Original Article

Tuberculosis Incidence in Iran and Neighboring Countries from 2010 to 2023

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ABSTRACT

A review of tuberculosis (TB) incidence in various countries was conducted for a descriptive epidemiological study of trends, focusing on Iran and its surrounding WHO regions from 2010 to 2023. The analysis revealed significant differences in TB incidence rates among these regions, with the highest rates reported in the African Region and South-East Asia Region. Factors contributing to these disparities include socioeconomic status, healthcare access, and health system vulnerabilities. Notable decreases in TB rates were observed in Iran, the United Arab Emirates, and Saudi Arabia, attributed to improved healthcare services and public health interventions. However, challenges persist, such as high rates in Afghanistan and Pakistan, and the presence of drug-resistant strains in some countries. The study highlights the importance of tailored prevention campaigns, improved healthcare capacity, and enhanced TB control measures, including early detection and treatment adherence. Data from Iran illustrate the need for targeted public health strategies, particularly in high-risk areas. The correlation between TB incidence and the Human Development Index underscores the impact of poverty and limited healthcare access. The study suggests that better data quality and longitudinal research are required for a more nuanced understanding of TB trends and the effectiveness of interventions. Additionally, the findings emphasize the need for regional cooperation in TB control, especially considering the influence of migration and neighboring countries' health situations. Overall, the abstract underscores the ongoing health challenge posed by TB and the importance of sustained efforts to achieve global TB elimination goals set by the WHO.

Introduction

Tuberculosis (TB) is a severe global health issue caused by Mycobacterium tuberculosis. It primarily affects the lungs but can also harm other areas such as the spine, kidneys, and brain. In 2015, the World Health Organization reported 10.4 million new cases and 1.8 million deaths, particularly in developing countries. TB spreads when a person inhales droplets from an infected person's cough or sneeze. It can also be

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contracted by consuming unpasteurized dairy products. Key factors in the spread of TB include the overall health of the population, existing conditions such as HIV, and drug-resistant strains. Vulnerable groups include those with HIV, and risk factors include age, gender, asthma, smoking, family history, and poor living conditions. In regions such as Southwest Asia, civil war, poverty, and immigration exacerbate TB cases due to inadequate living conditions and healthcare challenges [1]. The "Global Tuberculosis Report 2024" emphasizes the ongoing battle against tuberculosis (TB), which still poses a significant health challenge, especially in low- and middle-income countries. While there was a slight decline in new TB cases in 2023, the global incidence rate remains at 134 cases per 100,000 people. The report highlights the urgent need for increased funding for TB research, diagnosis, and treatment, particularly as the COVID-19 pandemic has strained healthcare finances. It also emphasizes the importance of improved diagnostic tools like rapid tests and the necessity of shorter, more manageable treatment plans to enhance patient outcomes. The COVID-19 pandemic has negatively impacted TB control and may have led to an increase in undiagnosed cases. However, some regions have experienced a slower rise in TB cases and lower death rates since 2010, indicating that positive actions can yield better results [2].

A previous study sheds light on global TB incidence rates across various WHO regions from 2010 to 2023, revealing significant differences among these regions. The African Region and the South-East Asia Region report the highest incidence rates, at 255 and 245 cases per 100,000 people, respectively, while the European Region and the Region of the Americas have much lower rates of 31 and 28 cases per 100,000 people [3].

In Kazakhstan, regional trends in TB rates mirror those seen worldwide, influenced by factors such as socioeconomic status and healthcare access. Regions such as Kyzylorda, Atyrau, and North Kazakhstan report higher TB rates, potentially due to health system issues and vulnerabilities. There has been a slight increase in TB rates recently, likely linked to

the impact of the COVID-19 pandemic on TB services. This aligns with the WHO's END TB Strategy, which emphasizes the importance of early detection and treatment to achieve goals set for 2035 [4].

The WHO report also indicates that access to medical institutions and technicians correlates with TB incidence, suggesting that better healthcare capacity can enhance disease management. The overall incidence of TB decreased from 2.03 per 1,000 person-years in 2012 to 0.44 per 1,000 person-years in 2022, indicating successful HIV treatment and prevention efforts [5]. However, high rates in Eastern Europe highlight the need for targeted strategies. Social factors such as poverty and malnutrition play a role in TB rates, indicating the necessity for wider access to screenings and preventive treatments [6]. In Khuzestan, Iran, TB incidence rose by 0.84% annually from 2010 to 2019 but decreased after 2013, likely due to improved diagnostics and control programs. Males had a higher incidence than females, particularly in younger age groups, pointing to exposure to risk factors such as poverty and overcrowding. Female rates have notably decreased since 2013 [7].

Studies on tuberculosis (TB) cases reveal that most infections are pulmonary, with lymphatic TB being the most common extrapulmonary type. These data are important for healthcare providers and policymakers to create effective intervention strategies. In Iran, HIV co-infection among TB patients is low compared to global patterns, though incomplete HIV status data might affect this finding. Iran's low rate of multidrug resistance suggests successful TB control efforts, but a 72% cure rate for smear-positive pulmonary TB is below WHO standards, indicating a need for better care delivery. Differences in extrapulmonary TB by gender and age highlight the importance of tailored prevention campaigns. The study calls for ongoing surveillance and research to address the high incidence of TB in Iran. Health policies should focus on improving TB control, case detection, treatment adherence, and drug resistance management. Medical education needs updates to align with current epidemiological data and treatment guidelines [8].

