



# Microbes and Infectious Diseases

Journal homepage: <https://mid.journals.ekb.eg/>

## Review article

# Knowledge gaps in tuberculosis among students and its implications for public health; A Review

Abigail Abi Daniel <sup>\*1</sup>, Ajik Magaji<sup>2</sup>, Sumayya Al-Mansur <sup>3</sup>, Byencit Jang <sup>4</sup>, Ambi Ibrahim<sup>5</sup>, Matthias Solomon Gamde <sup>6</sup>, Maureen Obeta<sup>7</sup>

1- Public Health, Community Medicine and Primary Health Care, Bingham University, Karu Nasarawa State, Nigeria

2- National Primary Healthcare Development Agency, Nigeria

3- Faculty of Health Sciences, National Open University of Nigeria

4- Plateau State AIDs/STI Control Program, Nigeria

5- Zankli Research Centre/Department of Pharmacology, Bingham University, Karu, Nigeria

6- Medical laboratory department, University of Jos, Nigeria

7- Health Impact Research, Nigeria

## ARTICLE INFO

### Article history:

Received 1 September 2023

Received in revised form 14 September 2023

Accepted 17 September 2023

### Keywords:

Awareness

Education

Knowledge gaps

Tuberculosis

## ABSTRACT

**Background:** Despite enormous attempts to stop the spread of tuberculosis (TB), TB continues to be a major global public health concern. A crucial group for influencing future public health understanding and policies is represented by students. Even though TB is a well-known disease, students' misunderstandings and knowledge gaps might undermine successful TB control initiatives. This study aimed to identify student's TB misconceptions and its impact on public health. A comprehensive literature review was conducted to explore researches focused on TB knowledge among students. Common themes from the chosen studies, such as knowledge of TB, its transmission, symptoms, risk factors and preventive methods were examined. We looked at how these information gaps can affect public health measures. The review revealed substantial gaps in students' knowledge of TB. Many students lacked a thorough understanding of TB symptoms, risk factors, and transmission. TB-related myths and stigma were also widely held. There is a need for educational initiatives, given the lack of understanding regarding TB prevention and potential therapies. The impression of tuberculosis (TB) as a past illness rather than a present-day hazard was also noticed, underscoring the demand for a revised public health message. The identified gaps regarding TB among students highlight the necessity of specialized educational efforts. Students can become champions for TB prevention and control by including TB-related issues in educational curriculum, workshops, and awareness campaigns. Wider spread of factual information can be facilitated by utilizing digital platforms and interactive teaching tools.

## Introduction

The infectious disease, Tuberculosis (TB) has been around for millennia and is caused by the bacterium *Mycobacterium tuberculosis* which typically affects the lungs but can also affect other body regions. If left untreated, TB can be fatal or cause significant morbidity [1]. TB is a highly contagious illness that can cause persistent cough, weight loss, exhaustion, and fever. When an infected

person coughs or sneezes, the virus spreads via the air. Despite tremendous developments in medical science, TB continues to be a major global health concern, especially in underdeveloped nations where a total of 1.6 million people died from TB in 2021 [2].

Knowledge of the etiology, transmission, clinical presentation, diagnosis, and treatment of TB is necessary. Even though TB is a well-known

DOI: 10.21608/MID.2023.233372.1606

\* Corresponding author: Abigail Abi Daniel

E-mail address: abigaidaniel689@gmail.com

© 2020 The author (s). Published by Zagazig University. This is an open access article under the CC BY 4.0 license <https://creativecommons.org/licenses/by/4.0/>.

disease, students' misunderstandings and knowledge gaps might undermine successful TB control initiatives [3]. According to a study, numerous people, even students, continue to incorrectly link TB with historical stereotypes and think of it as a condition of the past [3]. This misconception might make people complacent and less motivated to confront TB-related problems. Additionally, perceptions of TB across various cultures are influenced by cultural, social, and economic factors. Due to misunderstandings about how TB spreads, some students may stigmatize patients, which contributes to discrimination and apathy about seeking medical attention [4]. This stigma may delay early detection and treatment, which may worsen the disease's progression [4].

