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An Epidemiological Prospective Of Drug-Resistant Tuberculosis In India: A Comprehensive Type Of Scoping Review

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Abstract

Background: Tuberculosis is a chronic infectious disease caused by Mycobacterium Tuberculosis. Worldwide, 0.45 million people developed MDR-TB/RR-TB disease, and in India, 0.049 million people developed MDR-TB/RR-TB. Drug-resistant tuberculosis (DR-TB) is another major public health problem, especially in developing countries. It is associated with various risk factors, comorbidities, an increase in different resistance patterns, and drug reactions for DR-TB. Programmatic management of DR-TB varies from district to district and across different geographical areas. A detailed understanding of different DR-TB patients is needed to modify the program on time and strengthen it. There are few reviews and a lack of scientific evidence on drug-resistant tuberculosis. A comprehensive type of evidence synthesis and a detailed review of research paper analysis are needed for DR-TB; hence, the current study is undertaken.

Objectives: **1.** To determine the socio-demographic profile and risk factors associated with DR-TB. **2.** To assess the pattern of drug resistance, treatment pattern, and adverse drug reactions among DR-TB cases.

Material And Method: A comprehensive type of scoping review was conducted with the help of different databases. It included PubMed, Scopus, Google Scholar, ResearchGate, Scilit, Index Copernicus, Index Medicus, Scope Med, CrossRef, and BMC for articles published, as well as those cited in various official public health reports and books up to 2023.

Results And Conclusion: Most of the DR-TB patients were in the 31-60 years age group, with a mean (SD) age was 37.87±14.51 Years; the majority were males, of Hindu religion, living in rural areas, and married couples. Others, more than 2/3, had completed middle school, were working as laborers, belonged to low socioeconomic status, and lived in nuclear families. Risk factors associated with DR-TB were the 31-60 years age group, low socio-economic class, overcrowding, inadequate ventilation, indoor air pollution, tobacco chewing, nonpractice of safe sputum disposal methods, and pallor, respectively. MDR-TB was the most prevalent pattern, followed by RR-TB, XDR-TB, and HR-TB. Cough was the most common presenting symptom, and Adverse drug reactions most prevalent among DRTB subjects were GI symptoms, headache, arthralgia & loss of appetite. The regular program modifications and strengthening through IEC and training, early screening and initiation of treatment, appropriate use of advanced digital health technologies, and time-to-time updates of various registrations. The modified treatment regimen for the drug reaction patients. The periodic installment and follow-up for a monthly five hundred rupees under the Ni-Kshay Poshan Yojana. Preventive and control measures should be implemented in remote, hilly, and rural areas. Nutritional counselling, support throughout the treatment, use of incentives, enhancing contact tracing, and increasing awareness regarding sputum disposal practices were needed for effective control of DR-TB patients.

Keywords: Tuberculosis, Drug resistance Tuberculosis, MDR-TB, RR-TB, XDR-TB, Adverse drug reactions, Information, education and communication

Introduction

Tuberculosis is an important public health issue globally, which is a chronic infectious disease in the world and caused by a single acid-fast bacterium, "Mycobacterium Tuberculosis". It mainly affects the lungs, which is called pulmonary TB, and also affects other body parts, known as extrapulmonary TB [(1)]. It is more common in developing countries compared to developed countries. Currently, only 5-10 per 100 people develop the clinical disease in the later part of life [(2)]. Tuberculosis is one of the top 10 causes of death worldwide. It is the leading killer of people with HIV and the second most common cause of death from infectious diseases. Worldwide, 0.45 million people developed MDR-TB/RR-TB disease in 2022, and in India, 0.049 million people developed MDR-TB/RR-TB disease in 2022 [(3)]. As per the annual report of TB 2023, in Karnataka state, the total number of RR-TB/MDR-TB cases is 586, and the deaths are 94 in the year 2021[(4)].

In the year 2020, the drug resistance treatment success rate was about 59%. Most people discontinue their treatment and die [(5)]. The World Health Organization is identifying the top thirty high-burden countries (HBC), among which India is associated with a high incidence of TB, HIV with TB, and MDR/RR-TB. During the COVID-19 pandemic, there was a reversal in essential TB services and a gross reduction in the TB disease burden, with 16 countries accounting for 93% of the reduction in TB, whereas India, Indonesia, and the Philippines were the worst-affected countries [(6)]. Drug-resistant tuberculosis (DR-TB) is another major public health problem, especially in developing countries, because it has a very long duration of disease and treatment, and it is not able to achieve a high cure rate even by introducing a short course of chemotherapy. MDR-TB and XDR-TB also accounted for in pediatric age groups, and no estimation of the overall burden of the disease was made because of difficulty in diagnosis and exclusion of children in most DR-TB surveys [(7)]. Nowadays, the number of DR-TB patients is increasing, and drug-resistant types, MDR-TB, pose a major threat to global health security [(8)]. The Government of India launched the Ni-Kshay Poshan Yojana (NPY scheme in April 2018, providing financial incentives of five hundred rupees monthly via direct benefit transfer (DBT) to all persons affected with TB to support their nutritional requirements during their treatment [(9)]. Once the treatment regimen is finalized, all patients should have a treatment card and enter it into the Nikshay online portal. MO-PHI (Medical Officer-Peripheral Health Institute) should ensure that treatment details are entered into Ni-Kshay by the PHI staff. It is not a separate activity. All events start from the notification of the treatment outcome. It is an integral part of the documentation of the NTEP program [(10)].

Currently trend of DR-TB increases as years pass, becoming a major public health problem in terms of social security and economics, which is influenced by various social and cultural factors, low adherence to treatment and DOTS services, infrastructural, advanced technologies in diagnosis and treatment, availability of resources, lack of public and private partnerships, and geographical limitations [(11,12,13,14)]. Tuberculosis is one of the top 10 causes of death worldwide. It is the leading killer of people with HIV and the second most common cause of death from infectious diseases. There are few studies and a lack of scientific evidence on drug-resistant tuberculosis. A comprehensive type of evidence synthesis and detailed review of research papers' analysis is needed on the DR-TB; hence, the current study is undertaken.

Objectives: 1. To determine the socio-demographic profile and risk factors associated with DR-TB. 2. To assess the pattern of drug resistance and adverse drug reactions among DR-TB cases.

Material And Methods: We conducted a comprehensive type of scoping review to explore and synthesize evidence regarding the. To ensure a robust and systematic approach, database-specific search strategies were developed for Ovid, PubMed, Scopus, Embase, Index Copernicus, and DOAJ. The search strategy utilized a combination of carefully selected keywords and Boolean operators (AND/OR) to maximize the capture of relevant studies. The database

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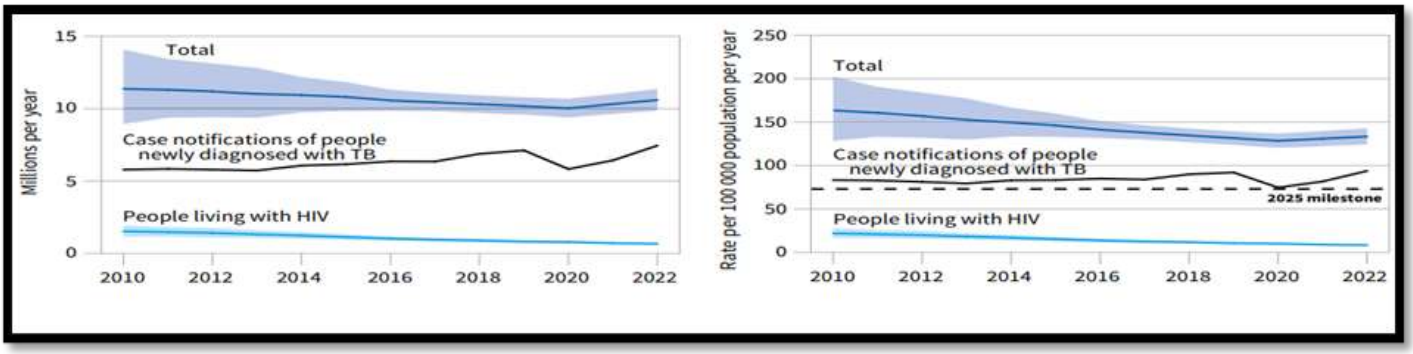
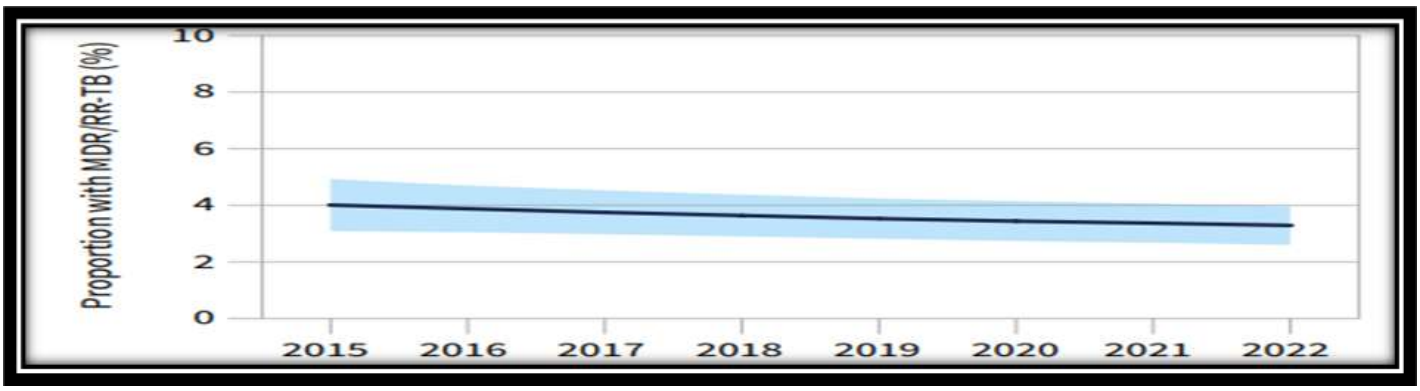
searches were conducted on. To streamline the process, we used Raayan®, a software tool designed for managing reviews, to identify and remove duplicate records and organize the search results efficiently. Screening and selection process. Following the deduplication process, a thorough screening of titles and abstracts was conducted to assess the relevance of each study. Full-text articles of potentially eligible studies were subsequently retrieved and reviewed in detail to evaluate their alignment with the inclusion criteria. Studies were included if they met the following conditions: (1) were published in English up to 2023 year; (2) provided data on DR-TB and (3) utilized study designs such as cross-sectional studies, case-control studies, cohort designs like cross sectional, case control, over review, Cohort, our review process adhered to the as per standard guidelines for scoping reviews to ensure a transparent and methodologically sound approach.

Data Extraction: Key characteristics of the included studies, such as the first author, publication year, study setting, population, and findings related to clinical and demographic profile, risk factors, adverse drug reactions, and coverage of NPY among DR-TB.