Materials and Methods

Literature Review

A comprehensive review was conducted for a descriptive epidemiological study on the trends in the incidence of TB in Iran. Online databases such as Google Scholar and Scopus were utilized to search for keywords related to tuberculosis, incidence, and countries within the World Health Organization (WHO). The objective of this review was to gather relevant scientific literature and data on tuberculosis incidence in WHO countries, including Iran and neighboring regions.

Data Collection

Data on the incidence of tuberculosis per 100,000 population in WHO countries, including Iran and neighboring regions, for a descriptive epidemiological study on trends were collected. The information was obtained from the World Health Organization (WHO) database, which can be accessed at https://www.who.int/data/gho/data/indicators/indicator-details/GHO/incidence-of-tuberculosis-(per-100,000-population-per-year) [3,9].

Data Distribution Analysis

A one-sample Kolmogorov-Smirnov test was performed using SPSS v27 to assess the normality of tuberculosis incidence data for countries in the Middle East region surrounding Iran from 2010 to 2023. This test was utilized to analyze the distribution of tuberculosis incidence data for each country during the study period, as well as the distribution of tuberculosis incidence data for all countries in each year of the study [3-9,10].

Descriptive and Analytical Statistics Study

The study aimed to analyze the incidence of tuberculosis (TB) per 100,000 population in WHO countries, including Iran and neighboring regions, from 2010 to 2023. SPSS v27 software was used for data analysis. The research sought to explore the correlation between the study years and the TB incidence rate, using the Pearson and Spearman correlation tests for this purpose [10].

Results and Discussion

Tuberculosis Incidence in Iran and Neighboring Countries

The data illustrate the annual tuberculosis (TB) incidence rates from 2010 to 2023 for various countries in the Middle East and beyond, emphasizing public health and socioeconomic factors. Overall, there is a trend of decreasing TB rates, but the extent of this change varies widely among countries.

In the United Arab Emirates (UAE), TB incidence dropped significantly from 2.2 to 0.8 cases per 100,000 people. This reduction can be attributed to a strong healthcare system, effective TB control measures, and substantial investment in health services, which could serve as a model for other countries in the region.

Jordan saw a decrease from 5.8 to 3.4 cases per 100,000 population, indicating progress in TB control efforts. However, its rate remains higher than the UAE's, possibly due to differences in resources and healthcare access. Strategies in Jordan, such as enhanced surveillance and public awareness, may provide models for neighboring countries.

Oman's rate fell from 12.8 to 11.1 cases per 100,000, reflecting some progress but still revealing challenges, such as higher initial rates and healthcare access issues. Lebanon experienced a modest decrease from 11.7 to 10.1 cases per 100,000, indicating a need for intensified TB control, especially amid the recent political and economic crises.

Iran's TB incidence decreased from 17.6 to 10.9 cases per 100,000, aligning with global goals for reducing TB by 50% by 2035. This decline likely stems from improved healthcare services and public health interventions. Saudi Arabia saw a substantial decline from 19.5 to 8.4 cases per 100,000, thanks to healthcare initiatives and public health policies. However, challenges such as a large migrant population persist.

Bahrain achieved a notable reduction from 23.3 to 11.9 cases per 100,000, benefiting from its

resources and focused health interventions. Turkey's drop from 25.2 to 13.3 cases per 100,000 illustrates effective TB control, aided by a strong healthcare system.

Kuwait's significant decrease from 37.4 to 9.7 cases per 100,000 underscores the potential for progress with effective public health strategies. Iraq decreased from 45.3 to 20.9 cases per 100,000, but it still has a high incidence due to its recent history and healthcare rebuilding efforts. Armenia's decline from 61.3 to 24.6 cases per 100,000 is a notable achievement linked to following international guidelines and receiving global health support.

Uzbekistan experienced a reduction from 97.1 to 57.2 cases per 100,000, indicating that TB control measures are having an impact despite ongoing challenges in health and economic development. Azerbaijan's incidence dropped from 104.5 to 71.8 cases per 100,000, showing progress but still remaining relatively high.

Afghanistan's slight decrease from 189.3 to 180.2 cases per 100,000 indicates a severe ongoing TB burden, influenced by conflict and limited healthcare access. Yemen's marginal decrease from 51.8 to 47.9 cases per 100,000 is concerning due to the humanitarian crisis compromising healthcare systems. Pakistan's increase from 275.6 to 277.3 cases per 100,000 highlights serious challenges in TB control tied to population density and poverty.

Russia reported a substantial decrease from 85.1 to 37.7 cases per 100,000, benefiting from sustained TB control efforts and improved healthcare access, despite a history of high incidence among marginalized populations (Table 1 and Figure 1).