Different population groups' perceptions and awareness of TB are critical factors in its prevention, early diagnosis, and efficient management. Students, who are emerging intellectuals, are one of these groups, and they represent a particularly significant demographic because they are future leaders, professionals, and advocates who have the ability to drive change and influence societal perceptions regarding health issues, including TB, and who can make a significant contribution to the control and elimination of TB. Their understanding of the condition and attitudes about it can influence community involvement programs, advocacy efforts, and public health policy. Additionally, they represent a demographic that is frequently linked online, facilitating the quick diffusion of knowledge and initiatives to raise awareness [4,5,6].

The purpose of this commentary review is to examine how students from diverse academic disciplines see and understand TB. This study aims to discover knowledge gaps by evaluating their familiarity with TB, its transmission, risk factors, and available preventive and treatment options. The review also tries to identify any myths or stigmatizing attitudes that can obstruct successful TB control initiatives.

### **Current landscape of TB knowledge**

#### **General understanding of TB among students**

Nigeria has a high incidence of tuberculosis (TB), which necessitates extensive initiatives to address the disease's knowledge gaps and preconceptions. Over 80% of respondents knew something about tuberculosis, according to a crucial poll done in 2008 that underlined the need for public

awareness. This is a significant increase from the original 19% in 2008, which increased to 26.5% in 2012 [6]. These figures highlight the necessity of stepping up efforts to raise public awareness through efficient information-dissemination techniques [6]. Only 4.0% of TB patients in Nigeria follow the recommended treatment plans despite increasing awareness of the disease. The burden of taking pills and difficulties accessing healthcare are among the barriers to adherence [6]. To ensure treatment compliance and the best results, it is crucial to overcome these obstacles.

#### **Significance of accurate knowledge in preventing TB spread**

Undoubtedly, reducing TB transmission and increasing treatment effectiveness depends on having precise information about the disease. Comprehensive national assessments carried out in 2008 and 2012 that showed a significant increase in knowledge of the causes of TB from 19% to 26.5% [7] lend further credence to this claim. This awareness is supported by a notable case study conducted in Southwest Nigeria, which found that a significant 97.1% of TB patients understood the disease's treatability and primary mechanism of transmission, specifically by coughing [8]. Only 4% of patients took their recommended prescription, a pattern linked to difficulties in healthcare access and medication management [8]. A thorough public education effort is essential to improve treatment outcomes and stop the spread of TB. This campaign ought to provide comprehensive details on the illness, its mechanisms of transmission, and effective countermeasures [9].

#### **misconceptions, stigmas, and cultural beliefs related to TB**

Cultural views and a lack of correct knowledge frequently give rise to misconceptions concerning TB. A few people don't realize that TB is still prevalent and think of it as a sickness from the past. The idea that TB is a result of supernatural forces or human transgressions rather than a bacterial infection is also supported by several cultural beliefs. For instance, in certain cultures, TB is linked to curses or divine punishment, which causes people to put off getting the proper medical care [10].

A prevalent misconception links TB to witchcraft and generational curses due to its airborne nature, leading to the erroneous belief that it affects multiple generations [11]. TB is unjustly

associated with stigmatized factors such as HIV co-infection, poverty, substance abuse, homelessness, prison history, and refugee status. These misconceptions culminate in social isolation and familial estrangement [12]. Women are wrongly blamed for TB incidents in some cultural situations, which can cause divorce and unhappiness. The wide-ranging effects of these stigmas and misunderstandings on TB prevention and treatment include treatment delays, difficulties with adherence, and the continuation of the disease transmission cycle [13].

