Scientific Research Publishing

Journal of Tuberculosis Research, 2024, 12, 165-181
https://www.scirp.org/journal/jtr
ISSN Online: 2329-8448
ISSN Print: 2329-843X

Impact of Migrant Populations on Tuberculosis Rates in Saudi Arabia: Assessing How Migration Patterns Affect TB Incidence and Control Measures: A Narrative Review

Neda Ali Al Bati

Medical and Clinical Affairs, Rural Health Network, Eastern Health Cluster, Dammam, Kingdom of Saudi Arabia
Email: nalbati88@gmail.com

How to cite this paper: Al Bati, N.A. (2024) Impact of Migrant Populations on Tuberculosis Rates in Saudi Arabia: Assessing How Migration Patterns Affect TB Incidence and Control Measures: A Narrative Review. *Journal of Tuberculosis Research*, **12**, 165-181.
https://doi.org/10.4236/jtr.2024.123012

Received: August 23, 2024
Accepted: September 15, 2024
Published: September 18, 2024

Abstract

This research focuses on the effects of migration on the TB infection rate and its prevention in Saudi Arabia, which has a large number of expatriates from TB-affected countries. Despite, based on the current global statistics of TB occurrence, it is evident that the national incidence of TB has reduced from 10.55 per 100,000 in 2015 to 8.36 per 100,000 in 2019; despite this, there are still some difficulties because migrants bring new strains of Mycobacterium tuberculosis. Hindrances, including language barriers and perceived immigration status, hinder patients from seeking medical attention or doctors from diagnosing diseases. Each patient and each cultural group need special attention to public health, enhancing living circumstances, and health care support. Community participation, inclusion of TB control programs into functional healthcare facilities, and the functioning of TB programs need to be stressed to address TB issues. Considering the focus on social, economic, and cultural approaches, the country can make severe advancements in TB control and population protection. This holistic analysis is critical for a long-term effective strategy to combat TB in the Kingdom.

Keywords

Kingdom Saudi Arabia (KSA), Tuberculosis (TB), Prevalence, Migrants, Control Measures

1. Introduction

Tuberculosis (TB) still poses a significant problem to human health and communities, especially in the world's most developed nations, where more and more

people migrate on an annual basis. Kingdom of Saudi Arabia (KSA) is a country with a relatively large proportion of migrants, and hence, understanding the burden of TB and responding to it in relation to migration brings out a perfect example displayed by KSA [1]. Its economic advancement has helped the Kingdom attract millions of expatriates across the world, which has resulted in a relativistic population structure [1]. Such an influx results in changes to the patterns of infectious diseases, of which Tuberculosis is not an exception. This systematic review is planned to investigate the influences of migration on TB disease rate and the efficiency of control actions in KSA, focusing on the intricacies and difficulties that exist in managing the disease. Tuberculosis is a global threat, and people are continually on the move across borders; therefore, TB prevention and control must take into account various characteristics associated with migration [2]. Migrant-related TB has been a challenge in the KSA, which has informed the country's understanding of TB within a diverse mobile population. Therefore, this review targets to present an understandable synthesis of the research done previously on this subject with the aim of understanding the effects of migration in relation to the prevalence of TB as well as the eventual control measures in Saudi Arabia.

2. Epidemiology of Tuberculosis

Figure 1 revealed that non-Saudi populations (8362; 53%) had a higher incidence of pulmonary TB than the Saudi population (7444; 47%). In this case it was observed that the percentage of cases of pulmonary TB in the non-Saudi population, was comparatively low in the years 2017, 2019 & 2020 [2]. However, in the other years, the incidence of pulmonary TB in the non-Saudi population was slightly higher, but there was not much difference when comparing the number of cases in the Saudi and non-Saudi populations using the t-test which is 0. 107 > α of 0. 05 as illustrated in Figure 1. This data underscores the progress made in TB control, highlighting ongoing challenges and areas for further improvement.

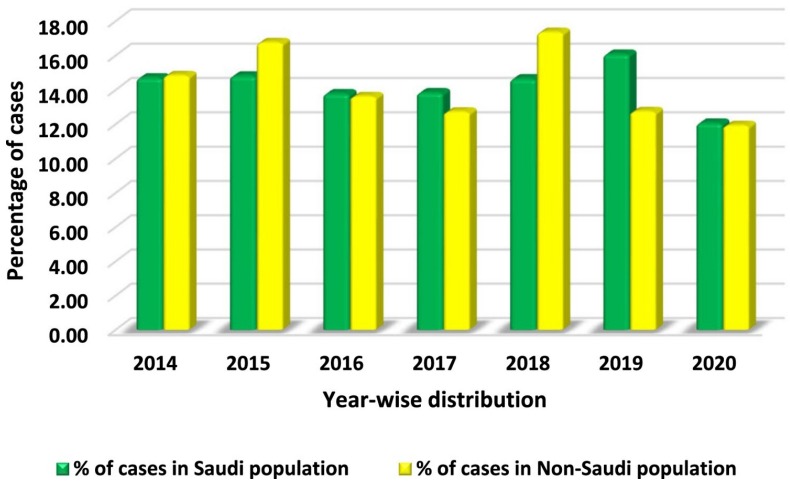

Figure 1. TB Incidence in KSA [2].

3. Narrative Analysis

3.1. Migration and Tuberculosis in KSA

Saudi Arabia's economy is labour-intensive and depends mainly on foreign employees who work in the construction industry, domestic services, and hospitals. Census, as of today's use, shows that expatriates form thirty-eight percent of Saudi Arabia's population. Such migrants arrive from areas of high TB prevalence, such as South Asia, Southeast Asia, and Africa, where the TB incidence is higher compared with KSA's incidence [3]. Pulmonary TB dominated among the immigrant study groups with more than 72% (P/E ratio-2.7-7.5, depending upon the geographical origins consisted of individuals from 21 different countries, of which the most represented ones were India (12.9%), Pakistan (10.6%), Indonesia (10.1%), Philippines (7.2%) and Bangladesh (5.3%) [4]. TB patients among such migrants develop their illness in areas of high TB prevalence, which have a higher TB rate than that of KSA. Population migration from high TB burden regions to Saudi Arabia is likely to elevate the TB spread in the area, thus becoming a challenge to TB control programs.