Table 1. Tuberculosis incidence in the studied countries from 2010 to 2023

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Iran	17.6	18.4	18.3	18.1	16.4	16.3	14.5	14	13.6	12.9	12.4	11.8	11.3	10.9
Iraq	45.3	44.3	42.9	41	39	37	34.9	32.8	30.5	28.2	26.2	24.3	22.5	20.9
Egypt	17.9	17.3	16.8	16.3	14.8	14.6	13.7	13	12.3	11.6	11	10.3	9.8	9.2
Azerbaijan	104.5	125	85.9	78	76.1	70.9	66.2	66.4	63.3	60	58.4	62.4	68.3	71.8
Bahrain	23.3	21.4	21.3	19.1	17	14.9	12.4	11.6	11.8	13.8	15	15	14.1	11.9
Afghanistan	189.3	189.3	189.2	188.7	188.7	188.7	188.7	188.7	188.7	188.7	183.4	185.5	183.9	180.2
Jordan	5.8	5.4	5.1	5.1	5.4	5.7	5.4	6.7	5	5.5	4.6	4.2	3.8	3.4
Armenia	61.3	54.8	52.6	60.3	57	50	43.7	35.7	31.1	26.2	25.2	25	24.9	24.6
Saudi Arabia	19.5	16.6	15	13.5	12.3	12.1	10.4	10.2	10.7	10.6	8.7	9	8.8	8.4
Turkey	25.2	23.6	21.8	19.9	19.5	18.4	17.6	16.8	16.2	15.5	14.9	14.4	13.8	13.3
United Arab Emirates	2.2	1.6	1.2	1.2	0.8	0.8	0.8	0.8	1	1	0.8	0.8	0.7	0.8
Yemen	51.8	49.6	48.4	47.9	47.9	47.9	47.9	47.9	47.9	47.9	47.9	47.9	47.9	47.9
Kyrgyzstan	119.9	124.6	126.7	142	125.7	135.6	133	124.2	115.6	110	107.2	111.3	112.2	111.8
Uzbekistan	97.1	92.9	89.3	85.8	82.4	79.2	76.1	73	70.1	67.3	64.6	62	59.6	57.2
Qatar	39	35.1	43.9	33.5	24.1	25.1	22.3	25.5	31.2	35.3	35.3	40.2	34.7	35.2
Lebanon	11.7	11.2	13.8	13.8	12.2	11.7	11.7	11.5	12.6	15	13.3	9.5	10.2	10.1
Kuwait	37.4	24.7	25.4	23.1	23	22.4	24	27.3	21.8	20.5	18.1	19.4	11.3	9.7
Syrian Arab Republic	21.5	21.5	18.4	17.5	23.3	20.2	21.9	20.1	19.4	19	18.4	17.9	17.4	16.9
Turkmenistan	79.4	66	69.7	71	58	49.2	45.7	42.7	46.1	44.5	46.3	47.2	48.2	49.2
Oman	12.8	12.6	12.4	9.9	10.3	9	9	6.8	6.2	9.2	8	5.9	9	11.1
Tajikistan	128.2	117.1	107.6	99.6	91.1	86.2	85.4	84.5	83.7	82.9	80.5	79.8	79.5	78.5
Pakistan	275.6	275.7	275.6	275.1	270.1	270.1	268.4	266.7	265	263.3	259.2	272.9	278.5	277.3
Russian federation	85.1	81.1	76.7	73.3	70	66.6	62.9	58.9	54.5	49.8	48.6	47.3	38.6	37.7
Kazakhstan	144.1	134.7	121.8	106.1	90.9	80.7	73.2	68.7	67.1	68.4	66.9	71.2	72.2	70.1

Results of Data Distribution for the Studied Variables

The One-Sample Kolmogorov-Smirnov Test was used to analyze the data distribution of tuberculosis incidence during the studied years in each country, as well as the data distribution of tuberculosis incidence in each year of study for all countries. The data on tuberculosis incidence during the study period in Kazakhstan, Tajikistan, Turkmenistan, United Arab Emirates, Yemen, Azerbaijan, Bahrain, and Afghanistan did not follow a normal distribution. Therefore, non-parametric tests were used for further analysis. In contrast, the data on tuberculosis incidence in the remaining countries studied followed a normal distribution, allowing for the use of parametric tests in further analysis. Upon examining the normal distribution of tuberculosis incidence data in different countries for each year of the study, it was found that only in 2010 did the results show a normal distribution (Asymp. Sig. (2-tailed) = 0.51) (Table 2).

Descriptive Study Results

The information provided highlights the disparities in tuberculosis (TB) incidence rates across different countries, with some nations experiencing significantly higher burdens than others. The data suggest that the incidence of TB follows a pattern where certain regions, particularly South Asia and Central Asia, exhibit higher rates compared to others, such as the Middle East. To understand these disparities, it is essential to consider various factors that influence the prevalence of TB, including socioeconomic conditions, healthcare systems, public health policies, and the overall health status of the population.

Pakistan, with the highest incidence rate at 270.96 cases per 100,000 people, is part of the South Asian region, which has traditionally seen high TB rates. This can be attributed to several factors such as overcrowded living conditions, poor nutrition, inadequate healthcare infrastructure, and a high prevalence of HIV/AIDS, which weakens the immune system and increases susceptibility to TB infection. Additionally, the emergence of drug-resistant TB strains poses a significant challenge to controlling the spread of the disease.

Afghanistan, with the second-highest incidence at 187.26 cases per 100,000 people, has experienced prolonged conflict and instability, leading to poor access to healthcare services, weakened public health systems, and increased vulnerability to infectious diseases such as TB. Moreover, the high prevalence of malnutrition and poverty exacerbates the TB burden.

