score  $\geq$  40 points; possible diagnosis: score between 30 and 35 points; and unlikely diagnosis: score  $\leq$  25 points.

unfeasible for this population, the authors made changes to the numerical values assigned to this variable so that normal chest X-ray findings were assigned -5 points, whereas abnormal chest X-ray findings, as defined by the standards described in this system, were assigned +5 points. The system with the previously mentioned changes was then designated modified Brazilian NMH Scoring System for the diagnosis of pulmonary tuberculosis in smear-negative indigenous children and adolescents (Chart 2). The modified Brazilian NMH Scoring System was retrospectively applied to all cases that had recorded data regarding at least four of the five attributable variables (Chart 2). Cases of tuberculosis were defined as reported cases in which the diagnosis was made by the ESI, with or without positive bacteriological testing, and whose outcome was not a change in diagnosis. Microsoft Office Excel 2003 was used to build the database. The present study was approved by the Human Research Ethics Committee of the Anhanguera University and

by the *Conselho Nacional de Ética em Pesquisa* (CONEP, Brazilian National Ethics Committee; no. 25000.140518/2010-96).

## Results

During the study period, 76 indigenous patients under 15 years of age were reported to have tuberculosis. Initially, we selected 69 cases reported in the base clinics with the highest incidence of tuberculosis, all of which were located in the south of the state. Among those cases, there was a change in diagnosis in 3, the records were not found in 8, the available records were incomplete in 6; and it was impossible to go to the base clinic of origin in 3. Therefore, we selected 49 cases reported and treated by the ESI. Of those 49 patients, 29 (59%) and 20 (41%) were male and female, respectively. In relation to age group, 27 patients (56%) were under 5 years of age, 13 (27%) were between 5 and 9 years of age, and 8 (17%) were between 10 and 14 years of age. Among the 49 patients, there were symptoms

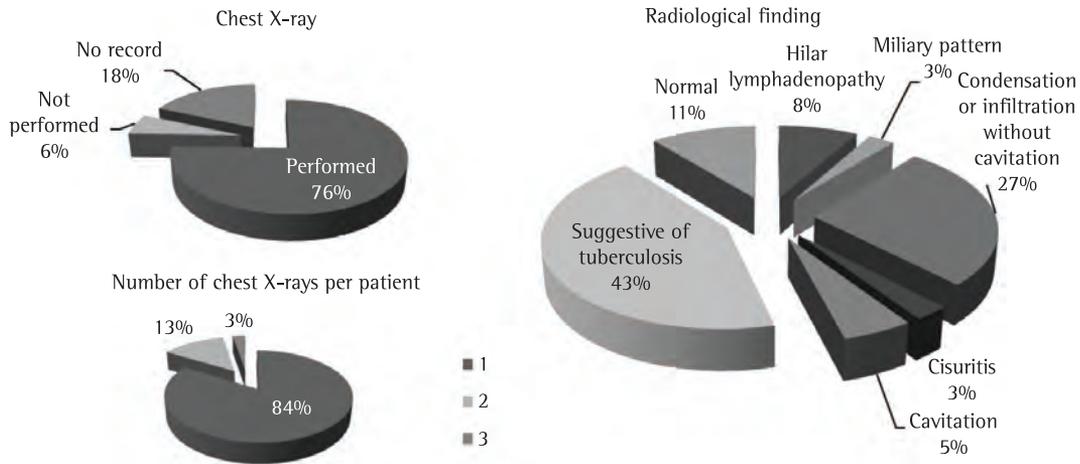
**Chart 2** – Modified Brazilian National Ministry of Health Scoring System for the diagnosis of pulmonary tuberculosis in smear-negative indigenous children and adolescents, Brazil, 2011.

