



# SPUTUM SMEAR POSITIVITY GRADE AND CHEST X-RAY FINDINGS IN TUBERCULOSIS: A CROSS-SECTIONAL STUDY

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**Abstract.** Despite many advances in the diagnosis, screening, and rapid treatment of tuberculosis, it is still a public health concern in the world. Due to the importance of this issue in diagnosis and reduction of transmission of infection and treatment of the disease especially where this study was conducted due to the high prevalence of tuberculosis, the aim of our study was to determine the relationship between sputum smear positivity grade and chest X-ray findings in pulmonary tuberculosis patients in a hospital in southeast of Iran. This cross-sectional study was performed on all patients with pulmonary TB referencing the health centers in the Zabol city from January 1, 2015 to December 30, 2020. Sputum smear and radiographic findings of the chest X-ray were evaluated. Data was collected using a form of information and finally analyzed by SPSS 22. Out of 101 patients examined in the present study, 71 were women and 30 were men. The mean age of the patients was  $62.68 \pm 13.61$  years. The frequency of opacity in patients with grades 1, 2, and 3 was 71.4, 78.5, and 76.5%, respectively. Frequency of cavitation in patients with grade 1, 2 and 3 was 11.5%, 28.5% and 52.9% respectively (P value 0.001). The frequency of reticulonodular presentations in patients with grade 1, 2, and 3 was 24.2, 7.1, and 0%, respectively. In general, the results of this study showed that, with increasing grading of smears (1+, 2+, and 3+), the frequency of cavitation presentation increased significantly and the frequency of reticulonodular presentations decreased significantly. The findings of the present study can help physicians to improve TB diagnostics.

**Key words:** cross-sectional studies, sputum, X-ray, tuberculosis, radiography.

## ВЗАИМОСВЯЗЬ СТЕПЕНИ ПОЗИТИВНОСТИ МАЗКА МОКРОТЫ И РЕНТГЕНОЛОГИЧЕСКОЙ КАРТИНЫ ОРГАНОВ ГРУДНОЙ КЛЕТКИ ПРИ ТУБЕРКУЛЕЗЕ: ОДНОМОМЕНТНОЕ ИССЛЕДОВАНИЕ

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**Резюме.** Несмотря на многочисленные достижения в диагностике, скрининге и лечении туберкулеза, он по-прежнему остается проблемой общественного здравоохранения во всем мире. Ввиду важности этого вопроса для диагностики, снижения уровня распространения инфекции и лечения заболевания мы определяли взаимосвязь между степенью позитивности мокроты и рентгенологической картиной грудной клетки у больных туберкулезом легких на юго-востоке Ирана. Данный регион был выбран для проведения настоящего исследования по причине высокой распространенности в нем туберкулеза. Поперечное исследование было проведено с вовлечением всех пациентов с легочным туберкулезом в медицинских центрах города Заболь с 1 января 2015 года по 30 декабря 2020 года. Были изучены мазки мокроты и рентгенологические данные грудной клетки.

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Результаты каждого пациента были внесены в специально разработанную форму и проанализированы с помощью программы SPSS 22. В исследовании принял участие 101 пациент — 71 женщина и 30 мужчин. Средний возраст пациентов составил  $62,68 \pm 13,61$  года. Частота затемнения легочного рисунка у пациентов с позитивностью мазка 1, 2 и 3 степени составила 71,4, 78,5 и 76,5% соответственно. Частота обнаружения каверн в легких у пациентов с позитивностью мазка 1, 2 и 3 степени составила 11,5, 28,5 и 52,9% соответственно (значение  $p = 0,001$ ), а частота ретикулонодулярных признаков — 24,2, 7,1 и 0% соответственно. В целом результаты этого исследования показали, что с увеличением степени позитивности мазков (1+, 2+ и 3+) частота формирования каверн в легких существенно увеличивалась, а частота ретикулонодулярных проявлений значительно снижалась. Результаты настоящего исследования могут быть полезны практикующим врачам для диагностики туберкулеза.

**Ключевые слова:** *кросс-секционные исследования, мокрота, рентген легких, туберкулез, рентгенография.*

## Introduction

Despite many advances in the diagnosis, screening, and rapid treatment of tuberculosis, it is still a public health concern in the world. According to the latest WHO report, more than 10 million people worldwide are infected with tuberculosis. Geographically, most TB patients are in Africa and EMRO [20].