Kyrgyzstan (121.41 cases per 100,000) and Tajikistan (91.75 cases per 100,000) are both Central Asian countries that have faced similar challenges in TB control due to their post-Soviet transitions, which have affected their healthcare systems and economic development. Kazakhstan (88.29 cases per 100,000) and Azerbaijan (75.51 cases per 100,000) are also part of the same general region, suggesting that regional factors may play a significant role in the incidence of TB.

In contrast, the United Arab Emirates, Jordan, and Oman, with the lowest incidence rates at 1.035, 5.07, and 9.44 cases per 100,000 people per year, respectively, have more robust healthcare systems and better socioeconomic conditions. These factors contribute to earlier detection and treatment of TB cases, as well as effective public health interventions that help prevent the spread of the disease.

The decline in the average incidence of TB from 67.3125 cases per 100,000 in 2010 to 48.6708 cases per 100,000 in 2023 reflects global efforts to control the disease through strategies like the Stop TB Partnership and the World Health Organization's (WHO) End TB Strategy. This includes increased investment in TB research, improved diagnostic tools, enhanced access to treatment, and better implementation of infection control measures.

Correlation Study Results

In this study, the incidence of tuberculosis in the countries examined, with the exception of Qatar, Pakistan, and Lebanon, shows a negative correlation with the year of study. This suggests

a decline in tuberculosis incidence during the study period in most countries. There is a positive correlation in the trend of tuberculosis incidence among different countries, indicating a similar decrease in tuberculosis incidence across all countries. Qatar, Pakistan, and Lebanon show no significant correlation. While the incidence of tuberculosis in Pakistan was higher in 2023 than in 2010, it was lower in Qatar and Lebanon in 2023 compared to 2010 (Tables 3 and 4).
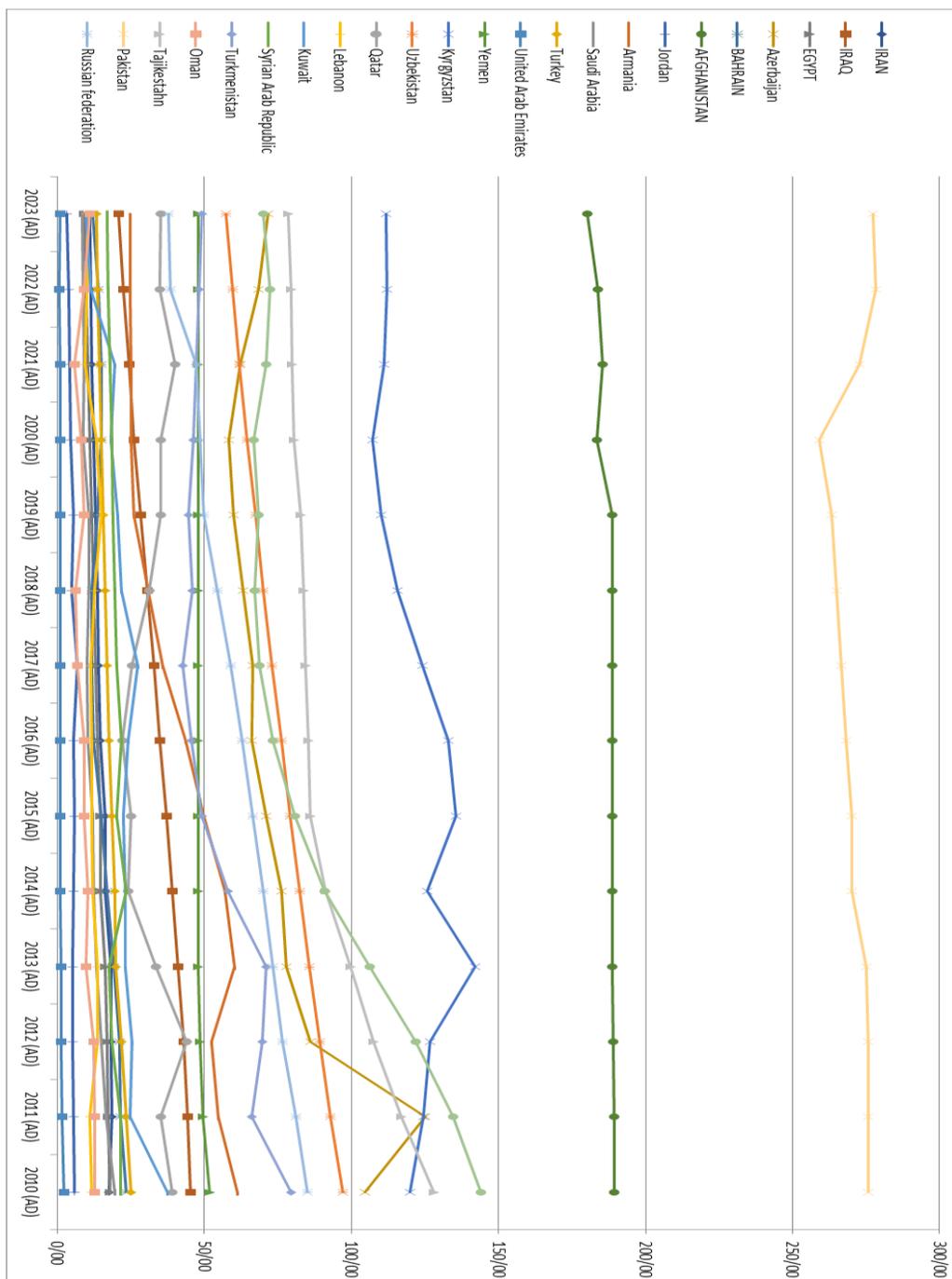