Review Of Literature: Global: Drug-resistant TB continues as a major public health problem, and it should be treated as early as possible by taking various preventive measures. Resistance to rifampicin was one of the most common problems, which was most effectively treated by first-line drugs, whereas rifampicin and isoniazid, defined as multidrug-resistant tuberculosis (MDR-TB), had another common problem. Both multidrug-resistant (MDR-TB) and rifampicin-resistant (RR-TB) required treatment with second-line drugs. The estimated number in 2022 was 410,000. The number of people developing MDR/ RR-TB was relatively stable from 2020–2022, in contrast to an estimated increase in the overall number of people developing TB, which was also compensated [6]. **Global trends in the estimated number of incident TB cases (left) and the incidence rate (right), 2010–2022. (Fig. 3 and 4: WHO TB Report 2023) [6]**



In 2022, the estimated proportion of people with TB who had MDR/RR-TB was 3.3% among new cases and 17% among previously treated cases. There was a downward trend in the proportion of people with TB who had MDR/RR-TB, particularly among those with a previous history of treatment [6]. **People previously treated for TB (Fig. 5: WHO TB Report 2023) [6].**



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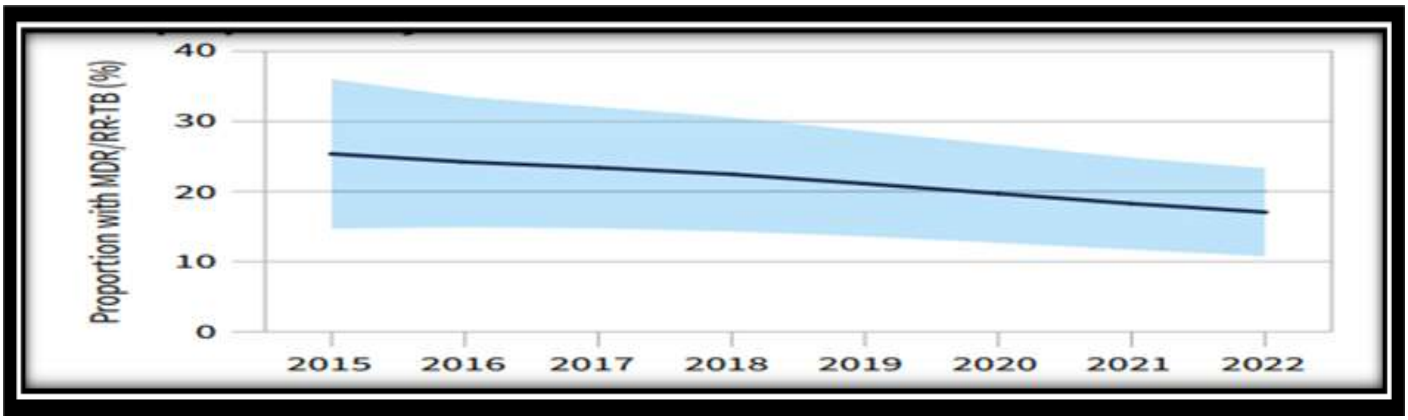
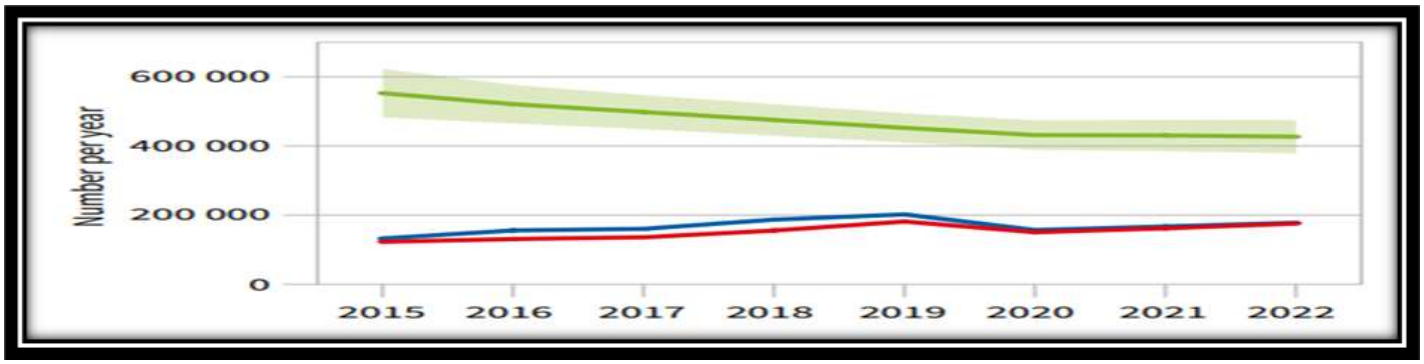
Global trend in the estimated percentage of people with TB who had MDR/RR-TB, 2015–2022 (Fig. 6: WHO TB Report 2023) [6].

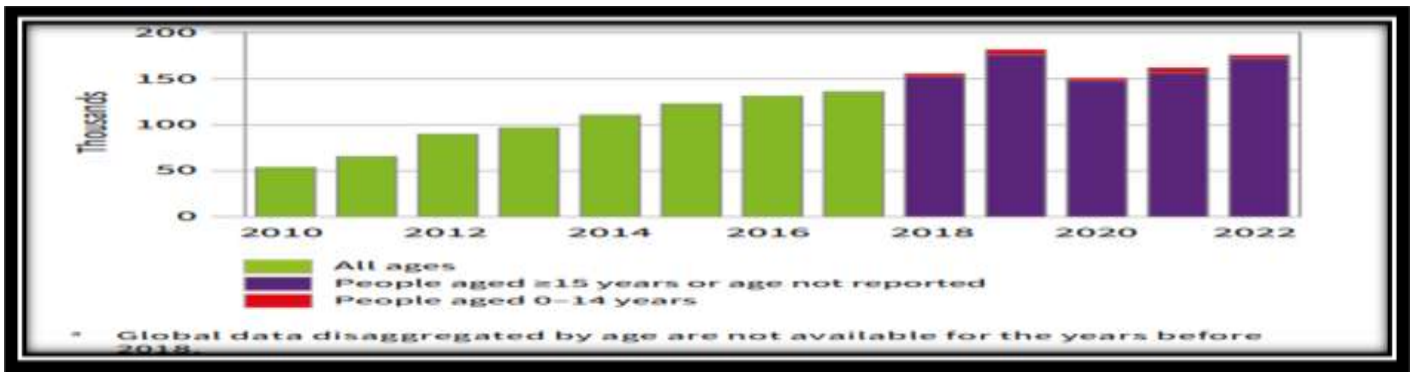


Globally in 2022, 73% of people (2.9/4.0 million) diagnosed with bacteriologically confirmed pulmonary TB were tested for rifampicin resistance. This was an increase from 69% (2.4/3.5 million) in 2021 and above the pre-pandemic level of 62% (2.2/3.6 million) in 2019. Among those tested, 149,511 people with MDR/RR-TB and 27,075 people with pre-XDR-TB or XDR-TB were detected, giving a combined total of 176,586 cases (4.4% of those tested). Despite increased testing coverage and the absolute number of people tested, the number of people detected with MDR/RR-TB was lower in 2022 than in 2019 (when the total was 202,009, or 5.6% of those tested). This decline suggests a reduction in the proportion of people with TB who had MDR/RR-TB [6]. Worldwide, 175,650 people with MDR/RR-TB were enrolled in treatment in 2022, an increase of 8.5% from 161,843 in 2021, a rise of 17% from 150,510 in 2020, but still below the pre-pandemic level of 181,533 in 2019 [6].

Global number of people diagnosed with MDR/RR-TB (blue) and number enrolled on an MDR-TB treatment regimen (red), compared with estimates of the global number of incident cases of MDR/RR-TB (green), from 2015–2022 [6]. Fig. 7: WHO TB Report 2023 [6].



(The global number of people reported to have been enrolled in treatment for MDR/RR-TB, 2010–2022, Fig. 8: WHO TB report 2023) [6].



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Region: In 2022, the three countries accounted for 42% of the estimated global number of people who developed MDR/RR-TB. Countries like India (27%), the Philippines (7.5%), and the Russian Federation (7.5%), respectively. The highest proportions of (>50%) previously treated cases with MDR/RR-TB were found in the Russian Federation and several Eastern European and Central Asia countries. The eight countries ranked in descending order of the total number of RR-TB incident cases in 2022 were India, the Philippines, the Russian Federation, Indonesia, China, Pakistan, Myanmar, and Nigeria, respectively [6]. **Estimated number of people who developed MDR/RR-TB (incident cases) in 2022, for countries with at least 1000 incident cases (Fig. 9: WHO TB Report 2023) [6].**

Fig. 10: Chronology of the development of the NTEP [10].

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Treatment Regimens:

Table 1: For DR-TB [10].

Phases	Intensive phase	Continuation phase
MDR/RR-TB cases (Conventional)	6-9months of Kanamycin, Levofloxacin, Ethambutol, Pyrazinamide, Ethionamide, Cycloserine	18 months of Levofloxacin, Ethambutol, Ethionamide, Cycloserine
MDR/RR-TB Cases (Shorter regimen)	4-6 months kanamycin, High dose Moxifloxacin, Ethambutol, Pyrazinamide, Ethionamide, Clofazimine, high dose INH	5 months of high-dose Moxifloxacin, Ethambutol, Clofazimine, Pyrazinamide
MDR/RR and resistance to fluoroquinolones	6-9 months of Kanamycin, high-dose Moxifloxacin, Ethambutol, Clofazimine, Pyrazinamide, Cycloserine	18 months of high-dose Moxifloxacin, Ethionamide, Clofazimine, Cycloserine, Linezolid
MDR/RR and resistance to second-line injectables	6-9months of Capreomycin, Levofloxacin, Pyrazinamide, Ethionamide, Clofazimine, Cycloserine, Linezolid	18 months of Levofloxacin, Ethionamide, Cycloserine, and Linezolid
Isoniazid monoresistance or poly DR-TB	3-6 months of Levofloxacin, Kanamycin, Rifampicin, Ethambutol, Pyrazinamide	6months of Levofloxacin, Rifampicin, Ethambutol, Pyrazinamide
Extensive drug-resistant TB	6-12 months of Capreomycin, PAS, Moxifloxacin, high dose INH, Clofazimine, Linezolid, Amoxicillin, or clavulanate	18 months of PAS, Moxifloxacin, high-dose INH, Clofazimine, Linezolid, Amoxicillin or clavulanate

Table 2: Follow-Up Evaluation Schedule Of DR-TB Patients During Treatment on Various Regimen classes [10].

