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Impact of Wars and Disasters on Tuberculosis Epidemiology

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ABSTRACT

Tuberculosis (TB) remains one of the major public health problems globally. Key risk factors for TB include poverty, living conditions such as overcrowding, and the presence and prevalence of significant biological and behavioral risk factors that impair the immune system or contribute to additional biological risk factors. Wars and disasters increase the risk of developing TB mainly due to population movement and displacement into overcrowded camps and temporary shelters, destruction of infrastructure, breakdown of health services, or discontinuation of ongoing treatment for human immunodeficiency virus (HIV) co-infection. This leads to a higher risk of TB transmission, reactivation of latent TB infection, worsening of active disease, and increased vulnerabilities. Any factor that increases risk factors for TB is a primary driver of changes in TB epidemiology during wars and disasters. A TB preparedness plan should include a coordination mechanism, pre-assessment of data such as TB prevalence and incidence, drug-resistance status, prevailing major biological and behavioral risk factors for TB, resource requirements, a contingency plan for procurement and supply chain, surveillance, monitoring and evaluation tools, health facility details, effective TB infection control measures, and testing and screening protocols. Strategies to ensure the continuity of the National TB Control Program and to decrease vulnerabilities and risk factors for TB should be developed. Since most wars and disasters cause refugees to cross borders and affect multiple countries, developing an international data-sharing system would be useful.

Keywords: Disasters, epidemiology, public health, tuberculosis, wars.

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INTRODUCTION

Tuberculosis (TB) remains one of the major public health problems globally. According to the World Health Organization (WHO) Global Tuberculosis Report, 10.6 million people developed TB worldwide in 2022. Additionally, multidrug-resistant TB (MDR-TB) still poses a threat to public health, with a total of 410,000 MDR-TB or rifampicin-resistant TB (RR-TB) cases reported in 2022. Despite being a preventable and usually curable disease, TB caused 1.3 million deaths in 2022, making it the second leading cause of death from a single infectious agent after coronavirus disease 2019 (COVID-19).[1]

Poverty, overcrowded living conditions, and the presence and prevalence of significant biological and behavioral risk factors that impair the immune system or increase biological risk factors are the major key risk factors for TB.[2]

Proximate risk factors for TB refer to the biological and physical factors that directly affect the disease pathogenesis and include those that raise the level and duration of exposure to infectious droplets. The TB burden in the population is an important determinant of the likelihood of contact with an active TB patient. Early diagnosis and treatment initiation of active TB cases will interrupt further transmission. Thus, there is a strong association between the strength of the healthcare system and the risk of TB infection.[3,4]

The risk of exposure to TB bacilli is influenced by several factors, including the level of infectiousness of the source case, the duration and closeness of the contact, and the physical environment, such as ventilation quality and crowding intensity. Overcrowded and poorly ventilated places increase the risk of exposure and, consequently, the risk of TB infection. Indoor air pollution, resulting from burning solid fuels in poorly ventilated dwellings, is associated with a higher risk of TB disease.[3]

The level of exposure, the virulence of the bacterial strain, and the ability of the person's immune system to cope with the primary infection determine the risks of progressing from infection to active disease once exposed. The capacity of the host's immune system depends on factors such as age, gender, genetic predisposition, and underlying medical conditions. Human immunodeficiency virus (HIV) infection, smoking, malnutrition, alcohol abuse, diabetes, indoor air pollution due to burning solid fuels, malignancies, silicosis, immunosuppressive therapy, and many chronic systemic diseases are the main risk factors that weaken the host's immune system, causing the progression from infection to active TB disease. Additionally, stress and depression may theoretically increase the risk of TB through negative effects on the cell-mediated immune system.[3,4]

An analysis of 22 high-TB countries, accounting for 80% of the global TB burden, suggested that malnutrition, smoking, HIV, diabetes, indoor air pollution, and alcohol use are significant risk factors for TB worldwide. The risk factors differ from region to region. For example, smoking is the leading risk factor in the Western Pacific Region, while HIV is the most significant risk factor for TB in the African Region.[3,4]

TB epidemiology is influenced by various social and economic factors. The recent COVID-19 pandemic has negatively impacted the reach of essential TB services, including diagnosis, treatment, and follow-up or preventive treatment, in many countries in 2020 compared with 2019. This has led to a global increase in the burden of TB.[2]

The impact of two serious situations, wars, and disasters, on TB epidemiology is described in this article.

