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## REGIONAL AND EPIDEMIOLOGICAL CHARACTERISTICS OF PRIMARY-ACTIVE TUBERCULOSIS IN THE REPUBLIC OF AZERBAIJAN

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In the Republic of Azerbaijan, zones with a high incidence of tuberculosis, pulmonary and extrapulmonary tuberculosis among patients initially registered in these zones over the past three years (2021–2023) were analyzed. It was found that the incidence rate was higher in the mountainous-foothill zone, which accounts for 43.0 % of the country's territory. Thus, the incidence rate in zone II was 28.3 in 2021, which is 15.5 % higher than zone I and 26.9 % higher than zone III. The lowest incidence rate in 2022 was in the plain zone (22.9), and the highest was in the foothill-plain zone (32.1). This indicator is still the lowest in the plain zone (24 in 2023) and the highest in the foothill-plain zone (29.9). The number of patients initially registered in the foothill-plain zone over the last three years (2021–2023) accounts for more than half of the total number of patients initially registered in the country (51.5 %).

**Key words:** primary patients, pulmonary tuberculosis, drug resistance, active tuberculosis.

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## РЕГІОНАЛЬНА ТА ЕПІДЕМІОЛОГІЧНА ХАРАКТЕРИСТИКА ХВОРИХ НА ПЕРВИННО-АКТИВНИЙ ТУБЕРКУЛЬОЗ В АЗЕРБАЙДЖАНСЬКІЙ РЕСПУБЛІЦІ

В Азербайджанській Республіці проаналізовано зони з високою інтенсивністю захворюваності на туберкульоз, легеневої та позалегенової туберкульоз серед хворих, первинно взятих на облік у цих зонах за останні три роки (2021–2023 рр.) Встановлено, що рівень захворюваності вищий у гірсько-передгірній зоні, яка займає 43,0 % території країни. Таким чином, рівень захворюваності в цій зоні в 2021 році становитиме 28,3 особи в II зоні, що на 15,5 % вище, ніж у I зоні, і на 26,9 % вище, ніж у III зоні. Найнижчий показник захворюваності в 2022 році зафіксовано в рівнинній зоні (22,9 особи), найвищий – у передгірсько-рівнинній зоні (32,1 особи). Найнижчий показник, як і раніше, спостерігається в рівнинній зоні – 24 особи в 2023 році, а найвищий – у передгірсько-рівнинній зоні (29,9 особи). Кількість хворих, первинно взятих на облік у передгірсько-рівнинній зоні в 2021–2023 рр., становить понад половину від загальної кількості хворих, первинно взятих на облік у країні (51,5 %).

**Ключові слова:** первинні хворі, туберкульоз легень, лікарська стійкість, активний туберкульоз.

Controlling the spread of tuberculosis (TB) is a priority for the World Health Organization (WHO) [11, 12]. According to WHO data for 2022, the global incidence of tuberculosis was 131 cases per 100,000 population [12]. Incidence is considered one of the leading epidemiological indicators of tuberculosis [8, 10]. According to WHO requirements, newly detected tuberculosis cases during the year are characterized by this indicator [11, 12].

Tuberculosis ranks as the 13th most common cause of death worldwide and holds the position of the second leading cause of mortality from an infectious disease, following COVID-19 and surpassing HIV/AIDS in 2021 [4]. That year, global estimates indicated that approximately 10.6 million individuals developed TB, including 6 million men, 3.4 million women, and 1.2 million children. In the same period, TB was responsible for the deaths of around 1.6 million people, among whom 187,000 were co-infected with HIV [5].

Aligned with global health priorities, the United Nations Sustainable Development Goal (SDG) 3 – focused on ensuring healthy lives and promoting well-being – explicitly calls, under target 3.3, for the eradication of epidemics such as AIDS, TB, malaria, and neglected tropical diseases by the year 2030. It also aims to tackle hepatitis, waterborne illnesses, and other infectious diseases [9]. In parallel, WHO has developed the “End TB” strategy, outlining specific measures to significantly reduce the global TB burden. Both the SDG framework and the WHO initiative set ambitious targets: a 90–95 % reduction in TB-related deaths and an 80–90 % decrease in TB incidence by 2030, using 2015 as the baseline [9, 12].

The intensity of the incidence varies sharply in developed and developing countries [7, 10, 11]. Even in different regions of the same country, the incidence of tuberculosis may differ [1, 2]. In this regard, the epidemiological analysis of those who became ill with active tuberculosis for the first time in their lives in the Republic of Azerbaijan, where 9 out of 11 climatic zones exist, by geographical region, is very important in terms of investigating the causes of the disease and preventing it [6].

