

COVID-19 pandemic impacting tuberculosis clinical forms prevalence in Extreme North

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Abstract. We analyzed epidemiologic situation for pulmonary tuberculosis (TB) and distribution by clinical forms in newly diagnosed adult cases, among the population of the Sakha Republic (Yakutia), during restrictive measures against COVID-19 pandemic. Arctic zone of Yakutia was chosen as a specific region of interest, to show epidemiologic situation for TB in a territory with low population density and limited transport accessibility. Two periods were analyzed: 2 pre-pandemic years versus 2 pandemic years. Stringent infection control measures were followed by substantial decrease in epidemiologic rates for TB, but at the same time had profoundly aggravating effect on timeliness of TB detection. During pandemic, we observed significantly reduced population coverage with preventive screening for TB, and growth in number of individuals with 2-year or larger gap in undergoing screening for TB. The study showed statistically meaningful escalation in the proportion of new adult cases with advanced forms of TB, and clear statistical correlation between weakened TB detection activities and prevalence of clinical forms of newly diagnosed pulmonary TB.

Keywords: pulmonary tuberculosis, COVID-19, Extreme North, Arctic.

1. Introduction.

Sakha Republic (Yakutia) is a large region, occupying 18% of the Russian Federation, with population density of 0.32/km². Over 40% of the territory of Yakutia lies above the Arctic Circle, and the rest of territory is an area of the Extreme North.

Over the last 10 years, marked improvement and stabilization were observed in epidemiologic situation with tuberculosis (TB) in Yakutia, following a series of advancements in anti-TB services, such as efforts to organize: centralized treatment for patients with multidrug- and extensively drug-resistant (MDR, XDR) *M.tuberculosis* (MTB), high-tech surgical treatment, early population screening for TB well adapted to local difficult transport accessibility.

During recent COVID-19 pandemic, global wide anti-epidemic restrictive measures caused numerous readjustments in TB case detection, diagnosis and treatment routines [2,3,5,10]. As several authors have pointed out, reduced coverage with preventive checkups for TB in 2020-2021 caused a decrease in TB incidence rates, although, at the same time, coverage with unscheduled exams for TB among TB case contacts had decreased likewise [1,7-9].

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In Sakha Republic (Yakutia), epidemiologic situation with TB had been gradually improving until the onset of COVID-19 pandemic. During 10 pre-pandemic years (2009 to 2019) TB incidence had decreased by 30.3%, mortality from TB had decreased by 58.5%, presence of necrotic lesions in newly identified cases had decreased by 28.5%, while coverage with preventive chest x-rays for TB had increased by 23.2%.

By the Decree of the Head of the Sakha Republic issued on March 17, 2020, a heightened preparedness regime was announced in the republic, mandating measures to be taken to counteract the spread of novel coronavirus infection (COVID-19). Anti-epidemic measures included discontinuation of national health checkup program (dispensarization) and mass preventive checkups (chest x-rays), which substantially diminished the threat of infection spread (coronavirus, and other communicable infections, TB as well), but caused a new threat – late detection of active TB cases. Two years before the pandemic, mean total incidence of TB over Yakutia was 47.9/100 000. During pandemic, the rate had decreased by 39.5%, but the proportion of destructive TB forms had escalated by 15.9%. Total population coverage with preventive checkups for TB had reduced by 18.1%, which caused changes in the distribution of clinical forms of newly diagnosed TB.

2. Material and methods.

For this study, we used rates from federal statistical recording and reporting forms (‘Form 33’, ‘Form 30’, ‘TB-03’), patient lists from ‘Contingent’ and ‘Treatment control’ databases maintained within ‘Barclay’ HDBMS (health database management system), and data from Federal TB Register of the Sakha Republic (Yakutia). Rates for adult (aged ≥ 18) patients newly diagnosed with pulmonary TB (PTB) were analyzed for two pandemic years (2020-2021) against two pre-pandemic years (2018-2019). Data for Arctic zone of Yakutia were analyzed separately, to focus specifically on territories with low population density (0.01-0.08/km²) and limited transport accessibility. Relationships between changes in variables over time were assessed using Pearson’s correlation coefficient. To assess associations between trends, variables were weighed by values of chest x-ray coverage.

