

The prevalence of tuberculosis among Azerbaijani military personnel before the Second Karabakh War

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Military personnel are considered an occupational risk group for tuberculosis (TB) because of crowded living conditions, shared sanitary facilities and deployment to endemic areas. Azerbaijan is a high-priority TB country; however, data on TB among its armed forces are scarce. This study described the epidemiology of newly detected TB among Azerbaijani military personnel and identified service-related risk groups to inform preventive measures. Over the 10-year period, 57.99% of TB cases were detected in personnel with >6 months of service, 24.44% in those with <3 months and 17.57% in those with 3–6 months. Young servicemen aged 18–25 years accounted for 92.12% of all cases. Pulmonary TB predominated; focal and infiltrative forms together represented more than 95% of pulmonary diagnoses, while tuberculous pleurisy was the leading extrapulmonary manifestation. Passive case detection accounted for approximately two-thirds of cases. More than half of patients originated from foothill and plain regions, and undernourished servicemen (by BMI) were over-represented in both age groups. TB remains an important health problem among Azerbaijani military personnel, particularly among young servicemen with longer service duration and suboptimal nutritional status. Strengthening systematic screening at enlistment and during service, improving nutritional support, and prioritising units in high-incidence regions may enhance early detection and prevention of TB in the armed forces.

Keywords: *Tuberculosis, military personnel, epidemiology, risk factors, preventive measures*

INTRODUCTION

Tuberculosis (TB) remains a persistent threat in congregate environments, and military service barracks living, shared facilities, intensive training, and close-contact routines can amplify transmission risk and progression from infection to disease (Bayramov et al., 2020). Experience from military hospital settings has also shown that drug-resistant TB can become an operational and clinical challenge when detection and continuity of care are strained (Lee et al., 2009). Surveillance within military-linked health systems further demonstrates how routine laboratory signals can help characterize burden and guide more targeted interventions (Mancuso et al., 2013).

Across settings, structured screening and

preventive management in congregate groups can shift diagnosis earlier and reduce exposure opportunities; this is reflected in programs that include military units in latent TB screening and treatment strategies (Mancuso et al., 2017).

Standardized reporting frameworks also matter for consistent surveillance and response across units and facilities (WHO, 2013). Even when TB events are not frequent, military surveillance reports show they can demand disproportionate public health effort because of contact intensity and readiness implications (Sanchez et al., 2015).

System shocks can weaken diagnostic pathways: during the COVID-19 period, maintaining the TB diagnostics cascade required deliberate reinforcement in military health

facilities (WHO, 2021). Immunological tools such as interferon-gamma release assays have been evaluated in military cohorts to refine risk prediction and support prevention, depending on feasibility and policy (Diel et al., 2011). National epidemiological updates continue to emphasize that TB control relies on finding higher-risk groups early rather than waiting for advanced symptomatic disease (WHO, 2024). Evidence from military hospitals and related occupational settings also highlights that risk reflects both exposure and individual vulnerability (Franco et al., 2024). Wartime conditions underscore the need for adaptable surveillance and prevention under changing operational realities (Dahl et al., 2022), and active case-finding approaches in high-risk military contexts illustrate how structured screening can reduce diagnostic delay and onward transmission (Pohl et al., 2025).

In Azerbaijan, TB remains a public health concern, yet systematic epidemiological descriptions of newly detected TB among military personnel are limited. Therefore, this retrospective study aimed to describe the epidemiology of newly detected TB among Azerbaijani military personnel during 2009–2018, characterising cases by service duration, age group, clinical form, detection method, geographical origin, nutritional status (BMI), and bacteriological status, to inform targeted screening and prevention in military units.

The aim of the study is to study the spread of tuberculosis among Azerbaijani servicemen in the years preceding the Second Karabakh War.