3.2. Control Efforts in Saudi Arabia of Tuberculosis

The authors described the healthcare in Saudi Arabia as good since the government provides substantial amounts of money for healthcare development [3]. The Saudi government has put measures in place to control TB by involving active search to find patients, monitoring and reviewing patients on treatment, and spreading awareness. However, the effectiveness of these TB control measures varies. The National TB Program (NTP) has successfully reduced TB incidence by implementing active case finding, particularly in high-risk areas such as Makkah and Riyadh. Yet, challenges remain in areas like Jazan, where TB rates have not significantly declined. The program's emphasis on Directly Observed Therapy (DOT) has improved treatment adherence but requires further enhancement to reach migrant populations. Areas for improvement include increasing accessibility of services to migrants, enhancing follow-up protocols, and integrating more culturally sensitive healthcare practices. Nevertheless, the number of migrant TB patients continues to rise and clearly points towards a need for specific campaigning for this particular category [5]. This systematic review will aim to identify the effects of the mentioned factors on the prevalence of TB and the efficacy of control procedures in KSA [3].

3.3. Social and Economic Factors of TB among Migrants

The other important variable to discuss is what may be attributed to the migration group's social and economic characteristics and how these affect TB incidence rates. Some of the migrants inhabit cramped, poorly ventilated houses and other shelter types [6] [7]. Also, stress and vulnerability resulting from migration can lead to the breakdown of an individual's immunity to diseases such as TB [6]. Lack of "cultural compatibility" in terms of language and the patients' immigration

status proves to be a huge problem in diagnosing and treating TB. For instance, a case of a migrant worker from the Makkah region found that a man from South Asia put off receiving treatment due to his concern about deportation and lack of understanding of health care. In the other example, the symptoms cannot be communicated by a group of migrants from Southeast Asia which results in delayed diagnosis by the healthcare providers. The following review will strive to analyse the determinants of TB among migrants in Saudi Arabia and the relevance of these determinants for future efforts in managing TB.

3.4. Cultural and Legal Context

Policies and the existing culture of the country also help in influencing the control of TB in Saudi Arabia. The Saudi government has stringent rules when it comes to immigration, and the sponsorship system (Kafala) in place may influence migrants' desire or capacity to access medical services [7]-[9]. Persons in fear of losing their jobs or being deported might fail to show that they have flu-like symptoms, hence putting treatment out of reach, yet they freely mix with the community, thus increasing the circle of infections [7] [8] [10]-[13]. This review will also analyse how these influences in culture and law affect control measures against TB and possible measures that can be taken.

3.5. Tuberculosis among Refugees and Migrant Populations

There were 11 articles from research carried out in 10 countries focused on TB among migrants, refugees, and asylum seekers. A study showed that the country of origin of the refugee and migrant population screened for TB was diverse and depended on regions/ countries [14]. In two research studies, subjects with a clinical diagnosis of TB were confirmed with CXR, while three studies conducted bacteriological examinations to confirm TB diagnosis. However, three meta-analyses used CXR and bacteriological examination, while two meta-analyses used clinical, CXR, and bacteriological examination as the method of TB diagnoses [14].

The studies' design and the range of the phenomena explored also differed across the included studies. Thus, six cross-sectional surveys, three retrospective cohorts, one cohort, and one scientific report study were identified. Procedures of the included studies were noted to be heterogenic; therefore, the study results were dichotomized into incidence and prevalence studies (**Table 1**) [14].

Over 3 million forcibly displaced refugees and migrants were screened for TB with standard tools and techniques, utilizing clinical history, chest X-ray (CXR), and bacteriological tests predominantly in hospital and reception facilities. Out of the ten studies, data collection ranged from 2002 to 2017; one study had data collection ranging from 1991 to 2013 [14].

Eleven publications documented the rate of TB infection or disease among refugees and migrants. Here, the incidences of TB varied from 19 to 754/motions within 100000 populations of the seven included options, while prevalence ranged from 18 to 250/million of the included studies. The incidence of the four studies

Table 1. Statistics on TB among migrants [14].

Aspect	Details
Number of Articles	11
Countries Covered	10
Regions	Europe (9 studies), Asia (3 studies), USA (1 study), Canada (1 study)
Publication Year	2016 (6/11 articles)
TB Diagnosis Methods	CXR (2 studies), Bacteriological Examination (3 studies), Both (3 studies), Clinical, CXR & Bacteriological (2 studies)
Study Designs	Cross-sectional (6 studies), Retrospective Cohort (3 studies), cohort (1 study), Scientific Report (1 study)
Screening Population	Over 3 million refugees and migrants
Data Collection Period	2002-2017 (10 studies), 1991-2013 (1 study)
Incidence of TB	19 to 754 cases per 100,000 population (7 studies)
Prevalence of TB	18.7 to 535 cases per 100,000 population (4 studies)
Age Range of TB Cases	13 to 54 years
Gender Distribution	Higher incidence in males compared to females
Most Reported Countries of Origin	Asia (India, Philippines, Pakistan, Syria, Thailand, Vietnam), Africa (Somalia, Eritrea)

ranged from 7 to 535 per 100,000 people. More than fifty percent of the research conducted revealed that TB patients were aged between 13 and 54 years and that males had presumably more cases of TB than females [14]. From the studies conducted and analysed, Asia and Africa were identified as the most reported countries of origin of TB among refugees and migrants. In this case, the six top reported countries of origin in TB cases in Asia were India, Philippines, Pakistan, Syria, Thailand, and Vietnam, while those in Africa included Somalia and Eritrea [14].