CLINICAL AND RESEARCH CONSEQUENCES

Impact of Wars on TB Epidemiology

The World Bank reports that two billion people currently live in poverty and fragile situations[5] and estimates that by 2030, 59% of the world's poorest population will live in fragile and conflict-affected countries.[6]

Fifty-five state-based conflicts were recorded in 38 conflict-affected countries in 2022, with 22 of them being internationalized civil conflicts. Of these 55 conflicts, eight were classified as wars. In addition to state-based conflicts, there were 82 non-state conflicts worldwide in 2022.[7]

Unfortunately, another conflict started in the early morning hours of October 7, 2023 in Israel and the occupied Palestinian territory, causing more than 30,000 deaths since then. Moreover, there has been heavy destruction of health facilities, interruption of essential health services including treatment for chronic diseases, several communicable disease outbreaks, and deaths from malnutrition.[8]

War-associated risk factors, such as massive population displacement into temporary shelters and overcrowded camps, breakdown of health services, interruption in HIV co-infection treatment, and malnutrition, increase the risk of TB transmission, reactivation of latent TB infection (LTBI), or worsening of active disease.[9]

TB poses a significant threat not only to the population in war areas but also to people in regions and countries outside the war zone, as wars force large numbers of people to flee to other parts of the country and even to neighboring countries.[5,10]

There have been numerous reports evaluating the impact of wars on TB epidemiology. Selected reports are presented in Table 1.[1,5,10–15]

Impact of Disasters on TB Epidemiology

The term "disaster" generally refers to natural events such as floods, earthquakes, tornadoes, etc., with harmful effects including the demolition of buildings and infrastructure and the loss of lives. The health effects of disasters appear at different times and vary in severity in the affected area.[16]

Natural disasters increase the risk of developing TB mainly due to population movement and displacement, destruction of infrastructure, interruption of health services, and increased

Table 1. Selected reports assessing the impact of wars on TB epidemiology

Country	Summary	Reference
Multiple countries (World War I)	During and after World War I, a dramatic increase in TB incidence was observed, mainly due to conversion from LTBI to active disease in war-torn countries.	5, 10
Multiple countries (World War II)	TB mortality increased in many European countries during WWII due to malnutrition, overcrowding, and the breakdown of health care services.	11
Bosnia and Herzegovina	The number of TB cases increased fourfold during the war in Bosnia and Herzegovina.	12
Guinea-Bissau	The TB-related case fatality rate increased threefold during the war in Guinea-Bissau, mainly due to the interruption of treatment of TB patients.	13
Congo-Brazzaville	Following the war period from 1997 to 1999, the number of new TB cases in Congo-Brazzaville increased two and a half fold in 2000 compared to 1994.	13
Somalia	During the civil war and famine in Somalia, a marked increase in both the incidence of new cases and the TB mortality rate was observed due to the interruption of TB control activities.	12
Syrian Arab Republic	TB incidence rate increased from 13 per 100,000 people in 2013 to 17 per 100,000 people in 2022 in Syria due to ongoing conflict.	1, 14
Democratic Republic of Timor-Leste	Smear-positive TB cases increased almost threefold during the conflict in the Democratic Republic of Timor-Leste in 1999.	15

vulnerabilities.[5] A total of 432 catastrophic events due to natural disasters affected 185 million people, with 30,374 deaths recorded in 2022.[17]

The series of massive earthquakes that struck southeastern Türkiye and the Syrian Arab Republic on February 6, 2023 caused significant demolition on each side of the border, damaged or destroyed infrastructure including health facilities, and displaced approximately 12 million people in the two countries. A significant reduction in newly diagnosed TB cases has been reported in Syria due to decreased access to health services after the earthquakes.[18]

Natural disasters affect poor people and increase their vulnerabilities. Rapid-onset natural disasters, such as floods and earthquakes, often generate immediate migration, while slow-onset disasters, such as droughts, do not cause sudden migration. The number of displaced people due to natural disasters is expected to increase as the frequency of these events rises due to climate change.[19]

Climatic changes have been identified as one of the main risk factors for the indirect drivers of TB in Pacific countries, alongside socioeconomic factors, malnutrition, smoking, and non-communicable diseases. Climatic change decreases crop production, which affects food security and nutrition, leading to malnutrition. Moreover, extreme weather can cause population displacement towards overcrowded conditions, increasing the risk of exposure to TB bacilli.[20]

The collapse of TB control activities has a major impact on both developed and underdeveloped countries. Experiences from the 2011 earthquake in Japan, the 2010 earthquake in Haiti, and Hurricane Katrina in the United States in 2005 have demonstrated that population movement, destruction of infrastructure, and insufficient coordination hinder early case detection, treatment, patient follow-up, and contact tracing activities. These issues are the major obstacles to establishing TB prevention and control services.[21]

Selected reports evaluating the impact of natural disasters on TB epidemiology are presented in Table 2.[22–24]

Drivers for Alteration in TB Epidemiology in Wars and Disasters

Any causal factor leading to an increase in risk factors for TB is the main driver of alteration in TB epidemiology during wars and disasters.