MATERIALS AND METHODS

Study design and data sources We conducted a retrospective descriptive study of TB among military personnel in the Republic of Azerbaijan between 1 January 2009 and 31 December 2018. Data were obtained from periodic medical reports of the Ministry of Health, archival materials and official statistical records from the Lung Diseases Hospital of the Armed Forces (LDH of the AF). The LDH of the AF is the main referral centre for diagnosis and treatment of TB among Azerbaijani military personnel. Study population and case definition. The study population comprised conscripts and professional servicemen who were

discharged from the LDH of the AF with a first-time diagnosis of TB during the study period. Only newly detected cases (patients without a previous history of TB treatment in their medical records) were included. Demographic, clinical and epidemiological data were extracted from individual medical records and consolidated into an anonymised database. Clinical assessment and laboratory methods Clinical and laboratory assessment followed national TB guidelines. Diagnostic procedures included chest radiography and, when indicated, fluorography, computed tomography or magnetic resonance imaging; general blood and urine tests; sputum smear microscopy using the Ziehl–Neelsen method; and bacteriological and molecular genetic testing, including Xpert MTB/RIF assays where available. TB was classified as pulmonary or extrapulmonary. Pulmonary TB was further categorised into focal, infiltrative and other pulmonary forms; extrapulmonary TB was classified as tuberculous pleurisy or other extrapulmonary forms. Variables and operational definitions Service duration at the time of TB diagnosis was calculated from the date of entry into active duty and categorised into three groups: group I (0–3 months of service), group II (3–6 months) and group III (>6 months). Age was grouped as 18–25 years and 26–45 years according to military reporting standards. Detection method was classified as active (systematic medical examinations, screening fluorography, contact investigations) or passive (self-presentation or referral due to symptoms). Bacteriological status was defined as smear-positive (acid-fast bacilli [AFB]–positive) or smear-negative (AFB-negative) based on sputum microscopy and culture results. Geographical origin was coded according to the State Service for Mobilization and Conscription (SSMC) regional units and grouped into three zones: zone I (highland and foothill areas), zone II (foothill and plain areas) and zone III (plain areas). Nutritional status was assessed using body mass index (BMI, kg/m²) as recorded in medical records and classified according to military medical documentation as normal nutrition, malnutrition, high nutrition and class I–II overnutrition.

Data were entered into Microsoft Excel and

analysed using IBM SPSS Statistics, version 28.0 (IBM Corp., Armonk, NY, USA). Categorical variables were summarised as frequencies and percentages; continuous variables were expressed as means and standard errors where appropriate. Differences in categorical variables between service-duration groups were evaluated using Pearson’s chi-square test or the Kruskal–Wallis test. Distributional assumptions were explored using the one-sample Kolmogorov–Smirnov test. Statistical significance was set at $p < 0.05$.

RESULTS AND DISCUSSION

Service duration and geographical origin

Service duration among TB patients was divided into three groups (0–3, 3–6 and >6 months). Over the study period, the frequency of newly detected TB was highest among personnel with more than 6 months of service (group III), who accounted for 57.99% of all cases. Servicemen diagnosed within the first 3 months of service (group I) represented 24.44% of cases, whereas those diagnosed between 3 and 6 months (group II) represented 17.57%. In each study year, between 51.3% and 70.0% of cases occurred in group III, and in the last four years (2015–2018) there was a rising trend in TB detection after 6 months of service.

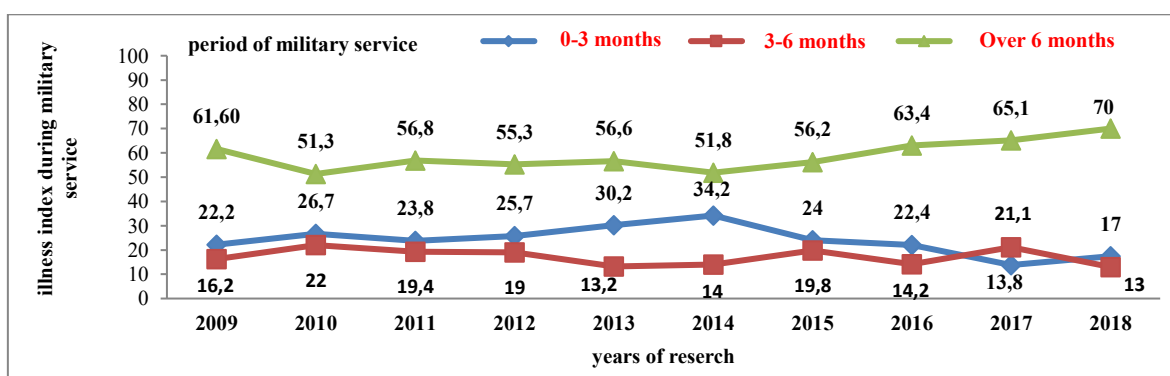
Fig. 1 summarizes the distribution of newly detected TB cases by service duration. The figure highlights the predominance of diagnoses after more than 6 months of service and supports the

