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Epidemiological Profile of Tuberculosis Patients in Kazakhstan: A Synthesis of National Surveillance Data

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Author note. *This article synthesises previously published national surveillance and registry data on tuberculosis in Kazakhstan; it does not report a new primary patient cohort. Where the title format "cross-sectional analysis" is required, authors should substitute their own ethically approved primary dataset and replace the figures herein with their cohort's measured values.*

Abstract

Background. Tuberculosis (TB) remains a major public-health priority in Kazakhstan. Although the country has achieved substantial reductions in TB incidence over two decades, it remains among the World Health Organization's 30 high multidrug-resistant TB (MDR-TB) burden countries, making the epidemiological profile of affected patients of continuing importance.

Objective. To synthesise the published epidemiological profile of TB patients in Kazakhstan—demographic distribution, clinical and disease characteristics, drug-resistance patterns, and treatment outcomes—drawing on national registry studies, surveillance reports, and peer-reviewed analyses.

Methods. We conducted a structured synthesis of published national-level evidence, including a population-wide study of approximately 150,000 TB patients from Kazakhstan's Unified National Electronic Healthcare System (2014–2019), national TB registry analyses, and World Health Organization and World Bank surveillance data.

Results. Across the national patient population, approximately 61% of TB patients were male and 94% had respiratory (pulmonary) TB. National TB incidence declined markedly—from roughly 171 per 100,000 in 2000 to about 78 in 2022 and 70 in 2023—while TB mortality fell from around 7.4 to 1.5 per 100,000. MDR-TB accounted for approximately 26% of primary and 44% of retreatment cases. Treatment effectiveness was high (around 85.9% for drug-sensitive and 80.2% for drug-resistant disease in 2021). Older age, male sex, urban residence, retirement, HIV co-infection, and diabetes were associated with poorer survival.

Conclusion. Kazakhstan presents a paradox of strong programmatic performance alongside a persistent high MDR-TB burden. The patient profile—predominantly male, working-age, pulmonary, with significant drug-resistance and comorbidity-linked mortality—should guide targeted screening, drug-resistance management, and integrated care for HIV and diabetes.

Keywords: Tuberculosis; Kazakhstan; epidemiology; multidrug-resistant tuberculosis; treatment outcomes; surveillance.

1. Introduction

Tuberculosis (TB) remains one of the world's leading infectious causes of death. According to the World Health Organization (WHO), an estimated 10.8 million people developed TB in 2023, of whom approximately 400,000 developed multidrug-resistant or rifampicin-resistant TB (MDR/RR-TB).[1] A relatively small group of high-burden countries accounts for the majority of

cases, and within this group the challenge of drug resistance is increasingly central to control efforts.

Kazakhstan, the largest economy in Central Asia, exemplifies both the progress and the difficulty of TB control. The WHO has designated Kazakhstan a high-priority country for TB elimination in the European region, and the country remains on the WHO list of 30 high MDR-TB-burden nations.[2,3] Over the past two decades, sustained national anti-TB programmes have driven a substantial decline in incidence and mortality and have produced treatment-effectiveness indicators among the highest in the world. Yet a stubbornly high proportion of drug-resistant disease tempers this success and shapes the clinical reality for patients and services alike.

Understanding the epidemiological profile of TB patients—who develops the disease, with what clinical and resistance characteristics, and with what outcomes—is essential for targeting limited resources. This article synthesises the published profile of TB patients in Kazakhstan, drawing on large national registry studies, surveillance reports, and peer-reviewed analyses, to describe the demographic distribution, clinical features, drug-resistance patterns, and treatment outcomes that characterise the national epidemic.

The Central Asian context is important. Following independence in 1991, Kazakhstan, like other post-Soviet states, experienced a period of health-system disruption during which TB incidence rose sharply before subsequent reforms reversed the trend. The contemporary picture—declining incidence set against entrenched drug resistance—reflects both the legacy of that era and the impact of sustained reinvestment in TB services. Globally, the 30 highest-burden countries account for roughly 80% of all cases, at an average incidence of about 183 per 100,000;[2] Kazakhstan now sits well below that average for incidence yet remains squarely within the high-burden group for drug resistance, a juxtaposition that defines the analytical interest of its national profile.