Clinical manifestations	Points
Fever or symptoms such as cough, adynamia, expectoration, weight loss, and sweating for more than 2 weeks	+15
No symptoms or symptoms for less than 2 weeks	0
Respiratory infection that improved with antibiotics for common pathogens or without antibiotics	-10
Chest X-ray findings	
Hilar lymphadenopathy or miliary pattern	+5
Condensation or infiltration (with or without cavitation) for more than 2 weeks, remaining unchanged	+5
Condensation or infiltration (with or without cavitation) for more than 2 weeks, worsening or not improving with antibiotics for common pathogens	+5
Condensation or infiltration of any type for less than 2 weeks	+5
Normal	-5
History of contact with adult tuberculosis	
Close contact in the last 2 years	+10
Occasional or no contact	0
Tuberculin skin test results	
Induration $\geq$ 5 mm in patients who have not been BCG vaccinated, or who were BCG vaccinated 2 or more years earlier, or who are immunocompromised	+15
Induration $\geq$ 10 mm in patients who were BCG vaccinated 2 or more years earlier	+15
Induration from 0 to 4 mm	0
Nutritional status	
Severe malnutrition	+5
Normal nutritional status or no severe malnutrition	0

Result interpretation: highly likely diagnosis: score  $\geq$  40 points; possible diagnosis: score between 30 and 35 points; and unlikely diagnosis: score  $\leq$  25 points.

suggestive of tuberculosis, such as fever, cough, adynamia, expectoration, and weight loss, in 33 (67%), and the clinical course lasted 2 or more weeks in 31 (63%). Of the remaining patients, 11 (23%) had no recorded data regarding clinical profile, 4 (8%) were asymptomatic, and 1 (2%) had other symptoms. In relation to nutritional status,<sup>(16)</sup> 24 patients (49%) had severe malnutrition or had weight below the 10th percentile, 8 (16%) had weight at or above the 10th percentile, and 17 (35%) had no recorded data regarding it. We found that 36 cases (73.5%) had been BCG vaccinated. The TST was positive in 28 patients (57%), whereas 13 (27%) did not undergo the TST and 8 (16%) had no recorded data regarding it. Among those 28 patients, 18 (64%) had a TST induration  $\geq$  10 mm, 3 (11%) had a TST induration from 5 to 9 mm, and 7 (25%) had a TST induration from 0 to 4 mm. Among the 18 patients with a TST induration  $\geq$  10 mm, 10 (56%) had been BCG vaccinated 2 or more years earlier, 6 (33%) had been BCG vaccinated less than 2 years earlier, and 2 (11%) had no

recorded data regarding it. There was a positive history of contact with adult active tuberculosis in 63% of the cases, and there was no information regarding history of contact in 37%. The results for the variable *chest X-ray findings* (Figure 1) revealed that 37 patients (76%) underwent chest X-ray, 3 (6%) did not, and 9 (18%) had no recorded data regarding it. Among those 37 patients, the radiological findings were described as suggestive or suspicious of tuberculosis in 16 (43%), as specific in 17 (46%)—in 10 (27%), there was infiltration and/or condensation—and as normal in 4 (11%; Figure 1). One, two, and three chest X-rays were performed, respectively, in 31 (84%), 5 (13%), and 1 (3%; Figure 1). As shown in Table 1, the diagnosis of tuberculosis was made by the ESI and by other professionals during hospitalization, respectively, in 63% and 37% of the cases. In the diagnoses made by the ESI, the Brazilian NMH Scoring System was used in 45% of the cases, it was not used in 45% of the cases, and it was not applicable in 7% of the cases (because those were cases of



**Figure 1** – Performance of chest X-ray, number of chest X-rays per patient, and radiological findings in indigenous patients under 15 years of age with tuberculosis, Special Indigenous Health District of Mato Grosso do Sul, 2007-2010.

**Table 1** – Application of the Brazilian National Ministry of Health Scoring System for the diagnosis of tuberculosis to smear-negative indigenous children and adolescents under 15 years of age who were diagnosed with tuberculosis, by health care professional responsible for the diagnosis, Special Indigenous Health District of Mato Grosso do Sul, 2007-2010.