Population displacement and migration, deterioration of the environment, movement of animals, the breakdown of healthcare systems, interruption of disease control programs, impaired disease surveillance and early warning and response systems, insufficient diagnostic services, disruption of

Table 2. Selected reports assessing the impact of natural disasters on TB epidemiology

Country	Summary	Reference
Haiti	After the earthquake on January 12, 2010, TB cases doubled at the largest treatment center in Haiti. The number of TB cases in children increased from 29 in 2009 to 242 in 2010 after the earthquake. Additionally, adolescent and adult TB cases rose from 1,026 in 2009 to 2,719 in 2014. The annual number of TB cases in the country increased from 14,315 in 2011 to 17,040 in 2013.	22
Armenia	Following the 1988 earthquake, an increase in patients with newly diagnosed pulmonary TB and a higher incidence of TB complications were reported in the affected areas.	23
China	After the earthquake on May 12, 2008, an increase in TB cases was observed in hospitals in the affected regions compared to the same period of the previous year. Additionally, the number of new pulmonary TB cases in severely affected districts increased by 6.74%.	23
Indian Ocean	Two patients were reported to be infected with TB following the Sumatra-Andaman tsunami on December 26, 2004.	24

infection control measures, treatment ineffectiveness, and the development of drug resistance are common drivers of infectious diseases outbreaks, including TB, in conflicts and disasters.[5]

Within these factors, population displacement and migration leading to overcrowding and poor ventilation, disruption of TB control programs, and the presence or prevalence of proximate risk factors, especially HIV and malnutrition, are of great importance in influencing TB epidemiology during crises.

The impact, drivers, consequences, and results of wars and disasters associated with TB epidemiology are summarized in Table 3.

The major impact and drivers of TB epidemiology are discussed in detail below.

Population Displacement and Migration

Population movement and migration are key determinants of health globally.[25] TB is a significant health problem among displaced populations.[12]

Armed conflicts and population displacements have been linked to a significant increase in TB risk, by up to 20-fold.[10,26] For example, 26% of adult deaths among refugees in Somalia in 1985 were caused by TB, while between 38% and 50% of all deaths in two camps in Sudan during the 9 to 10 months after the camps opened were attributed to TB.[27] The number of forcibly displaced people due to conflict and disasters has continued to increase worldwide.[25]

The United Nations High Commissioner for Refugees (UNHCR) estimated that 108.4 million people were forcibly displaced globally in 2022 due to conflicts, wars, violence, and cruelty. Almost 58% of the forcibly displaced population did not cross international borders and remained in their country as internally displaced persons (IDPs), while 35.3 million people became refugees. Climate-related crises and disasters, including natural or environmental disasters, are other causes of displacement. In 2022, 32.6 million people were forced to move within their country due to disasters.[28]

Most of these displacements (97.7%) were triggered by water-related disasters such as floods, storms, droughts, and wildfires. Earthquakes were the most common geological disaster in 2022, causing 699,000 people to move to safer places.[29]

Displaced populations are more vulnerable than might be expected from baseline demographics and are at increased risk of developing TB due to several factors. Crowded and poor living conditions, poorly ventilated living quarters, loss to follow-up, poor access to medicines, poor socioeconomic status, limited access to TB services, interruption of healthcare provision or treatment, and comorbidities (such as HIV and diabetes mellitus) that impair the immune system make displaced populations more vulnerable to developing TB.[2,3,25]

The risk for the displaced population of being infected or developing active TB depends on the TB incidence in their region of origin, their exposure to infectious cases during their journey or at their destination, their living conditions, and their access to health services and social protection.[5]

Table 3. Impact, drivers, consequences, and results of wars and disasters on TB epidemiology

Impact	Driver	Consequences	Results
Direct impact	• Destruction of infrastructure • Security problems	• Destruction of health facilities • Blocked access to functioning facilities and the community • Loss of life among health staff	• TB infection • Reactivation of LTBI • Worsening of active disease • Drug resistance
Indirect impact through human behavior	• Population displacement and migration	• Overcrowding • Poor ventilation • Poor socioeconomic status • Limited access to TB prevention services or interruption of healthcare provision or treatment	
Indirect impact through healthcare system disruption	• Breakdown of healthcare systems • Interruption of disease control programs • Impaired disease surveillance and response systems • Insufficient diagnostic services • Disruption of infection control measures • Treatment ineffectiveness	• Interruption of treatment • Poor case diagnosis • Lost of follow-up in patients • Poor access to medicines	
Indirect impact through individual vulnerabilities	• Comorbidities • HIV infection, alcohol abuse, tobacco smoke, diabetes, indoor air pollution • Food insecurity • Malnutrition	• Impaired host defense	