Figure 1. Incidence of tuberculosis in the countries studied from 2010 to 2023

Table 2. Results of data distribution for the studied variables

One-Sample Kolmogorov-Smirnov Test for data distribution of tuberculosis incidence during the studied years in each country was conducted						
Countries	N	Mean	Std. Deviation	Test Statistic	Asymp. Sig. (2-tailed)	Monte Carlo Sig. (2-tailed)
Iran	14	14.75	2.72757	0.144	0.200	0.592
Iraq	14	33.5571	8.32131	0.101	0.200	0.964
Egypt	14	13.4714	2.90131	0.121	0.200	0.829
Azerbaijan	14	75.5143	18.63643	0.233	0.039	0.037
Bahrain	14	15.9	3.91683	0.234	0.037	0.036
Afghanistan	14	187.2643	2.85188	0.407	0.000	0.000
Jordan	14	5.0786	0.85411	0.178	0.200	0.264
Armenia	14	40.8857	14.76127	0.197	0.145	0.145
Saudi Arabia	14	11.8429	3.29282	0.207	0.106	0.1
Turkey	14	17.9214	3.68952	0.119	0.200	0.84
United Arab Emirates	14	1.0357	0.41437	0.287	0.003	0.003
Yemen	14	48.3357	1.09868	0.44	0.000	0.000
Kyrgyzstan	14	121.4143	10.63925	0.164	0.200	0.383
Uzbekistan	14	75.4714	12.76687	0.096	0.200	0.978
Qatar	14	32.8857	6.47502	0.182	0.200	0.234
Lebanon	14	12.0214	1.5646	0.153	0.200	0.492
Kuwait	14	22.0071	6.68241	0.163	0.200	0.394
Syrian Arab Republic	14	19.5286	1.95032	0.147	0.200	0.557
Turkmenistan	14	54.5143	11.9982	0.314	0.001	0.001
Oman	14	9.4429	2.26094	0.137	0.200	0.668
Tajikistan	14	91.7571	15.55708	0.282	0.003	0.003
Pakistan	14	270.9643	5.83196	0.189	0.186	0.186
Russian federation	14	60.7929	15.33264	0.12	0.200	0.832
Kazakhstan	14	88.2929	27.13024	0.282	0.003	0.003
One-Sample Kolmogorov-Smirnov Test for the data distribution of tuberculosis incidence in the studied countries for each year of the study						
Countries	N	Mean	Std. Deviation	Test Statistic	Asymp. Sig. (2-tailed)	Monte Carlo Sig. (2-tailed)
2010	24	67.3125	66.89388	0.175	0.055	0.054
2011	24	65.1875	67.37426	0.186	0.031	0.030
2012	24	62.4917	65.47171	0.185	0.033	0.033
2013	24	60.8250	65.64799	0.182	0.039	0.038
2014	24	57.3333	63.65289	0.199	0.015	0.013
2015	24	55.5542	63.96920	0.201	0.013	0.011
2016	24	53.7417	63.61621	0.203	0.012	0.011
2017	24	52.2708	62.91230	0.207	0.009	0.009
2018	24	51.0583	62.29180	0.213	0.006	0.006

2019	24	50.2958	61.66225	0.218	0.005	0.005
2020	24	48.9542	60.58746	0.217	0.005	0.005
2021	24	49.8000	63.28558	0.220	0.004	0.004
2022	24	49.2167	64.38489	0.226	0.003	0.004
2023	24	48.6708	63.97842	0.227	0.002	0.004

Table 3. Pearson correlation between the studied variables

	Year			Iran			Iraq		
	Pearson Correlation	Sig. (2-tailed)	N	Pearson Correlation	Sig. (2-tailed)	N	Pearson Correlation	Sig. (2-tailed)	N
Russian federation	-.997**	0.00	14	0.972**	0.00	14	0.995**	0.00	14
Pakistan	-0.211	0.469	14	0.263	0.363	14	0.215	0.459	14
Oman	-0.608*	0.021	14	0.613*	0.02	14	0.603*	0.022	14
Syrian Arab Republic	-0.607*	0.021	14	0.496	0.071	14	0.605*	0.022	14
Kuwait	-0.836**	0.00	14	0.723**	0.003	14	0.817**	0.00	14
Lebanon	-0.338	0.237	14	0.371	0.192	14	0.341	0.232	14
Qatar	0.004	0.988	14	0.015	0.961	14	-0.033	0.912	14
Uzbekistan	-0.997**	0.00	14	0.971**	0.00	14	0.994**	0.00	14
Kyrgyzstan	-0.666**	0.009	14	0.739**	0.003	14	0.700**	0.005	14
Turkey	-0.976**	0.00	14	0.933**	0.00	14	0.965**	0.00	14
Saudi Arabia	-0.923**	0.00	14	0.872**	0.00	14	0.905**	0.00	14
Armenia	-0.946**	0.00	14	0.954**	0.00	14	0.954**	0.00	14
Jordan	-0.653*	0.011	14	0.577*	0.031	14	0.654*	0.011	14
Egypt	-0.998**	0.00	14	0.984**	0.00	14	0.997**	0.00	14
Iraq	-0.998**	0.00	14	0.984**	0.00	14			
Iran	-0.977**	0.00	14						