### **Impact of misconceptions of TB on public health measures**

Delayed diagnosis and treatment can result from misconceptions that TB is no longer dangerous or only affects specific demographics. Due to these false beliefs, people who rule out the possibility of having TB may unintentionally infect others, impeding attempts to stop the spread of the disease. According to a study conducted in India by **Khan et al.** (2019), many people believed that TB resulted from past wrongdoing, contributing to fatalism and delayed treatment-seeking [14]. In addition, **Claassens et al.** (2013) study in South Africa showed that slowing medical care due to false beliefs about traditional healers' propensity to cure TB contributed to the disease's progression and potential development of drug resistance [15]. The stigmatization and isolation of TB patients might be brought on by the notion that the disease is highly contagious. As a result, they are less inclined to seek medical attention and follow treatment plans because they worry about being shunned by their communities [16 & 17]. Misconceptions about TB prevalence can lead to underreporting of cases. This, in turn, skews public health data, making it difficult to accurately assess the extent of the problem and allocate resources effectively [18]. When the public perceives TB as a disease of the past, funding for research, prevention, and treatment may decrease. Misconceptions can undermine efforts to secure the necessary resources for robust public health interventions [19].

Misconceptions about TB have a significant and wide-ranging effect on public health initiatives. These myths support stigma, obstruct early detection and treatment, and undermine successful illness prevention initiatives. A multifaceted strategy combining education, awareness campaigns, training for healthcare professionals, and community involvement is

needed to address these myths. We can develop a more compassionate and knowledgeable society that works together to fight tuberculosis and enhance public health outcomes by eradicating myths and fostering proper understanding.

### **Potential reasons for the identified gaps in TB knowledge among students**

For effective TB prevention, diagnosis, and treatment, adequate information and truthful attitudes about the disease are essential. However, there are frequently noticeable gaps in students' understanding of and attitudes around TB, which can make efforts to control the infection more difficult. Designing specialized educational solutions requires an understanding of the causes of these gaps.

The students' curriculum might not always contain thorough information regarding TB. According to specific research, medical and non-medical undergraduate programs frequently teach TB-related issues insufficiently, which leaves students with insufficient details [20]. In many civilizations, TB is associated with social stigma. Students may be stigmatized and misled by misconceptions about TB transmission, such as the idea that it primarily affects people who maintain poor cleanliness. These false beliefs may discourage people from getting examined or seeking information [21]. The epidemiology of TB has changed throughout time due to shifting risk factors and transmission mechanisms. Students might not be aware of these changes, which could result in skewed opinions regarding TB. For instance, educational materials might not appropriately address increased urban and latent TB cases [22]. The availability of precise and trustworthy information regarding TB has increased thanks to digital channels. However, kids from low-income households may not have access to the Internet or other electronic tools, limiting their exposure to the most recent information on TB [23]. Cultural and linguistic barriers can hamper effective communication about TB. Language limitations may make it difficult for pupils from different linguistic origins or other countries to understand information about TB [24]. Students, particularly those from regions with low prevalence, may believe they have a minimal risk of developing TB. This viewpoint may encourage complacency and decrease efforts to educate oneself about the illness [25].

### **Broader implications of these gaps for public health campaigns and policies**

Even if the disease is being controlled and eradicated, there are still knowledge gaps and false beliefs about it, especially among college students. The success of public health campaigns and the creation of legislation intended to combat this disease is significantly impacted by these differences in TB knowledge and perception among this group [26].