Studies have revealed that while the risk of TB transmission is increased in displaced populations, the risk of TB transmission to the local community is limited if a strong prevailing health system covers refugees and migrants, ensuring early diagnosis and effective treatment of cases.[25]

Around 52% of the refugees originated from the Syrian Arab Republic (6.5 million), Afghanistan (5.7 million), and Ukraine (5.7 million). The number of refugees in European countries increased to 12.4 million at the end of 2022, mostly due to refugees from Ukraine. Türkiye has become the country hosting the largest refugee population worldwide, with nearly 3.6 million refugees at the end of 2022.[28]

Foreign-born TB patients constituted 9.9% of all cases notified in the European Region in 2021. The proportion of foreign-origin TB cases was as high as 33.8% in European Union/European Economic Area (EU/EEA) countries. Foreign-born patients with TB represented a vast majority in many countries, reaching up to 98% of the total cases notified in some countries, such as Malta.[30]

A rapid increase in the number of foreign-born TB cases in Türkiye has been observed. The proportion of foreign-born TB cases among total reported cases in Türkiye increased from 0.3% in 2005 to 15.9% in 2020.[31,32] The proportion of Syrian-born TB patients among foreign-born patients in Türkiye increased from 1.1% in 2010 to 53.0% in 2017.[32,33]

The percentage of MDR-TB cases among foreign-born patients in Türkiye increased from 15.42% in 2014 to 34.5% in 2020. Among the total of 1,290 MDR-TB cases between 2014 and 2020, 35 were extensively drug-resistant TB (XDR-TB), of which 31 were foreign-born.[31]

Breakdown of Health Systems and Interruption of Disease Control Programs

Destruction of infrastructure due to bombings and attacks, including healthcare facilities, transport, electricity, water, and gas supply, is a direct impact of wars and conflicts. This leads not only to the injury and death of health staff but also to the disruption of routine and acute emergency healthcare and disease control programs, including those for TB and HIV.[5]

Table 4. Recommended actions for infection prevention and control of TB during wars and disasters

Action	Recommendations
Elaborating a national TB preparedness plan	• Establish international and national coordination mechanisms. • Pre-assess data such as incidence and prevalence of TB, and drug resistance, along with major biological/behavioral risk factors. • Determine resource (finance and human) requirements. • Develop a contingency plan for procurement and supply management. • Determine surveillance, monitoring, and evaluation tools. • Assess the capacity and capabilities of TB diagnosis and treatment health facilities. • Provide recommendations for effective TB infection control measures. • Develop regional/provincial TB preparedness plans considering local conditions.
Defining strategies to enable the continuity of national TB control program	• Enhance TB diagnostic facilities (e.g., mobile laboratories). • Prepare guidelines and protocols for testing and screening of the local population as well as refugees and migrants. • Arrange for specimen transport. • Develop standard guidelines and protocols for case finding, treatment, patient follow-up, and contact tracing.
Preparation of strategies to decrease the vulnerabilities and risk factors for TB	• Ensure the continuity of treatment for people with HIV, diabetes mellitus, etc. • Establish a food support chain. • Improve living conditions of displaced populations to avoid overcrowding and poor ventilation.
Integration of refugees and migrants into the host country's healthcare system	• Determine strategies for the integration of refugees and migrants into the host country's healthcare system.
Development of an international data and information-sharing system	• Establish an international data and information-sharing system that allows instant communication.

Beyond the destruction of health facilities, the implementation of TB prevention and control programs, including screening, diagnosis, surveillance, and treatment of patients, can also be hindered due to blocked access to functioning facilities and communities as a result of security problems during wars and conflicts.[5]

In the earthquake that struck Mexico City in 1985, 13 hospitals collapsed, causing the deaths of 866 people, 100 of whom were health personnel. Nearly 10% of the country's health facilities were damaged in Peru as a result of El Niño events in 1997–1998.[16]

After natural disasters, an undiagnosed case of TB or a known case of TB not being treated can result in longer periods of contagion, serving as an index case and spreading the disease to others in overcrowded conditions.[34]

Poor access to healthcare services, discrimination, and social stigma are other barriers causing delays in testing and diagnosis of TB and HIV for refugee and migrant populations. Laboratory support for TB surveillance is usually severely limited in conflict areas and during disasters.[25]