	Turkey			Saudi Arabia			Armenia			Jordan			Egypt		
	Pearson Correlation	Sig. (2-tailed)	N	Pearson Correlation	Sig. (2-tailed)	N	Pearson Correlation	Sig. (2-tailed)	N	Pearson Correlation	Sig. (2-tailed)	N	Pearson Correlation	Sig. (2-tailed)	N
	0.976**	0.00	14	0.920**	0.00	14	0.946**	0.00	14	0.643*	0.013	14	0.994**	0.00	14
	0.314	0.274	14	0.371	0.191	14	0.348	0.223	14	-0.349	0.221	14	0.248	0.392	14
	0.702**	0.005	14	0.727**	0.003	14	0.628*	0.016	14	0.033	0.911	14	0.627*	0.016	14
	0.573*	0.032	14	0.474	0.087	14	0.575*	0.032	14	0.656*	0.011	14	0.557*	0.039	14
	0.823**	0.00	14	0.800**	0.001	14	0.709**	0.005	14	0.805**	0.001	14	0.815**	0.00	14
	0.232	0.424	14	0.216	0.459	14	0.234	0.422	14	0.395	0.163	14	0.337	0.238	14
	0.132	0.653	14	0.258	0.373	14	-0.118	0.687	14	-0.422	0.133	14	0.026	0.93	14
	0.988**	0.00	14	0.945**	0.00	14	0.945**	0.00	14	0.617*	0.019	14	0.997**	0.00	14
	0.536*	0.048	14	0.426	0.129	14	0.785**	0.001	14	0.492	0.074	14	0.684**	0.007	14
				0.977**	0.00	14	0.908**	0.00	14	0.556*	0.039	14	0.975**	0.00	14
							0.846**	0.00	14	0.481	0.082	14	0.926**	0.00	14
										0.531	0.051	14	0.950**	0.00	14
													0.625*	0.017	14

	Kuwait Pearson Correlation	Kuwait N	Lebanon Sig. (2-tailed)	Lebanon Pearson Correlation	Lebanon N	Qatar Sig. (2-tailed)	Qatar Pearson Correlation	Qatar N	Uzbekistan Sig. (2-tailed)	Uzbekistan Pearson Correlation	Uzbekistan N	Kyrgyzstan N	Kyrgyzstan Pearson Correlation	Kyrgyzstan Sig. (2-tailed)	Kyrgyzstan N
1	0.844**	14	0.301	0.298	14	0.991	0.003	14	0.00	0.995**	14	14	0.664**	0.01	14
2	-0.058	14	0.072	-0.495	14	0.222	0.348	14	0.372	0.259	14	14	0.247	0.394	14
3	0.289	14	0.639	0.138	14	0.281	0.31	14	0.012	0.649*	14	14	0.259	0.371	14
4	.626*	14	0.9	0.037	14	0.041	-0.552*	14	0.027	0.588*	14	14	0.35	0.219	14
5		14	0.339	0.277	14	0.935	-0.024	14	0.00	0.830**	14	14	0.423	0.132	14
6						0.833	0.062	14	0.287	0.306	14	14	0.185	0.526	14
7									0.888	0.042	14	14	-0.433	0.122	14
8												14	0.639*	0.014	14
9												14			

Pakistan			Oman			Syrian Arab Republic				
N	Sig. (2-tailed)	Pearson Correlation	N	Sig. (2-tailed)	Pearson Correlation	N	Sig. (2-tailed)	Pearson Correlation	N	Sig. (2-tailed)
14	0.461	0.215	14	0.025	0.594*	14	0.02	0.611*	14	0.00
			14	0.036	0.564*	14	0.559	-0.171	14	0.843
						14	0.418	0.235	14	0.316
									14	0.017

Table 4. Spearman correlation among the studied variables

Variables			Kazakhstan	Tajikistan	Turkmenistan	Yemen	United Arab Emirates	Afghanistan	Bahrain	Azerbaijan
Year	Correlation Coefficient		-0.807**	-1.000**	-0.618*	-0.719**	-0.746**	-0.921**	-0.686**	-0.727**
	Sig. (2-tailed)		0.00	0.00	0.018	0.004	0.002	0.00	0.007	0.003
	N		14	14	14	14	14	14	14	14
Iran	Correlation Coefficient		0.780**	0.974**	0.592*	0.651*	0.718**	0.888**	0.660*	0.719**
	Sig. (2-tailed)		0.001	0.00	0.026	0.012	0.004	0.00	0.01	0.004
	N		14	14	14	14	14	14	14	14
Iraq	Correlation Coefficient		0.807**	1.000**	0.618*	0.719**	0.746**	0.921**	0.686**	0.727**
	Sig. (2-tailed)		0.00	0.00	0.018	0.004	0.002	0.00	0.007	0.003
	N		14	14	14	14	14	14	14	14
Egypt	Correlation Coefficient		0.807**	1.000**	0.618*	0.719**	0.746**	0.921**	0.686**	0.727**
	Sig. (2-tailed)		0.00	0.00	0.018	0.004	0.002	0.00	0.007	0.003