3.6. Knowledge, Attitude, and Preventive Behaviour of Saudi Women Regarding Tuberculosis at Tabuk City

Tuberculosis (TB) infection is one of the world's most prevalent transmissible illnesses and results in over two million deaths every year alone [15]. Saudi Arabia occupies third place among Arab countries in terms of a moderate rate of TB [15]. Culture, beliefs, and client practice in handling TB in the community are pivotal to the efficiency of control programs [15]. This study aimed to assess Saudi resident's awareness, perception, and practice of TB in Tabuk City [15].

The research was descriptive in design and was conducted in five primary healthcare units in Tabuk City [15]. Thirty women were selected from the 40,000 registered women that met the criteria for the study [15]. Three tools were used for data collection: The questionnaire used in the study was a self-constructed questionnaire, which consisted of closed questions from the modified Likert scale and practice items. Therefore, the questionnaire was comprised of socio-demo-

graphic details, past health history, and knowledge questionnaire [15]. The Likert scale measured women's attitudes toward TB, while the practice items focused on women's preventive behaviours or practices toward TB [15]. Regarding knowledge about TB, 5% of the participants had a positive attitude towards TB [15]—additionally, 65. Among the participants, 4% implemented satisfactory practices regarding TB prevention [15]. Altogether, the findings suggested that even though the knowledge about TB among Saudi women in Tabuk City is significantly low, their attitude and practice about the disease are sufficiently positive and satisfactory [15].

On the whole, the overall knowledge level of the Saudi women in Tabuk City is poor. Still, they have a positive attitude, and the practice level was found satisfactory regarding TB [15]. From the above findings, it is argued that health education needs to be adopted within the TB control program to enhance the knowledge, attitude as well as preventive behaviour of TB [15]. Increased education could narrow the knowledge gap and improve the population's preventive measures and disease perceptions [15].

3.7. The Impact of COVID-19 on Tuberculosis Control and Epidemiology

TB remains a significant public health challenge [16]. This has been highlighted by the COVID-19 pandemic through the targeting of resources from one infectious disease to another, thereby making TB sidelined and resulting in a decline in the new diagnoses and reporting of the cases globally [16]. For instance, between the years 2019 and 2020, it was noted that there was a reduction in the number of notifications of people newly diagnosed with TB by 18%, from 7.1 million to 5.8 million [16]. Furthermore, there was a decrease in the TB incidence rate in 2020 compared to 2019 by 1.9% [16].

This aetiologic delay of diagnosis and management of Tuberculosis is reflected by an estimated 1. 3 million TB incident cases and deaths among the HIV-negative population in the year 2020 and approximately 214000 among the HIV population [16]. Thus, according to the WHO classification, Oman has a low TB rate; in 2020, it was 6.45 cases per 100,000 of the population. Thus, out of a total population of 4. 6 million, 380 thousand are expatriates from South East Asia and come to Oman for work [17]. The epidemiology of TB in Oman conforms to low-incidence countries, and active TB is confirmed in expatriates, mainly from South East Asia, due to the reinfection of the carriers from their original countries [16]-[20].

A negative attitude toward TB would be to accept as true things that are said about the disease and are not [16]. Misinformation plays an influential role in TB in many regards, including transmission, the way it is being managed, and people's attitudes towards others who have been infected. An assessment survey implemented in Tunisia revealed that 86%. Regarding misconceptions about the transmission, only 1% endorsed this reason, while 22% said they had a sick family. Only 1 percent of the respondents understood free care [16]. The level of stigma was also found to be high, with a mean score of 54/70. 9% [16]. A cross-sectional

study carried out in the Kingdom of Saudi Arabia in 2017 also indicated that the attitude of the participants towards TB was negative [17].

Besides that, evaluating the population's knowledge, attitude, and practice concerning TB is a method of identifying the proper strategy for making people receive accurate information about TB [16]. For instance, According to TB information sources, 8% of the Tunisians solely relied on television [16]-[18]. Thus, the successful operationalization of a TB program requires engaging the public in the program, and this begins by establishing gaps in knowledge that can be addressed to enable improved attitudes and practices about Tuberculosis [16] [20].

3.8. Tuberculosis Control in Saudi Arabia

The rates of TB globally in 2020 were relatively high compared to the region with at least 501/100 000 to below 5/100 000 population (**Table 2**) [21]. Among the Gulf Cooperating Council countries, Saudi Arabia possesses a LOW Tuberculosis Prevalence with a TB rate of less than 10 /100,000 population (**Table 2**) [21]. Nevertheless, given the potentiality that the GCC nation is well-placed to assume a highly focused attack on the elimination of TB, there is heterogeneity arising strictly within the regional association, primarily because a large number of TB incidences are associated with foreigners (**Table 2**) [21]. However, in 2018, the Kingdom of Saudi Arabia reported having 10 TB cases per 100,000 population, a version stable in previous years (**Table 2**) [21].

Table 2. Tuberculosis epidemiology and control in Saudi Arabia [21].

Aspect	Details
Global TB Incidence (2020)	Varied widely, from more than 500 to less than 5 per 100,000 population
GCC TB Incidence Category	Low incidence (<10 cases per 100,000 population)
Saudi Arabia TB Incidence (2018)	10 cases per 100,000 population
Predominant TB Lineages in Saudi Arabia	Delhi/CAS, Beijing, and EAI sub-lineages
Foreign Community Influence	Large foreign population from the Indian subcontinent and Southeast Asia
Geographical Influence	The central position of the Arabian Peninsula at the crossroads between Asia and Africa
Phylogenetic Lineages	High similarity between Saudi nationals and foreigners
Comparison with Western Countries	This contrasts with Europe and the US, where Euro-American lineage predominates among natives.
Mixed-Cluster Lineages	59.5% of total patient strain clusters include both natives and foreigners
TB Control Strategy	Emphasizes clinical and community-based approaches
Community Participation	Crucial for effective TB prevention programs influenced by public knowledge and behaviour
KAP Improvement Needs	Enhancing knowledge, attitudes, and practices among the Saudi population is essential for TB control.
Educational Initiatives	Utilizing diverse resources, including digital platforms, to engage various population segments
Conclusion	Continued efforts are needed to address TB among foreign populations and improve public participation in TB prevention programs.