interpretation that cumulative exposures and service-related stressors may contribute to disease manifestation or detection during prolonged service.

Fig.2 depicts the ecological-zone distribution of TB cases by region of origin. The concentration of cases among recruits from foothill and plain regions suggests geographic heterogeneity in pre-service TB burden and supports risk-based screening strategies during recruitment. Geographical analysis grouped TB cases by SSMC regional units into three ecological zones. Among servicemen discharged with TB during 2009–2018, 20.9% originated from highland and foothill areas (zone I), 56.5% from foothill and plain areas (zone II) and 22.6% from plain regions (zone III). Thus, more than half of TB patients were conscripted from zone II regions.

Fig.3 illustrates the distribution of TB cases by age group in the armed forces. The overwhelming predominance of the 18–25-year cohort reflects the demographic structure of the conscription-based force and indicates the importance of targeted preventive measures and screening among younger servicemen.

Fig.4 presents multi-year trends in active and passive detection. The sustained dominance of passive case finding suggests missed opportunities for earlier diagnosis through systematic screening and supports strengthening routine active case-finding approaches.



- Tuberculosis patients detected in Zone II: 56.5%
- Tuberculosis patients detected in Zone III: 22.6%
- Tuberculosis patients detected in Zone I: 20.9%

Fig. 1. Distribution of newly detected tuberculosis cases among military personnel by length of service, Azerbaijan, 2009–2018.

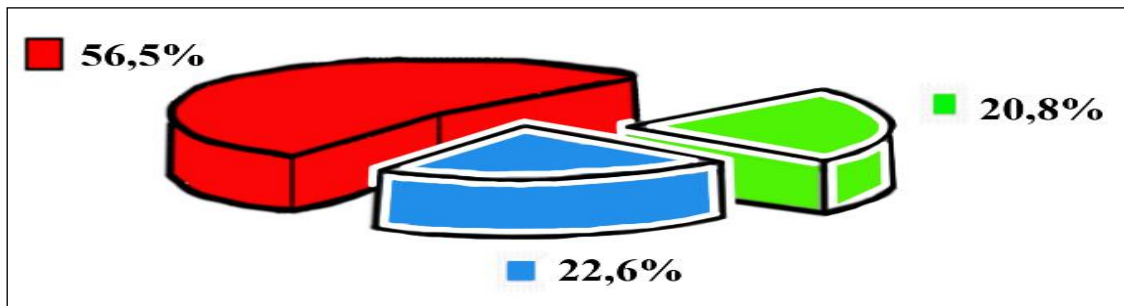


Fig. 2. Geographical distribution of newly detected tuberculosis cases among military personnel by ecological zone, Azerbaijan, 2009–2018.