The implementation of minimum laboratory standards is needed for proper microscopic smear diagnosis of TB. Given the long duration of TB treatment, relying on laboratories to diagnose and manage treatment failures is a significant challenge, especially in settings with high drug resistance. The interruption of TB treatment due to the collapse of existing health programs can trigger the reactivation of LTBI and lead to the development of drug resistance.[26]

MDR-TB is one of the most important problems among refugees, displaced populations, and migrants. Migration

itself may make it difficult to reach and maintain treatment adherence, contributing to the development of MDR-TB. MDR-TB and LTBI are reported at higher levels in refugees and migrants than in host populations.[25] The rate of TB drug resistance in refugee populations was more than three times higher than in non-refugee populations in Kenya.[5]

Indirect Impact Through Individual Vulnerabilities

HIV co-infection leads to an increased risk of TB transmission, reactivation of LTBI, and worsening of active disease.[9]

Population movement, overcrowding, poor access to health services, sexual violence, sex work, injecting drug use, unsafe blood transfusions, and adolescent health are all risk factors for increased HIV transmission in crises.[35]

An association between HIV infection and ineffective TB treatment outcomes has been found in a study conducted in refugee camps in Ethiopia.[25] Moreover, HIV decreases the sensitivity and specificity of TB screening methods such as the tuberculin skin test (TST), chest radiography, and sputum analysis. HIV also increases the case fatality rate of TB, while TB raises the mortality rate of HIV.[26]

Malnutrition, one of the main risk factors for TB due to food insecurity, is generally observed in conflict situations and disasters.[5] Even mild malnutrition may increase the risk of TB development and mortality rate.[26]

Food insecurity is a major concern for refugees as they may have to rely entirely on external sources for food for extended periods.[16,25] For example, food insecurity is reported among 88.7% of Afghan refugees in Iran, and numerous Afghan refugees living in Pakistan experience food shortages regardless of the length of their stay. Similarly, undernutrition is generally reported more frequently among IDPs than among non-displaced persons. In Afghanistan, displaced people spent almost three-quarters of their income on food in 2012 and still had to reduce the quantity and quality of their food. Additionally, 93% of asylum seekers in Norway suffered from food shortages, indicating that refugees can face food problems even in developed countries.[25]

There is also a strong relationship between food insecurity and HIV infection. Undernutrition increases susceptibility to HIV, and HIV infection decreases the patient's capability to prepare and acquire food.[5]

Infection Prevention and Control of TB During Wars and Disasters

Seven indicators, including coverage of essential health services, health expenditure per capita, and the prevalence of TB risk factors (HIV, smoking, diabetes, and alcohol use), have been determined within the scope of the United Nations (UN) Sustainable Development Goals (SDGs) and are being monitored according to the framework developed by WHO. A comprehensive action aiming to decrease the prevalence of TB risk factors such as malnutrition, smoking, HIV, and other determinants (poverty and Gross Domestic Product (GDP) per capita) that are attributed to many new cases, is more important than ever due to the wars and conflicts and the challenges with food security and energy.[1,2]

In the acute phase of disasters, TB control is not a priority compared to high mortality rates owing to acute respiratory infections, malnutrition, diarrheal diseases, etc.[35] Incidence rates of TB generally remain steady immediately after disasters.[22] An increase in TB transmission is generally observed 1–3 months after the crisis onset, particularly where refugees or IDPs are in camps or overcrowded communities, followed by a higher TB burden in the months or years afterward.[26,35] For example, a study comparing data from two years before and two years after the Great East Japan Earthquake in 2011 showed that the number of TB patients in the affected area increased in the post-disaster period compared to the pre-disaster period.[15]

Case finding and contact tracing are significant as a person with active TB can transmit the disease to 10–15 other people over a year.[36] Screening for LTBI among migrants and refugees due to high prevalence among these groups has been performed in most WHO European Region countries. Nevertheless, it is not always feasible due to stigma, different sensitivity of the screening methods used, and high costs.[25]

The European Centre for Disease Prevention and Control (ECDC) recommends screening for LTBI in migrants from countries with high TB incidence immediately upon arrival and initiating care and treatment where indicated.[37]

After the mass influx of people arriving in European countries from Ukraine, even though Ukraine is not among the high-TB incidence countries, ECDC recommends screening certain at-risk groups, such as people living with HIV or those who are contacts of TB patients, and assessing for TB preventive treatment in those without the disease.[38] This recommendation is likely due to the high burden of RR-TB or MDR-TB in Ukraine.