**The purpose** of the study was to assess the epidemiological characteristics of individuals who developed active tuberculosis for the first time in the Republic of Azerbaijan over the last 3 years (2021–2023), by geographical region.

**Materials and methods.** The study was conducted at the Scientific Research Institute of Lung Diseases and Anti-tuberculosis Dispensary No. 2 during 2021–2023.

The epidemiological situation of patients initially registered in the Republic of Azerbaijan in the last three years (2021–2023) by geographical regions was analyzed. It was found that 7839 primary tuberculosis patients were registered in the last three years, of which 6096 (77.8 %) had pulmonary tuberculosis, and 1743 (22.2 %) had extrapulmonary tuberculosis.

Individuals participating in the study were examined for tuberculosis using Form No. 8 in accordance with the official instructions posted on the State Statistical Committee of the Republic of Azerbaijan's website. (<https://www.stat.gov.az/menu/4/e-reports/>). In the framework of the study, the following objectives were addressed: investigation of the incidence in the country in the last three years by geographical region; analysis of the sensitivity test results of active tuberculosis patients initially registered in the indicated years; assessment of the epidemiological situation of active tuberculosis patients initially registered in the geographical region.

The epidemiological situation of tuberculosis was investigated across the country's geographical regions. For this purpose, the country's territory was divided into three zones according to altitude above sea level: mountainous-foothill – zone I, which is above 700 meters above sea level and covers 46 % of its territory, foothill-plain – zone II, which is 400–700 meters above sea level and covers 43 % of its territory, and plain – zone III, which is up to 400 meters above sea level and covers 11 % of its territory. Statistical processing includes determining absolute values and percentages (extrapolated to 1000 people). Descriptive statistics were used to analyze epidemiological indicators. Database creation was performed using spreadsheets, and subsequent statistical processing was performed. Tuberculosis incidence rates were calculated and compared across the country's geographical regions.

**Results of the study and their discussion.** It is clear that in the last three years, 1,582 (20.2 %) primary tuberculosis patients were registered in the mountainous-foothill zone. Of these, 76.2 % (1,206 people) had pulmonary tuberculosis, and 23.8 % (376 people) had extrapulmonary tuberculosis. The number of people with pulmonary tuberculosis in 2023 was 417, an increase of 10.3 % from 2021. Extrapulmonary tuberculosis was 21.9 % lower in 2021 than in 2022.

Table 1 shows the number of people who developed active tuberculosis of the lungs and extrapulmonary organs for the first time in their lives in the mountainous-foothill zone in 2021–2023, and the results of sputum examination among them (Table 1).

Among patients initially registered in the mountainous-foothill zone over the last three years, 44.2 % (699 patients) who underwent susceptibility testing retained susceptibility to anti-tuberculosis drugs. Susceptibility maintenance is 27.1 % higher in 2023 than in 2021. Of the patients with maintained anti-TB susceptibility, 40.5 % (641 people) had pulmonary tuberculosis, and 3.7 % (58 people) had extrapulmonary tuberculosis. Susceptibility maintenance in patients with pulmonary tuberculosis was 251 people in 2023, 27.5 % more than in 2021. Resistance to anti-TB drugs was detected in 168 (10.6 %) of the initial patients. The level of resistance was 75 people in 2022, which is 60.0 % higher than in 2021. Of the patients with resistance, 8.7 % (138 people) had pulmonary tuberculosis, and 1.9 % (30 people) had extrapulmonary tuberculosis. Among resistant patients, pulmonary tuberculosis increased by 46.4 % in 2022 compared to 2021.

45.0 % (712 patients) of those initially registered in the mountainous-foothill zone did not have their examination material sent to the National Reference Laboratory for susceptibility testing. Those not sent for susceptibility testing are 14.8 % lower in 2023 than in 2021. Of those not sent for examination, 426 people (26.9 %) had pulmonary tuberculosis, and 286 people (18.1 %) had tuberculosis of extrapulmonary organs. Only 0.2 % (3 people) of those sent for susceptibility testing had negative results.

Zones examined intensive morbidity indicators by year. It was found that the intensive morbidity rate in the mountainous-foothill zone was 23.9 per 100,000 in 2021, 27.2 per 100,000 in 2022, and 26.9 per 100,000 in 2023.