As observed in Oman, the analysis of *M. tuberculosis* in Saudi Arabia also revealed the widespread Delhi/CAS, Beijing, and EAI sub-lineages in the Indian subcontinent and Southeast Asia [21]. These patterns are because the Kingdom of Saudi Arabia hosts a significant percentage of the foreign population, especially those from TB-endemic areas [21]. Historically, Saudi Arabia has been involved in trading activities with both Asia and Africa, which are two regions in which TB is well-established, and the geographical location of the Arabian Peninsula makes Saudi Arabia a focal point between Asia and Africa, which are both continents known to be affected by TB diversely [21].

One of the more significant epidemiological studies is that there is little difference regarding the *M. tuberculosis* lineages among Saudi nationals and foreigners [21]. This pattern has been observed in Oman, where no differences were identified between nationals and foreigners concerning the phylogenetic lineages of the individuals infected by the virus [21]. This contrasts European and American tendencies, where Euro-American origin prevails among indigenous people, and the lineages of immigrants are less frequent [21]. As mentioned in the previous notes concerning Saudi Arabia, the mixed-cluster lineages, derived from native and foreign origins, account for a significant portion of the numerous patient strain clusters, suggesting the complete interconnection of the country's transmission systems [21]-[23].

Saudi Arabia currently faces a burden of TB, and therefore, the country has instigated a TB control strategy that targets both clinical and community involvement [21]. There is also a need for participation and endorsement from the public because TB prevention programs rely on the public's knowledge and action [21]. Encouraging changes in the Saudi population's knowledge, attitudes, and practice toward TB is essential to strengthen health interventions in controlling the disease [21]. The necessary interventions should involve tapping into various forms of reach, reach sources, and reach types, such as online tools to educate the different segments of the population stream, including expatriates [21].

Despite the recent achievement in tackling TB in KSA, further strategies are still needed to deal with the increasing rate of TB among foreign nationalities and enhance people's knowledge of the importance of implementing programs fighting against TB. Higher education, combined with improved community participation, remains a critical pillar in the country's agenda to address TB better and reduce its prevalence [21]-[25].

3.9. Genetic Diversity of Tuberculosis Strains in Saudi Arabia

TB still poses a considerable threat to the health of people worldwide, and this is not a different case to KSA [26] [27]. The various genotypes of *M. tuberculosis* in Saudi Arabia show more than one facet of the epidemiologic scenario. This diversity is in favour of the country's population demographics, where there is a large ratio of the expatriate populace from regions with high TB rates [27]. Therefore, knowledge of the genetic variation of the TB strains circulating in Saudi Arabia is

essential in designing control measures and managing the TB threat to the nation's public health.

The most common *M. tuberculosis* sub-lineages in Saudi Arabia are Delhi/CAS, Beijing, and EAI. Both of these lineages are mainly connected with the region of the Indian subcontinent and Southeast Asia. This is because many people from these countries live and work in KSA [28]. Rich with geographical factors that enhance trade and have historically made the country suitable for business, population diversification explains how various TB strains were introduced and spread further.

Another usually dominant sub-lineage, Delhi/CAS, is widely described in India, Pakistan, and Bangladesh. The Beijing lineage has higher rates of transmission and resistance to drugs, with the Philippines and China as part of East Asian countries affected by it. The EAI lineage is more rampant in Southeast Asia, with Indonesia and the Philippines in the endemic zone [29]. Their presence in Saudi Arabia supports the idea of the global connectivity of TB transmission and migration as components of the disease's epidemiological context.

The genetic variation of TB strains in KSA has the following implications for the authorities. First, the density of lineages hinders diagnosis and treatment since the behaviours of two or more strains can differ in pathogenicity, transmission, and resistance to drugs. MDR TB is still associated with the Beijing lineage, which is particularly widespread; this makes its treatment and control a complicated venture [30].

Secondly, the high degree of relatedness between Saudi nationals and expatriates reveals continued transmission in the community [31]. This frequency pattern differs from the ones reported in Euro-American countries, where the natives are representatives of the Euro-American cluster, while the immigrants are more likely to belong to other genetic lineages [32]. Surprisingly, significant clusters with patient strain in Saudi Arabia are composed of mixed cluster lineages, native and foreign, which gives further insight into a well-interconnected transmission in the country.

Thus, it remains evident that Saudi Arabia will require a wide-ranging and complex strategy in the fight for tuberculosis control. This strategy embraces improving the diagnostic methods and tests that can determine and distinguish between the strains of TB, expanding proper screening tests throughout high-risk societies, and supporting public health institutions in controlling DR-TB. Third, Netcom and other organizations dealing with the public are essential in expanding health promotion activities and strategies for nationals and expatriate residents and early reporting and treatment [33].

3.10. The Role of Expatriates in TB Transmission in Saudi Arabia

TB remains one of the leading causes of morbidity and mortality in the world and is a significant public health concern in Saudi Arabia because of the receptiveness of the sizeable expatriate population. Considering the diversification of the

expatriates' sources and their countries with heightened TB rates, the expatriates' contribution to the TB disease in Saudi Arabia is significant. For this purpose, recognizing and combating such a relationship is crucial in achieving and implementing the Kingdom's TB control and prevention agenda [34].

KSA is home to millions of expatriates from the Indian subcontinent, SEA, and African countries, where the TB incidence is much higher than in Saudi Arabia. For instance, this group of countries comprises India, Pakistan, and Bangladesh, which are top sources of expatriate workers in Saudi Arabia, and the countries have a high burden of TB. Increased immigration of workers from these areas with high TB incidence brings another factor that still has to be taken into account in the epidemiology of TB in KSA. These people may have TB infections in a latent form or active TB cases and spread the disease into the Kingdom [35].

An assessable risk of disease incidence is latent TB infection (LTBI) among expatriate employees. LTBI can reactivate, especially when the social and working conditions are unstable and highly stressed, which is often observed in executives working abroad. The previously infected individuals can reactivate and develop TB, resulting in outbreaks, especially in places with high populations, such as labour camps where people are in close contact with one another. This situation is made worse by the fact that most of the expatriates get universal health coverage or are ashamed to seek medical treatment for fear of being repatriated or losing their jobs [36].