Türkiye's experiences in terms of TB control in refugees from the Syrian Arab Republic can serve as an example of integrating refugees into the host country's healthcare system. Syrian refugees in temporary shelters were screened for TB. Between 2012 and 2016, a total of 108 active TB patients among Syrian refugees were diagnosed and treated in temporary shelters. Additionally, the Bacille Calmette-Guérin (BCG) vaccine was administered to Syrian children.[39]

TB diagnosis, patient follow-ups, and treatments, including for foreigners, are free of charge in Türkiye.[40] Thus, Syrian refugees are integrated into the system and are being treated according to the strategies of the National TB Control Program.

A country with a strong prevailing National TB Control Program has an advantage in coping with TB under war and natural disaster conditions. To increase the ability and capacity of the health system to deal with the consequences of conflict and disasters, National TB Strategic Plans can be developed or strengthened by a TB Preparedness Plan at national and sub-national levels (regional, provincial, etc.).[2,5]

The TB preparedness plan should include international and national coordination mechanisms, pre-assessment of data such as the incidence and prevalence of TB and prevalence of drug resistance, and prevailing biological/behavioral risk factors (such as malnutrition, smoking, HIV, alcohol use, and diabetes) that impair host defense. It should also detail resource (finance and human) requirements, a contingency plan for procurement and supply management, surveillance, monitoring and evaluation tools, and TB diagnosis and treatment health facilities details (such as the number of TB dispensaries, laboratories, as well as reference laboratories and their capabilities, etc.). Recommendations for effective TB infection control measures, testing, and screening protocols should also be included. Moreover, strategies to enable the continuity of the National TB Control Program, such as early diagnosis and treatment of patients, patient follow-up, contact tracing, preventive treatment, and vaccination, should be part of the TB preparedness plan. Strategies aiming to decrease the vulnerabilities and risk factors for TB should also be developed. Since most wars and disasters cause refugees to travel across borders, affecting more than one country, the development of an international data-sharing system would be useful for tracking, particularly MDR/RR-TB cases.[2,5,25,37]

Recommended actions for infection prevention and control of TB during wars and disasters are summarized in Table 4.

CONCLUSION

Even though TB is a preventable and usually curable disease, it is still one of the major public health problems globally. Wars and disasters increase the risk of developing TB by causing population displacement into overcrowded places, destruction of infrastructure including health services, and interruption of ongoing TB programs. Given that the number of forcibly displaced people due to conflict and disasters continues to increase worldwide, countries should be prepared to take necessary measures to ensure the continuity of TB control in conflict and disaster situations.

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REFERENCES

1. World Health Organization. Global tuberculosis report 2023. Geneva: World Health Organization; 2023. Available from: URL: https://www.who.int/teams/global-tuberculosis-programme/tb-reports/global-tuberculosis-report-2023. Accessed Jul 2, 2024.
2. World Health Organization. Tuberculosis prevention and care among refugees and other populations in humanitarian settings: an interagency field guide. Geneva: World Health Organization; 2022. Available from: URL: https://www.who.int/publications/i/item/9789240042087. Accessed Jul 2, 2024.
3. Lönnroth K, Jaramillo E, Williams B, Dye C, Raviglione M. Tuberculosis: the role of risk factors and social determinants. Blas E, Kurup A, editors. Equity, social determinants and public health programmes. Geneva, Switzerland: WHO; 2010.p.219–37.
4. Lönnroth K, Jaramillo E, Williams BG, Dye C, Raviglione M. Drivers of tuberculosis epidemics: the role of risk factors and social determinants. Soc Sci Med 2009; 68(12): 2240–6. [CrossRef]
5. Topluoglu S, Taylan-Ozkan A, Alp E. Impact of wars and natural disasters on emerging and re-emerging infectious diseases. Front Public Health 2023; 11:1215929. [CrossRef]
6. The World Bank. Pursuing Development Goals amid Fragility, Conflict, and Violence. Available from: URL: https://www.worldbank.org/en/results/2024/01/16/pursuing-development-goals-amid-fragility-conflict-and-violence. Accessed Jan 5, 2024.
7. Obermeier AM, Rustad SA. Conflict Trends: A Global Overview, 1946–2022. Oslo: Peace Research Institute Oslo (PRIO); 2023. Available from: URL: https://www.prio.org/publications/13513. Accessed Jan 05, 2024.
8. World Health Organization. oPt Emergency Situation Update. Issue 24. 7 Oct 2023 - 2 April 2024. Available from: URL: https://www.emro.who.int/opt/information-resources/emergency-situation-reports.html. Accessed Jan 7, 2024.