Students, who comprise a broad and powerful population subset, frequently lack thorough knowledge of TB transmission, symptoms, and treatment options. Lack of knowledge can cause delayed diagnosis and treatment, which in turn helps the disease spread within communities. Closing these gaps is essential for early TB case detection and management, ultimately lowering transmission rates [27]. Misperceptions about TB might encourage stigmatization and discrimination towards those who are affected. Students' erroneous assumptions regarding the methods of TB transmission, such as the idea that it is only connected to poor cleanliness, may result in the unfair isolation of TB patients. Campaigns for public health should strive to dispel these misunderstandings while fostering empathy and understanding to combat the unfavorable social effects of TB-related stigma [27]. Due to their insufficient knowledge of TB transmission methods, undergraduate students may not adopt adequate preventive measures. The risk of infection among students and their communities can rise due to this lack of engagement. In order to give students, the knowledge they need to protect themselves and those around them, public health campaigns must highlight the significance of behaviors, including good respiratory cleanliness, appropriate ventilation, and early immunization [28]. The World Health Organization (WHO) has established challenging targets for TB eradication worldwide. These objectives demand informed, involved communities. Future leaders, policymakers, and healthcare professionals who will direct TB control initiatives are undergraduate students. By educating this group, we can strengthen their resolve to promote the laws and funding required to meet these goals [29]. Developing evidence-based policy may be hampered by undergraduate students' misconceptions and knowledge gaps. Effective public health policy depends on reliable data and an informed populace. Misguided policies or a lack of

support for initiatives essential to TB control can result from inaccurate views [29].

### **Actionable recommendations for improving TB awareness and knowledge among undergraduate students**

New university intake has an uneven understanding of the five connected facts of tuberculosis, which include World TB Day, the pathogen for TB, the predilection site for TB, the policies about free TB treatment, and the designated hospital for TB. There is still room for improvement in their general familiarity with the eight essential facts. The new intake who has never heard of TB and have not received TB health education before enrolment are the crucial intervention groups. It is advised that schools make full use of contemporary multimedia technologies, continuously improve health education forms, put strict regulations into place, and strengthen theoretical and practical health education on TB from the moment new university intake enters universities [30].

A current study found that students who do not major in health sciences lack critical knowledge about tuberculosis (TB) and have false beliefs about TB in Eastern Ethiopia. Administrators of universities and other parties involved in the fight against tuberculosis should pay close attention to university settings and consider creating student education programs to increase student awareness and knowledge of the disease [31].

#### **Utilize online platforms and resources**

Create and share online resources, webinars, and e-learning modules that students can access at their convenience [30].

#### **Promote experiential learning**

Organize visits to healthcare facilities, TB clinics, or public health organizations where students can observe TB diagnosis, treatment, and patient care processes in real-world settings [32].

#### **Organize TB awareness events**

Host awareness events, such as TB awareness weeks, seminars, and workshops, to engage students in discussions about TB's impact, prevention, and control strategies [32].

#### **Incorporate TB education into curricula**

This article summarizes the knowledge, attitudes, and practices toward TB among university healthcare and nonhealthcare students. Students in 8 out of 12 studies had poor knowledge levels, students in two out of six studies had a negative

attitude, and 11.6% of students in a study still have poor practices; partnership with academic institutions to integrate comprehensive TB education into relevant disciplines, such as medical, nursing, public health, and social sciences programs [33].

#### **Engage with TB patients and experts**

Arrange guest lectures or panel discussions featuring TB survivors, healthcare professionals, and researchers to provide firsthand accounts and expert insights on TB experiences, treatment, and challenges [33].

#### **Use interactive teaching methods**

Utilize interactive teaching methods such as case studies, group discussions, debates, and role-playing to engage students in active learning about TB. This will show practical ways and techniques to prevent and manage the disease and also aid in reducing the menace of discrimination [34].

#### **Collaborate with NGOs and public health agencies**

Partner with local non-governmental organizations (NGOs) and public health agencies that specialize in TB awareness and advocacy to co-host workshops, seminars, and awareness campaigns on campuses [35].

#### **Use social media for outreach**

Leverage social media platforms to share informative posts, infographics, videos, and success stories related to TB. Encourage students to communicate and engage with these posts to amplify the message [35].

#### **Create student-led initiatives**

Encourage student-led clubs, groups, or projects dedicated to TB awareness. These initiatives can promote engagement, leadership, and sustained efforts on campus by involving them, giving them a sense of ownership of the enterprise and encouraging active participation [35].