Regimen class	Regimen for H Mono, Poly DR -TB & with FQ SLI Lzd resistance	Shorter MDR-TB regimen	Conventional regimen MDR-TB regimen	Regimen for RR-TB with resistance to FQ SLI ± Lzd (Without newer drugs)	Newer drugs containing regimen for RR-TB with resistance to FQ -SU-±- Lzd
Duration	9-12 months	9-11 months	24-27 months	24-27 months (6-9m IP, 18m CP)	

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	(3-6m IP, 6m CP)	(4-6m IP, 5m CP)	(6-9m IP, 18m CP)	24-30 months in XDR & MPR (6-12m IP, 18m CP)
Clinical + Wt.	As suggested by the treating clinician, at least monthly in IP and quarterly in CP			
Smear Microscopy	Monthly till the end of IP, monthly in extended IP only if the previous month S + ve		With culture at C-DST labs	
Culture	End of IP, end of extended IP & end of treatment		Monthly from 3m to the end of IP if converted, monthly in extended IP only if previous month's culture + ve, quarterly in CP, 2 consecutive monthly if any culture + ve from 12m onwards	
DST (Drug Susceptibility Testing)	SL-LPA if S+ve/C+ve at the end of IP &/or extended IP & expanded DST SL-LPA if C+ve at end of IP &/or extended IP or any time If any resistance to SL-LPA		SL-LPA if C+ve at the end of IP &/or extended IP or any time If any resistance on SL-LPA in CP & expanded DST, if any resistance on SL-LPA	
S. Creatinine	Monthly till 3m, then every 3m till the SLI course is completed			
Audiometry	As and when clinically indicated till the SLI course is completed			
UPT (Urine Pregnancy Test)	As and when clinically indicated			
CBC/Hb/platelets (1)	As and when clinically indicated			Monthly in IP. Quarterly in CP
CXR (Chest Radiography), TSH (Thyroid-stimulating hormone & LFT (Liver function test (2)	As and when clinically indicated	At the end of IP, as and when clinically indicated CXR also at the end of treatment		
ECG (Electrocardiography) (3)	As and when clinically	At 2 weeks, monthly	As and when clinically	At 2 weeks, monthly in IP, as and when clinically indicated

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	indicated	in IP, as and when clinically indicated	indicated	
S. Electrolytes (Na, K, Cl)	As and when clinically indicated		Quarterly in IP as and when required	
S. Mg, Ca, Amylase, Proteins, Lipase	As and when clinically indicated		Quarterly in IP as and As and when clinically indicated, when required	
Specialist cons	As and when clinically indicated			
Long-term follow-up	at 6, 12, 18, and 24 months after completion of treatment, and if found symptomatic, clinical evaluation, and CXR. Smear and culture. DST would be repeated if the culture is positive.			

1. CBC/ Hb/Platelets done to rule out bone marrow suppression and Anaemia only if Linezolid is included in the regimen.
2. HBsAg and other viral markers (Hepatitis A, C & E) to be done on signs of jaundice during treatment.
3. In patients with baseline ECG abnormalities, ECGs must be done daily for the first 15 days if the case is managed with a regimen containing high doses of moxifloxacin (Mfxh), Bedaquiline (BDQ), Clofazimine (CFZ), and further frequency as advised by the cardiologist. Repeat ECG after an hour if abnormal at any time to reconfirm with long lead II for one minute [10].

Epidemiological Parameters: The most common sociodemographic characteristics of individuals with drug-resistant tuberculosis include being economically productive, typically within the age group of less than 45 years. Males are affected high proportion compared to females. Many of these individuals are married, have an education up to the primary level, and reside in rural rather than urban areas. They are predominantly daily workers (labourers) and belong to low socioeconomic classes. Additionally, the majority of these families live in joint households and hold below-poverty-line ration cards [11,12,13]. **Drug Resistant Pattern:** DR-TB has different types of drug resistance patterns to TB medications. RR-TB is the most common, frequently occurring type of pattern, followed by MDR-TB, and XDR-TB is the least common type of pattern drug resistance, respectively [12]. The DR-TB treatment regimen is a fixed-dose combination (FDP) based on weight and high daily dosage. It is the longer period of the course of treatment. Medication adherence is one of the most challenging factors. It's associated with various adverse drug reactions. Gastrointestinal upset, fatigue, headache, vertigo, drowsiness, loss of appetite, ringing of ears, skin lesions (arthralgia), joint pain, oral ulcer, and visual problems were more common adverse drug reactions encountered with DR-TB patients [11,12]. **Risk Factors:** The risk factors for drug-resistant tuberculosis (DR-TB) include age, and males are more at risk compared to females. Daily workers, individuals from low socioeconomic classes, and those exposed to environmental conditions such as overcrowding and inadequate ventilation are also more susceptible. Common comorbidities that increase risk include diabetes mellitus and HIV-TB co-infection. Substance abuse, such as frequent tobacco chewing, smoking, and alcoholism, is at risk. Other risk factors associated with DR-TB patients include previous treatment for tuberculosis, poor adherence to the basic DOTS plus strategy, excessive use of TB drugs outside the ongoing program, low body mass index (BMI), and pallor, respectively [11,12,13,14,15,16,17]. **Socio-Economic Effect and NPY:** In addition to the NTEP's provision of free diagnostics, free drugs, and Ni-kshay Poshan Yojana (NPY) benefits to all TB patients notified from both public and private sectors, the Government of India has launched "The Pradhan Mantri TB Mukt Bharat

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Abhiyaan," envisioned to bring together all community stakeholders to support those on TB treatment and accelerate the country's progress towards TB elimination by augmenting community [12,13]. **Causes Of Inadequate Treatment For DR-TB:** The main causes of inadequate treatment for drug-resistant tuberculosis can be categorized into three groups. Inadequate regimen issues are the absence of or inappropriate guidelines, non-compliance with guidelines, inadequate training of health staff, and a lack of treatment monitoring. Drug-related issues are the non-availability of certain drugs (e.g., stockouts or delivery disruptions), poor quality of drugs, poor storage conditions, incorrect dosages, and drug combinations. Patient-related issues are poor adherence to treatment (poor DOTS services), lack of information about the disease and treatment, lack of advanced technology and infrastructure, non-availability of free drugs adverse drug reactions, social and economic barriers (isolation, lack of support, social stigma, fear of disease and drugs, low socio-economic class and financial burden), malabsorption, and substance abuse disorders. These categories reflect the complex challenges involved in managing drug-resistant tuberculosis effectively [13,14].

Indian and International Articles Review: An observational study was done by Gaurav Derashri et al. (2022) in Madhya Pradesh, India. In this study, male cases, the age group < 45 years, and RR-TB were the most common findings. The main reasons for defaulters were feelings of improvement, side effects of drugs, financial strain, unavailability of drugs, etc. [11]. A cross-sectional study was done by Nalini Prava Das et al. (2022) in Odisha, India. The highest number of study participants was within the 18-45 years age group, males, living in rural areas and engaged in labour work, low socio-economic class, rifampicin resistance type, symptom was cough, and gastrointestinal upset was the common adverse drug reaction encountered during therapy [12]. A cross-sectional study was done by Manila Sharma et al. (2019) in South Delhi, India. The risk factors like middle age, consumption of alcohol, pallor, treatment failure, and the number of prior courses of anti-tuberculosis treatment taken were significantly associated with drug resistance [13]. A cross-sectional study was done by Amit M Shah et al. (2018) in Gujarat, India. The reasons for poor adherence, adverse drug reactions, substance abuse are most commonly seen in the middle-aged group, smokers, alcoholics, tobacco chewers, and body mass index below the normal range, living with HIV, diabetes mellitus, low socioeconomic status, secondary MDR-TB, not completed the treatment [14]. A record-based cross-sectional study was conducted by Kumar R et al. (2013-2015) in Davangere, Karnataka, India. The factors influencing to development of MDR-TB were age, gender, pattern of resistance, and high random blood sugar level. The main component in stopping the spread of MDR-TB was to rapidly diagnose and initiate a treatment regimen [15]. A hospital-based, cross-sectional study was carried out by Venkatesh U et al. (2015-2016) in Gorakhpur division, Uttar Pradesh, India. The majority of study cases were male gender, the mean age was 32.15 ± 13.19 years, overcrowding, inadequate ventilation of living rooms, history of contact with TB cases, practices of unhygienic sputum disposal methods at home and in public places, history of irregular treatment, and were resistant to isoniazid (H) and rifampicin (R), HIV positive and history of diabetes [16]. A hospital-based cross-sectional study was done by Raazi J et al. (2015) in Allahabad, Uttar Pradesh, India. The younger age, male gender, with previous TB treatment, previously on non-DOTS treatment, incomplete previous TB treatment, positive contact history of MDR-TB cases, presence of associated co-morbidities, and substance abuse were significantly associated with MDR-TB patients than Non-MDR-TB patients ($p<0.05$) [17]. A descriptive cross-sectional study was done by Gautam P B et al. (2017) in Gorakhpur, Uttar Pradesh, India. The majority were MDR-TB, males, 20-40 years age group, pulmonary type, previously treated, relapse type, HIV test positive. The previously treated cases were significantly associated with RR-TB [18]. A descriptive study was done by Avashia S et al. (2015-2016) in Indore, Madhya Pradesh, India. The highest study patients were from the age group 21- 40 years, MDT-TB, young males, urban slums, followed by undeveloped rural areas, positive for contact and family history, HIV positive, primary MDR cases, treatment failure, treatment interrupted, and a mean body index between 10 –15Kg/M^2. Greater emphasis should be given to screening and treatment, awareness regarding proper nutrition and proper dietary supplements, health education, program awareness, and strict compliance monitoring [19]. A hospital, record-based study was conducted by Rai D K et al.