9. Dahl VN, Tiberi S, Goletti D, Wejse C. Armed conflict and human displacement may lead to an increase in the burden of tuberculosis in Europe. Int J Infect Dis 2022; S104–6. [CrossRef]
10. Ismail MB, Rafei R, Dabboussi F, Hamze M. Tuberculosis, war, and refugees: Spotlight on the Syrian humanitarian crisis. PLoS Pathog 2018; 14(6): e1007014. [CrossRef]
11. Loddenkemper R, Murray JF. Tuberculosis and War: Lessons Learned from World War II. In: Tuberculosis and War. Lessons Learned from World War II. Prog Respir Research. Murray JF, Loddenkemper R, editors. Basel, Karger; 2018.p.214–28. [CrossRef]
12. Toole MJ, Waldman RJ. The public health aspects of complex emergencies and refugee situations. Annu Rev Public Health 1997; 18: 283–312. [CrossRef]
13. Munn-Mace G, Parmar D. Treatment of tuberculosis in complex emergencies in developing countries: a scoping review. Health Policy Plan 2018; 33(2): 247–57. [CrossRef]
14. World Health Organization. Syrian Arab Republic: Annual report 2018. Cairo: WHO Regional Office for the Eastern Mediterranean; 2018. Available from: URL: https://www.who.int/publications/i/item/world-health-organization-syrian-arab-republic-annual-report-2018. Accessed Jan 7, 2024.
15. Sakurai M, Takahashi T, Ohuchi M, Terui Y, Kiryu K, Shikano K. Increasing incidence of tuberculosis infection in the Coastal Region of Northern Miyagi after the Great East Japan Earthquake. Tohoku J Exp Med 2016; 238(3): 187–95. [CrossRef]
16. Pan American Health Organization. Natural Disasters—Protecting the Public's Health. PAHO; Washington, DC, USA: 2000. Scientific Publication No: 575.
17. Centre for Research on the Epidemiology of Disasters (CRED). 2022 Disasters in Numbers. Brussels: CRED Institute Health and Society; 2023.
18. World Health Organization. Whole of Syria Earthquake Response: Situation Report. Reporting period: 6-12 March 2023. Available from URL: https://www.who.int/europe/emergencies/situations/turkiye-and-syria-earthquakes/situation-reports-syria). Accessed Jan 18, 2024.
19. Rigaud KK, Sherbinin Ad, Jones B, Bergmann J, Clement V, Ober K, et al. Groundswell: Preparing for Internal Climate Migration, (Groundswell: Preparing for Internal Climate Migration), Washington, DC: World Bank; 2018. [CrossRef]
20. Tazerji SS, Nardini R, Safdar M, Shehata AA, Duarte PM. An overview of anthropogenic actions as drivers for emerging and re-emerging zoonotic diseases. Pathogens 2022; 11(11): 1376. [CrossRef]
21. Murray KO, Castillo-Carandang NT, Mandalakas AM, Cruz AT, Leining LM, Gatchalian SR; PEER Health Bohol Pediatric Study Team. Prevalence of tuberculosis in children after natural disasters, Bohol, Philippines. Emerg Infect Dis 2019; 25(10): 1884–92. [CrossRef]
22. Koenig SP, Rouzier V, Vilbrun SC, Morose W, Collins SE, Joseph P, et al. Tuberculosis in the aftermath of the 2010 earthquake in Haiti. Bull World Health Organ 2015; 93(7): 498–502. [CrossRef]
23. Yang X, Liu Q, Zhang R. Epidemiology of pulmonary tuberculosis in Wenchuan earthquake-stricken area: population-based study. J Evid Based Med 2013; 6(3): 149–56. [CrossRef]
24. Othman N, Ismail IH, Yip R, Zainuddin Z, Kasim SM, Isa R, et al. Infections in post-tsunami victims. Pediatr Infect Dis J 2007; 26(10): 960–1. [CrossRef]
25. World Health Organization. World Report on the Health of Refugees and Migrants. Geneva: World Health Organization; 2022. Available from: URL: https://www.who.int/publications/i/item/9789240054462. Accessed Jul 3, 2024.
26. Kimbrough W, Saliba V, Dahab M, Haskew C, Checchi F. The burden of tuberculosis in crisis-affected populations: a systematic review. Lancet Infect Dis 2012; 12(12): 950–65.
27. Toole MJ, Waldman RJ. An analysis of mortality trends among refugee populations in Somalia, Sudan, and Thailand. Bull WHO 1988; 66: 237–47.
28. Global trends forced displacement in 2022. Copenhagen, Denmark: The UN Refugee Agency (UNHCR); 2023.
29. Internal Displacement Monitoring Centre (IDMC). Global Report on Internal Displacement-GRID 2023. IDMC and NRC (Norwegian Refugee Council). Available from: URL: https://www.internal-displacement.org/publications/2023-global-report-on-internal-displacement-grid/. Accessed Jul 3, 2024.
30. European Centre for Disease Prevention and Control, WHO Regional Office for Europe. Tuberculosis surveillance and monitoring in Europe 2023 – 2021 data. Stockholm: European Centre for Disease Prevention and Control and Copenhagen: WHO Regional Office for Europe; 2023. Available from: URL: https://www.ecdc.europa.eu/en/publications-data/tuberculosis-surveillance-and-monitoring-europe-2023-2021-data. Accessed Jul 3, 2024.
31. Ministry of Health of Türkiye. Türkiye'de Verem Savaşı 2018 Raporu (In Turkish). Ankara, Türkiye: T.C. Sağlık Bakanlığı Halk Sağlığı Genel Müdürlüğü Tüberküloz Dairesi Başkanlığı; 2019. Available from: URL: https://hsgm.saglik.gov.tr/depo/birimler/tuberkuloz-db/Dokumanlar/Raporlar/Tu_rkiye_de_Verem_Savas_2018_Raporu_kapakl_.pdf. Accessed Jul 3, 2024.