The TB strain genetics identified in Saudi Arabia is connected with the origin of foreigners staying there. Specifically, Delhi/CAS, Beijing, and EAI strains, which are dominant in the Indian subcontinent and several Southeast Asian countries, have been detected in Saudi Arabia, An expatriate population as a carrier of such strains [37]. This genetic variability poses a problem for TB control since the virus strains are likely to exhibit different responses to the treatment regimen and a different level of drug resistance [38].

To tackle the disease among expatriates, Saudi Arabia has put several measures in place, such as the compulsory screening of expatriate workers for TB disease. However, such steps can not suffice on their own [39]. Continuous staff follow-up is required for medical check-ups for expatriates throughout their working period in the country. Also, measures to increase the quality of life, protect and treat diseases of expatriates, and provide knowledge about TB are essential.

The existing health intervention approaches must be culturally appropriate, preferably translated into different languages to suit the diverse population of expatriates [40]-[42]. Employer and community support for the campaigns can increase their effectiveness. Also, some measures always need to be taken to ensure that expatriates do not get infected by transmitting the TB bacteria to others since there is always the component of timely and effective TB treatment in strengthening the health care infrastructure.

3.11. Tuberculosis Awareness in Saudi Arabia

The major problem which hampers the control of TB is illiteracy and ignorance

on the part and breadth of the disease. This problem is not specific to Saudi Arabia only. Still, it is a global problem that occurs in regions like Africa, America, and Asia, where neglected tropical diseases such as schistosomiasis are prevalent. For instance, in KSA, especially in rural settings, the prevalence of communicative diseases such as TB is recognized [43]. The research carried out has revealed that even when people have heard about TB and its causes, symptoms, and ways it spreads, they do not have enough knowledge as agencies and healthcare workers [43].

They aimed to assess the awareness level of the PCPs and other health personnel in Makkah City health facilities. Although the quantitative cross-sectional descriptive study conducted with 200 participants assessed participants' knowledge about schistosomiasis to represent overall communicable diseases understanding in the context of this study, focusing on TB [43]. The findings provided in the present paper showed that the concerned healthcare personnel demonstrated low levels of knowledge on the informative signs and symptoms of infectious diseases, a lack that was attributed to inadequate training and education [43].

Thus, the study's results support the need to improve health education and continuing education for healthcare providers [43]. Another critical performance area is that all healthcare workers should know about the disease and identify signs, symptoms, and transmission patterns [43]. This knowledge is helpful in early diagnosis and treatment and critical strategies for controlling TB among the population [43].

In these circumstances, practical, top-to-bottom, versatile health promotion campaigns are needed in Saudi Arabia. These should centre on increasing awareness of Tuberculosis among the public at large as well as healthcare workers. It also indicates that such campaigns could include information about the causes of TB, the signs or symptoms of the disease, the ways through which it spreads, and the possibilities of preventing the disease [43]. Furthermore, preventive measures such as good personal hygiene and cleanliness, which enhance personal hygiene, can also significantly control the prevalence of TB and other infectious diseases. The strategy of linking disease control programs with the existing healthcare delivery structures is efficient and cost-effective. This strategy has been recommended for diseases such as schistosomiasis in Saudi Arabia, and it can also apply to the present case of TB. Through the extension of TB education as part of regular outpatient services, the nation can provide continuity in creating awareness and passing on any information about the disease to providers and patients [43].

4. Analysis

Tuberculosis (TB) is a primary health issue combating the world and countries with high rates of migration. About KSA, one can indicate certain peculiarities of the executive's challenges and responses regarding TB in the context of significant migratory processes. The economic development of KSA has included millions of expatriate populations originating from various parts of the world and has given

the country a cosmopolitan area [2]. Such migration shifts the dynamics of the spread of such diseases as TB. It imposes the need to appreciate the disease burden and ways to implement control strategies in mobile populations. Key Trends in Tuberculosis Control in Saudi Arabia is given in **Table 3**.

Table 3. Key trends and challenges in tuberculosis control in Saudi Arabia.

Aspect	Details
National TB Incidence (2015-2019)	Decreased from 10.55 per 100,000 in 2015 to 8.76 per 100,000 in 2019.
Major Regions Affected	Makkah (40.3%), Riyadh (24.6%), and Jazan (consistently high incidence)
Demographic Trends	Younger age categories, predominantly males and native Saudis
Drug Resistance Trends	Polydrug resistance decreased from 4.7% to 1.9%, and multidrug resistance from 4.4% to 2.4%
Economic and Migration Context	38% of the population are expatriates, primarily from high TB prevalence regions (South Asia, Southeast Asia, Africa)
Healthcare Investments	Significant government investments in healthcare, including active case finding, patient monitoring, and public awareness campaigns
Barriers for Migrants	Language differences, cultural misunderstandings, and fear of deportation lead to delays in diagnosis and treatment.
Living Conditions for Migrants	Overcrowded and poorly ventilated housing, increasing TB spread.
Impact of Stress and Vulnerability	Stress and vulnerability weaken immune systems, increasing TB susceptibility.
Cultural and Legal Barriers	Strict immigration policies and the sponsorship system (Kafala) deter migrants from seeking medical help, hindering TB diagnosis and treatment.
Suggested Strategies for Improvement	Enhancing public health education, improving living conditions for migrants, ensuring culturally sensitive healthcare services
Integration into Healthcare Systems	Integrating TB control efforts into existing healthcare systems, leveraging community participation.