	Jordan			Afghanistan			Bahrain			Azerbaijan		
	Correlation Coefficient	Sig. (2-tailed)	N	Correlation Coefficient	Sig. (2-tailed)	N	Correlation Coefficient	Sig. (2-tailed)	N	Correlation Coefficient	Sig. (2-tailed)	N
	0.314	0.275	14	0.700**	0.005	14	0.779**	0.001	14	0.899**	0.00	14
	0.636*	0.014	14	0.921**	0.00	14	0.686**	0.007	14	0.727**	0.003	14
	-0.038	0.898	14	0.421	0.134	14	0.837**	0.00	14	0.849**	0.00	14
	0.298	0.3	14	0.765**	0.001	14	0.719**	0.004	14	0.713**	0.004	14
	0.355	0.213	14	0.790**	0.001	14	0.587*	0.027	14	0.541*	0.046	14
							0.532	0.05	14	0.625*	0.017	14
										0.636*	0.015	14
												14

	United Arab Emirates			Turkey			Saudi Arabia			Armenia		
	N	Sig. (2-tailed)	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient
	14	0.054	0.525	14	0.00	0.807**	14	0.001	0.793**	14	0.001	0.771**
	14	0.002	0.746**	14	0.00	1.000**	14	0.00	0.952**	14	0.00	0.965**
	14	0.05	0.532	14	0.018	0.618*	14	0.012	0.649*	14	0.018	0.618*
	14	0.002	0.750**	14	0.004	0.719**	14	0.004	0.719**	14	0.037	0.560*
	14			14	0.002	0.746**	14	0.00	0.812**	14	0.009	0.671**

	Qatar			Uzbekistan			Kyrgyzstan			Yemen		
	N	Sig. (2-tailed)	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient
	14	0.84	0.059	14	0.00	0.807**	14	0.01	0.662**	14	0.004	0.719**
	14	0.858	-0.053	14	0.00	1.000**	14	0.007	0.684**	14	0.004	0.719**
	14	0.329	0.282	14	0.018	0.618*	14	0.124	0.431	14	0.015	0.634*

Turkmenistan			Syrian Arab Republic			Kuwait			Lebanon		
N	Sig. (2-tailed)	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient	N	Sig. (2-tailed)	Correlation Coefficient
14	0.00	0.834**	14	0.232	0.341	14	0.017	0.626*	14	0.869	-0.049
14	0.018	0.618*	14	0.018	0.621*	14	0.00	0.873**	14	0.221	0.349
			14	0.976	-0.009	14	0.295	0.301	14	0.887	0.042

	N	Sig. (2-tailed)	Correlation Coefficient
Russian federation	14	0.00	0.807**
Pakistan	14	0.015	0.634*
Tajikistan	14	0.00	0.807**
Oman	14	0.002	0.748**
	14	0.021	0.607*

Discussion

The data reveal varying trends in tuberculosis (TB) rates in Middle Eastern and nearby countries from 2010 to 2023. Most countries have experienced declines in TB cases, aligning with global efforts and WHO targets for TB elimination by 2035. However, the extent of these reductions differs among countries, highlighting the challenges they face in managing the disease.

Several factors help explain these trends. Higher baseline TB rates are often linked to weak healthcare systems and socioeconomic challenges, making it harder for countries like Afghanistan, Yemen, and Pakistan to lower incidence rates. In contrast, countries with better healthcare access, such as the UAE and Kuwait, have made significant progress due to improved treatment coverage and earlier diagnoses.

Public health measures, such as the WHO's directly observed treatment, short-course strategy (DOTS), have proven effective in countries like Iran by enhancing case detection and treatment adherence. Socioeconomic factors, including poverty and overcrowding, also play a crucial role in TB rates, with wealthier nations experiencing greater declines due to better living conditions.

Political instability in places such as Lebanon and Yemen hampers TB control by straining healthcare services. Countries with large migrant populations, such as Saudi Arabia, face additional hurdles in providing comprehensive TB services. The availability of resources, trained workers, and the prevalence of drug-resistant TB further influence control efforts.

Socioeconomic determinants such as poverty, malnutrition, and poor living conditions significantly affect TB risk. Analyzing the link between TB incidence and economic health indicators can reveal social factors contributing to the TB burden. Additionally, the impact of migration and refugee health should be considered, especially in nations such as Lebanon that have experienced significant refugee inflows. Understanding the access these populations have to healthcare services and their TB status is important for prevention strategies.