Health care professional responsible for the diagnosis	Application of the Scoring System									
	Yes		No		Not applicable		Unknown		Total	
	n	%	n	%	n	%	n	%	n	%
Indigenous Health Care Teams	14	45.16	14	45.16	2	6.45	1	3.23	31	63.27
Regional hospital professionals	2	11.11	1	5.56	2	11.11	13	72.22	18	36.73
<b>Total</b>	<b>16</b>	<b>32.65</b>	<b>15</b>	<b>30.61</b>	<b>4</b>	<b>8.16</b>	<b>14</b>	<b>28.57</b>	<b>49</b>	<b>100.00</b>

**Table 2** – Score obtained by the retrospective application of the modified Brazilian National Ministry of Health Scoring System for the diagnosis of pulmonary tuberculosis to smear-negative indigenous children and adolescents under 15 years of age who were diagnosed with tuberculosis and number of cases in which one of the variables of the system was missing, Special Indigenous Health District of Mato Grosso do Sul, 2007-2010.

Score, n	Cases		Cases in which one variable was missing		
	n	%	Score for the missing variable		
			5	10	15
≥ 40	16	53.3	1	0	0
30-35	11	36.7	1	1	1
≤ 25	3	10.0	1	1	0
<b>Total</b>	<b>30</b>	<b>100.0</b>	<b>3</b>	<b>2</b>	<b>1</b>

extrapulmonary tuberculosis). In addition, there were no records of the diagnostic criteria used in 3% of the cases. Table 2 shows the result of the retrospective application of the modified Brazilian NHM Health Scoring System for the

diagnosis of pulmonary tuberculosis in smear-negative indigenous children and adolescents. By using this system, it was possible to assign a score to 30 patients (61%), whereas it was impossible to assign a score to 14 patients (29%)

because of missing information regarding two or more variables. In addition, the system was not applicable in 5 patients (10%) because those were cases of extrapulmonary tuberculosis. Among the 30 cases scored, a diagnosis of tuberculosis was found to be highly likely, possible, and unlikely in 16 (53%), 11 (37%), and 3 (10%), respectively.

## Discussion

Scoring systems for the diagnosis of pulmonary tuberculosis in children have been developed as a strategy for the clinical management of patients.<sup>(17)</sup> However, those instruments show a wide variation in sensitivity and specificity, as well as in predictive values.<sup>(18)</sup> Their importance is due to the fact that they are based on clinical practice, they are intended to reduce costs, and they are easy to operate in public health care facilities. One of the criticisms to scoring systems is that the numerical values assigned are arbitrary, for the most part.<sup>(19)</sup> Accordingly, more recently, international experts have proposed a new scoring system, based on mathematical methods, recognizing that there is no gold standard for the diagnosis of tuberculosis in children.<sup>(20)</sup> The development of the Brazilian NMH Scoring System was partly based on the results of a study that was conducted in Brazil, comparing three diagnostic criteria sets<sup>(19)</sup> in which the numerical values assigned are also arbitrary. Among the few studies investigating the use of the Brazilian NMH Scoring System in indigenous populations, a clinical and radiological study involving children and adolescents of the Suruí indigenous group concluded that the application of this scoring system is important for the correct diagnosis of tuberculosis in indigenous populations and for the acquisition of more detailed epidemiological knowledge regarding these populations.<sup>(21)</sup> Although the present study has the limitations inherent to secondary data studies, it raises important questions regarding the national guidelines for the diagnosis of tuberculosis in children, which are also recommended by the PNCT/MS for the indigenous population. Since 2002, when the Brazilian NMH proposed the Scoring System<sup>(12)</sup> as a guideline, the technical coordinators of the DSEI-MS have developed continuing training activities for the ESI for the application of this system, which requires the combined analysis of five variables: clinical findings; radiological findings; interpretation of TST results on the

