



The Trend of Tuberculosis in Southwestern Iran, 2011–2025

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Abstract

Background and aims: Tuberculosis (TB) remains a major global health concern and one of the leading causes of death among infectious diseases. Accurate surveillance of incidence trends is essential for planning and implementing effective control strategies. This study aimed to assess the temporal trends in TB incidence in Dezful, Khuzestan Province, southwestern Iran.

Methods: This ecological study analyzed TB incidence data from March 21, 2011, to March 20, 2025. Data on new TB cases and population size were obtained from the Health Deputy of Dezful University of Medical Sciences. Joinpoint regression analysis was applied to estimate annual percentage changes (APCs) and average annual percentage changes (AAPCs) in TB incidence over time.

Results: TB incidence was higher among males. From March 21, 2011, to March 20, 2025, the overall incidence of TB in Dezful demonstrated a statistically significant decreasing trend, with an AAPC of -3.65% (95% CI: -5.91 to -1.40). A considerable declining trend was observed in females [AAPC: -5.25% (95% CI: -7.49 to -2.98)], whereas the reduction in males [AAPC: -2.57% (95% CI: -5.28 to 0.10)] was not statistically significant.

Conclusion: The incidence of TB in Dezful showed a significant decline among women over the study period, but no significant reduction was observed among men.

Keywords: Tuberculosis, Incidence, Iran, Time trend, Regression analysis

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Introduction

Tuberculosis (TB), caused by *Mycobacterium TB*, primarily affects the lungs and is transmitted through airborne particles produced by coughing, sneezing, or spitting from infected individuals. Despite being both preventable and curable, TB remains a major public health threat, particularly in low- and middle-income countries.¹

According to the World Health Organization (WHO), in 2020, an estimated 10 million new TB cases and 1.5 million deaths occurred globally, making TB the leading cause of death from a single infectious agent.² In the same year, the estimated TB incidence in the Eastern Mediterranean Region was 112 per 100,000 population, while in Iran, it was reported at 13 per 100,000.³ Several social determinants, including overcrowded and substandard housing, malnutrition, diabetes, HIV infection, tobacco use, and alcohol abuse, are recognized risk factors contributing to TB transmission and progression.⁴

The WHO declared TB a global emergency in 1993. As part of the End TB Strategy, the global targets are a 90% reduction in TB incidence and a 95% reduction in TB

mortality by 2035, compared to 2015 levels.⁵

In Iran, data from 1990 to 2014 suggest a decline in TB prevalence between 1995 and 2010, followed by an upward trend thereafter.⁶ Regional studies have reported similar findings, such as a rising incidence of TB in West Azerbaijan province between 2001 and 2010⁷, and national projections also indicate a growing trend in TB incidence across the country.⁸

Although Khuzestan Province ranks average in terms of smear-positive pulmonary TB (SPPTB) incidence compared with other provinces in Iran, its geographic proximity to Iraq and its shared borders underscore the need for vigilant surveillance and tailored public health responses.⁹ Understanding time trends in TB incidence in southwest Iran is essential for assessing disease burden, identifying high-risk groups, and evaluating the effectiveness of local TB control programs.

Temporal trend analysis using Joinpoint regression models can provide valuable insights into changes in TB incidence over time and inform evidence-based strategies for disease prevention and control. This method is particularly effective for detecting points in time when statistically significant changes occur, such

as increases or decreases in incidence following public health interventions, behavioral shifts, or external factors. Therefore, Joinpoint regression was selected in this study to identify potential inflection points and estimate the average annual percent change (AAPC) in TB incidence over the study period.¹⁰

Accordingly, the present study aimed to evaluate TB incidence trends in the northern region of Khuzestan Province, focusing on age- and sex-specific subgroups from March 2011 to March 2025. The findings aim to support local TB control efforts, evaluate progress toward sustainable development goals, and inform the design of targeted interventions.

Materials and Methods

Study Area

This ecological study was conducted in Dezful County, Khuzestan Province, southwestern Iran. According to the most recent national census (2024), the population of Khuzestan Province was 6,462,509 individuals.¹¹ During the study period (2011–2025), the population of Dezful County varied between 470,096 and 490,712, reflecting demographic changes over time.