32. Ministry of Health of Türkiye. Türkiye'de Verem Savaşı 2021 Raporu (In Turkish). Ankara, Türkiye: T.C. Sağlık Bakanlığı Halk Sağlığı Genel Müdürlüğü Tüberküloz Dairesi Başkanlığı; 2023. Available from: URL: https://hsgm.saglik.gov.tr/depo/birimler/tuberkuloz-db/Dokumanlar/Raporlar/Turkiyede_Verem_Savasi_2021_Raporu.pdf. Accessed Jul 3, 2024.
33. Ministry of Health of Türkiye. Türkiye'de Verem Savaşı 2019 Raporu (In Turkish). Ankara, Türkiye: T.C. Sağlık Bakanlığı Halk Sağlığı Genel Müdürlüğü Tüberküloz Dairesi Başkanlığı; 2020. Available from: URL: https://hsgm.saglik.gov.tr/depo/birimler/tuberkuloz-db/Dokumanlar/Raporlar/Turkiyede_Verem_Savasi_2020_Raporu.pdf. Accessed Jul 3, 2024.
34. Kanamori H, Hatakeyama T, Uchiyama B, Weber DJ, Takeuchi M, Endo S, et al. Clinical and molecular epidemiological features of tuberculosis after the 2011 Japan earthquake and tsunami. Int J Tuberc Lung Dis 2016; 20(4): 505–14.
35. Connolly, Máire A. World Health Organization. (2005). Communicable disease control in emergencies: a field manual. World Health Organization; 2005. Available from: URL: https://www.who.int/publications/i/item/communicable-disease-control-in-emergencies-a-field-manual. Accessed Jul 3, 2024.
36. World Health Organization. Syrian Arab Republic: Annual report 2021. Cairo: WHO Regional Office for the Eastern Mediterranean; 2022. Available from: URL: https://reliefweb.int/report/syrian-arab-republic/world-health-organization-syrian-arab-republic-annual-report-2021?gad_source=1&gclid=Cj0KCQjw7ZO0BhDYARIsAFttkChsuCo9AL26dS_bnA3J7jwB8XtRxNLHhgg4U9UEGn1o9h4BMmJZ0JEaAphHEALw_wcB Accessed Jul 3, 2024.
37. European Centre for Disease Prevention and Control. Public health guidance on screening and vaccination for infectious diseases in newly arrived migrants within the EU/EEA. Stockholm: ECDC; 2018. Available from: URL: https://www.ecdc.europa.eu/en/publications-data/public-health-guidance-screening-and-vaccination-infectious-diseases-newly. Accessed Jul 3, 2024.
38. European Centre for Disease Prevention and Control (ECDC) and World Health Organization (WHO). Testing for tuberculosis infection and screening for tuberculosis disease among refugees arriving in European countries from Ukraine. Information Note. 2022. Available from: URL: https://www.ecdc.europa.eu/en/publications-data/testing-tuberculosis-infection-and-screening-tuberculosis-disease-among-displaced. Accessed Jul 3, 2024.
39. Ergönül Ö, Tülek N, Kayı I, Irmak H, Erdem O, Dara M. Profiling infectious diseases in Turkey after the influx of 3.5 million Syrian refugees. Clin Microbiol Infect 2020; 26(3): 307–12. [CrossRef]
40. Sahan S, Topluoglu S, Temel F, Gokler ME, Kaygusuz S. Did financial social support for tuberculosis patients lead to better treatment outcomes in Türkiye during 2018-2019? Jpn J Infect Dis 2023; 76(6): 365–71. [CrossRef]