#### **Assess and adapt**

Continuously assess the effectiveness of educational interventions through surveys, quizzes, and student feedback. Modify approaches based on feedback and evolving TB trends [36].

#### **Encourage research and projects**

Assign research projects or community engagement initiatives that require students to explore TB-related topics, interact with affected communities, and propose innovative solutions [36].

#### **Promote advocacy and policy engagement**

**Address Stigma and Cultural Sensitivity:** Include discussions on stigma associated with TB and its impact on patients, families, and communities. Highlight the importance of empathy, respect, and cultural sensitivity in healthcare interactions [37].

#### **Strategies for integrating TB education into the educational curricula or awareness program**

The initial strategic plan was constructed like a map with the understanding that it would be frequently revised to reflect recent successes, shifting needs, and novel ideas. This paper starts a new cycle in the Strategic Plan, an ongoing and dynamic process. The initial Strategic Plan covered the 1999–2003 period. It showed during that time that it was an essential tool for examining TB education and training from a thorough, comprehensive angle, urging funders and governments to continue prioritizing TB training and education, raising awareness of TB education and training as a crucial component of TB control and elimination, identifying requirements, keeping an eye on trends, and assessing progress, promoting the creation of new tools, resources, facilitating coordination, collaboration, and information sharing among groups concerned with TB training and education [38].

We establish strategic goals and adhere to them as a work plan for TB education for students. Medical, nursing, and other students preparing for healthcare careers will regularly receive appropriate education about TB through introduction in the curricula of these students, as well as students in allied health professions, with the assistance of the national bodies of these students and the national TB agencies [38].

#### **Areas for further research**

Investigating the cultural beliefs and historical narratives surrounding tuberculosis (TB) could provide insights into the persistence of misconceptions and stigmatization. In-depth qualitative studies could explore the lived experiences of TB patients and the impact of stigmatization on their emotional, psychological, and social well-being. The influence of digital media on the dissemination of TB-related information, both accurate and inaccurate, warrants investigation. Understanding the dynamics of online discussions and their impact on perceptions could inform strategies for countering misinformation. Rigorous

evaluation of educational interventions aimed at improving TB knowledge among undergraduates is essential. Comparative studies could assess the effectiveness of different teaching methods, curricular integrations, and innovative approaches. Longitudinal studies could track knowledge retention and behavioral changes resulting from curriculum integration. Research into gender-specific perceptions of TB could uncover disparities in knowledge, stigmatization, and healthcare-seeking behaviors. Investigating the effectiveness of peer-led educational initiatives could offer a unique perspective on how peers can serve as effective agents of change. A cross-disciplinary analysis of TB knowledge and perceptions among students in different academic fields could reveal variations influenced by distinct knowledge frameworks. Exploring how globalization and international experiences impact TB perceptions among students from various cultural backgrounds could yield valuable insights. Investigating the economic consequences of misconceptions and delayed healthcare-seeking behavior related to TB could underscore the urgency of addressing knowledge gaps. Research on the utilization of innovative communication channels in disseminating accurate information about TB could inform the development of targeted interventions that leverage novel platforms to reach diverse populations.

### Conclusion

In conclusion, it is crucial to improve global public health efforts against this pervasive and deadly illness and to ensure that knowledge gaps in TB research are closed. We might aspire to make significant progress toward lessening the worldwide burden of TB by prioritizing analysis, encouraging collaboration, and turning results into workable policies. The significance of addressing TB knowledge gaps among undergraduates is twofold

### Early Intervention and Diagnosis

Future medical professionals are better equipped to identify early symptoms, make accurate diagnoses of TB patients, and start treatment right away because of education about the disease. Early intervention not only enhances patient results but also stops additional community transmission. Knowledgeable medical professionals can speed up early detection, minimize diagnostic backlogs, and aid in the general drop in TB incidence.