The study by Fallahzadeh *et al.* (2023) analyzes the tuberculosis (TB) situation in Iran from 2010 to 2019, using data from the Global Burden of Disease (GBD) study. It finds that TB incidence and mortality rates have declined during this time, though rates vary by sex, age group, and region. The research highlights regional differences, with higher rates seen in Sistan and Baluchestan and Golestan provinces, indicating the need for targeted public health strategies. The study shows a negative correlation between TB mortality and the Human Development Index (HDI), pointing out that areas with lower HDI face a higher TB burden. This relationship may be linked to factors like poverty and limited healthcare access, consistent with global trends that show TB affects less developed regions more heavily. The ecological study design aids in examining disease patterns among large populations but may lead to the ecological fallacy, where group-level correlations do not reflect individual cases. Additionally, data quality, especially in less developed regions, could introduce errors in the findings. To improve future studies, the authors suggest using individual-level data to explore the connections between HDI and TB outcomes more directly [11].

A study conducted from 1999 to 2008 in Mazandaran Province, North Iran, aimed to identify high-risk areas for tuberculosis (TB) and aid health programs. The analysis included 2,444 TB patients, using descriptive and spatial statistics to find disease clusters, and mapping incidence rates with Geographic Information System (GIS) software. Findings revealed that 52.5% of patients were male, with 61% from urban areas. The overall TB incidence rate was 10.69 per 100,000, varying significantly by district. Behshahr and Tonekabon had the highest rates, 30% above the average. The study pinpointed eight areas with unusually high rates, especially in eastern Mazandaran. It highlighted the need for targeted interventions and better healthcare education, as current detection rates are below the WHO's 65% target [12].

The findings of a systematic review indicate that the pooled prevalence of TB diagnosis among PWID was significantly higher in hospital settings (10.1%, 95% CI: 4.5-15.8%) compared to other settings (0.54%, 95% CI: 0.04-1.04%). This suggests that PWID in Iran may have a substantially higher burden of TB compared to the general population, with hospital studies potentially capturing a higher proportion of TB cases due to the nature of the setting and the presence of comorbidities or increased healthcare utilization. The demographic characteristics of the participants generally indicated that they were predominantly male, with a high rate of unemployment and a history of imprisonment, which are known risk factors for TB infection [13].

The information on tuberculosis (TB) rates in neighboring countries and those near Iran is concerning. Countries such as India, China, South Africa, Indonesia, and Pakistan show high TB prevalence, highlighting the need for global efforts to manage this disease. In Iran, TB cases decreased from 142 to 16 per 100,000 people between 1965 and 2015. However, high rates in neighboring countries, such as Afghanistan and Pakistan, increase the risk of transmission. Neighboring countries exhibit varying TB incidence rates, influenced by different factors like socioeconomic conditions, healthcare quality, public health policies, and individual behaviors. Co-infection with HIV, especially in Africa, worsens TB outcomes. Multi-drug resistant TB (MDR-TB) and extensively drug-resistant TB (XDR-TB) add further challenges, particularly in resource-limited areas. Iran's TB situation is affected by its neighbors' high incidence rates, with drug resistance present in countries like Kazakhstan and Russia indicating the need for regional cooperation [1,2].

A study conducted by Mohammadzadeh *et al.* (2020) provided valuable insights into the role of immigration in the transmission of tuberculosis (TB) in Iran, specifically emphasizing the importance of the Beijing strain among non-Iranian individuals, notably Afghans. The analysis of 16 molecular epidemiological studies carried out between 1997 and 2017 reveals that the common

clustering rate between Iranians and non-Iranians was 19.8%, indicating a significant overlap in TB strains between these populations. The recent intra-community transmission rate varied from 0% to 49%, averaging at 18.1%, suggesting that a considerable number of TB cases stem from recent transmission events within communities. The study's findings emphasize the necessity of monitoring and addressing TB among migrant populations, as they can contribute to the disease's spread within and across communities. The higher prevalence of MDR-TB among immigrants, particularly Afghans, and the frequent association of the Beijing strain with this group underscore the importance of targeted interventions and surveillance. The Beijing strain, known for its heightened pathogenicity and transmissibility, poses a significant challenge to TB control efforts, especially given its tendency to exhibit multidrug resistance [14].

To fight TB effectively, the following steps are necessary: strengthen surveillance and diagnostic systems, ensure timely and effective treatment access, invest in public health infrastructure, collaborate with neighboring nations to tackle shared challenges, and implement infection control measures in healthcare settings [1,2].

Conclusion

The Iranian government, in collaboration with international organizations and neighboring countries, must prioritize implementing programs to achieve the WHO's End TB Strategy targets. These targets include reducing TB incidence by 90% and TB mortality by 95% by 2035.

Comparing TB control programs across countries can help identify the best practices and areas needing improvement. Additionally, conducting a cost-effectiveness analysis assists in prioritizing interventions based on resource allocation. Investigating health equity provides a deeper understanding of TB's impact across different socioeconomic and ethnic groups. Finally, examining the influence of climate on TB transmission can offer valuable insights into

future challenges. Statistical methods such as regression analysis can aid in identifying predictors of TB incidence and assessing the impact of various interventions and risk factors. Integrating qualitative data on healthcare policies and public health strategies will enhance the overall view of TB control efforts. Investigating specific interventions, including active case finding, vaccination, and support for treatment adherence, will help evaluate their effectiveness in lowering TB rates. Ensuring that healthcare utilization reflects the needs of TB patients is also vital for identifying systemic issues in control programs. The quality of surveillance and reporting systems in each country affects data accuracy, making this evaluation essential for trend analysis.

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Conflict of Interest

The author has no conflicts of interest in this study.

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