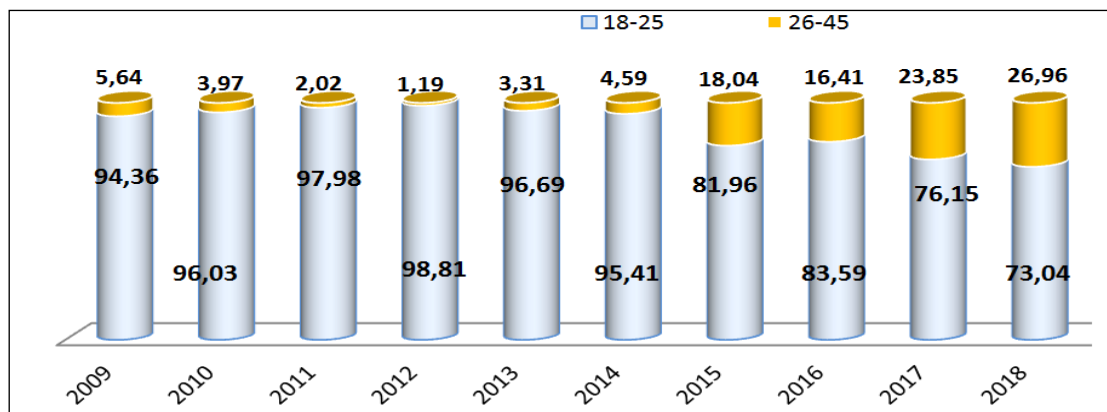


Fig. 3. Frequency of tuberculosis in the 18–25 and 26–45-year age groups among military personnel, Azerbaijan, 2009–2018.

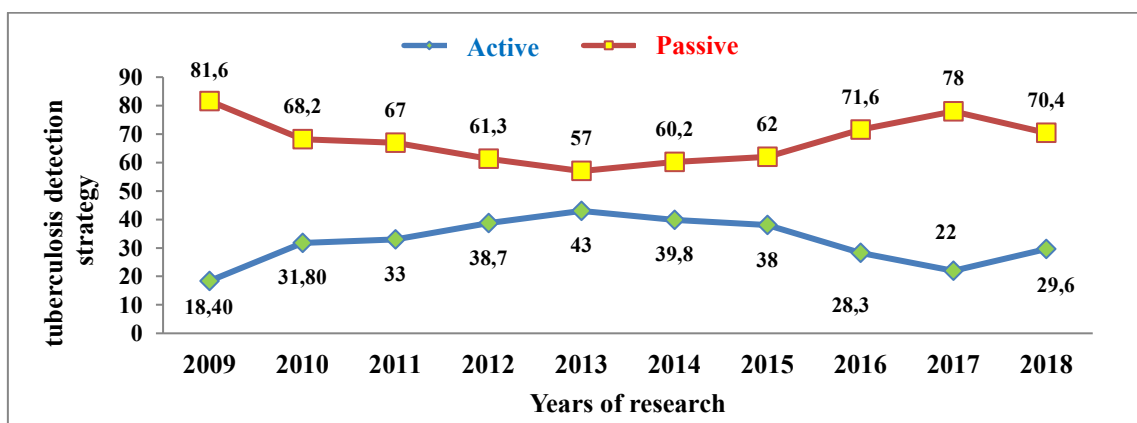


Fig. 4. Multi-year dynamics of tuberculosis case detection among military personnel by active and passive methods, Azerbaijan, 2009–2018.

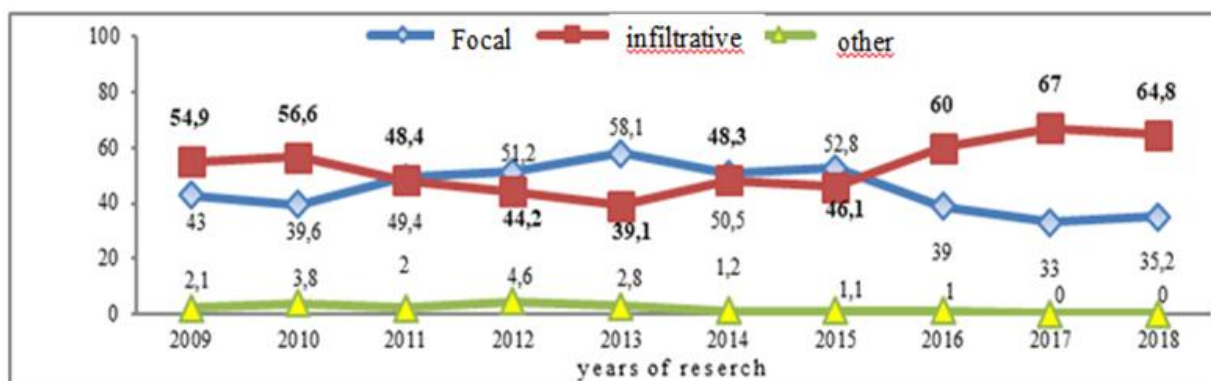


Fig. 5. Ten-year dynamics of clinical forms of pulmonary tuberculosis among military personnel, Azerbaijan, 2009–2018.