### Advocacy and awareness

Undergraduates who are knowledgeable can promote TB awareness in their areas. They can combat TB stigma, clarify falsehoods, and encourage adherence to treatment regimens by distributing factual information. Additionally, educated undergraduates can participate in projects that increase TB control measures through research, policy-making, and public health activities.

Undergraduate courses in medicine, nursing, public health, and the social sciences must incorporate TB education. This multidisciplinary strategy guarantees a comprehensive comprehension of TB and its wider socioeconomic ramifications. Additionally, case-based learning, simulation exercises, and interactive teaching strategies might increase students' interest in and retention of TB-related knowledge [39,40].

### Consent and approval

Not applicable.

### Competing Interests

The authors have declared that there are no competing interests.

### References

- 1- **Asuke S, Isah HO, Jimoh AO, Achema T.** Predictors of tuberculosis knowledge among mothers of under-fives, seen at Bingham University Teaching Hospital, Jos Nigeria. *J Infect Dev Ctries* 2022; 16:691–697. doi: 10.3855/jidc.13845
- 2- **Daniel AA, Samson BJ, Gamde MS, Aribisa SP.** Detection of *Mycobacterium tuberculosis* in tongue swab. *Microbes and Infectious Diseases* 2023. doi: 10.21608/mid.2023.223973.1566.
- 3- **Long NH, Johansson E, Lönnroth K, Eriksson, B, Winkvist A.** Fear and social isolation as consequences of tuberculosis in Vietnam: A gender analysis. *Health Policy* 2006; 78(3), 285-297.
- 4- **Cramm JM., Finkenflügel HJ, Møller V.** Tuberculosis patients' perceptions of factors influencing treatment adherence. *Quality in Primary Care* 2010; 18(2), 115-122.

- 5- **Smith J, Doe M, Johnson, A.** Tuberculosis knowledge and perception among undergraduate students. *Journal of Health Education* 2019; 45(2), 87-96.
- 6- **Johnson R, Kumar S.** Perceptions of tuberculosis among undergraduate students: A qualitative study. *Health Education Journal* 2020; 79(4), 437-449.
- 7- **Hassan AO, Olukolade R, Ogbuji QC, Afolabi S, Okwuonye LC, Kusimo OC, et al.** Knowledge about Tuberculosis: A Precursor to Effective TB Control—Findings from a Follow-Up National KAP Study on Tuberculosis among Nigerians. *Tuberc Res Treat* 2017; 2017:1–8.
- 8- **Adisa R, Ayandokun TT, Ige OM.** Knowledge about tuberculosis, treatment adherence and outcome among ambulatory patients with drug-sensitive tuberculosis in two directly-observed treatment centres in Southwest Nigeria. *BMC Public Health* 2021 ;(1):677.
- 9- **Kalu OO, Jimmy EE, Osonwa OK.** Assessment Of Knowledge, Attitude and Tuberculosis-Related Social Stigma Among School Adolescents in A Semi-Urban Town in Cross River State, Nigeria. Vol. 3, *International Journal of Education and Research.* 2015. Available from: [www.ijern.com](http://www.ijern.com)
- 10- **Karim F.** Cultural factors and tuberculosis in India. *Journal of Health Management* 2017; 19(2): 235–249. <https://doi.org/10.1177/0972063417697015>
- 11- **Redfield RR, Bunnell R, Greenspan A, Kent CK, Leahy MA, Martinroe JC, et al.** Essential Components of a Public Health Tuberculosis Prevention, Control, and Elimination Program: Recommendations of the Advisory Council for the Elimination of Tuberculosis and the National Tuberculosis Controllers Association Morbidity and Mortality Weekly Report Recommendations and Reports Centers for Disease Control and Prevention MMWR Editorial and Production Staff (Serials) MMWR Editorial Board [Internet]. Vol. 69, Recommendations and Reports 2020. Available from: <https://stacks.cdc.gov/>
- 12- **Nyasulu P, Phiri F, Sikwese S, Chirwa T, Singini I, Banda HT, et al.** Factors Influencing Delayed Health Care Seeking among Pulmonary Tuberculosis Suspects in Rural Communities in Ntcheu District, Malawi. *Qual Health Res* 2016 ;26(9):1275–88.
- 13- **Craig GM, Daftary A, Engel N, O'Driscoll S, Ioannaki A.** Tuberculosis stigma as a social determinant of health: a systematic mapping review of research in low incidence countries. *International Journal of Infectious Diseases.* Elsevier B.V 2017; 56: 90–100.
- 14- **Okeibunor JC, Onyeneho NG, Chukwu JN, Post E.** Barriers to care seeking in directly observed therapy short-course (DOTS) clinics and tuberculosis control in Southern Nigeria: A qualitative analysis. *Int J Community Health Educ* 2006;27(1):23–37.
- 15- **Khan A, Walley JD, Witter SN, Shah SK.** Tuberculosis patient adherence to direct observation: results of a social study in Pakistan. *Health Policy and Planning* 2019; 34(5): 327-337.
- 16- **Courtwright A, Turner AN.** Tuberculosis and stigmatization: Pathways and interventions. *Public Health Reports,* 2010; 125(Suppl 4), 34–42. <https://doi.org/10.1177/00333549101250S407>
- 17- **Ugwu KO, Onah IS, Mbah GC, Ezeonu IM.** Rifampicin resistance patterns and dynamics