The national TB incidence in Saudi Arabia has been cut down from 10. Every year, the incidence rate per 100,000 decreased from 55 in 2015 to 8. This resulted in a rate of 76 per 100,000 newborns in 2019, in line with the WHO's milestone estimation [2]. The Makkah and Riyadh regions portrayed more TB cases than Makkah, even though other regions are experiencing increased TB incidences. Nasr at 3% and Riyadh at 24.6%. The Jazan region has always remained the most affected [2]. Tuberculosis disease is now affecting younger persons more, and those more affected are mainly male individuals and native Saudis. Resistance to

first-line anti-TB drugs has also been reduced. Indeed, polydrug resistance has reduced from 4.7% to 1.3%. It has reduced selective resistance from 16% to 10% and multidrug resistance from 4.4% to 2.4%. It shows the improvement in the rates but remains a current theme stressing the continuing problems in TB control [2]. Saudi Arabia has a labour-demanding economy, and most of the workforce comprises foreigners in areas such as constriction, housekeeping, and nursing. Foreign workers make up nearly 12 percent of the population, and most arrive from TB-endemic countries in South Asia, SE Asia, and Africa. The migration of people from one area to another poses a significant challenge to the goal of containing the spread of TB.

The Saudi government has spent much money in the sector of health to observe TB and has started controlling TB through early detection, tracking down the patients, and creating awareness among the people. Nonetheless, an increasing proportion of migrants is being affected by TB, which requires an increased focus on this population. Delay in seeking treatment arises due to language barriers, cultural differences, and fear of deportation, which are some of the issues that mat, SK, and migrants encounter in seeking treatment. This is an added challenge, especially when it comes to contact tracing and follow-up on patients who are mostly migrant workers due to their unstable nature in the workplace due to migration.

About the social and economic determinants, the burden of TB in the migrant population is well explained by the increased rate of infection [44]. They live in congested and poorly illuminated rooms, which favours TB's passing on Stress levels. Thus, fear and insecurity, which are common among immigrants, have adverse effects as they impair the immune system, making people succumb to TB [2]. Management of these determinants forms an important component that needs to be addressed in the case of Tuberculosis. The immigration policies of the country and the sponsorship system (Kafala) can dissuade a migrant from seeking medical attention for the risk of losing a job or being deported [44] [45]. It may cause a delay in TB diagnosis and management; hence, the transmission of the disease becomes more rampant [2]. It is, therefore, essential to comprehend these cultural and legal obstacles to develop efficient TB control measures.

5. Conclusions

The current study emphasizes the significance of migration in TB transmission and control in Saudi Arabia. There is a diverse population of *M. tuberculosis* strains brought in by migrants from high TB countries; diagnosis and treatment of the disease are not only made difficult by the varying degrees of drug resistance and transmissibility of the strains. Hence, the identification of Delhi/CAS, Beijing, and EAI sub-lineages within the expatriate population proves the existence of global TB transmission. Results of the present study reflect this genetic diversity and suggest that more robust and more flexible TB control strategies that are more relevant to the country's epidemiological profile are required. Some of the factors

that force migrants to encounter health care challenges and barriers, such as language, culture, and the fear of deportation, increase the TB rate. They all lead to diagnosis and treatment delay, and hence, TB transmission in the community is escalated. Another challenge is organizational because the migrant workers' turnover is high, and it is challenging to have coordinated follow-ups or conduct contact tracing.

Eradicating these barriers is very important in enhancing TB results and preventing further spread of the disease. Therefore, increasing the public's understanding of Tuberculosis is crucial. TB prevention and control are, thus, reliant on the population and healthcare workers' cognizance. Awareness campaigns must be used to educate the public on the signs and symptoms of TB, the reasons for its spread, measures that should be taken to avoid the infection, and general standard hygiene practices. Seminars considering cultural and language diversities can help provide crucial information on health-related issues and prompt expatriates to seek appropriate medical attention. Including TB control in an already existing health facility system is feasible and more economical. With the implementation of TB education and screening in regular health care services in Saudi Arabia, information will continue to be passed to the general public with early identification of those affected.

Furthermore, other architectural modifications regarding housing facilities, for migrants in particular, which increase living density and may be accompanied by poor interior ventilation, may be a candidate for significant impact on TB spread reduction. Thus, Saudi Arabia requires a multilateral approach towards the elimination of TB as there are risks that are inherent in the society. This involves improving the diagnostic assets, developing effective screening initiatives for high-risk individuals/communities, and providing culturally appropriate health care. This strategy cannot be successfully implemented without enhancing the public health care system and engaging communities. By focusing on TB's social, economic, and cultural factors, KSA can considerably decrease the disease burden and improve the population's health.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

[1] Al-Mahrouqi, S., Ahmed, R., Al-Azri, S., Al-Hamidhi, S., Balkhair, A.A., Al-Jardani, A., *et al.* (2022) Dynamics of Mycobacterium Tuberculosis Lineages in Oman, 2009 to 2018. *Pathogens*, **11**, Article No. 541. https://doi.org/10.3390/pathogens11050541

[2] Almatroudi, A. (2024) Epidemiological Analysis of Pulmonary Tuberculosis and Extra-Pulmonary Tuberculosis in Saudi Arabia: A Cross-Sectional Study. *All Life*, **17**, Article 2381571. https://doi.org/10.1080/26895293.2024.2381571

[3] Fuller, D., Colwell, E., Low, J., Orychock, K., Tobin, M.A., Simango, B., *et al.* (2020) Reliability and Validity of Commercially Available Wearable Devices for Measuring Steps, Energy Expenditure, and Heart Rate: Systematic Review. *JMIR mHealth and*

uHealth, **8**, e18694. https://doi.org/10.2196/18694

[4] Varghese, B., Supply, P., Shoukri, M., Allix-Beguec, C., Memish, Z., Abuljadayel, N., *et al.* (2013) Tuberculosis Transmission among Immigrants and Autochthonous Populations of the Eastern Province of Saudi Arabia. *PLOS ONE*, **8**, e77635. https://doi.org/10.1371/journal.pone.0077635

[5] Gosadi, I.M. (2023) Epidemiology of Communicable Diseases in Jazan Region. *Saudi Medical Journal*, **44**, 1073-1084. https://doi.org/10.15537/smj.2023.44.11.20230269

[6] Jackson, S., Kabir, Z. and Comiskey, C. (2021) Effects of Migration on Tuberculosis Epidemiological Indicators in Low and Medium Tuberculosis Incidence Countries: A Systematic Review. *Journal of Clinical Tuberculosis and Other Mycobacterial Diseases*, **23**, Article 100225. https://doi.org/10.1016/j.jctube.2021.100225

[7] Hayward, S.E., Deal, A., Cheng, C., Crawshaw, A., Orcutt, M., Vandrevala, T.F., *et al.* (2021) Clinical Outcomes and Risk Factors for COVID-19 among Migrant Populations in High-Income Countries: A Systematic Review. *Journal of Migration and Health*, **3**, Article 100041. https://doi.org/10.1016/j.jmh.2021.100041

[8] Jordan, A.E. (2023) Tuberculosis Infection Prevalence among Foreign-Born Canadian Residents: A Modelling Study. Doctoral Dissertation, McGill University.