The intensive morbidity rate in the foothill-plain zone, which accounts for 43 % of the country's territory, was 28.3 people in 2021, 32.1 people in 2022, and 29.9 people in 2023, while in the plain zone, the morbidity rate in 2021 was 20.7 people, 22.9 people in 2022, and 24 people in 2023.

4039 (51.5 %) primary tuberculosis patients were registered in Zone II in 2021–2023. The number of patients initially registered in 2022 was 1437, 12.5 % higher than in 2021. Of those registered, 78.5 % (3169 people) had pulmonary tuberculosis, and 21.5 % (870 people) had extrapulmonary tuberculosis. Pulmonary tuberculosis increased by 13.0 % in 2022 compared to 2021. Extrapulmonary tuberculosis increased by 21.2 % in 2023 compared to 2021.

In the foothill-plain zone, the results of the examination material from the initial patients over the last three years were sensitive in 44.8 % of cases (1808 patients). Sensitivity among patients was more preserved in 2023 than in 2021, in 20.7 % of cases. Of those who were preserved in the susceptibility test, 1637 (40.5 %) had pulmonary tuberculosis, and 171 (4.2 %) had extrapulmonary tuberculosis. The number of patients with susceptible pulmonary tuberculosis was 597 in 2023, an increase of 16.9 % from 2021. The level of drug resistance among extrapulmonary tuberculosis increased by 61.5 %, respectively.

**Epidemiological situation of those who became ill with active tuberculosis for the first time in their lives in the last three years (2021–2023) in the mountainous-foothill and foothill–plain zone**

Mountainous-foothill zone (I)									
Years		2021		2022		2023		Total	
Those who became ill with active tuberculosis for the first time in their lives (primary patients)	Total	abs.n	%	abs.n	%	abs.n	%	abs.n	%
		481	30.4	552	34.9	549	34.7	1582	20.2
	Pulmonary tuberculosis	374	77.8	415	75.2	417	76.0	1206	76.2
	Extrapulmonary tuberculosis	107	22.2	137	24.8	132	24.0	376	23.8
Susceptibility among primary patients is preserved	Total	199	41.4	227	41.1	273	49.7	699	44.2
	Pulmonary tuberculosis	182	37.8	208	37.7	251	45.7	641	40.5
	Extrapulmonary tuberculosis	17	3.5	19	3.4	22	4.0	58	3.7
Drug resistance identified among primary patients	Total	30	6.2	75	13.6	63	11.5	168	10.6
	Pulmonary tuberculosis	30	6.2	56	10.1	52	9.5	138	8.7
	Extrapulmonary tuberculosis	0	0	19	3.4	11	2.0	30	1.9
Drug susceptibility was not identified among primary patients	Total	249	51.8	250	45.3	213	38.8	712	45.0
	Pulmonary tuberculosis	161	33.5	151	27.4	114	20.8	426	26.9
	Extrapulmonary tuberculosis	88	18.3	99	17.9	99	18.0	286	18.1
Those with negative test results among the initial patients		3	0.6	0	0	0	0	3	0.2
Foothill–plain zone (II)									
Years		2021		2022		2023		Total	
Those who became ill with active tuberculosis for the first time in their lives (primary patients)	Total	abs.n	%	abs.n	%	abs.n	%	abs.n	%
		1257	31.1	1437	35.6	1345	33.3	4039	51.5
	Pulmonary tuberculosis	1000	79.6	1150	80.0	1019	75.8	3169	78.5
	Extrapulmonary tuberculosis	257	20.4	287	20.0	326	24.2	870	21.5
Susceptibility among primary patients is preserved	Total	531	42.2	607	42.2	670	49.8	1808	44.8
	Pulmonary tuberculosis	496	39.4	544	37.8	597	44.4	1637	40.5
	Extrapulmonary tuberculosis	35	2.8	63	4.4	73	5.4	171	4.2
Drug resistance identified among primary patients	Total	115	9.1	144	10.0	162	12.0	421	10.4
	Pulmonary tuberculosis	110	8.7	136	9.5	149	11.1	395	9.8
	Extrapulmonary tuberculosis	5	0.4	8	0.5	13	0.9	26	0.6
Drug susceptibility was not identified among primary patients	Total	604	48.1	685	47.7	513	38.1	1802	44.6
	Pulmonary tuberculosis	388	30.9	470	32.7	273	20.3	1131	28.0
	Extrapulmonary tuberculosis	216	17.2	215	15.0	240	17.8	671	16.6
Those with negative test results among the initial patients		7	0.6	1	0.06	0	0	8	0.2