3. Results.

During COVID-19 pandemic, restrictive measures were brought to effect in Sakha Republic (Yakutia), which negatively impacted population coverage with mass chest x-rays for TB, further leading to changes in the rates reflecting effectiveness of TB detection by primary care health facilities.

Coverage of the adult population with chest x-rays decreased by 18.6% (in the Arctic zone by 14.9%). Alongside with that, incidence of PTB among adult population of the republic decreased markedly, both over Yakutia and in Arctic zone: by 41.3% and 32.7%, respectively (Fig. 1).

Strong and meaningful linear correlation was observed between PTB incidence decline rates and chest x-ray coverage decline rates, among the adult population, analyzed in breakdown by municipal entities (Table 2).

In Fig. 1, upsurge can be seen in mean proportions of newly diagnosed adult PTB cases with necrotic lesions, both over the entire republic (by 19.1%) and in the Arctic zone (by 5.3%). Also, rates in the Arctic zone exceeded all-republic rates by 16.6% before pandemic, and by 4.3% during pandemic.

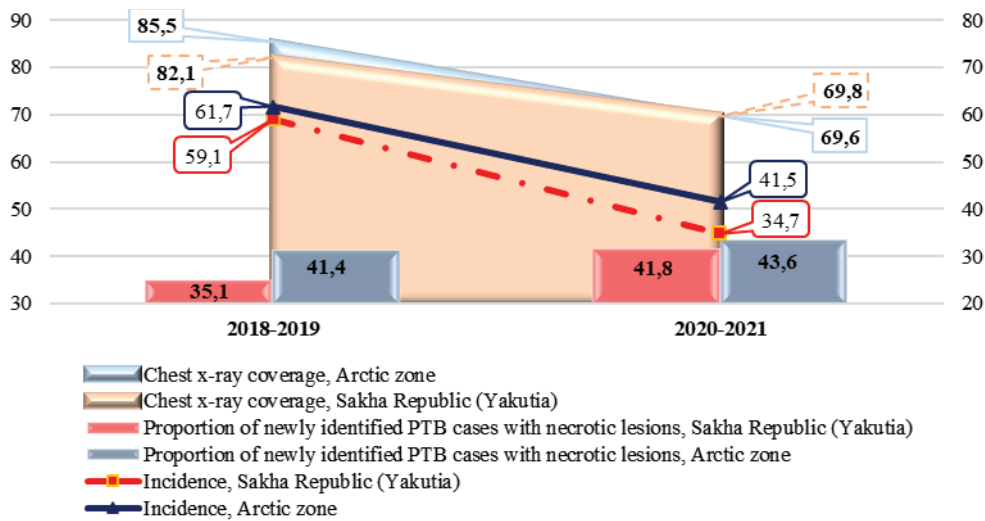


Fig. 1. Incidence of pulmonary TB (PTB), coverage with chest x-rays, and proportions of new adult PTB cases with necrotic lesions; Sakha Republic (Yakutia) and Arctic zone; Years 2018-2021.

Linear correlation between chest x-ray coverage decline rates and the proportions of new PTB cases with necrotic lesions was inverse and negligible, when analyzed in breakdown by municipal entities. At the same time, a strong correlation was observed between chest x-ray coverage rates and the proportions of advanced PTB cases among newly diagnosed patients (Table 2).

During pandemic years, proportions of population avoiding chest x-rays for ≥ 2 years had increased by 11.1% in entire republic, and by a factor of 2.6 in the Arctic zone (Table 2). Proportion of new TB cases detected by visit to primary care facility had increased by 46.8% in the republic overall, and by a factor of 2.6 in the Arctic zone (Fig. 2).