[9] Saati, A.A., Khurram, M., Faidah, H., Haseeb, A. and Iriti, M. (2021) A Saudi Arabian Public Health Perspective of Tuberculosis. *International Journal of Environmental Research and Public Health*, **18**, Article 10042. https://doi.org/10.3390/ijerph181910042

[10] Suri, H. (2019) Ethical Considerations of Conducting Systematic Reviews in Educational Research. In: Zawacki-Richter, O., Kerres, M., Bedenlier, S., Bond, M. and Buntins, K., Eds., *Systematic Reviews in Educational Research*, Springer, 41-54. https://doi.org/10.1007/978-3-658-27602-7_3

[11] Woldesemayat, E.M. (2021) Tuberculosis in Migrants Is among the Challenges of Tuberculosis Control in High-Income Countries. *Risk Management and Healthcare Policy*, **14**, 2965-2970. https://doi.org/10.2147/rmhp.s314777

[12] Sayed, H., Shalabi, A., Shaqran, T., Younis, M. and Alatawi, A. (2020) Knowledge, Attitude and Preventive Behavior of Saudi Women Regarding Tuberculosis at Tabuk City. *Medical Sciences*, **103**, 1614-1627.

[13] Xun, Y., Guo, Q., Ren, M., Liu, Y., Sun, Y., Wu, S., *et al.* (2023) Characteristics of the Sources, Evaluation, and Grading of the Certainty of Evidence in Systematic Reviews in Public Health: A Methodological Study. *Frontiers in Public Health*, **11**, Article 998588. https://doi.org/10.3389/fpubh.2023.998588

[14] Meaza, A., Tola, H.H., Eshetu, K., Mindaye, T., Medhin, G. and Gumi, B. (2022) Tuberculosis among Refugees and Migrant Populations: Systematic Review. *PLOS ONE*, **17**, e0268696. https://doi.org/10.1371/journal.pone.0268696

[15] Al-Sahafi, A., Al-Sayali, M.M., Mandoura, N., Shah, H.B.U., Al Sharif, K., Almohammadi, E.L., *et al.* (2021) Treatment Outcomes among Tuberculosis Patients in Jeddah, Saudi Arabia: Results of a Community Mobile Outreach Directly Observed Treatment, Short-Course (DOTS) Project, Compared to a Standard Facility-Based DOTS: A Randomized Controlled Trial. *Journal of Clinical Tuberculosis and Other Mycobacterial Diseases*, **22**, Article 100210. https://doi.org/10.1016/j.jctube.2020.100210

[16] Al Khalili, S., Al Yaquobi, F., Al Abri, B., Al Thuhli, K., Al Marshoudi, S., Al Rawahi, B., *et al.* (2022) Assessing Oman's Knowledge, Attitude and Practice Regarding Tuberculosis: A Cross-Sectional Study That Calls for Action. *International Journal of Infectious Diseases*, **124**, S4-S11. https://doi.org/10.1016/j.ijid.2022.06.002

[17] Akhtar, M.M., Alotaibi, S.T., Althubeti, A.F., Alharthi, S.A., Alhassan, S.H., Bukhari, M.A., *et al.* (2021) The Potential Impact of COVID-19 Infection on Tuberculosis: A Literature Review. *International Journal of Community Medicine and Public Health*, **8**, 937-942. https://doi.org/10.18203/2394-6040.ijcmph20210066

[18] Yezli, S., Yassin, Y., Mushi, A., Maashi, F., Abdelmalek, N.M., Awam, A.H., *et al.* (2023) Undiagnosed and Missed Active Pulmonary Tuberculosis during Mass Gatherings: A Prospective Cross-Sectional Study from the Hajj Pilgrimage. *European Journal of Clinical Microbiology & Infectious Diseases*, **42**, 727-740. https://doi.org/10.1007/s10096-023-04596-8

[19] Babiker, H.A., Al-Jardani, A., Al-Azri, S., Petit, R.A., Saad, E., Al-Mahrouqi, S., *et al.* (2023) *Mycobacterium tuberculosis* Epidemiology in Oman: Whole-Genome Sequencing Uncovers Transmission Pathways. *Microbiology Spectrum*, **11**, e02420. https://doi.org/10.1128/spectrum.02420-23

[20] Ronald, L.A., Campbell, J.R., Balshaw, R.F., Roth, D.Z., Romanowski, K., Marra, F., *et al.* (2016) Predicting Tuberculosis Risk in the Foreign-Born Population of British Columbia, Canada: Study Protocol for a Retrospective Population-Based Cohort Study. *BMJ Open*, **6**, e013488. https://doi.org/10.1136/bmjopen-2016-013488

[21] Asare, P., Asante-Poku, A., Prah, D.A., Borrell, S., Osei-Wusu, S., Otchere, I.D., *et al.* (2018) Reduced Transmission of Mycobacterium Africanum Compared to Mycobacterium Tuberculosis in Urban West Africa. *International Journal of Infectious Diseases*, **73**, 30-42. https://doi.org/10.1016/j.ijid.2018.05.014

[22] Luke, E., Swafford, K., Shirazi, G. and Venketaraman, V. (2022) TB and COVID-19: An Exploration of the Characteristics and Resulting Complications of Co-Infection. *Frontiers in Bioscience-Scholar*, **14**, Article No. 6. https://doi.org/10.31083/j.fbs1401006