Data Collection

Data on newly diagnosed TB cases and population size were obtained from the TB registry of the Health Deputy of Dezful University of Medical Sciences, covering the period from March 21, 2011, to March 20, 2025 (Farvardin 1, 1390–Farvardin 1, 1403 Hijri Shamsi). Data were stratified by sex (male/female) and age groups (0–19, 20–29, 30–59, and ≥60 years).

Analysis

Crude incidence rates of TB were first calculated separately for men and women across predefined age groups. To account for differences in age distribution, direct age standardization was applied using the 2000 World Standard Population as the reference.¹² Age-standardized incidence rates (ASIRs) were then expressed per 100,000 population using the following parameters: (1) the number of newly diagnosed TB cases in each age group (numerator), (2) the corresponding age-specific population (denominator), and (3) the weights of the standard population.¹²

Temporal trends were assessed using Joinpoint regression analysis, which estimated the annual percentage change (APC) and AAPC in TB incidence over time. The model identified significant changes in trends and computed the rate of change between joinpoints, along with 95% confidence intervals (CIs). A P -value < 0.05 was considered statistically significant. All analyses were performed using the Join point software, version 4.8.0.1.

Results

TB Statistics in Dezful, Khuzestan

Between 2011 and 2025, a total of 1,343 new cases of TB

were recorded in Dezful County, including 860 cases among men (64.0%) and 483 among women (36.0%). Throughout the study period, the age-standardized rates (ASRs) were consistently higher in men than in women (Table 1).

Time Trend of TB in Dezful, Khuzestan

Over the study period, a decreasing pattern was observed in the ASR of TB across the total population. The highest ASIRs were reported in the early years of the study (e.g., 22.10 per 100,000 in 2011), while the lowest were observed at the end of the period (e.g., 16.39 per 100,000 in 2025). The decline was particularly notable among women, with the ASRs dropping from 22.78 in 2011 to 13.26 in 2025. A similar but less marked pattern was noted among men, ASRs declining from 21.86 to 19.37 per 100,000 during the same period.

Table 2, presents the results of the trend analysis. Overall, TB incidence demonstrated a statistically significant decrease of 3.65% per year (AAPC = -3.65% , 95% CI: -5.91 to -1.40 , $P < 0.001$). When stratified by sex, a significant downward trend was observed in women (AAPC = -5.25% , 95% CI: -7.49 to -2.98 , $P < 0.001$). Among men, although the AAPC was negative (-2.57%), the decline was not statistically significant (95% CI: -5.28 to 0.10 , $P = 0.060$). Therefore, the decreasing pattern in men should be interpreted with caution, as the value exceeds the conventional threshold of statistical significance.

Figure 1 presents the ASRs of TB in Dezful County from 2011 to 2024, stratified by sex. Joinpoint regression analysis revealed no joinpoints in any of the three groups (men, women, and total population), suggesting a linear trend across the study period. The figure illustrates a steeper downward slope among females compared to

Table 1. Frequency and ASIR of TB per 100,000 Among Men and Women in Dezful, Khuzestan Province, Iran (2011–2025)