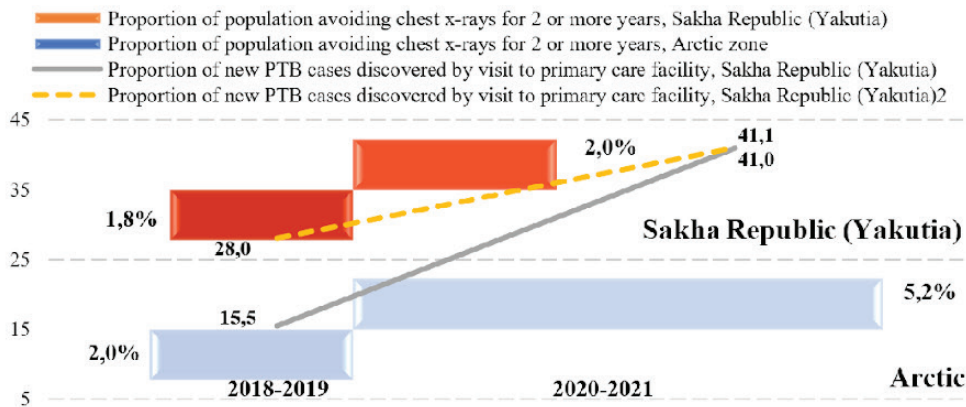


Fig. 2. Proportions of population avoiding chest x-rays for ≥ 2 years compared to proportions of new PTB cases discovered by visit to primary care facility; Sakha Republic (Yakutia) and Arctic zone; Periods 2018-2019 and 2020-2021.

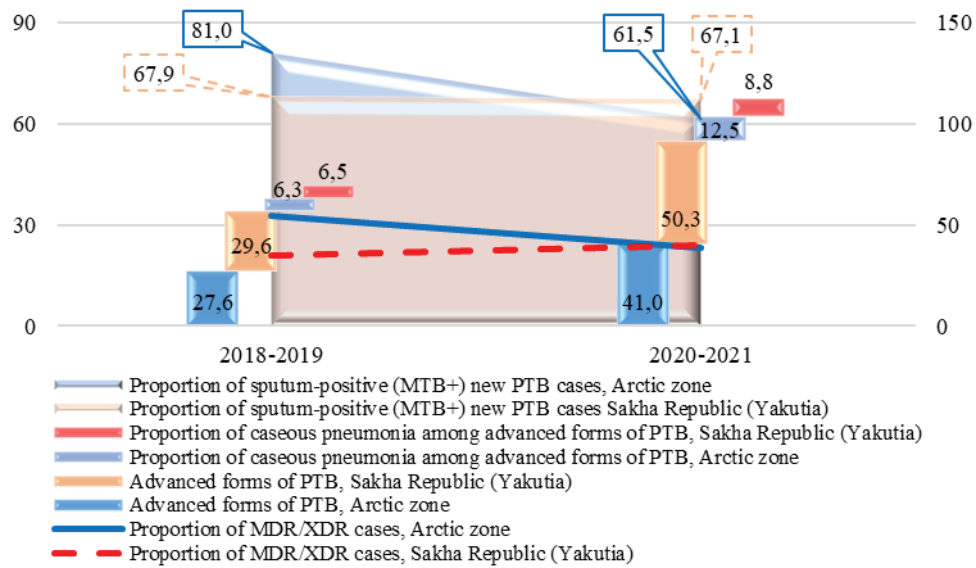


Fig. 3. Changes in clinical forms of new adult (aged 18 and above) pulmonary TB (PTB) cases over time; Periods 2018-2019 and 2020-2021 (%)

Over time, mean proportions of advanced cases increased by 69.9% in the republic, and by 48.6% in the Arctic zone. Importantly, the proportion of patients with caseous pneumonia among newly diagnosed advanced cases had risen by 35.4% in the republic, and by 98.4% in the Arctic zone (Fig. 3).