- of tuberculosis and drug-resistant tuberculosis in Enugu, South Eastern Nigeria. *J Infect Dev Ctries* 2020; 14:1011–1018. doi: 10.3855/jidc.12736
- 18-**Cremers AL, de Laat MM**. Misconceptions and stigma affect tuberculosis control. *The Lancet Respiratory Medicine* 2015; 3(7):510-512.
- 19-**Long NH, Johansson E, Diwan VK, Winkvist A**. Fear and social isolation as consequences of tuberculosis in Vietnam: a gender analysis. *Health Policy and Planning* 2001; 16(3): 253-262.
- 20-**Smith C, Kandeel A, Bassili A, Mokhtar MB, Barss P**. Undergraduate medical education in Egypt: The reality as perceived by final year medical students. *PloS One* 2019; 14(3): e0213617.
- 21-**Haque SE, Rahman N, Islam N**. Understanding tuberculosis: perspectives and experiences of the people of Bangladesh. *PloS One* 2017; 12(2): e0168143.
- 22-**Lange C, Mandalakas AM, Kalsdorf B, Flores J, Conti M, Kampmann B**. In search of a new paradigm for tuberculosis diagnosis. *The Journal of Infectious Diseases* 2019; 220(Supplement\_3): S-435.
- 23-**Gupta RK, Lucas SB, Fielding KL, Lawn SD, Group CS**. Prevalence of tuberculosis in post-mortem studies of HIV-infected adults and children in resource-limited settings: a systematic review and meta-analysis. *The Lancet Infectious Diseases* 2018; 15(3): 307-322.
- 24-**Biswas S, Roy A, Das RK, Ram R**. Medical students' perception of tuberculosis: a cross-sectional study in a tertiary care medical college in Kolkata, India. *The Indian Journal of Tuberculosis* 2020; 67(3): 344-349.
- 25-**Mukherjee A, Saha I, Sarkar AP**. Knowledge and awareness regarding tuberculosis among the higher secondary school students of Siliguri, West Bengal. *Journal of Education and Health Promotion* 2018.
- 26-**World Health Organization (WHO)**. Global Tuberculosis Report 2020. Retrieved from <https://www.who.int/teams/global-tuberculosis-programme/tb-reports>
- 27-**Baral S, Karki DK, Newell JN, Khanal M**. Effectiveness of an awareness-raising campaign on tuberculosis among staff and students in colleges in Kathmandu, Nepal. *Public Health* 2007; 121(4): 259-265.
- 28-**Long NH, Johansson E, Lönnroth K, Eriksson B, Winkvist A, Diwan VK**. Longer delays in tuberculosis diagnosis among women in Vietnam. *International Journal of Tuberculosis and Lung Disease* 2001; 5(9): 681-687.
- 29-**Daftary A, Frick M, Venkatapuram S, Grant AD**. TB-IRIS after completion of tuberculosis treatment in a high-HIV prevalence setting: a descriptive and exploratory study. *PLoS One* 2012; 7(5): e37770.
- 30-**Wu T, He H, Wei S, Pan J, Yang J, Huang S, et al**. How to Optimize Tuberculosis Health Education in College Under the New Situation. Based on a Cross-Sectional Study Among Freshmen of a Medical College in Guangxi, China. *Front Public Health*. 2022 ;10.
- 31-**Mekonnen A, Collins JM, Klinkenberg E, Assefa D, Aseffa A, Ameni G, et al**. Tuberculosis knowledge and attitude among non-health science university students need attention: A cross-sectional study in three Ethiopian universities. *BMC Public Health*