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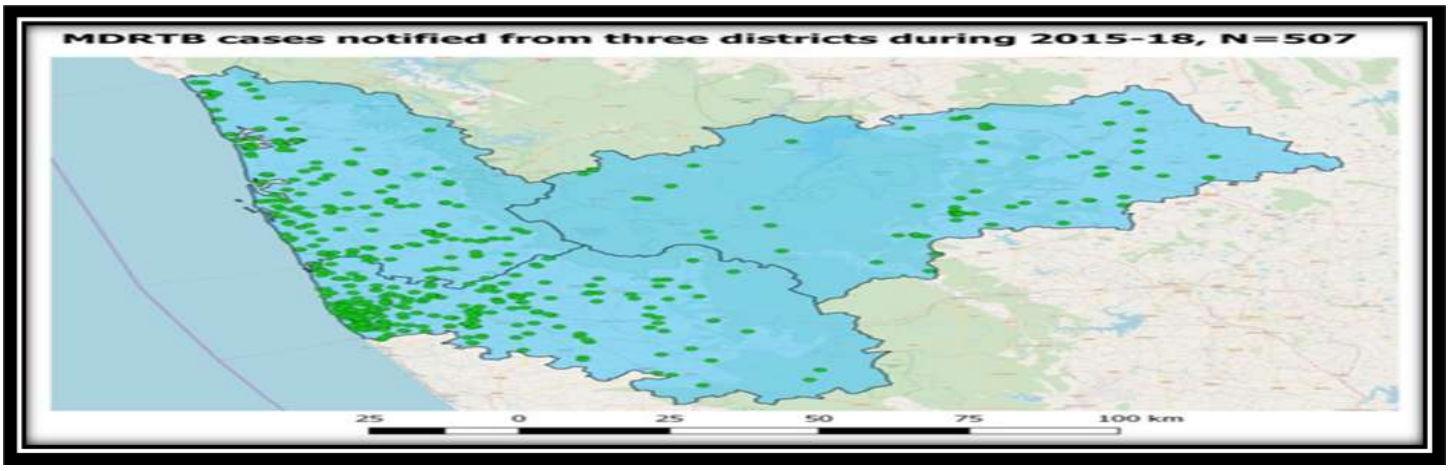
(2016-2017) in Patna, Bihar, India. The most common symptom was cough [20]. A descriptive cross-sectional study was carried out by Basu et al. (2016-2017) in Kolkata. West Bengal, India. In DR-TB control, the main focus should be on the younger age group, as the number of resistance has increased among them. Relapse in previously cured cases was found to be a major contributor to DR-TB suspect cases. The early detection, treatment, and nutritional improvement of drug-resistant TB cases were needed [21]. A record-based cross-sectional study was done by Awasthi S et al. (2015) in the Kumaun Region, Uttarakhand, India. The majority belonged to the younger age group, males, undernutrition, alcohol, smoking, on treatment for TB. Relapse was found to be the major contributor to MDR-TB [22]. A cross-sectional study was conducted by Nagendra Singh Chauhan et al. (2019) in Tundla, Firozabad, Uttar Pradesh, India. The majority were males, clinical features were fever, MDR-TB resistance type, and pulmonary cases. The parameters like clinical features, type of resistance, and types of TB showed statistical significance (if $P < 0.05$) [23]. A hospital-based, descriptive, cross-sectional study was done by Santosh Kumar et al. (2016-2017) in Agra, Uttar Pradesh, India. The relapse of previous antituberculosis treatment was found to be a major contributor to MDR-TB suspects, as 96.58% had taken ATT previously. Early diagnosis of drug resistance, quality DOTS services, and rational use of anti-TB drugs prevented the emergence of MDR-TB as a major public health problem. Adequate dose, duration, and regimen were the keys to success in the treatment of tuberculosis and the prevention of drug resistance [24]. An observational cross-sectional study was done by Choudhary A. et al. (2015) in Allahabad,Uttar Pradesh, India. The proportion of MDR-TB was high among them, retreatment, 21-40 age groups, males, married, and rural dwellers, low BMI, history of TB contact in the family, Pulmonary TB, and illiterates, respectively. The proportion of MDR-TB was high among retreatment cases in north India. Among them, low BMI and education status were modifiable factors, and the burden can be reduced by improving a case's health and education status [25]. A descriptive cross-sectional study was done by Dr. Niranjan Kumar Sit et al. (2015-2016) in Burdwan, West Bengal, India. More than 2/3rd were males, age group 18-55 years, educated up to primary level, living in overcrowded and ill-ventilated houses, belonging to upper, lower, and lower class (IV & V) on Kuppuswamy socioeconomic status 2014, MDR-TB type, pulmonary TB, and relapse cases. It was the primary cause of the financial crunch and lack of knowledge. Most of the patients perceived some degree of improvement in their condition following the treatment [26]. A cross-sectional study was carried out by Basavaraj Poojar et al. (2015-2018) in Dakshin Kannada and Udupi, Karnataka, India. From 2015 to 2018, the number of cases increased from 85 to 209 per year, the area of aggregation in square kilometers rose from 113.6 to 205.7, and the number of rectangular grids with more than the expected DR-TB patients more than one increased from 12 to 47. The increase in the number of DR-TB patients, area of aggregation, and grids with more than the expected count was a cause for concern. The NTP used routine programmatic data to develop maps to identify disease aggregation areas for targeted TB control activities [27].

Fig. 12: spot map of drug-resistant TB patients in the state of Karnataka, India [27] .



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A hospital-based cross-sectional study was conducted by Nagpal M et al. (2014-2015) in Amritsar, Punjab, India. The various treatment outcomes were observed: 30 (34.5%) cured, 19 (21.8%) treatment completed, 18 (20.7%) died, 13 (14.9%) defaulted, 4 (4.6%) shifted to the XDR-TB regimen, and 3 (3.4%) failed, respectively [28]. A prospective cross-sectional study was carried out by Mukati et al. (2019) in Ujjain, Uttar Pradesh, India. The majority were 31 to 40 years old males, underweight, defaulter cases, anemia, followed by diabetes mellitus, others like HIV, thyroid, asthma, and COPD, respectively. Most of the patients had taken anti-tuberculosis treatment from the RNTCP, in which defaulter and relapse were the major contributors to MDR-TB. Management of comorbidities was essential for compliance with treatment. It required prolonged hospitalization and frequent follow-up in the DR-TB center [29]. A cross-sectional study was carried out by Uike P et al. (2013) in Yavatmal, Maharashtra, India. There was a total of 60 confirmed MDR and XDR-TB cases enrolled in the study. Male cases (65%) were comparatively more than the female (35%) gender group. Almost half (46.67%) of the patients belonged to the productive age group, i.e., 30-45 years, followed by another one-third (35%) in the age group of 15-30 years. 93.33% of patients were previously treated patients, out of them 48.51% were failures, 37.50% relapsed, and 14.29% were defaulters, respectively [30]. A retrospective type of cross-sectional study was done by OMP Giri et al. (2015-2016) in Darbhanga, Bihar, India. The majority belonged to males, MDR-TB. The mean age was 20.52 years. Adequate control of DR-TB was needed among youths [31]. A cross-sectional study was done by GS Kulkarni et al. (2016) in Nasik, Maharashtra, India. The main reasons for defaulting were becoming asymptomatic, feeling better, and medication side effects, respectively. The Isoniazid and rifampicin resistance (74.28%) were more than rifampicin monoresistance (25.72%), and there was a significant association between addiction of the patient and defaulting the previous antituberculosis treatment, The factors for drug resistance showed that MDR-TB which was more commonly seen in males, age between 21 to 40 years, low socioeconomic status, history of ATT, defaulted on previous antituberculosis treatment, alcoholic and tobacco addiction [32]. A hospital-based observational cross-sectional study was conducted by Manna N et al. (2014) in Kolkata, West Bengal, India. 53.6% of cases disposed of their sputum/ expectorations in a pot kept at the bedside and later disposed of in bathrooms. 29.2 % spitted on roadsides and the rest in their toilets [33]. A hospital record-based study was conducted by Mukherjee P et al. (2013) in Kolkata, West Bengal, India. The majority were between 21-30 years, whereas males were predominant (61.62%) and females were significantly younger compared to males (p=0.002). Most of the patients (59.9%) were underweight (BMI <18.5kg/m2). The HIV seropositivity and XDR-TB were found in 2.9% of each group. Most of the MDR-TB cases were relapse cases (35.46%). The associated comorbidities were COPD and DM. The relapse of previous antituberculosis treatment was found to be a major contributor to MDR-TB. Early diagnosis of drug resistance from all re-treatment cases, quality DOTS services, more control, and rational use of second-line anti-TB drugs could prevent the emergence of MDR/XDR-TB as a major public health problem [34]. A cross-sectional study was carried out by Bhatt G. et al. (2013) in Ahmedabad City, Gujarat, India. The >2/3rd were males, belonged to the age group 16-45 years, educated up to primary level, living in overcrowded and ill-ventilated houses. The majority initially, almost all had pulmonary TB, started with category II, defaulters, and the main cause was the financial crunch. The mean number of Anti-Tubercular Treatments (ATT) taken before the start of category IV was 2.85. More than 90% experienced side effects of drugs and unsafe sputum disposables. The >2/3 cases showed MDR-TB and 1st lined drugs. Smear and culture conversion rates at three-month follow-up were 62.0% and 58.7% respectively. Only one patient (1.2%) was reactive for HIV [35]. A single-centric cross-sectional observational study was carried out by Adarsh N et al. (2018) in Mangalore, Karnataka, India. Rifampicin-resistant, multidrug-resistant TB (MDR-TB) among new treatment-naïve, sputum-positive presumptive tuberculosis cases was 4.4%. The positive contact history, poorly controlled diabetes mellitus, heavy alcohol consumption, and BMI (<17 Kg/M^2) were found to be significant risk factors for primary MDR-TB [36]. A cross-sectional study was carried out by Parashuram Rao et al. (2011-2014) in Udupi, Karnataka, India. A total resistance of 33.4% was observed, which includes the mono-resistance of 22.5%, multidrug resistance (MDR) of 6.3%, and extensive drug resistance (XDR) of 0.3%.

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Category 2 patients were important risk for the development of MDR in pulmonary tuberculosis. Due to high mortality and low cure rate in MDR [37].

A descriptive cross-sectional study was done by Porwal C et al. (2010) in Delhi, India. Factors associated with DR-TB were family history of TB, socioeconomic status, concomitant illness, and previous intake of 2nd line injectable drugs. 2 cases had HIV, but culture for M. tuberculosis was -ve, and no significance with Pre and XDR-TB. There was a presence of lack of literature on XDR-TB in India and a need for program strengthening at different levels [38]. A descriptive retrospective type cross-sectional study was done by Dholakia N Y et al. (2010) in Mumbai, Maharashtra, India. Out of the 29 cases, 3 (11%) were mono-resistant, 20 (69%) were multidrug-resistant (MDR-TB) with E/Z/EZ resistance; 4 were pure MDR-TB. One case had XDR TB, and 13 (44.8%) had resistance to at least one conventional second-line drug, respectively. The 7 cases had adverse drug reactions (ADR), whereas 4 required drug substitutions. The 2 patients were on treatment, 27 (51%) were successfully treated, 5 (18%) died, 2 (7%) failed treatment, 5 (18%) were lost to follow-up, and 1 migrated. The high levels of drug resistance due to the amplification of drugs cause poor outcomes. There was an urgent need to introduce daily DOTS for susceptible cases, DST for all new cases, and scaling up DST for second-line drugs, and also a need for treatment for DR-TB [39].