According to the latest meta-analysis reports, the prevalence of TB in Iran is 23% [13] to 27% [6]. TB is the biggest cause of death among single-agent infectious diseases (even more so than AIDS, malaria, and measles) and has a tenth-highest global burden of disease, and is expected to continue to maintain its present status until 2020 [9]. The basis of the diagnosis of pulmonary tuberculosis is a direct and simple screening of susceptible patients. In the best of cases, the sensitivity of the sputum test to detect pulmonary tuberculosis is fifty to sixty percent [17]. By the standard definition, patients who experience at least two positive sputum smear tests, or have only a positive sputum smear test for bacilli acid-fast associated with radiographic changes in the chest X-ray, or a positive smear for acid bacilli in addition to a positive culture are considered as positive for active tuberculosis [2, 12, 21]. The grade of the smear is determined by the bacillary load in each microscopic field. Some studies have found that the grade of primary smear can be considered as a predictive factor of patient's morbidity and mortality, which, in the case of a higher grade of positivity, it is more likely to be a failure in treatment and cause death [7, 18]. In some studies, the relationship between the grade of primary positive smear and increased clinical manifestations has been stated [19]. Chest X-ray is also a suitable and sensitive diagnostic tool for detecting pulmonary lesions, including in tuberculosis, so that in the case of a normal chest X-ray, the diagnosis of tuberculosis is partially excluded [8, 12]. On the other hand, in cases where this disease is actively sought, and when it is diagnosed at an early stage, pulmonary involvement can be a sign of our success in the early detection of these patients, resulting from radiographic findings [7]. Based on the researcher's best knowledge there is no study has been

conducted to investigate the relationship between the findings of chest X-ray radiography and the grade of positivity of sputum smear in Iran and especially Southeast of Iran as an area with a high prevalence of tuberculosis. According to the statistics of the Ministry of Health of Iran, Sistan and Baluchestan province and Zabol city are the most common cities for tuberculosis in Iran [1, 10].

Some studies have been done in this regard, and due to the importance of this issue in diagnosis and reduction of transmission of infection and treatment of the disease especially where this study is conducted due to the high prevalence of tuberculosis, this study was done to determine The relationship between sputum smear positivity grade and chest X-ray findings in pulmonary tuberculosis patients in a hospital in southeast of Iran.

## Materials and methods

This cross-sectional study was performed on all patients with pulmonary TB referencing the health centers in the Zabol city, southeast of Iran, from January 1, 2015 to December 30, 2020.

In this study, the national TB diagnosis protocol based on the WHO guidelines was used to diagnose TB in included patients. Patients over 18 years of age were included. Patients without smear grading that had chest radiographs were excluded. A researcher-made checklist for collecting information. The checklist were containing demographic information, smear positivity grading, and chest radiographs. The study protocol approved has in the Ethics Committee of Zabol University of Medical Sciences. Written consent was obtained from all participants prior to the study. Participants were assured that their information would be kept confidential. STROBE checklist was used to report the study.

The patient's characteristics were described using descriptive tests including mean, standard deviation, frequency, and percentage. The Kolmogorov–Smirnov test was used to evaluate data normality. SPSS Version 22 for Windows (SPSS Inc., Chicago, IL, USA) was used to analyze the data. The confidence interval of 95% and a significance level of P-value less than 0.05 was considered significant.

## Results

Of the 101 participants, 71 (70.3%) were male and the rest were women. The mean age of patients was 62.68 years with a standard deviation of 13.61. The youngest and oldest patients were 18 and 86 years old respectively. Women with a sputum positivity grade of 1, 2, and 3 were 73.3%, 50%, and 70.6%, respectively, and the prevalence of men in grade 1, 2, and 3 was 25.7%, 50%, and 29.4%. There was no significant difference between the two sexes in terms of smear grade ( $p = 0.192$ ). The following table shows that the frequency of consolidation in 3 chest X-rays of patients with smear grade of 1, 2, 3 and was 71.4, 78.5, and 76.5%, respectively. This difference in the size of consolidation in patients with different grades was not statistically significant ( $p = 0.833$ ) (Table 1).

The following table shows that the frequency of cavitation in patients with grade 1, 2, and 3 was 11.5%, 28.5%, and 52.9% respectively. This difference in the frequency of cavity was statistically significant in three groups ( $p = 0.001$ ) (Table 2).

The following table shows that nodular presentations in patients with grades 1, 2, and 3 were 18.6, 42.8, and 35.3%, respectively. This difference was not statistically significant in the three groups ( $p = 0.086$ ) (Table 3).

The following table shows that the prevalence of reticulonodular involvement in patients with grade 1, 2, and 3 was 24.2%, 7.1%, and 0.0%, respectively. The difference between the frequency of reticulonodular involvement in the three groups was statistically significant ( $p = 0.022$ ) (Table 4).

## Discussion

Among the studied patients 70 had grade 1 (74.3% female and 25.7% male), 14 had grade 2 (male = female) and 17 grade 3 (70.6% female and 35.7% male). There was no significant difference between the sexes in terms of smear grade. The findings of this study cannot be compared to any other studies because of the lack of similar research on the relation between sex and grading of the smear. The mean age of patients was 62.68 years with a standard deviation of 13.61. The youngest and oldest patients were 18 and 86 years old. The mean age of patients with grades 1, 2, and 3 was 64.47, 62.07, and 55.82 years, respectively. The age difference of patients in different grades was not statistically significant. Also there was no relation between age and grading of the smear. The frequency of consolidation in patients with grades 1, 2, and 3 was 71.4, 78.5, and 76.5%, respectively. The difference in the degree of opacity in patients with different grades was not statistically significant. Although grade 2 patients were more frequent than grade 1 and grade 3 patients, the difference between the three groups was not significant. There does not seem to be any relation