Fig.5 summarizes long-term trends in pulmonary TB clinical forms. These patterns provide context for planning diagnostic capacity and clinical management priorities in military medical facilities.

Clinical forms, bacteriological status and nutritional factors between 2009 and 2018, among pulmonary TB cases detected in military personnel during their service, focal pulmonary TB accounted for $50.8 \pm 2.6\%$, infiltrative pulmonary TB for $46.3 \pm 2.6\%$ and other pulmonary forms for $2.9 \pm 0.9\%$.

Table 1 provides a consolidated overview of key epidemiological characteristics stratified by service duration. Presenting these variables side by side facilitates identification of service-related risk groups and highlights where targeted screening and prevention may yield the greatest benefit. During the study period, TB bacilli were detected in 34.1% of patients with infiltrative pulmonary TB, and 88.33% of military personnel with bacterial secretion were diagnosed with infiltrative pulmonary TB. The incidence of bacterial excretion was highest among servicemen with more than 6 months of service, who accounted for 60% of smear-positive cases.

During the research period, 31.8% of cases were detected through active case finding and 68.2% through passive detection. Within each service-duration group, passive detection predominated: 13.55%, 12.65% and 42.01% of all cases were passively detected in groups I, II and III, respectively, compared with 10.89%, 4.92% and 15.97% identified through active methods. Seasonal patterns of TB diagnosis varied by

service duration. In group I, TB was most frequently diagnosed in autumn (7.30% of all cases) and winter (6.35%), whereas in group II, the highest proportions occurred in autumn (4.92%) and winter (5.45%). In group III, autumn (16.84%) and winter (15.61%) again accounted for the largest shares of diagnoses. Overall, the highest number of cases occurred during autumn and winter. Age distribution, seasonality and detection methods. The majority of TB patients were young servicemen aged 18–25 years. Across all service-duration groups, 18–25-year-olds accounted for 92.12% of cases, whereas the 26–45-year age group represented only 7.88%. Within groups I, II and III, the proportions of cases aged 18–25 years were 99.4%, 98.8% and 92.4%, respectively.

In servicemen with ≤ 6 months of service, focal and infiltrative pulmonary TB represented $46.8 \pm 3.3\%$ and $51.1 \pm 3.3\%$, respectively, whereas among those with more than 6 months of service these proportions were $43.0 \pm 1.7\%$ and $54.9 \pm 1.7\%$. The distribution of pulmonary TB clinical forms across service-duration groups did not differ significantly ($\chi^2=8.13$, $p=0.087$). Extrapulmonary TB comprised $18.2 \pm 1.7\%$ of TB cases in the first 3 months of service, $30.4 \pm 2.5\%$ in the 3–6-month period and $21.9 \pm 1.2\%$ in those with more than 6 months of service ($\chi^2=17.88$, $p=0.001$). Tuberculous pleurisy was the leading extrapulmonary localisation in all service-duration groups. Overall, focal (36.6%) and infiltrative (41.11%) pulmonary TB and tuberculous pleurisy (16.08%) were the most frequently observed clinical forms.

Table 1. Epidemiological characteristics of newly detected tuberculosis in military personnel by duration of service, Azerbaijan, 2009–2018.