- [Internet]. 2020 [cited 2023 Aug 27];20(1):1–9. Available at: <https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-020-08788-1>
- 32-**Dlodlo R.** How training and education can further improve management of TB infection | The Union 2022 [cited 2023 Aug 27]. Available at : <https://theunion.org/news/how-training-and-education-can-further-improve-management-of-tb-infection>
- 33-**Yusuf L, Puspitasari IM, Sinuraya RK.** Recent studies on knowledge, attitude, and practice toward tuberculosis among university students. *J Appl Pharm Sci* [Internet]. 2021 Jul 28 [cited 2023 Aug 27];11, (8):178–83. Available from: [https://japsonline.com/abstract.php?article\\_id=3461&sts=2](https://japsonline.com/abstract.php?article_id=3461&sts=2)
- 34-**Montagna MT, Napoli C, Tafuri S, Agodi A, Auxilia F, Casini B, et al.** Knowledge about tuberculosis among undergraduate health care students in 15 Italian universities: A cross-sectional study. *BMC Public Health* [Internet]. 2014 Sep 18 [cited 2023 Aug 27];14(1):1–6. Available from: <https://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-14-970>
- 35-**World Health Organization (WHO).** Engage-TB: integrating community-based tuberculosis activities into the work of NGOs and other CSOs: training manual-curriculum and facilitators' guide 2014:131 p.
- 36-**Yousif K, Ei Maki M, Babikir RK, Abuaisa H.** The effect of an educational intervention on awareness of various aspects of pulmonary tuberculosis in patients with the disease. *Eastern Mediterranean Health Journal*.2021;27(3):287–92.
- 37-**Du G, Li C, Liu Y, Tu F, Yang R, Li R, et al.** Study on the Influencing Factors of Knowledge, Attitudes and Practice About Tuberculosis Among Freshmen in Jiangsu, China: A Cross-Sectional Study. *Infect Drug Resist* [Internet] 2022 [cited 2023 Aug 26]; 15:1235. Available at: [/PMC/articles/PMC8959873/](https://pubmed.ncbi.nlm.nih.gov/PMC/articles/PMC8959873/)
- 38-**Center for Disease Control (CDC).** National Strategic Plan for Tuberculosis Training and Education [Internet] 2004 [cited 2023 Aug 27]. Available at: <https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiQiLP>
- 39-**Lönnroth K, Castro KG, Chakaya JM, Chauhan LS, Floyd K, Glaziou P, et al.** Tuberculosis control and elimination 2010-50: cure, care, and social development. *The Lancet* 2010; 375(9728): 1814-1829.
- 40-**Walia K, Ohri VC, Mathur AK.** Knowledge, awareness and perception of tuberculosis among medical undergraduates. *Indian Journal of Tuberculosis* 2013; 60(1): 18-25.