basis of BCG vaccination status; nutritional status; and history of contact with adult active tuberculosis. According to this system, a score  $\geq 40$  indicates that the diagnosis of tuberculosis is highly likely, a score between 30 and 35 points indicates that the diagnosis is possible, and a score  $\leq 25$  indicates that the diagnosis is unlikely. The results of the present study reveal that, for the five variables included in the scoring system, the proportion of missing records was high (mean, 27%), denoting that the elements used to make the diagnosis in this age group are not valued. The ESI are the ones primarily responsible for the diagnosis of tuberculosis in this population. However, more than 30% of cases are diagnosed late, at tertiary care level, the disease being advanced and strongly associated with severe malnutrition. Despite continuing training, recording of use of the scoring system by the ESI for diagnosing the cases was lower than 50%, which is in agreement with the high rate of missing records regarding the previously mentioned variables. Retrospective application of the scoring system has been used by researchers to demonstrate the sensitivity (88.9%) and specificity (86.5%) of this diagnostic method<sup>(6)</sup> in different populations, on the basis of diagnostic agreement, by using the protocol of the referral health care facility as the gold standard,<sup>(22,23)</sup> even in the absence of positive bacteriology. In the present study, the standard diagnosis was cure without a change in diagnosis, in accordance with the PNCT/MS. The analysis of the variable *chest X-ray findings* showed the difficulties faced by the ESI in terms of imaging tests. Although chest X-ray service has been offered by municipal governments through a partnership between the DSEI and Municipal Health Departments, the delivery of the service is limited and time consuming because of the distances between the indigenous villages and the cities and because of the reduced availability of tests. The interpretation of radiological images is left to the physicians of the ESI, given that, as a rule, there are no radiologists to issue reports or to participate in the clinical discussion of the cases. This context explains why one single X-ray was performed in more than 80% of the investigated cases and why the radiological findings were considered suggestive or suspicious of tuberculosis, a classification used by the PNCT/MS,<sup>(14)</sup> without any description of the radiographic abnormalities.

This scenario shows the severe operational restrictions on the application of the Brazilian NMH Scoring System (Chart 1). It is of note that, except when chest X-ray findings are normal or specific (miliary pattern or hilar adenopathy), the Brazilian NMH Scoring System presupposes that a second chest X-ray will be taken in suspected cases in order to assess progression of imaging findings and only then determine the score for this variable. The response of researchers to this impasse was the experimental proposal of the modified Brazilian NMH Scoring System for the diagnosis of pulmonary tuberculosis in smear-negative indigenous children and adolescents. The change proposed applies to only two situations: normal chest X-ray findings, -5 points; and abnormal chest X-ray findings, showing any of the patterns described by the Brazilian NMH Scoring System, +5 points (Chart 2). Although the variable *chest X-ray findings* was assigned low numerical values, a fact that is explained by the previously mentioned difficulties with imaging tests, the clinical and epidemiological characteristics of the population maintained the high sensitivity of the modified Brazilian NMH Scoring System. This was demonstrated by the results of the diagnostic criteria in the 30 cases to which the modified Brazilian NMH Scoring System was applied. In 53.3%, the score was  $\geq 40$  points (highly likely diagnosis), and, in 36.7%, the score was between 30 and 35 points (possible diagnosis). Treatment is indicated in such cases. In 10% of the cases, the score was  $\leq 25$  (unlikely diagnosis); the approach in such cases is further diagnostic investigation. Therefore, the interpretation of the scores and the resulting diagnostic criteria were in agreement with the standard diagnosis provided by the teams in 90% of the patients, for whom tuberculosis treatment is indicated. Chief among the clinical and epidemiological characteristics are the clinical repercussions (symptoms and nutritional status), which were predominant, the TST reactivity, and the high rates of contact with patients with active tuberculosis because of the parental relationships and the cultural characteristics of shared housing of the indigenous population. Even if the methodological limitations of the present study are taken into account, it is possible to infer that the diagnosis of tuberculosis in indigenous patients under 15 years of age made by the ESI of the DSEI-MS only partially meets

the recommendations of the Brazilian NMH, the Brazilian NMH Scoring System being infrequently used. Despite the continuing training activities promoted by the regional technical teams responsible for the PNCT/MS, there are operational difficulties in obtaining information regarding the variables included in the Brazilian NMH Scoring System, especially regarding chest X-ray findings. In this context, the results of the experimental proposal of the modified Brazilian NMH Scoring System for the diagnosis of pulmonary tuberculosis in smear-negative indigenous children and adolescents demonstrate the epidemiological applicability of this scoring system, which is consistent with the characteristics of the health care provided to this population. Another important contribution of the present study is to show the possibilities of overcoming the technical difficulties by means of further studies involving adjustments in the variables and/or in their respective numerical values. Such studies should be based on the health care scenario as well as on the epidemiological peculiarities of the indigenous population (high incidence of tuberculosis, high transmissibility, prevalence in the age group at greatest risk for severe forms, and death), a population in which early diagnosis is required.

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