**Table 1. Frequency of consolidation in chest X-ray in association with the grading of sputum smear**

Grade of smear positivity		Grade1	Grade2	Grade3	P-value
Consolidation	Yes	50 71.4%	11 78.5%	13 76.5%	0.833
	No	20 28.5%	3 21.4%	4 23.5%	

**Table 2. Frequency of cavitation by the degree of smear**

Grade of smear positivity		Grade1	Grade2	Grade3	P-value
Cavitation	Yes	8 11.5%	4 28.5%	9 52.9%	0.001
	No	62 88.5%	10 71.4%	8 47.05%	

between the degree of smear and the consolidation in the graph. This finding is not consistent with other studies. In the study of Parcell B.J. et al. (2017), with increasing the degree of smear (+1, +2, +3 or +4), the frequency of consolidation increased significantly (in degrees +1, +2, +3, the frequency of consolidation was +4 81%, 95%, 100% respectively) [14]. In the study of Brahmapurkar K.P. et al. (2017), with increasing the grade of smear positivity, the number of cases also increased significantly [4] which can be the reason for this inconsistency. Bisognin F. et al. (2019) also showed that the frequency of opacity increased with increasing the number of acid bacilli [3]. The difference between the findings of the present and other studies could be attributed to the fact that the present study focused on investigating chest radiographs based on smear grading, while other studies examined the relation between CT scan and HRCT with smear grading. The frequency of cavitation in patients with grades 1, 2, and 3 was 11.5%, 28.5%,

**Table 3. Frequency of nodular presentation by the grade of sputum smear positivity**

Grade of smear positivity		Grade1	Grade2	Grade3	P-value
Nodular presentation	Yes	13 18.6%	6 42.8%	6 35.3%	0.086
	No	57 81.4%	8 57.1%	11 64.7%	

**Table 4. Frequency of reticulonodular presentation by the grade of smear positivity**

Grade of smear positivity		Grade1	Grade2	Grade3	P-value
Reticulonodular	Yes	17 24.2%	1 7.1%	0 0%	0.022
	No	53 75.7%	13 92.8%	17 100%	

and 52.9% respectively. This difference in the frequency of cavity was statistically significant in three groups. Different types of patients had different cavitation levels; in patients with grade 3 cavitation, there was a significant increase in grade 3 and grade 1 patients. Therefore, there seems to be a relation between the degree of smear and the presence of cavity. In the study of M. Saffari et al. (2017), with the increase in the degree of smear (+1, +2, +3, or +4), the frequency of CT scan findings including cavitation also increased significantly, so that the frequency of cavitation cases in degrees +1, +2, +3, and +4 was 33%, 68%, 94% and 100% respectively [16]. In the study of Penn-Nicholson A. et al. (2019) with the increasing of the degree of smear, cavitation also increased significantly [15]. Matsuoka S. et al. (2004) also showed that the frequency of covariation increased with the increasing of the number of acid bacilli [11]. In the study of Hassanzad M. et al. (2015), cavitation had a significant correlation with smear gradation [5]. This study showed that nodular facial abnormalities in patients with grade 1, 2, and 3 were 18.6, 42.8, and 35.3%, respectively. Nodular features were not significantly different in three groups. Although grade 2 patients had more nodular features in comparison with grade 1 and grade 3 patients, the difference between three groups was not significant; therefore, there is no significant relation between the degree of smear and nodular feature abnormalities. Matsuoka S. et al. (2004) also showed that the incidence of nodular presentation increased with the increasing degree of smear, but their differences were not statistically significant [11].

The incidence of reticulonodular involvement in patients with grades 1, 2, and 3 was 24.2%, 7.1%, and 0%. This difference in the frequency of reticulonodular involvement in three groups was statistically significant. On the other hand, patients with reticulonodular involvement were significantly more likely to have a grade 1 smear. The lowest frequency of reticulonodular appearance was associated with to grade 3. These results showed that there is a significant relationship between the degree of smear and reticulonodular involvement in a way that an increase in the grade of smear (1+, 2+, 3+) decreases the frequency of reticulonodular appearance. The findings

of this study cannot be compared to any other studies because of the lack of similar research on the relation between sex and grading of the smear. The most important limitations of the present study were:

- this is a cross-sectional study.
- when interpreting the results, the specific limitations of this type of study should be considered.
- the most important strength of this study was that this is the first report in this long period of this region as the most common area of the tuberculosis outbreak.

## Conclusion

In general, the results of this study showed that, with the increasing grading of smears, the frequency of cavitation presentation increased significantly and the frequency of reticulonodular presentations decreased significantly. The findings of the present study can help physicians to improve TB diagnostics.

## Conflict of interest

All authors declare that they have no conflict of interest.

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## Author contributions

RB and EN designed the study. EN collected, analyzed, interpreted data and wrote the manuscript. RB analyzed data, reviewed and revised the manuscript. All authors approved the final version of the manuscript.

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