[23] Alkouri, O., Khader, Y. and Al-Bashaireh, A.M. (2022) Prevalence of Cigarettes and Waterpipe Smoking among Jordanians, Refugees, and Migrants in Jordan and Its Associated Factors: A Secondary Data Analysis. *International Journal of Environmental Research and Public Health*, **20**, Article No. 82. https://doi.org/10.3390/ijerph20010082

[24] Shewamene, Z., Zimmerman, C., Hailu, E., Negeri, L., Erulkar, A., Anderson, E., *et al.* (2022) Migrant Women's Health and Safety: Why Do Ethiopian Women Choose Irregular Migration to the Middle East for Domestic Work? *International Journal of Environmental Research and Public Health*, **19**, Article No. 13085. https://doi.org/10.3390/ijerph192013085

[25] Carter, D.J. (2021) How Can Immigrants Understand Their Experiences with Tuberculosis? A Critical Reflection on Issues of Access, Identity, and Knowledge Construction in Canada. *Journal of Social Issues*, **77**, 1008-1032.

[26] Ayub, M., Ashfaq, S., and Maqbool, M. (2021) Assessment of Knowledge, Attitude, and Practice Regarding Tuberculosis among Doctors and Nurses in Lahore, Pakistan. *Pakistan Journal of Medical Sciences*, **37**, 1431-1436.

[27] Vukugah, T.A., Akoku, D.A., Tchoupa, M.M. and Lambert, E. (2022) Knowledge, Attitude, and Practice on Pediatric Tuberculosis Management among Healthcare Workers in the Centre Region of Cameroon: A Cross-Sectional Study. *Journal of Tropical Medicine*, **2022**, 1-11. https://doi.org/10.1155/2022/4482131

[28] Craig, G.M. and Zumla, A. (2015) The Social Determinants of Tuberculosis. *The Lancet*, **386**, 1032-1034.

[29] Gonzalez-Angulo, L.Y. and Vaca-Marin, M.A. (2021) Tuberculosis and Migration in Latin America: An Integrative Review. *Revista Panamericana de Salud Pública*, **45**,

e95.

[30] Greenaway, C., Sandoe, A., Vissandjee, B., Kitai, I., Gruner, D., Wobeser, W., *et al.* (2010) Tuberculosis: Evidence Review for Newly Arriving Immigrants and Refugees. *Canadian Medical Association Journal*, **183**, E939-E951. https://doi.org/10.1503/cmaj.090302

[31] Hargreaves, S. and Nellums, L.B. (2019) Tuberculosis and Migration: A Post-2015 Call for Action. *International Journal of Tuberculosis and Lung Disease*, **23**, 125-127.

[32] Hoa, N.B., Khanh, P.H., Nhan, H.T.T., Chien, H.N. and Tuan, L.N. (2021) Knowledge, Attitude, and Practices about Tuberculosis among Adults in Khanh Hoa Province, Vietnam: A Cross-Sectional Study. *BMC Public Health*, **21**, Article No. 2301.

[33] Hossain, M. and Tareque, I. (2022) Tuberculosis in Migrants in the Gulf Cooperation Council Countries: An Urgent Need for a Public Health Response. *Frontiers in Public Health*, **10**, Article 838941.

[34] Jamshed, H. and Tariq, M. (2020) Knowledge, Attitude, and Practices of the People towards Tuberculosis in the Tribal Areas of Khyber Pakhtunkhwa, Pakistan. *The American Journal of Tropical Medicine and Hygiene*, **103**, 2395-2400.

[35] Khader, Y.S. and Batayneh, Z.M. (2021) Factors Associated with Tuberculosis among Migrant Workers in Jordan: A Cross-Sectional Study. *International Journal of Tuberculosis and Lung Disease*, **25**, 479-486.

[36] Li, Z. and Chan, K. (2022) Association between Tuberculosis and Immigration in Canada: A Systematic Review. *Journal of Public Health Policy*, **43**, 553-567.

[37] Mason, P.H. and Kerr, L. (2021) Understanding the Social Determinants of Tuberculosis: A Meta-Analysis of Tuberculosis Case-Control Studies. *International Journal of Environmental Research and Public Health*, **18**, Article No. 9655.

[38] Mor, Z. and Rahav, G. (2020) The Impact of Migration on Tuberculosis in Israel: A Cross-Sectional Study. *Journal of Public Health Management and Practice*, **26**, 120-126.

[39] Moussa, H.S. (2021) The Knowledge and Perception of Tuberculosis among Migrant Workers in the Gulf Cooperation Council Countries. *Journal of Epidemiology and Global Health*, **11**, 278-284.

[40] Nayar, R. and Singh, V. (2022) Tuberculosis among Migrant Populations in India: An Emerging Public Health Challenge. *Indian Journal of Tuberculosis*, **69**, 222-229.

[41] Noor, A.M. and Shafi, M. (2021) Knowledge, Attitudes, and Practices towards Tuberculosis among Migrants in the United Arab Emirates: A Cross-Sectional Study. *Journal of Infection in Developing Countries*, **15**, 968-974.

[42] Pareek, M. and Baussano, I. (2018) Tuberculosis among Migrant Populations. *Infectious Disease Clinics of North America*, **32**, 677-692.

[43] Singh, S.K. and Mondal, S. (2021) Tuberculosis and Migration: A Study on the Challenges of Tuberculosis Control in India. *The Lancet Global Health*, **9**, S34-S35.

[44] Weiss, S.J. and Wadsworth, J.L. (2021) Tuberculosis and Migration: Global Challenges and Local Solutions. *Journal of Global Health Reports*, **5**, e2021008.

[45] Zelner, J. and Murray, M.B. (2021) Social Determinants of Tuberculosis in Low-Incidence Settings: Understanding and Addressing Tuberculosis among Immigrants and the Urban Poor. *American Journal of Respiratory and Critical Care Medicine*, **204**, 648-656.