Rates describing the proportions of sputum-positive (MTB+) patients and proportions of patients with MDR/XDR TB were controversial, and require further evaluation. In the Arctic zone, these rates showed negative trend (decrease by 24.0 and 29.6%, respectively), compared to mean all-republic rates (decrease in proportion of MTB+ cases by 9.1%, and increase in proportion of MDR/XDR cases by 29.6%). After subjecting the data to correlation analysis, we found no significant findings over time.

Table 1. Correlation analysis of variables for adult population; Sakha Republic (Yakutia); Periods 2018-2019 and 2020-2021.

Variable	Decline/growth rate (%)	Pearson’s r-coefficient	Two-tailed significance level
Sakha Republic (Yakutia)			
Incidence	-41.3	0.530558	0.001043
Chest x-ray coverage	-18.6	0.776775	0.000000
Proportion of patients avoiding chest x-ray for ≥2 years	11.1	0.767547	0.000000
Proportion of advanced PTB cases	69.9	0.491074	0.002556
Arctic zone			
Incidence	-32.7	0.534530	0.059842
Chest x-ray coverage	-14.9	0.808062	0.000831
Proportion of patients avoiding chest x-ray for ≥2 years	160.0	0.839557	0.000331
Proportion of advanced PTB cases	48.6	0.264876	0.381808*

* Pearson’s correlation did not show meaningful correlation (due to presence of outliers). Whenever Kendall’s τ coefficient was employed, coefficient value was -0.536925, significance level was -0.013316, which were considered as the presence of association between attributes.

Source: Compiled by authors.

Table 1 shows the results of Pearson’s correlation analysis applied to assess the significance of changes in variables over time, during pre-pandemic (2018-2019) and pandemic (2020-2021) periods.

Table 2 shows correlations between chest x-ray coverage, incidence of TB, and late TB detection.

Table 2. Paired correlation analysis of decline/growth rates for new adult cases of pulmonary TB (PTB); Sakha Republic (Yakutia) and Arctic zone; Periods 2018-2019 and 2020-2021.*

Paired variables (decline/growth rates)	M±m	Pearson’s r-coefficient	Two-tailed significance level
Sakha Republic (Yakutia)			
Chest x-ray coverage/Incidence	19.3±0.29 83.4±4.51	0.122412***	0.004817
Chest x-ray coverage/ Proportion of advanced PTB cases	19.3±0.29 91.7±5.17	0.289103***	0.000000
Proportion of population avoiding chest x-rays for 2 or more years/ Proportion of new cases with necrotic lesions	109.7±10.72 35.7±5.17	-0.124006***	0.004290
Proportion of population avoiding chest x-rays for 2 or more years/ Proportion of cases discovered by visit to health facility	109.7±10.72 51.5±4.39	0.143629***	0.000925
Incidence/ Proportion of advanced PTB cases	83.4±4.51 91.7±5.17	-0.091671**	0.035070
Incidence/ Proportion of MDR/XDR cases	83.4±4.51 5.5±3.38	-0.120161***	0.005661
Proportion of cases discovered by visit to health facility/ Proportion of advanced PTB cases	51.5±4.39 91.7±5.17	0.520253***	0.000000
Arctic zone			
Chest x-ray coverage/Incidence	20.5±0.50 60.8±6.37	0.355492***	0.000000
Chest x-ray coverage/ Proportion of advanced PTB cases	20.5±0.50 133.3±10.01	0.760004***	0.000000
Proportion of population avoiding chest x-rays for 2 or more years/ Proportion of new cases with necrotic lesions	220.5±24.23 -5.93±4.51	0.407058***	0.000000
Proportion of population avoiding chest x-rays for 2 or more years/ Proportion of cases discovered by visit to health facility	220.5±24.23 71.7±6.45	-0.073506 (no correlation)	0.302107
Incidence/ Proportion of advanced PTB cases	60.8±6.37 133.3±10.01	0.169259**	0.016838
Incidence/ Proportion of MDR/XDR cases	60.8±6.37 -5.4±4.73	-0.423332***	0.000000
Proportion of cases discovered by visit to health facility/ Proportion of advanced PTB cases	71.7±6.45 133.3±10.01	0.386985***	0.000000

* Data sets were subjected to weighing.