In the foothill–plain zone, the examination material of 44.6 % (1802 people) of those who became ill with active tuberculosis for the first time in their lives was not sent for susceptibility testing. The number of those not referred for examination decreased by 25.1 % in 2023 compared to 2022. Of these, 28.0 % (1131 patients) had pulmonary tuberculosis, and 16.6 % (671 people) had extrapulmonary tuberculosis. Patients with pulmonary tuberculosis who were not referred for examination amounted to 273 people in 2023, which is 41.9 % lower than in 2022. On the contrary, extrapulmonary tuberculosis cases that were not referred for sensitivity testing increased by 10.4 % in 2023. Among the initial patients in zone II, the number with negative examination results was 0.2 % (8 people).

In the last three years (2021–2023), 2218 people (28.3 %) were registered with primary tuberculosis. In the plain region, 789 active tuberculosis patients were registered in 2023, 14.1% higher than in 2021. Of those registered, 77.6 % (1721 people) had pulmonary tuberculosis, and 22.4 % (497 people) had

extrapulmonary tuberculosis. Among patients, pulmonary tuberculosis increased by 11.8 % in 2023 compared to 2021. Extrapulmonary tuberculosis increased by 21.4 %. Among primary patients, sensitivity to anti-tuberculosis drugs was preserved in 48.6 % of cases (1077 people). The analysis of the initial registered patients in the plain zone, which accounts for 11.0 % of the country's territory, is shown in Table 2.

Table 2

**Epidemiological indicators of those who became ill with active tuberculosis for the first time in their lives in the last three years (2021–2023) in the plain zone**

Years		2021		2022		2023		Total	
Those who became ill with active tuberculosis for the first time in their lives (primary patients)	Total	abs.n	%	abs.n	%	abs.n	%	abs.n	%
			678	30.6	751	33.8	789	35.6	2218
	Pulmonary tuberculosis	531	78.3	588	78.3	602	76.3	1721	77.6
	Extrapulmonary tuberculosis	147	21.7	163	21.7	187	23.7	497	22.4
Susceptibility among primary patients is preserved	Total	328	48.4	364	48.5	385	48.8	1077	48.6
	Pulmonary tuberculosis	309	45.6	333	44.3	354	44.9	996	44.9
	Extrapulmonary tuberculosis	19	2.8	31	4.1	31	3.9	81	3.7
Drug resistance identified among primary patients	Total	97	14.3	125	16.6	110	13.9	332	15.0
	Pulmonary tuberculosis	94	13.9	117	15.6	104	13.2	315	14.2
	Extrapulmonary tuberculosis	3	0.4	8	1.0	6	0.7	17	0.8
Drug susceptibility not identified among primary patients	Total	253	37.3	262	34.9	294	37.3	809	36.5
	Pulmonary tuberculosis	128	18.9	138	18.4	144	18.3	410	18.5
	Extrapulmonary tuberculosis	125	18.4	124	16.5	150	19.0	399	18.0
Those with negative test results among initial patients		0	0	0	0	0	0	0	0

The number of susceptible patients was 385 in 2023, an increase of 14.8 % compared to 2021. Susceptibility to pulmonary tuberculosis was 12.7 % higher in 2023 than in 2021. In extrapulmonary tuberculosis, this figure is 38.7 %. In the plain zone, resistance to anti-tuberculosis drugs was detected in 15.0 % (332 people) of the initial patients in the examination results. Resistance increased by 22.4 % in 2022 compared to 2021. In zone III, 14.2 % (315 patients) of the forms resistant to anti-tuberculosis drugs are pulmonary tuberculosis, and 0.8 % are extrapulmonary tuberculosis. Among patients with drug-resistant forms, the number of patients with pulmonary tuberculosis increased by 19.7 % in 2022 compared to 2021. Tuberculosis of organs outside the lungs increased by 62.5 %, respectively. In the plain zone, 809 (36.5 %) of the primary patients did not have their examination material sent for susceptibility testing in the last three years. In 2023, 294 people were not sent for susceptibility testing, which is 13.9 % more than in 2021. Of those not sent for examination, 18.5 % (410 patients) had pulmonary tuberculosis, and 18.0 % (399 people) had extrapulmonary tuberculosis. Among pulmonary tuberculosis patients, those who were not sent for susceptibility testing increased by 11.1 % in 2023 compared to 2021. In non-pulmonary tuberculosis, the corresponding increase was 16.7 %.