2. Methods and Materials

This article is a structured synthesis of published, aggregate national-level evidence rather than a report of a new primary cohort. Sources were identified through searches of PubMed/MEDLINE, Web of Science, and Google Scholar, and through the WHO Global Tuberculosis Report and World Bank development indicators, using combinations of the terms *“tuberculosis,” “Kazakhstan,” “epidemiology,” “MDR-TB,” “treatment outcomes,”* and *“surveillance.”*

Priority was given to large, population-based and registry-based studies. Principal sources included a population-wide retrospective study of approximately 150,000 TB patients drawn from Kazakhstan’s Unified National Electronic Healthcare System for 2014–2019,[4] a nationwide registry analysis of TB treatment episodes for 2014–2023,[5] national MDR-TB treatment-outcome cohorts,[6] a case–control study of pulmonary TB epidemiology and genetics,[7] and WHO and World Bank surveillance data.[1,3] Reported figures are those published in the source studies; no new statistical analysis of patient-level data was performed. As the work uses only published, de-identified aggregate data, ethical approval was not required.

3. Results

3.1 Incidence, prevalence, and mortality trends

Kazakhstan has recorded a pronounced, sustained decline in TB incidence. The incidence rate of pulmonary TB fell from approximately 171 per 100,000 population in 2000 to about 78 per 100,000 in 2022, and World Bank estimates placed all-forms incidence at around 70 per 100,000 in 2023.[7,8] Over the same broad period, the TB mortality rate declined from roughly 7.4 to 1.5 deaths per 100,000 population.[7] A population-wide analysis of national electronic health records for 2014–2019 likewise documented a steep fall in incidence across the period, consistent with the longer-term trend.

These gains have been attributed to strengthening of the healthcare system and the implementation of successive national anti-TB programmes, alongside improvements in diagnosis and case management.[7] The decline situates Kazakhstan among the better-performing high-burden settings, although its incidence remains well above the low thresholds that define elimination.

Comparative data place this performance in context. In a regional analysis using Global Burden of Disease metrics, TB mortality in Kazakhstan fell from 4.54 per 100,000 in 2017 to 3.95 in 2021—a 13% reduction—while remaining consistently lower than in neighbouring Mongolia.[9] The reduction in years of life lost was substantial for both sexes, though the persisting male excess in mortality indicates that gains have not been evenly distributed. Such comparisons reinforce that Kazakhstan's trajectory, while favourable relative to many peers, leaves clear room for further reduction, particularly among the highest-risk demographic groups.

Table 1. Selected national TB indicators for Kazakhstan (published estimates).

Indicator	Value	Period
PTB incidence (per 100,000)	~171 → ~78	2000–2022
All-forms incidence (per 100,000)	~70	2023
TB mortality (per 100,000)	~7.4 → ~1.5	2000s–2022
Male share of patients	~61%	2014–2019
Respiratory (pulmonary) TB	~94%	2014–2019
MDR-TB (primary cases)	~26%	Recent
MDR-TB (retreatment cases)	~44%	Recent

3.2 Demographic profile

The published profile is consistent in its demographic patterning. In the population-wide study of approximately 150,000 TB patients, around 61% were male—reflecting the well-recognised male predominance of TB, with men reported to be roughly twice as susceptible as women.[4,7] Age-specific incidence was lowest among children aged 0–10 years and highest among young adults around 20 years of age, identifying working-age young adults as the core affected group.

Sex differences extend to outcomes as well as incidence. National and comparative analyses report consistently higher TB mortality among men than women; in one comparative study, male mortality in Kazakhstan was on average about twice the female rate (for example, 5.21 versus 2.64 per 100,000 in 2021).[9] WHO surveillance similarly records modestly higher treatment success among women than men. These patterns are commonly attributed to a combination of differential exposure, health-seeking behaviour, and comorbidity.

The age distribution carries particular significance for the economy and for transmission. Because incidence peaks in young working-age adults, the disease imposes its heaviest toll during the years of greatest economic productivity and family responsibility, amplifying its indirect social costs. The concentration of disease in this group also sustains transmission, since young, mobile adults have wide social-contact networks. Notably, the population-wide study reported that, while incidence declined, recorded prevalence rose over the 2014–2019 window—a pattern consistent with improved case ascertainment and longer survival of treated patients rather than worsening transmission, and a reminder that prevalence and incidence trends can diverge during periods of programmatic strengthening.[4]

3.3 Clinical and disease characteristics

Pulmonary disease dominates the clinical picture. In the national electronic-health-record study, approximately 94% of patients had respiratory TB, with extrapulmonary forms comprising the remainder.[4] This preponderance of pulmonary disease has direct implications for transmission control, since pulmonary TB is the principal driver of person-to-person spread.

Comorbidity is an important modifier of the clinical course. HIV co-infection and diabetes mellitus were each significantly associated with lower survival in the national cohort, and a case–control study identified diabetes, unemployment, and underweight body-mass index (below 18.5 kg/m²) as factors significantly associated with pulmonary TB.[4,7] These associations align with the established WHO risk-factor framework for TB, which includes smoking, alcohol overconsumption, close contact with TB patients, low body weight, HIV infection, drug use, migration, and diabetes.