** Correlation was significant at 0.05 (two-tailed significance).

*** Correlation was significant at 0.01 (two-tailed significance).

Source: Compiled by authors.

Reduced chest x-ray coverage rates were found to be significantly related to reduced incidence of PTB on the one hand, and increased proportion of advanced disease forms among new cases on the other hand, both in Yakutia overall, and in the Arctic districts of Yakutia.

Increase in proportion of population avoiding chest x-rays for ≥ 2 years was significantly associated both with the proportion of new cases with necrotic lesions, and with the proportion of cases discovered by visit to health facility. In the Arctic zone, the latter two rates showed no correlation.

All of the above said correlations prove that a statistically significant association exists between reduced population coverage with chest x-ray screening and lower quality of TB detection. Furthermore, a marked aggravation among new cases of PTB was observed in our study, which was reflected by meaningful correlation between TB incidence rates and both the proportions of advanced cases, and proportions of patients with MDR/XDR TB.

4. Discussion.

COVID-19 pandemic that broke out in 2019 caused complete reset of healthcare systems across the world, and emphasized the importance of mass anti-epidemic measures aimed at reducing the threat of infectious disease spread. TB services during the pandemic faced the need to adjust to restrictive measures, which were developed and implemented primarily with the purpose of deescalating the threat of infection spread, but ended up largely neglecting the algorithms of proper dealing with socially significant diseases [1,4,10]. These circumstances have urged the leading federal and regional TB centers in Russian Federation to estimate risks and develop their own interventions and workflow schemes adapted to meet local needs, which however proved insufficient to maintain the stable decreasing trend of previous years in TB incidence and mortality [3,8]. Restrictive measures against the spread of coronavirus infection resulted in major reduction of population coverage with preventive checkups for TB, which caused the sharp decrease in TB incidence [8,10-13,15].

A number of authors predicted the risks associated with the upsurge in numbers of advanced and sputum-positive TB cases, the groups presenting the highest epidemiologic hazard, and, as it turned out, these concerns were confirmed by our study findings [9,11,14].

The present study was focused on the changes that occurred in the incidence of adult TB over study periods, while the consequences of work incapacity and mortality among adult population are directly associated with economic losses of a country, which we demonstrated in our previous study [2].

5. Conclusion.

Presented study results together with summarized experience reported by other authors showed that restrictive measures caused by COVID-19 pandemic had, without doubt, prevented the spread of this highly dangerous infection and the spread of other communicable infections as well, including TB. But the aspect largely missed out was that discontinuation of mass preventive checkups for TB fueled the threat associated with late TB detection, emergence of hidden (undetected) infection sources, including infection with MDR/XDR MTB as causative agent, all of which can adversely impact the incidence of TB and the prevalence of advanced clinical forms of the disease.

Pandemic in the territories of the Extreme North of Yakutia was associated with remarkable reduction in epidemiologic rates for TB incidence, mortality, and prevalence. But simultaneously, we observed escalation in proportions of patients with advanced forms of TB: newly identified patients with necrotic lesions; patients with MDR/XDR TB; patients with TB discovered by visit to primary care facility.

In our view, the task of preventing late TB detection (at advanced stages) and the aim to reduce mortality from TB demand strengthening our efforts to detect TB by universal chest x-ray screening of the population aged 15 and above.

Considering the 2-year (2020-2021) decline in population coverage with preventive chest x-rays, and a subsequent upsurge in the proportion of advanced new cases of TB registered in 2021, the changes in epidemiologic rates and prevalence of clinical forms of TB need to be further analyzed. As next steps, performance of primary care services needs to be assessed in terms of barriers to early TB detection, based on which necessary managerial decisions can be adopted at the level of regional healthcare authorities.

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