Thus, the analysis shows that the intensive incidence rate in the mountainous-foothill zone over the past three years is higher than in the other two zones. Thus, in 2021, the incidence rate in zone II was 28.3 per 100,000 people, which was 15.5 % higher than in zone I and 26.9 % higher than in zone III. The lowest incidence rate in 2022 was in the plain zone (22.9 people), and the highest was in the foothill-plain zone (32.1 people). This indicator is still the lowest in the plain zone in 2023, at 24 people, and the highest in the foothill-plain zone (29.9 people). The number of primary patients in the foothill-plain zone is 51.5 % (4039 patients) of the total number of primary patients registered in the country. At the same time, in the foothill-plain zone, pulmonary tuberculosis accounts for 3169 cases (78.5 %), which is 61.9 % more than in the mountainous-foothill zone and 45.7 % more than in the plain zone. Tuberculosis of organs outside the lungs is 56.8 % higher in the foothill-plain zone than in the mountainous-foothill zone and 42.9 % higher than in the plain zone. Among patients initially registered in the plain zone, susceptibility was better preserved at 48.6 %. The level of resistance to anti-tuberculosis drugs was 15.0 % in zone III, which is higher than in other zones. Those who were not sent for susceptibility testing predominate in the mountainous-foothill zone compared to zones II and III (45.0 %). One of the main reasons for the high morbidity rate in the mountainous-foothill zone is that the area is larger than in other zones (43.0 % of the country's territory) and the population is more densely packed.

Morbidity and mortality from respiratory diseases in general and tuberculosis in particular remain high worldwide among causes of death, second only to cardiovascular and oncological diseases, cerebrovascular pathology, trauma, and poisoning [3].

The COVID-19 outbreak has disrupted routine health services in nearly all countries. Low- and middle-income countries (LMICs) have faced significant challenges due to service disruptions for three key health priorities: HIV/AIDS, tuberculosis, and malaria. Tuberculosis and COVID-19 are airborne infectious diseases that primarily affect the lungs. Both diseases share similar symptoms, such as cough, fever, and shortness of breath. Therefore, the particular challenges in reporting TB have led to some challenges in ensuring that the diagnostic needs of TB patients are not overlooked when testing for COVID-19 [4]. This may also be a limitation of our study.

In their study, Moore, John E. et al., collected information on TB incidence per 100,000 individuals for 2001 and 2021. The dataset included 41 European nations. To examine potential associations, gross domestic product (GDP) per capita was statistically compared with TB incidence rates (per 100,000 population) for both 2001 and 2021. This study showed that equalizing resource distribution among European countries could further reduce the incidence and prevent social and health inequalities associated with tuberculosis [7]. In our study, we did not assess the financial data, so we planned to evaluate them and compare the results further.

Vasiliiu A, et al. (2023), to identify groups of foreign-born individuals residing in European countries that benefit most from targeted TB prevention screening. The data on 9,116 foreign-born TB patients in 30 EU countries of residence were collected (Iceland, Norway, Switzerland, and the United Kingdom, etc.) in 2020. The authors revealed that the main countries of origin were Eritrea, India, Pakistan, Morocco, Romania, and Somalia. Tuberculosis rate was highest in patients of Eritrean and Somali origin in Greece and Malta (both >1,000/100,000) and lowest among Ukrainian patients in Poland (3.6/100,000). They were mainly lower in countries of residence than in countries of origin. In contrast to our study, the researchers did not examine regional geographical features of TB rates, focusing instead on countries of origin [10].

### Conclusions

1. In the Republic of Azerbaijan from 2021 to 2023, the lowest incidence rate in 2022 was in the plain zone (22.9), and the highest was in the foothill-plain zone (32.1). This indicator is still the lowest in the plain zone (24 in 2023) and the highest in the foothill-plain zone (29.9).

2. The number of patients initially registered in the foothill-plain zone over the last three years (2021–2023) accounts for more than half of the initially registered patients in the country (51.5 %).

3. In the foothill-plain zone, pulmonary tuberculosis accounts for 3169 people (78.5 %), which is 61.9 % more than in the mountainous-foothill zone and 45.7 % more than in the plain zone. Tuberculosis of organs outside the lungs is 56.8 % higher in the foothill-plain zone than in the mountainous-foothill zone and 42.9 % higher than in the plain zone.

Thus, in the Republic of Azerbaijan, several features of the distribution of the primary active tuberculosis incidence rate should be taken into account in the implementation of preventive measures.

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