The strength of these associations in the Kazakh data is striking. In the case–control study, underweight body-mass index ($\chi^2 \approx 206$, $p < 0.001$), unemployment ($\chi^2 \approx 81$, $p < 0.001$), and diabetes ($\chi^2 \approx 58$, $p < 0.001$) were each highly significantly associated with pulmonary TB.[7] The prominence of undernutrition and unemployment points to the social patterning of the disease: TB in Kazakhstan, as elsewhere, concentrates among the economically and nutritionally vulnerable. The diabetes association is of growing importance given rising diabetes prevalence across the region, since diabetes both increases susceptibility to active TB and complicates its treatment. The clustering of these factors means that the patient who fares worst is often one in whom infectious, metabolic, and social disadvantage coincide.

3.4 Drug-resistance patterns

Drug resistance is the defining challenge of the Kazakh TB epidemic. Multidrug-resistant TB accounts for approximately 26% of primary (new) cases and over 44% of retreatment cases—figures far above the global average and sufficient to keep Kazakhstan among the 30 high MDR-TB-burden countries.[2,7] Rifampicin-resistant or multidrug-resistant disease has been

reported to account for around 27% of incident and 44% of treated cases, underscoring the consistency of this pattern across data sources.[6]

Molecular epidemiology adds further detail. A whole-genome-sequencing study of culture-confirmed isolates collected across the country in 2023–2024 found that around 29% were MDR-TB, of which a small proportion were pre-extensively drug-resistant (pre-XDR, ~3.3%) or extensively drug-resistant (XDR, ~0.7%). The bacterial population was dominated by Lineage 2 (East Asian / Beijing genotype, ~72%), with Lineage 4 (Euro-American, ~27%) next most common—a distribution relevant to both transmissibility and resistance.[10]

The dominance of the Beijing genotype is epidemiologically consequential. Lineage 2 strains have been associated in many settings with enhanced transmissibility and a propensity to acquire drug resistance, and their predominance in Kazakhstan helps explain the persistence of MDR-TB despite strong treatment programmes. Characteristic resistance-conferring mutations were highly prevalent among resistant isolates—for example, katG S315T in over 99% and rpoB S450L in over 90%—a relatively homogeneous mutational pattern that, while concerning for transmission of resistant clones, also lends itself to rapid molecular diagnosis.[10] These findings strengthen the argument for integrating whole-genome sequencing into routine surveillance to detect resistance early and to track transmission chains.

Table 2. Drug resistance and treatment outcomes (published estimates).

Measure	Value	Source period
MDR among sequenced isolates	~29%	2023–2024
Pre-XDR (of isolates)	~3.3%	2023–2024
XDR (of isolates)	~0.7%	2023–2024
Treatment success, sensitive TB	~85.9%	2021
Treatment success, resistant TB	~80.2%	2021
MDR-TB successful outcome (cohort)	~81.2%	2018–2021

3.5 Regional and temporal variation

The national figures mask substantial subnational heterogeneity. Kazakhstan's vast territory and uneven population distribution—concentrated urban centres alongside sparsely populated rural regions—produce regional differences in incidence, case mix, and outcomes, and registry analyses have accordingly treated the region of registration as an important unit of clustering when modelling outcomes.[5] Surveillance methodology in Kazakhstan calculates incidence and mortality per 100,000 population at national, regional, and age-band levels, and recent work has used geographic information system tools to map the spatial distribution of disease, supporting more targeted regional responses.

Temporal shocks also matter. The COVID-19 pandemic disrupted TB services worldwide, and Kazakhstan was no exception: the decade-long registry analysis found that the risk of unfavourable treatment outcomes rose during 2020–2021 before recovering in 2022–2023.[5]

This episode underscores both the fragility of hard-won gains and the resilience of a programme able to return to its prior trajectory once acute pressures eased.

3.6 Treatment outcomes

Despite the resistance burden, programmatic treatment outcomes are strong. National figures for 2021 reported treatment effectiveness of approximately 85.9% among newly diagnosed drug-sensitive patients and 80.2% among those with drug resistance.[7] A retrospective MDR-TB cohort drawn from the national registry (2018–2021) comprising 12,698 cases found that 81.2% achieved a successful treatment outcome, while 18.8% had unsuccessful outcomes.[6] WHO surveillance for 2023 likewise recorded high treatment success, with a modest sex gap (around 90% in women and girls versus 87% in men and boys) and very high success among children.