A retrospective type of cross-sectional study was carried out by SS Shivekar et al. (2013-2018) in Tamil Nadu and Pondicherry, India. The Rifampicin mono-resistant and Isoniazid mono-resistant TB were found in 5.4%, 2.5%, and 11.4% cases of presumptive MDR-TB, respectively. The presence of the (RNA polymerase) rpoB gene, true resistance, hetero-resistance, and inferred resistance to Rifampicin was found in 38%, 29.3%, and 32.7% of the 1582 MDR cases, respectively. S450L (MUT3) was the most common rpoB mutation present in 59.4% of the Rifampicin-resistant cases. Out of 3390 Isoniazid-resistant cases, 72.5% had mutations in the katG gene, and 27.5% had mutations in the inhA gene. True resistance, hetero resistance, and inferred resistance accounted for 42.9%, 22.2%, and 17.3% of the 2459 kat-G resistant cases. True resistance, hetero resistance, and inferred resistance for the inhA gene were found in 54.5%, 40.7%, and 4.7% cases, respectively. MDR contact, treatment failure, and female gender were associated with MDR-TB, whereas Previous TB treatment, old age, and HIV were not associated with MDR-TB. The rifampicin mono-resistance had a positive association with treatment failure with a negative association with previous TB treatment, or with a history of contact with MDR-TB. However, the INH mono-resistance showed a positive association with a prior history of treatment and MDR-TB contacts. It was developed due to a lack of treatment adherence, which may easily lead to the development of Rifampicin resistance. The MDR-TB resistance developed due to treatment failure, spread through contact, and was not treatment noncompliance. The temporal trend in this region showed a decrease in MDR prevalence from 8.4% in 2015 to 1.3% in 2018. A similar trend was observed for Rifampicin mono-resistance and Isoniazid mono-resistance. A higher proportion of inferred resistance was observed for Rifampicin compared with INH. The association of MDR-TB with age, gender, and HIV status suggested the role of the immune system in the emergence of the MDR phenotype [40]. A cross-sectional study was done by GS Kulkarni et al. (2016-2017) in Nasik, Maharashtra, India. 48.83% of patients showed resistance to fluoroquinolone, 20.93% showed resistance to XDR with second-line injectables, and 30.23% with fluoroquinolones + second-line injectables, where maximum resistance was seen in ofloxacin (81.4%), followed by kanamycin (44.2%). 41.86% of patients were diabetics, showing that drug resistance was more prevalent in the population. Maximum defaulters (80%) from the lower class were involved in the emergence of drug resistance. Fluoroquinolones and second-line drugs were administered rationally and considered to prevent widespread drug resistance [41]. The comparative cross-sectional study was conducted by Maharjan S et al. (2015-2016) in Nepal. 37.2% were resistant to any four anti-TB drugs. 11 (28.9%) were initially drug-resistant, and 28 (43.7%) acquired drug resistance during treatment. The overall prevalence of MDR-TB was 11.7%, of which 2 (5.3%) were initial MDR-TB and 10 (15.6%) were acquired MDR-TB. The female gender was significantly associated with MDR-TB. The most common resistance pattern was observed in both isoniazid and rifampicin (MDR-TB). Thus, the early diagnosis of TB and the provision of culture and DST were crucial to combat the threat of DR-TB [42].

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A prospective type of cross-sectional study was done by Pandhi N et al. (2018) in Amritsar, Panjab, India. 147 (73.5%) were drug-susceptible, and 53 (26.5%) were drug-resistant. Among the DR-TB cases, 21 (18.7%) were new and 32 (36.4%) were previously treated cases. The rifampicin mono-resistance was higher in both new (47.6%) and previously treated (37.5%) drug resistance cases. The majority of the cases with DR-TB had a previous history of ATT. The risk factors associated with DR-TB are female gender and a previous history of anti-tubercular therapy [43]. A hospital-based cross-sectional study was carried out by Gupta S et al. (2020) in Kolkata, West Bengal, India. Most of them (73.3%) were malnourished (BMI < 18.5). 62.2% of patients belonged to the 'below poverty line' (BPL) category, and 82.2% of patients lived in overcrowded rooms. The majority of them (82.3%) either had a history of tuberculosis or a history of contact or both [44]. A community-based cross-sectional study was conducted by Rupani M P. et al. (2016) in Bhavnagar, Gujarat, India. Of the 94 cases, 7.4% were compelled to think of discontinuing their treatment due to ADRs; 8.5% had discontinued Cat-I/Cat-II regimen in the past; 11.7% had discontinued their MDR-TB regimen in the past; 13.8% had their drug regimen changed due to ADRs and 94.7% had good adherence to their current regimen (took at least 80% of their doses till date). ADRs were the reason for 75% of the patients who discontinued their Cat-I/Cat-II regimen in the past, and 64% of the patients who discontinued their MDR-TB regimen in the past. Tobacco chewing, poor adherence, and the thought of discontinuing an MDR-TB regimen due to ADRs were significant predictors for discontinuation of treatment. The frequency of ADRs among patients with MDR-TB was high and a major reason for discontinuing MDR-TB drugs [45]. A hospital-based cross-sectional study was done by Swamy P N. et al. (2021) in Chennai, Tamil Nadu, India. According to Naranjo's scale, the causality assessment was done and observed among the 129 cases. According to Naranjo's causality assessment, most of the ADRs were possible, followed by probable, and most of the ADRs were observed to have moderate severity, followed by mild severity [46]. A hospital-based cross-sectional study was conducted by Patil S et al. (2017) in Navi Mumbai, Maharashtra, India. A Cough was the most common complaint in both patient groups. The most common side effect reported was gastritis (55%). Early diagnosis and treatment for side effects and more studies were needed [47]. A cross-sectional study was carried out by Mahata G et al. (2016-2017) in Bardhaman, West Bengal, India. The most common adverse drug reactions on the gastrointestinal system were nausea in 73 patients (96.10%), vomiting in 70 (92.10%), and acidity in 41 (53.9%). These were common in the first 60 days of the regimen and in patients with a BMI ≤18 Kg/M^2. Vigilant monitoring was required for these patients during the initial period; sputum smear and culture conversion were very well correlated with clinical and radiological improvement [48].

A hospital-based cross-sectional study was done by Gupta S et al. (2018-2019) in Kota, Rajasthan, India. About 60.74% of all ADRs were managed by symptomatic treatment. 32 (21.62%) patients required a change of regimen. 12 (8%) patients discontinued treatment due to adverse reactions. The treatment of MDR-TB with second-line antitubercular drugs was associated with a high rate of adverse effects experienced in more than half of the patients. Ototoxicity and neuropsychiatric symptoms were major adverse effects that led to an important drug being removed from the regimen. [49]. An observational study was carried out by Ahmed A. et al. (January 2015 to December 2015) in Bangalore, Karnataka, India. The majority of ADRs reported were Gastrointestinal symptoms (29.2%). The highest percentage of ADRs was seen in patients in the age group>60 years (66.7%). ADRs were most commonly reported in the first 3 months of initiation of therapy. 9 out of 72 patients (12.5%) or 20.5% of 44 patients who showed ADRs required a change of treatment. There was a significant impact of adverse drug reactions on treatment among those with ADRs (p=0.01). ADRs were varying with severity in MDR-TB cases, which occurred in more than half of the cases, with around one-fifth requiring a change of MDR-TB treatment [50]. An observational study was carried out by Fatima S. et al. (2015 to 2018) in Warangal, Telangana, India. 236 (ADRs) were reported among 400 patients. ADRs were found more among males and in the age group of 36–75 years. Most commonly encountered ADRs include nausea and vomiting (35.31%). 53% were of the possible category, 60% of the moderate to severe level, and 85% were unpreventable ADRs, respectively. A higher incidence in males. [51]. An observational study

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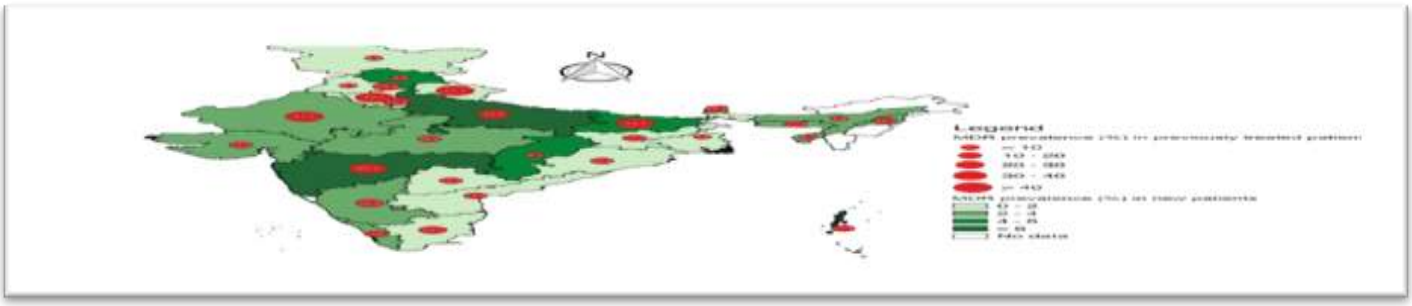
was carried out by Shinde MP, et al. (2014-2015) in Miraj, Maharashtra, India. 60 (12.82%) patients developed at least one adverse reaction and were hospitalized for the same. Gastrointestinal upset was the most common ADR [52]. An observational study was done by Gaude G. et al. (2013) in north Karnataka, India. The resistance to rifampicin was highest (80.4%). MDR-TB isolates were obtained in 52.2% of the cases. Illiteracy, low socio-economic status, previous history of TB, and alcoholism were found to have statistically significant associations with the development of MDR. The prevalence of drug resistance in this study was observed to be 69.7%. During the initiation of a new case, proper explanation and completion of the treatment were very important to avoid the development of future drug resistance in society [53]**.** An observational study was conducted by Latha S et al. (2021) in Northern Karnataka, India. Incidence of ADR was 32 (46%), and the commonly reported ADR was nausea. The causality assessment was done using the "Naranjo algorithm." The majority were probable (79.01%), and as per the modified Hartwig and Siegel severity scale, most ADRs were mild (87.65%). The history of TB and exposure to ATT were the major risk factors associated and were statistically significant (P = 0.009). Early recognition of the regimen and appropriate management might determine treatment adherence, prevent complications, and improve overall treatment outcomes [54]. A prospective study was conducted by Maharia D et al. (2020) in Bikaner, Rajasthan, India. The most DR-TB occurred in previously treated cases (80%), and 20% of cases were newly diagnosed cases of TB. A well-administered and dedicated first-line treatment in susceptible cases was needed to prevent the development of resistance [55]. **National level:** A state-wide prevalence of MDR-TB/RR-TB systemic review and meta-analysis was done by A. Lahiya et al. in 2020 in India. The prevalence of MDR, any drug resistance, and extensive drug resistance was 3.5%, 24.9%, and 0.06% among new cases and 26.7%, 58.4%, and 1.3% among previously treated cases, respectively. MDR prevalence among presumptive MDR, pediatric, and HIV-coinfected TB patients was 23.3%, 5.1%, and 18.8%, respectively. MDR prevalence among new TB patients was highest in Maharashtra, Uttar Pradesh, Bihar, Rajasthan, etc. The lowest is in Telangana, Andhra Pradesh, Tamil Nadu, etc. [56, 57]. **(Fig. 11: A. Lahiya et al. / Journal of Global Antimicrobial Resistance 2020-2022) [57]: Map of India showing the state-wise prevalence of MDR in new and previously treated patients.**