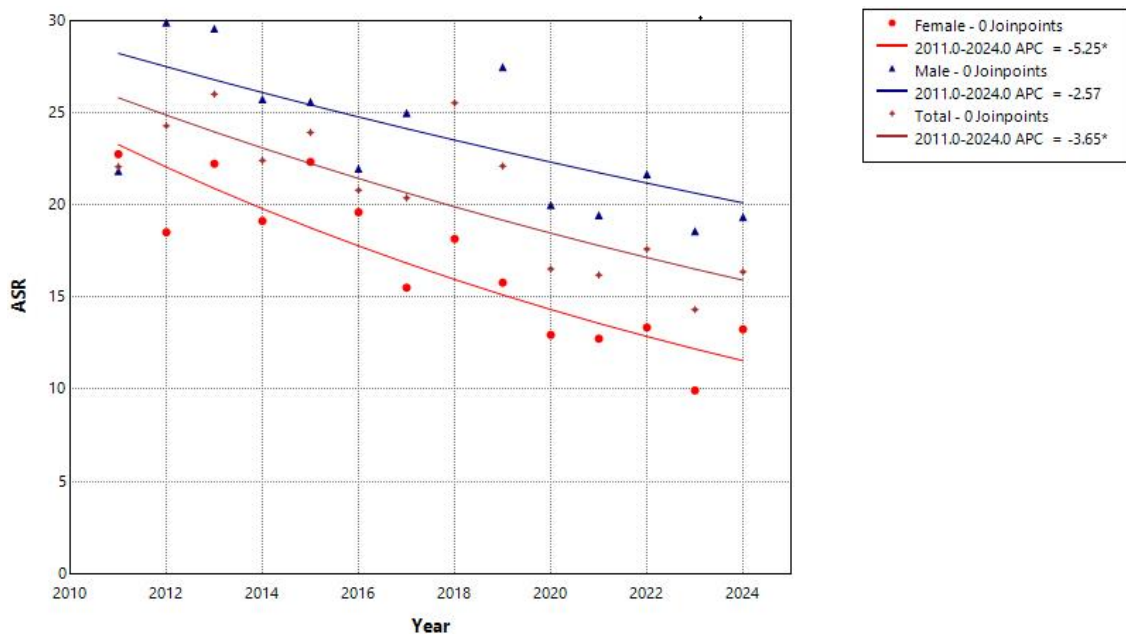
Year (Hijri Shamsi)	Women		Men		Total	
	New Cases	ASIR* per 100,000	New Cases	ASIR* per 100,000	New Cases	ASIR* per 100,000
2011 (1390)	43	22.78	56	21.86	99	22.10
2012 (1391)	35	18.53	74	29.94	109	24.31
2013 (1392)	44	22.26	69	29.60	113	26.04
2014 (1393)	37	19.15	72	25.76	109	22.44
2015 (1394)	44	22.36	66	25.62	110	23.96
2016 (1395)	41	19.62	60	21.99	101	20.82
2017 (1396)	32	15.53	69	25.02	101	20.40
2018 (1397)	34	18.18	73	32.68	107	25.56
2019 (1398)	35	15.80	60	27.52	98	22.13
2020 (1399)	26	12.96	45	20.01	71	16.54
2021 (1400)	27	12.75	49	19.47	76	16.21
2022 (1401)	30	13.36	59	21.69	89	17.62
2023 (1402)	23	9.94	52	18.60	75	14.34
2024 (1403)	32	13.26	53	19.37	85	16.39

Note. TB: Tuberculosis; *ASIR: Age-standardized incidence rate (calculated using the WHO 2000 World Standard Population).

Table 2. APC and AAPC of TB in Dezful, Khuzestan Province, Iran (2011–2025)

Group	Segment	Period	APC (%)	95% CI (Lower–Upper)	P-value	AAPC (%)	95% CI (Lower–Upper)	P-value
Men	1	2011–2025	–2.57	–5.28 to 0.10	0.060	–2.57	–5.28 to 0.10	0.060
Women	1	2011–2025	–5.25*	–7.49 to –2.98	<0.001	–5.25	–7.49 to –2.98	<0.001
Total	1	2011–2025	–3.65*	–5.91 to –1.40	<0.001	–3.65	–5.91 to –1.40	<0.001

Note. APC: Annual percentage change; AAPC: Average annual percentage change; TB: Tuberculosis; CI: Confidence interval. *Statistically significant at $P < 0.05$.

**Figure 1.** Time Trends of ASR TB Incidence Rates in Dezful, Khuzestan, I (2011–2025)

males, indicating greater reductions in TB incidence among women during the study period.

Discussion

The present study examined temporal trends in TB incidence in northern Khuzestan Province from 2011 to 2025. Findings revealed a statistically significant decrease in TB incidence among women. Among men, the trend was also downward but not statistically significant. These results suggest improvements in TB control across both sexes, though reductions have been more pronounced among women.

Globally, diverse trends in TB incidence have been documented. Several studies have reported an increasing incidence in specific populations or contexts. For instance, a study in Japan from 1993 to 2015 reported a rising TB trend, particularly attributed to demographic aging.¹³ Similarly, an upward trajectory was noted among migrants in Brazil between 2014 and 2019, highlighting the influence of migration and socioeconomic vulnerability in TB epidemiology.¹⁴ Another study in northeastern Brazil indicated a significant rise in TB cases, especially among males under 20 and those aged 20–39, during the 2001–2016 period.¹⁵ Although these findings suggest a growing burden among men, our study revealed a declining trend in TB incidence for both sexes in northern Khuzestan between 2011 and 2025; however, the reduction in men

was not statistically significant. These differences may reflect variations in population structure, healthcare access, and exposure to risk factors across settings.