Military epidemiological characteristics		Groups of military service			
		I Group (%)	II Group (%)	III Group (%)	
<i>Mycobacterium tuberculosis</i> secretion indicators, %	<i>Mycobacterium tuberculosis</i> secretors (AFB+)	3.38	2.96	9.52	
	Non-secreting <i>Mycobacterium tuberculosis</i> (AFB-)	21.05	14.6	48.46	
Detection strategy	Active detection	10.89	4.92	15.97	
	Passive detection	13.55	12.65	42.01	
By the season of the year	Spring season	4.07	3.81	12.80	
	Summer season	6.72	3.39	12.75	
	Autumn season	7.30	4.92	16.84	
	Winter season	6.35	5.45	15.61	
Age groups	18-25 age	24.3	17.34	53.53	
	26-45 age	0.16	0.21	4.44	
Clinical forms	Pulmonary tuberculosis	Focal pulmonary tuberculosis	10.32	6.02	20.28
		Infiltrative pulmonary tuberculosis	9.57	6.46	25.10
		Other clinical forms of pulmonary tuberculosis ¹	0.58	0.26	0.95
	Extrapulmonary tuberculosis	Tuberculous pleurisy	3.23	3.97	8.89
		Other clinical forms of extra-pulmonary tuberculosis ²	0.74	0.85	2.80

¹Other clinical forms of pulmonary tuberculosis - forms of pulmonary tuberculosis detected in addition to infiltrative and focal clinical forms were calculated (are included).

²Other clinical forms of extrapulmonary tuberculosis - extrapulmonary forms detected in addition to tuberculous pleurisy are included

Table 2. Nutritional status of military personnel with newly detected tuberculosis according to body mass index, Azerbaijan, 2009–2018.

Years of research	Age group	TB patients are primarily detected in military personnel, with nutritional indicators based on "body mass index" (%)			
		Normal nutrition	Malnutrition	High nutrition	I and II class overnutrition
From 2009 to 2018	18-25 years old	38.15	46.19	6.35	1.00
	26-45 years old	2.59	4.55	0.74	0.42

The overrepresentation of undernourished servicemen in both age groups reinforces the relevance of nutritional assessment and support as part of comprehensive TB risk reduction in the armed forces (Table 2).

This retrospective study summarises newly detected TB among Azerbaijani military personnel during 2009–2018 and identifies patterns with direct prevention value. Most cases were detected after longer service duration (>6 months), and the burden was concentrated in the 18–25-year age group a profile consistent with close-contact military living and service-related

stressors that can facilitate transmission or progression from latent infection to disease in susceptible individuals (Ahmedov et al., 2020).

A key operational signal is the dominance of passive case detection (approximately two-thirds of cases), implying missed opportunities for earlier diagnosis and reduced exposure time within units. Evidence from congregate and military settings supports strengthening entry and in-service screening packages (including structured follow-up and LTBI-focused approaches where feasible) to shift detection earlier (Mancuso, 2017). Standardised military

surveillance and case-definition frameworks can also improve consistency of reporting and response across units (WHO, 2013), and military surveillance reporting has highlighted the readiness implications of even limited TB events (Sanchez et al., 2015). Recent reports show that maintaining diagnostic pathways during system shocks (e.g., COVID-era disruptions) requires active reinforcement of the TB diagnostic cascade in military health services (WHO, 2021).

Clinically, pulmonary TB predominated (mainly focal and infiltrative forms), and tuberculous pleurisy was the leading extrapulmonary manifestation. Similar patterns in military-linked health systems underscore the usefulness of laboratory-based surveillance signals for guiding diagnostic prioritisation and service planning (Mancuso et al., 2013). In addition, undernutrition by BMI categories was over-represented among TB patients, aligning with findings from military-hospital contexts where underlying vulnerability and predisposing factors shape TB risk (Saunders et al., 2025). Drug resistance is not the focus of this dataset, but experience from military hospitals elsewhere indicates it can become a consequential clinical and operational issue when present, reinforcing the importance of timely detection and effective management pathways (Saunders et al., 2025).

Geographical heterogeneity was observed, with more than half of cases originating from foothill and plain regions (zone II). This supports risk-based recruitment screening and prioritised in-service surveillance for units drawing personnel from higher-burden areas, consistent with broader national epidemiological reporting emphasising early identification of higher-risk groups (Kang et al., 2024). Where resources allow, immunological tools (e.g., interferon-gamma release assays) may help refine prevention targeting in military cohorts (WHO, 2024). Finally, recent wartime experience in Ukraine underlines how quickly TB prevention priorities can escalate and why adaptive monitoring and active case finding may be necessary in high-risk operational circumstances (Dahl et al., 2022, Wilczek et al., 2023).