Tuberculosis has a long period of disease that has different effects on a patient's life, both directly and indirectly. The different types of social and economic impacts were unemployment, discontinued schools, lack of support from family and friends, social isolation, loss of family income source, treatment costs, and other expenditures, fear, anxiety, social stigma, dependency, and increased mental issues like stress and depression [58]. The National Tuberculosis Control Program (NTP) of India was launched in 1962. It relied on BCG, X-ray-based diagnosis, Streptomycin, and INH-based treatment, centralized at the district level. Based on a review of the NTP and WHO's recommendations of the DOTS Strategy, the Government of India revised the NTP and launched the Revised National Tuberculosis Control Program (RNTCP) in 1997. It used sputum microscopy at DMCs (Designated Microscopy Centers) for diagnosis, and multidrug short-course antituberculosis therapy was decentralized at the TU (TB Unit) level [58]. The social, economic, and psychological impacts were more severe and long-term in drug-resistant TB (DR-TB). The most common observations were losing their sense of identity due to their inability to work,

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social isolation, economic stress, and stigmatization from family and friends [59]. In recognition of the increasing drug resistance issue, the DOTS Plus/ PMDT (Programmatic Management of Drug-Resistant TB) was launched in 2006 and scaled up to the entire country by 2012. To further strengthen the monitoring and supervision system, a case-based notification system called Ni-kshay was introduced in 2012. The same year, Tuberculosis was added as a notifiable disease by all healthcare providers at the point of diagnosis [59]. Other key milestones from 2012 to 2020 include the development of the Standards of TB Care in India (STCI) in 2014, the introduction of the daily weight band-wise Fixed Dose Combination (FDC) in 2016, and the introduction of new drugs like Bedaquiline and Delamanid in 2017 and 2018, respectively. To emphasize the commitment of the Government of India and to accelerate efforts towards TB elimination, RNTCP was renamed "National Tuberculosis Elimination Programme (NTEP)" in 2020 [61]. Nutrition-TB App (N-TB App): The Yenepoya Institute in Mangalore developed this software with the cooperation of the McGill International TB Center in Canada, the RNTCP, and the WHO. The Nutrition-TB App (N-TB app) was created by the Common Technical Document (CTD) with assistance from partners to simplify the technical execution of nutritional assessment and appropriate supplementation. The App was a mobile-based program that made evaluation, counseling, and care for adult tuberculosis. It was free to download from the Google Play and IOS app stores [62].

Results And Discussion: The present review was done to compare sociodemographic profiles, clinical symptoms, drug resistance patterns, adverse drug reactions, and factors associated with drug-resistant tuberculosis patients. Drug-resistant tuberculosis major public health problem. It had a long duration for the disease and treatment. It was responsible for the increase in the burden. The results were discussed in the following sections and compared with other studies conducted in different regions.

Socio-Demographic Characteristics: Age: Age factor was statistically associated with drug-resistant tuberculosis. Manila Sharma et al. did a similar study (2019) in South Delhi. The majority were (21-60) years of age and associated with DR-TB patients [13]. A similar study was done by Ahmed et al. (2015) in Karnataka. The majority of patients belonged to the economically productive 45-year age group. The mean age was 35.86±12.62 years [50]. The same study was done by Basavaraj Poojar et al. (2015-2018) in Karnataka. They also found that a slightly higher mean (SD) age was 41.4(13.9) years old [27]. Gaurav Derashri et al did a similar study (2022) in Madhya Pradesh. They found that the age factor is associated with drug-resistant tuberculosis. It was more among the economically productive age group. It may be due to the high exposure rate of various risk conditions [11]. **Gender:** Venkatesh U et al. did a similar study (2015) in Uttar Pradesh. They also found that the majority were males as compared to females [16]. Raazi et al. did a similar study (2015) in Uttar Pradesh. They also found that the most patients were male (62.96%) male gender. Gaurav Derashri et al did a similar study (2022) in Madhya Pradesh. They found that the gender factor was associated with drug-resistant tuberculosis. It may be due to high exposure to various outside risk conditions [11]. **Religion:** Manila Sharma et al. (2019), South Delhi. They found the majority of patients were Hindu religion [13]. Venkatesh U et al. did a similar study (2015-2016) in Uttar Pradesh. Their study also made similar findings that the majority of study participants belonged to the Hindu religion [16]. It was a high proportion among Hindus may be due to the study areas being predominantly inhabited by Hindus and their cultural factors. **Marital status:** A study was done by Manila Sharma et al. (2019), South Delhi. Most of their study participants were married (60.4%) compared to unmarried. Rupani M P et al. did a similar study (2016) in Gujarat. Their study also found that the majority were married, and marital status was not associated with DR-TB patients [45]. Gaurav Derashri et al did a similar study (2022) in Madhya Pradesh. They found that the marital factor is associated with drug-resistant tuberculosis, contradicting the study by Rupani M P et al. study findings [13]. Marriage is a universal phenomenon; it may be dependent on sociocultural factors. **Residence:** Gaurav Derashri et al did a similar study (2022) in Madhya Pradesh. They found that more than half of patients reside in rural and hilly remote areas than in urban areas, and no association between residence factors with drug resistance [11]. Venkatesh U et al. did a similar study (2015-2016) in Uttar Pradesh. Their study also had a similar finding that a higher proportion of study participants belonged to (87.3%) than (12.7%) [16]. It was more common in rural areas, maybe be to a lack

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of health infrastructure, poor adherence to DOTS and other health services. **Educational status:** A study was done by Manila Sharma et al. (2019) in South Delhi. They found the majority of patients were studied up to the middle class, as compared to the illiterate, and the education factor did not show statistical significance with DR-TB patients [13]. Nalini Parva et al. did a similar study (2022) in Orissa. They also found that more than 2/3 of patients were literate [12]. A higher level of education helps in more healthcare-seeking behavior, easy to educate, and less development of infectious diseases. **Occupation:** Nalini Parva et al. did a similar study (2022) in Orissa. They found that a high proportion of patients were labourers [12]. Gaurav Derashri et al. did a similar study (2022) in Madhya Pradesh. They found that more than half of the patients were from the Labor class and had no association between occupational factors with drug drug-resistant TB patients [11]. It may be due to high exposure to risk conditions, lack of periodic screening and health care services, and less use of personal protective and occupational safety measures (masks and hand gloves). **Socio-economic status:** Venkatesh U et al. did a similar study (2015-2016) in Uttar Pradesh. Their study finds that more than half of the study participants belonged to the lower class [16]. Amit M Shah et al. did the same study (2018) in Gujarat. Their study also showed that the majority were from a lower socio-economic class, followed by a lower middle socio-economic class [14]. Drug-resistant tuberculosis infectious disease was more common in low-income countries. It is due to living in unhygienic conditions, less availability of high-quality health care services, and an increase in economic burden. **Type of ration card:** Gupta S et al. (2020), in West Bengal, their study also found that the majority (62.2%) belonged below the poverty line [44]. Rai D K et al. did the same study (2016-2017) in Bihar. Their study reported that a high proportion of the study participants had BPL ration cards [20]. Drug-resistant tuberculosis was most commonly seen below the poverty line due to a lack of access to high-quality healthcare facilities, economic burden, and living in unhygienic conditions. **Type of family:** Nagpal M et al. did a study (2014-2015) in Panjab. Their study reported that more than half of the population were living with (67.7%) nuclear families, followed by (32.2%) joint families. And the type of families not associated with drug-resistant tuberculosis [28]. **Family size:** Nalini Parva Das et al. did the same study (2022) in Orissa. They also found that the majority of participants belonged (70.3%) to less than 5 family members [12].

ENVIRONMENTAL CONDITION: Overcrowding: Venkatesh U et al. did a study (2015-2016) in Uttar Pradesh. Their study found that more than half of the study participants had an (82.8%) presence of overcrowding [16]. Niranjan Kumar et al. did a similar study (2015) in West Bengal. Their study also made similar findings that more than half of the study participants had a presence of overcrowding [26]. Overcrowding seems to be an important factor favorable to the spread of the disease. **Inadequate ventilation:** Venkatesh U et al. did a similar study (2015-2016) in Uttar Pradesh. Their study findings were that more than half of the study participants (72.7%) presence of Inadequate ventilation [16]. Niranjan Kumar et al. did a similar study (2015) in West Bengal. Their study also made similar findings that more than half of the study participants had the presence of Inadequate ventilation [26]. Inadequate ventilation seems to be an important factor in favor of the spread of the disease. **Indoor air pollution:** Ladha N et al. did a similar study (2022) in Rajasthan. Their study found that more than half of the study participants (62.7%) presence of Inadequate ventilation [63]. Indoor air pollution occurred due to the use of cooking fuel such as cow dung, firewood, the absence of a chulha, and natural and artificial ventilation in the kitchen, which leads to respiratory damage and increased respiratory tract infection, which seems to be an important factor favorable for the spread of the disease.

COMORBIDITIES: Hypertension: Nalini Parva et al. did a study (2022). They found that the second highest proportion of comorbidity was (24%) Hypertension [12]. **Diabetic mellitus:** Ladha N et al. did a study (2022) in Rajasthan. Their study had a finding that (3.3%) of participants had a presence of diabetic mellitus, which was not associated with DR-TB [63]. Atre et al. did a similar study (2011) in Maharashtra. Their study also found that a smaller proportion of study participants had Diabetic Mellitus. It was not associated with drug resistance [64]. Venkatesh U et al. did a similar study (2015-2016) in Uttar Pradesh. Their study found that (7%) of study participants had Diabetic Mellitus disease [16]. **HIV:** SS Shivekar et al. did the study (2013-2018) in Tamil