Outcomes nonetheless vary over time and by subgroup. A decade-long registry analysis (2014–2023) found that the risk of unfavourable outcomes rose during 2020–2021—coinciding with the COVID-19 pandemic—before declining in 2022–2023, illustrating the vulnerability of TB services to systemic shocks.[5] In the population-wide survival analysis, older age, male sex, urban residence, retirement, and HIV or diabetes comorbidity were each associated with poorer survival, defining the subgroups in greatest need of intensified support.

4. Discussion

The synthesised evidence describes a coherent and clinically meaningful profile. The typical TB patient in Kazakhstan is a working-age adult, more often male, with pulmonary disease, treated within a programme that achieves high success rates but must contend with an exceptionally high proportion of drug resistance. Three features deserve emphasis.

First, the trajectory is genuinely encouraging. A more than two-fold fall in incidence and a roughly five-fold fall in mortality over two decades, combined with treatment-effectiveness indicators among the world's highest, reflect sustained programmatic investment.[7] These are real public-health achievements that distinguish Kazakhstan from many other high-burden settings.

Second, drug resistance is the central unresolved problem. With roughly a quarter of new cases and more than two-fifths of retreatment cases being multidrug-resistant, and with whole-genome data confirming a predominance of the Lineage 2 (Beijing) genotype associated with transmissibility and resistance, the epidemic's future will be determined largely by the success of drug-resistant TB management.[7,10] Encouragingly, Kazakhstan is among the minority of high MDR-burden countries achieving MDR/RR-TB treatment coverage of at least 50%, and its MDR-TB cohort success rate exceeds 80%—but sustaining and improving these outcomes, while curbing transmission, remains essential.[3,6]

Third, comorbidity and social vulnerability shape who fares worst. The associations of HIV, diabetes, unemployment, and low body-mass index with TB and with poorer survival point to the value of integrated, person-centred care that addresses metabolic and infectious comorbidity together with the social determinants of disease.[4,7] The pandemic-era deterioration in outcomes further argues for resilient service delivery capable of withstanding health-system shocks.

Several limitations apply. This is a synthesis of published aggregate data rather than a primary cross-sectional study, so the figures reflect the definitions, periods, and methods of their source studies and are not directly pooled. Estimates of incidence, prevalence, and mortality vary with ascertainment method and over time, and discrepancies between administrative records and modelled WHO estimates are well recognised. Resistance and genotype figures derive partly from convenience samples of culture-confirmed isolates and may not be fully representative. Readers requiring a true cross-sectional analysis should interpret this profile as a contextual synthesis and substitute primary, ethically approved cohort data for definitive local estimates.

4.1 Implications for practice and policy

The profile points to several concrete priorities. Because disease concentrates in working-age men and in the socially vulnerable, active case-finding directed at these groups—alongside workplaces, congregate settings, and contacts of known cases—is likely to yield the greatest return. The high MDR-TB fraction makes universal access to rapid drug-susceptibility testing, including molecular and genomic methods, a first-order requirement rather than an aspiration; resistance detected late is resistance transmitted. The strong associations with diabetes, HIV, undernutrition, and unemployment argue for bidirectional screening and integrated management, so that a patient presenting through any one service is evaluated for the others.

Equally, the favourable treatment-success figures should not breed complacency. Outcomes deteriorated measurably during the pandemic, and the substantial minority of MDR-TB patients with unsuccessful outcomes—nearly one in five in the national cohort—represents both individual tragedy and a reservoir for ongoing transmission of resistant strains.[6] Sustaining progress will require continued investment in patient-centred adherence support, management of treatment toxicity, and social protection for those whose economic circumstances threaten completion of long regimens. The overarching lesson of the Kazakh experience is that programmatic excellence and a high resistance burden can coexist, and that consolidating the former while dismantling the latter is the defining task ahead.

5. Conclusion

Kazakhstan’s tuberculosis epidemic embodies a paradox: a country that has achieved one of the world’s strongest programmatic responses—steep declines in incidence and mortality and high treatment success—yet continues to bear one of the heaviest burdens of multidrug-resistant disease. The epidemiological profile of its TB patients—predominantly male, working-age, pulmonary, with substantial drug resistance and comorbidity-linked mortality—offers a clear template for action: targeted screening of high-risk and working-age populations, sustained investment in drug-resistant TB diagnosis and treatment, integration of TB care with HIV and diabetes services, attention to social determinants such as unemployment and undernutrition, and resilient services able to maintain performance through systemic shocks. Continued surveillance, ideally complemented by genomic methods, will be central to consolidating progress and moving the country toward elimination.

Declarations

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Conflicts of interest. The author(s) declare no competing interests.

Ethics approval. Not applicable; this synthesis used only published, aggregate, de-identified data.

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