Limitations include lack of denominator data for incidence estimation and incomplete

individual-level risk factors, restricting causal inference; operational reporting constraints may also limit disclosure of stratified counts, though analyses rely on underlying raw data. Overall, the findings support strengthening risk-based entry screening, expanding active in-service case finding, and integrating nutritional interventions to improve early detection and reduce operational impact of TB in the armed forces.

STRENGTHS AND LIMITATIONS

A major strength of this study is the 10-year (2009–2018) coverage of routinely collected tuberculosis data from the main military referral centre, which allows for a clearer depiction of service duration patterns and the association with nutritional status. At the same time, interpretation is limited by the absence of dichotomising data (preventing the estimation of incidence) and incomplete information on individual-level risk factors, which makes it difficult to draw causal inferences and to perform more comprehensive adjustment for confounding factors.

RECOMMENDATIONS

To ensure the early detection of tuberculosis among military personnel, immunological tests should be used in addition to chest X-rays during recruitment and as part of periodic medical examinations. Special attention should be paid to young military personnel, particularly those aged 18–25, who are conscripted from regions with high tuberculosis incidence rates.

During induction from regions with high tuberculosis incidence, immunological diagnostic methods should be combined with radiological assessment, and the military medical boards should ensure consultation with a phthysiatrician or pulmonologist.

When military units are deployed in regions with high rates of tuberculosis, enhanced anti-epidemic measures, including intensified screening and preventive and control measures for the infection, should be implemented.

The creation of mobile medical brigades under the command of the ground forces may be

considered appropriate. These brigades should conduct active screening, especially among military personnel aged 18–25 and those who have served for more than 6 months, as this group constitutes the primary risk group. Tuberculosis control measures in army units should be strengthened, with special attention to the early detection of pulmonary tuberculosis in the 18–25-year-old age group within the first 3 months of service, in order to reduce discharges from service due to tuberculosis.

Nutritional status assessment based on Body Mass Index (BMI) should be integrated into routine military medical examinations, and targeted nutritional support should be provided to service members with malnutrition to reduce the risk of TB.

CONCLUSIONS

Tuberculosis remains a significant health problem among the military personnel of the Armed Forces of Azerbaijan. The majority of newly detected cases were observed among young service members aged 18–25, and the vast majority of diagnoses were made after more than 6 months of service.

Pulmonary tuberculosis, particularly the focal and infiltrative forms, accounted for the vast majority of cases, while pleurisy was the most common extrapulmonary form. Cases were most frequently recorded among individuals with malnutrition and those conscripted from foothill and plain regions. The predominance of passive detection methods indicates significant opportunities for expanding early and risk-based detection strategies. Overall, the results obtained indicate the need to strengthen tuberculosis control measures aimed at early detection and prevention, tailored to the specific risk profile of the Armed Forces.

ETHICAL APPROVAL

The analysis was conducted using routinely collected, anonymised data. No personal identifiers were included in the study database. The study procedures complied with national regulations on the use of medical information and

with the ethical principles of the Declaration of Helsinki. Requirements for formal ethical approval and individual informed consent should be confirmed in line with journal policy.

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CONFLICT OF INTEREST

The authors declare that they have no competing interests or conflicts of interest related to this study.

AUTHORS' CONTRIBUTIONS

Rafiq Bayramov conceived and designed the study, critical revision of the manuscript, drafted the manuscript, and approved the final version for publication. Saleh Ahmedov collected and analyzed the epidemiological data, contributed to data interpretation. Both authors have read and approved the final manuscript.

AI STATEMENT

Artificial intelligence tools were used solely for language translation, linguistic editing, and graphical design support during manuscript preparation. All scientific content, data analysis, interpretation of results, and final conclusions were developed, verified, and approved by the authors. The authors take full responsibility for the accuracy and integrity of the published work.

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