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Nadu and Pondicherry. They found that HIV was not associated with Drug-resistant Tuberculosis [40]. Atre et al. did a similar study (2011) in Maharashtra. Venkatesh U et al. did a similar study (2015-2016) in Uttar Pradesh. Their study found that (3.8%) of study participants were HIV positive [16]. **SUBSTANCE ABUSE: Smoking:** Venkatesh U et al. did a similar study (2015-2016) in Uttar Pradesh. Their study found that (43%) of study participants had smoking as a substance abuse [16]. Manila Sharma et al. did the same study (2019) in South Delhi. Their study reported that a high proportion of (41.7 %) smoking substance abuse, which was not associated with drug resistance [13]. Atre et al. did a similar study (2011) in Maharashtra. Their study also found that a smaller proportion of study participants had smoking as a substance abuse. It was not associated with drug resistance [64]. **Alcohol:** Venkatesh U et al. did a similar study (2015-2016) in Uttar Pradesh. Their study found that (12.7%) of study participants had smoking as a substance abuse [16]. Atre et al. did a similar study (2011) in Maharashtra. Their study also found that a smaller proportion of study participants had alcohol as a substance abuse. It was not associated with drug resistance [64]. **Tobacco chewing:** Maharia et al. conducted a study (2020) in West Bengal. They found that a higher proportion of tobacco chewing is substance abuse [55]. Venkatesh U et al. did a similar study (2015-2016) in Uttar Pradesh. Their study found that (14.6%) of study participants had smoking as a substance abuse [16]. Raazi et al. did a similar study (2015) in Uttar Pradesh. Their study also found that a higher proportion had tobacco chewing as a substance abuse. It was associated with drug resistance [17]. Substance abuse was one of the key factors increase in drug resistance. Most of the studies were conducted only on the presence of substance abuse, smoking, and alcohol, not on tobacco chewing, and it depends on the commonest type of substance study area. It was leading to the splitting of tobacco in different places, which caused the spread of infection. **PAST HISTORY: Family history of TB:** A study was conducted by Choudhary A. et al. (2015) in Uttar Pradesh. They also found an almost similar proportion of (29.7%) family history of tuberculosis in the past [25]. Avashia et al. did the same study (2015-2016). Their study found less of a family history of tuberculosis in the past [19]. The family history of tuberculosis in the past was important to screening all family members, and it helps to take early preventive measures and early initiation of TB preventive treatment. **Contact history of TB:** In a study done by Venkatesh U et al. (2015-2016) in Uttar Pradesh. They found a lesser proportion of the (21.7%) history of contact with confirmed TB cases [16]. In a study done by Raazi et al. (2015) in Uttar Pradesh. They found a lesser proportion of the (5.8%) history of contact with confirmed TB cases [17]. The contact history of tuberculosis in the past was important to screening all family members, and it helps to take early preventive measures and early initiation of TB preventive treatment. **FIRST POINT OF CONTACT:** Nalini Parva Das et al. (2022) in Orissa. Their study had a higher proportion of patients dependent on (72%) government healthcare services, followed by (16%) private healthcare services, and (8%) of DOTS centers [12]. It may be due to drug-resistant tuberculosis chronic infectious disease, more common in low socioeconomic loss of jobs, and classes with higher costs of treatment; hence, most families depend on government health care services to overcome the family income burden and cost of treatment. **ADAPTION OF SAFE SPUTUM DISPOSABLE:** Nalini Parva Das et al. (2022) in Orissa. And Bhatt G et al. (2013) in Gujarat [35]. Their study showed that the majority were not practicing safe sputum disposal (98%) among study patients [12]. In a study done by Venkatesh U et al. (20115-2016), they also found similar results; most of the study patients were not practicing (91.7%) safe sputum disposal [16]. Most of the study participants were unaware of safe sputum disposables. They will spread sputum around houses and open places like public toilets, roadsides, steps, etc., which can help spread the infection. **CATEGORIES OF DR-TB:** Nalini Parva Das et al. did the study (2022) in Odisha. They reported that the majority had new cases (64%), followed by old cases (36%), respectively. Out of previous cases, a high proportion were defaulters [12]. Pandhi N et al. (2018) in Panjab [43], Nagpal M et al. (2014-2015) in Panjab [29], Manila Sharma et al. (2019) in South Delhi [13], and Bhatt G et al. did the same study (2013) in Gujarat. They also found that the majority were defaulters in old cases [35]. It may occur in new cases due to a lack of health services, low economic status, no drug adherence, late detection of cases, and multiple use of higher antimicrobial drugs. **CATEGORIES BODY MASS INDEX:** Santosh Kumar et al. did the study

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(2016-2017) in Uttar Pradesh, most of the patients had (61.9%) Low BMI [24]. Basu et al did the same study (2016-2017) in West Bengal, India. Most of the patients had (56.6% a low BMI [21]. Atre et al. did a similar study (2011) in Maharashtra. Their study found that a higher proportion of study participants had (70.7%) low BMI followed by (29.3%). It was not associated with drug resistance [64]. BMI was influenced by multiple factors like lifestyle, socioeconomic conditions, and physical activities. It varies with geographic areas. More had working and low socioeconomic hence most of the patients had low BMI.

BCG IMMUNIZATION: Nalini Parva Das et al. (2022) in Orissa. Their study found that a higher proportion were vaccinated for the BCG vaccine (80.8%), respectively [12]. It prevents childhood and severe TB in children, not adult TB. **PALLOR:** Basu et al. did a study (2016-2017) in West Bengal. Their study found a higher proportion (94.3%) of pallor [21]. A similar study was done by Amit M Shah et al. (2018) in Gujarat. Their study also found that finding majority (59.6%) presence of pallor, and it was significantly associated drug drug-resistant tuberculosis [14]. It may be that drug-resistant tuberculosis is a chronic infectious disease that leads to loss of appetite, low BMI, malabsorption, and malnutrition. **NI-KSHAY POSHAN YOJANA:** In the Nikshay Poshan Yojana program monthly direct transfer of five hundred rupees is made for nutrition and transport support. Jeyashree K et al. did a nationwide survey (2018-2022) in India. More than 2/3 of patients knew and successfully installed nationwide (76.1%) installed nationwide. Half of the people have had one installment in the past [66]. Begum J et al. did the same study (2019) in Andhra Pradesh. They found that less than half of the people were aware of the (NPY) Nikshay Poshan Yojana, and 1/3rd of patients received one installment in one month [67]. The common reasons for less awareness and lack of getting NPY benefits were lack of communication, stigma, unawareness, ignorance, illiteracy, a multistep approval process, and technical issues were a few themes that emerged as difficulties encountered while utilization. **SYMPTOMS OF DRUG-RESISTANT TUBERCULOSIS:** Rai D K et al. (2016-2017), a study in Bihar. Their study found that the majority presented with cough, breathlessness, fever, anorexia, and minor haemoptysis [20]. The same study was conducted by Nalini Prava et al. (2022), Orissa. They found that most of the patients had symptoms like coughs and generalized weakness [12]. A similar study was done by Nagendra Singh Chauhan et al. (2015), Uttar Pradesh. Their study also showed major symptoms of DR-TB were cough, breathlessness, fever, and chest pain [23]. **DRUG-RESISTANT PATTERN:** SS Shivekar et al. (2013-2018), a study in Tamil Nadu. More than half of the patients had multidrug resistance, followed by rifampicin and isoniazid drug resistance respectively [40]. More et al. did a similar study (2017) in Maharashtra. They found that more than 2/3rd of patients had MDR-TB [65]. The same study was done by Bhatt G. et al. (2103), Gujarat. They found that more than 2/3 of patients had multi-drug resistant MDR-TB [36]. A similar study was conducted by Venkatesh U et al. (2015-2016) years Uttar Pradesh. Their study also showed that a majority of more than half of patients had MDR-TB, followed by RR-TB, HR-TB, XDR-TB, etc [16]. The same study was done by Dholankia N Y et al. (2010), Maharashtra. They also found that the majority were multi-drug resistant, followed by mono-resistant to first-line drugs, whereas minor extensive drug-resistant [39]. The drug resistance may be developed due to environmental factors influenced by changes in the genes of microorganisms, poor treatment adherence, and a previous history of use of multiple instances of higher antibiotics. **ADVERSE DRUG REACTION:** Drug-resistant tuberculosis requires long-term treatment, and most of the patients experienced mild to severe types of drug side effects. The study was conducted by Nalini Prava Das et al. (2022), Orissa. There findings majority were Gastrointestinal upset, fatigue, headache, and vertigo, whereas minors had psychiatry, vision problems, oral ulcer, skin lesions, convulsions, etc. [12]. A similar study was conducted by Gupta Set et al. (2108), Rajasthan. They also found the same findings, like the majority had Gastrointestinal symptoms of nausea, vomiting, joint pain, and headache [49]. Latha S. et al. also did the same study (2021) in North Karnataka. They also found that the majority were shown GIT symptoms like nausea, vomiting, joint pain, arthralgia, headache, etc. [54]. The drug-resistant treatment was long duration, and more numbers of drugs were added in fixed-dose combinations, hence drug reactions or side effects were induced during antitubercular

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therapy. To modified regimen and symptomatic treatment were needed.

Conclusion: Drug-resistant tuberculosis occurred high proportion of the economically productive age group (31-60 years, and the mean (SD) age was 37.87±14.51 years. The Majority belonged to the male gender, the Hindu religion, and married couples. More than half of the patients lived in rural areas, had education up to middle school, and worked in various labour industries, low socio-economic class according to the modified B.G. Prasad classification. More than half of the families had ration cards below the poverty line and belonged to nuclear families with 1 to 5 family members. More than 2/3 of study participants were exposed to different unhygienic environmental conditions like overcrowding, no proper ventilation, and indoor air pollution, which causes the spread of infection and also the development of drug resistance. The majority of patients had common symptoms, such as cough, breathlessness, fever, and generalized weakness, whereas minor symptoms were anorexia and chest pain, weight loss, haemoptysis, giddiness, vomiting, epilepsy, joint pain, body pain, headache, and gastric pain, respectively. Diabetic mellitus and hypertension were major comorbidities, whereas HIV and hypothyroidism were minor comorbidities. The most common substance abuse is tobacco chewing, followed by alcohol and smoking. The majority were more dependent on government health care centers than private ones due to most belonging to the labour class, low socio-economic class, and BPL ration card. Nearly half of the patients had a contact history of tuberculosis confirmed cases in the past. More than half of the patients do not practice safe sputum disposal methods and spit their sputum around houses and open areas, and toilets, which are also a source for the spread of infection. More than half of the cases were new, and among old cases, most of them were defaulters of antitubercular treatment and relapse type. More than 2/3 of patients knew Nikshay Poshan Yojana, whereas only half of the patients got regular benefits. The higher proportion had low body mass index (malnutrition) and the presence of pallor. >2/3 patients had completed BCG vaccination, which prevented childhood and severe forms not adult tuberculosis. Drug-resistance tuberculosis patient's associated risk factors were 31-60 years and mean age 37.87 years old, low socioeconomics, overcrowding, inadequate ventilation, indoor air pollution, tobacco chewing substance abuse, inadequate adoption of safe sputum disposable, pallor, whereas low socio-economic, tobacco chewing, overcrowding, non-practice of safe sputum disposable methods was highly significantly associated with it. The majority of patients had a multi-drug-resistant pattern, followed by rifampicin-resistant, extensively drug-resistant, and isoniazid-resistant. A higher proportion of patients had drug side effects like gastric symptoms (nausea, vomiting), headache, arthralgia, loss of appetite, fatigue, and drowsiness, whereas minors had oral ulcers, vision problems, skin lesions, etc. The health care professionals should be alert during the intensive phase of the treatment and identify symptoms at the earliest stage, which would help to minimize discontinuation of treatment, morbidity, and mortality. The motivation of private practitioners for increasing referrals, use of incentives and enablers, enhancing contact tracing, and growing awareness regarding sputum disposal practices and preventive measures was necessary for effective control of MDR-TB.