In contrast, multiple studies have demonstrated declining TB incidence over time. For example, a Brazilian study reported reductions in TB rates among individuals aged 20–59.¹⁶ Notably, in our study, the AAPC in TB incidence among women exceeded that reported for the Brazilian population. In Southern India, TB incidence declined significantly between 2010 and 2019, largely attributed to expanded DOTS coverage and improvements in health infrastructure.¹⁷ Similarly, a comprehensive analysis by Cui et al demonstrated a decreasing ASIR in China, India, and the United States between 1992 and 2017 for both sexes.¹⁸ In comparison, our study's trend among women mirrors these international patterns, although with a steeper decline.

China continues to show remarkable success in reducing TB incidence, with national data revealing a downward trajectory from 2004 to 2019¹⁹, further substantiated by a detailed epidemiological study covering 2005–2016.²⁰ In India, TB incidence declined steadily for both men and women between 1990 and 2019, with women experiencing a more pronounced decline.²¹ Likewise, in Brescia, Italy, a 54.6% decrease in TB incidence was reported between 2004 and 2020, attributed to coordinated public health interventions and improved living standards.²²

However, regional variations in TB incidence persist. In South Tunisia, for example, TB rates rose among children and adult females between 1995 and 2016, reflecting localized epidemiological and social determinants.²³ Similarly, although national TB incidence declined in Iran between 2008 and 2018, spatial analysis identified Khuzestan Province as a high-burden area, particularly for SPPTB.²⁴ This aligns with our findings and suggests the presence of persistent regional disparities in TB burden, possibly driven by environmental, socioeconomic, and healthcare-related factors.

In Iraq, TB incidence gradually decreased from 2011 to 2018, with the lowest rates observed in children aged 1–4 and 5–14 years.²⁵ However, unlike Iraq's trajectory, TB incidence among men in northern Khuzestan did not exhibit a similar decline, underscoring potential gaps in disease control and gender-specific vulnerabilities in this region.

Gender disparities in TB incidence have long been recognized. In a study among older adults in China (≥ 65 years), male gender emerged as a strong independent predictor of TB²⁶, a finding also confirmed in a Taiwanese cohort.²⁷ Biological susceptibility, differential exposure, and care-seeking behavior may underlie these patterns. Moreover, social network dynamics play a critical role in TB transmission. Studies have indicated that men often have larger and higher-risk social networks, increasing their exposure to infectious TB cases.^{28,29} Social network analysis further suggests that men are more likely to engage in social interactions in high-risk settings, thereby elevating their infection risk.³⁰ These findings are consistent with the male predominance and stagnant TB trend observed in our study.

Several factors may account for the observed trends. First, underreporting due to case-finding approaches likely contributes to the apparent increase in incidence, highlighting the need for the health system to improve coverage and case-finding methods. Second, gender differences in exposure to TB risk factors, such as smoking, incarceration, and occupational crowding, may further explain the observed sex-based discrepancies. Third, behavioral and cultural norms may limit women's exposure to high-risk environments or enhance their treatment adherence, thereby influencing incidence patterns.

Despite its strengths, this study has limitations. First, it relies on surveillance data from a single region, limiting generalizability. Second, the absence of data on socioeconomic, environmental, and behavioral risk factors restricts causal inference. Third, the analysis does not account for potential changes in diagnostic or reporting practices over time. Fourth, Joinpoint regression assumes linear changes within segments and may not fully capture complex, non-linear patterns in disease incidence. Future studies incorporating individual-level data and advanced modeling techniques could provide deeper insights into the determinants of TB trends in the region.

Conclusion

The findings of this study highlight a statistically significant downward trend in TB incidence among women. Among men, although the decreasing trend did not reach statistical significance at the 5% level, the direction of change was similar. These results underscore the need for sustained surveillance and further investigation into the underlying factors contributing to gender-based differences in TB trends, supporting equitable and effective public health interventions in the region. However, the decreasing trend in TB incidence after 2019 should be interpreted with caution, as the coronavirus disease 2019 (COVID-19) pandemic likely contributed to underdiagnosis and underreporting of cases.

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Competing Interests

The authors declare no conflict of interests.

Ethical Approval

This study was approved by the Ethics Committee of Kerman University of Medical Sciences (IR.KMU.REC.1401.031).

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