Recommendations: The periodic implementation of information, education, and communication activities to TB, DR-TB patients, and the general population about disease causation, risk factors, prevention, and control measures. Regular screening for disease identification, examination, and management among risk groups like middle-aged males' gender, labour class, low socioeconomic status, low BMI, family members, families with overcrowding, inadequate ventilation, indoor air pollution, and contact history with TB patients. The periodic modification and strengthening of program activities like awareness, disease screening, diagnosis, appropriate use of advanced digital health technologies, time-to-time updates of various registration and treatment, and preventive measures in remote areas like rural, hilly areas. The availability of infrastructure, rapid diagnosis, and programmatic management of drug-resistant tuberculosis was needed for both pulmonary as well as extra-pulmonary tuberculosis. For low BMI patients, early periodic examination, counselling, and follow-up supervision, supplementation of a nutritional kit, and advice on locally available food rich in protein, micro, and macronutrients to DR-TB patients by health workers. Also, ensure that all DR-TB patients get a direct transfer of five hundred rupees under the Ni-kshay Poshan yojana. The proper provision of good ventilation, living space area per

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person, and use of liquid petroleum gas (LPG) cylinders, and avoiding cooking on firewood, Cowden, to prevent indoor air pollution. For drug reactions, comorbidities, and substance abuse patients' early detection, admission to the hospital, the relevant investigation, referring to specific specialists, and administering a modified regimen, in case of substance abuse, also advising the deaddiction center, regular counselling, and follow-up, which determines increases in the drug adherence and cure rate. The provision of specific preventive measures like N95 masks to patients and health workers, morning temperature, daily 20-30 minutes physical exercise, yoga and meditation, support from community and family members, hygienic environmental conditions, and awareness of safe sputum disposable among patients. Health education regarding the spread of the disease, early detection of MDR-TB by strengthened laboratory support, effective therapy, and implementing innovative control measures was needed among immigrants, which interrupts the ongoing transmission and control of these emerging epidemics. The importance of the nutritional status of drug-resistant tuberculosis patients. The health providers were sensitized to the patients and their relatives about these ADRs for early detection and treatment. DR-TB centers should be integrated with other specialties, with all the provisions for early detection of ADR and treatment. Emphasis should be laid on the need to mainstream nutrition awareness in public health programs, and regular follow-up is needed for the Ni-Kshay Poshan Yojana program. The periodic training, supervision on early diagnosis tools, initiation of treatment regimens, community participation, voluntary organization, public and private coordination, use of advanced digital health technologies like mobile apps, artificial intelligence, and geographic information systems, regular updates on various registers, and publishing the updated program guidelines for all health workers. Drug resistance is a major public health problem and is increasing in hence, special focus is needed for more research, evidence synthesis, and training.

Strengths: The present review is more focused on individual clinical and epidemiological factors associated with DR-TB. The main focus of the present review is on drug-resistant patterns, side effects, and the Ni-Kshay Poshan Yojana program (NPY).

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References:

1. Kishore J. National Health Programs of India. 14th ed. New Delhi: Century Publications; 2022. P.256-258.
2. WHO. Global Tuberculosis Report 2004. World Health Organization. Geneva, Switzerland. Available from:http://www.who.int/tbreport/india/publications/globalreport/en/. [Last accessed on 2024 May 24].
3. Kadri A. IAPSM's Textbook of Community Medicine. 3rd ed. New Delhi: JAYPEE Medical Publishers; 2024.P.307.
4. TB India 2023, NTEP, Status Report, Dots for All, All for Dots, Central TB Division, Ministry of Health and Family Welfare, New Delhi,2023. [Last accessed on 2024 May 25].
5. TB India 2014 -RNTCP, Status Report, Dots for All, All for Dots, Central TB Division, Ministry of Health and Family Welfare, New Delhi,2014. [Last accessed on 2024 May 25].
6. WHO. Global Tuberculosis Report 2023. World Health Organization. Geneva, Switzerland. Available from:http://www.who.int/tbreport/india/publications/globalreport/en/. [Last accessed on 2024 May 24].
7. WHO. Global Tuberculosis Report 2018. World Health Organization. Geneva, Switzerland. Available from:http://www.who.int/tbreport/india/publications/globalreport/en/. [Last accessed on 2024 May 26].
8. WHO. Global Tuberculosis Report 2021. World Health Organization. Geneva, Switzerland. Available

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from:http://www.who.int/tbreport/india/publications/globalreport/en/. [Last accessed on 2024 May 27].

9. WHO. Global Tuberculosis Report 2020. World Health Organization. Geneva, Switzerland. Available from:http://www.who.int/tbreport/india/publications/globalreport/en/. [Last accessed on 2024 May 28].
10. Park's Textbook of Preventive and Social Medicine. 27th ed. Jabalpur, M/Ss BANARSIDAS BHANOT Publishers, 2023.
11. Derashri G, Nayak S, Asati A, Marathe N, Jadhav T. Assessment of Pattern of Drug-Resistance TB and Associated Factors in Rewa, Madhya Pradesh, India. International Journal of Epidemiologic Research. 2022 Feb 12;9(1):34-9.
12. Prava Das N, Panda A. Clinical Epidemiology of Multidrug Resistance Tuberculosis in a Nodal Drug Resistance TB Centre, Southern Odisha- A Cross-sectional Study. National Journal of Laboratory Medicine. 2022;11(2).
13. Sharma M, Roy N, Banerjee R, Kishore J, Jakhar A. Determinants of Drug Resistance in Previously-Treated Pulmonary Tuberculosis Patients Registered at a Chest Clinic in South Delhi, India. Cureus. 2019 Aug 31;11(8).
14. Shah AM, Shah RB, Dave PN. Factors contributing to the development of multidrug-resistant tuberculosis. National Journal of Physiology, Pharmacy, and Pharmacology. 2018;8(10):1463-9.
15. Kumar R, Shankar SK. A study on the prevalence of multidrug-resistant tuberculosis and factors influencing it in Davangere district, Karnataka, India. Int J Community Med Public Health 2016; 3:3349-52.
16. Venkatesh U, Srivastava DK, Srivastava AK, Tiwari HC. Epidemiological profile of multidrug-resistant tuberculosis patients in Gorakhpur Division, Uttar Pradesh, India. J Family Med Prim Care 2018; 7:589-95.
17. Raazi J, Prakash S, Parveen K, Shaikh S. Risk factors of multi-drug-resistant tuberculosis in urban Allahabad, India. Int J Community Med Public Health 2017; 4:2383-8.
18. Gautam PB, Mishra A, Kumar S. Prevalence of rifampicin-resistant Mycobacterium tuberculosis and associated factors among presumptive tuberculosis patients in eastern Uttar Pradesh: a cross-sectional study. Int J Community Med Public Health 2018; 5:2271-6.
19. Avashia S, Bansal D, Bhargava S, et al. A study of epidemiological pattern of multidrug-resistant pulmonary tuberculosis patients presenting to a tertiary care center in Central India. J. Evolution Med. Dent. Sci. 2018;7(08):962-964, DOI: 10.14260/jemds/2018/220.
20. Rai DK, Kumar A. Clinico-demographic characteristics of multidrug-resistant pulmonary tuberculosis presenting to a tertiary care hospital in India. J Assoc Chest Physicians 2020; 8:14-8.
21. Basu R, Kundu S, Biswas D, Nath S, Sarkar A, Bhattacharya A. Socio-Demographic and Clinical Profile of Drug-Resistant Tuberculosis Patients in a Tertiary Care Centre of Kolkata. Indian J Comm Health. 2021;33(4):608-614. https://doi.org/10.47203/IJCH.2021.v33i04.012.
22. Awasthi S, Verma N, Nautiyal RG, Solanki HK. Profile of Multi-Drug-Resistant Tuberculosis Patients: A Study at Drug-Resistant Tuberculosis Centre in Kumaun Region, Uttarakhand. Indian J Comm Health. 2020;32(4):647- 652. https://doi.org/10.47203/IJCH.2020.v32i04.007.
23. Dr. Nagendra Singh Chauhan. Assessment of the clinical profile of multi-drug-resistant tuberculosis patients. Int J Adv Res Med 2021;3(1):269-271. DOI: 10.22271/27069567.2021.v3.i1e.149.
24. Santosh Kumar, Gajendra V S, Benhur J S, Rishabh G, Chandrakant KZ. Clinical Profile of MDR Tuberculosis Patients Attending Tertiary Care Centre, SN Medical College, Agra. Sch. J. App. Med. Sci., Jun 2018; 6(6): 2310-2315. DOI: 10.21276/sjams.2018.6.6.2.
25. Chaudhary A, Mahmood T, Shukla A, Shreenivasa A, Arvind V, Ahmad K, Verma A. Association of Socio-Demographic Profile with Prevalence of Multi-Drug-Resistant Tuberculosis among Retreated Pulmonary Tuberculosis Patients in North India. SAARC J. Tuber. Lung Dis. HIV/AIDS [Internet]. 2018 Jun. 30 [cited 2024 Jun. 18];16(1):1-5. Available from:

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https://www.nepjol.info/index.php/SAARCTB/article/view/23238.

26. Munda Dmk, Sit Dnk, Ta Drk, Ghosh Ds. An Epidemiological Study of Drug-Resistant Tuberculosis Cases Registered Under DOTS Plus Center in A Rural-Based Treatment Hospital.Ijmbs[Internet].2019jun.18[Cited2024jun.18];3(6):125-33. Available from: Https://Ijmbs.Info/Index.Php/Ijmbs/Article/View/314.

27. Poojar B, Shenoy KA, Naik PR, Kamath A, Tripathy JP, Mithra PP, Chowta MN, Badarudeen MN, Nagalakshmi N, Sharma V, Shaman Wadi AN. Spatiotemporal analysis of drug-resistant TB patients registered in selected districts of Karnataka, South India: a cross-sectional study. Tropical medicine and health. 2020 Dec; 48:1-0.

28. Nagpal M, Chawla S, Devgan P, Chawla N. Socio-demographic determinants of treatment outcome in multidrug-resistant tuberculosis cases registered under programmatic management of drug-resistant tuberculosis services in Amritsar, Punjab. Int J Community Med Public Health 2019; 6:2688-93.

29. Mukati S, Julka A, Varudkar HG, Singapurwala M, Agrawat JC, Bhandari D, Jain A. A study of the clinical profile of cases of MDR-TB and evaluation of challenges faced in the initiation of second-line Anti-tuberculosis treatment for MDR-TB cases admitted to drug-resistant tuberculosis centers. Indian Journal of Tuberculosis. 2019 Jul 1;66(3):358-63.

30. Uike P, Hiwarkar P, Malkar V, Aswalle K. Profile of multi-drug resistant (MDR) and rifampicin-resistant TB patients treated under category IV of RNTCP. Int J Basic Clin Pharmacol 2017; 6:784-7.

31. Giri OP, Giri VP, Nikhil N. Socio-demographic Profile of MDR-TB and XDR-TB Patients Admitted in DR-TB Centre, North India. The Journal of the Association of Physicians of India. 2019 Oct 1;67(10):61-4.

32. Kulkarni GS. Resistance to Isoniazid and Rifampicin and Factors Associated with Resistance Among MDR TB Patients Visiting DOTS PLUS Site. MVP Journal of Medical Sciences. 2017 May 22:14-8.

33. Manna N, Giri K, Mundle M. Drug resistance pattern, related sociodemographic factors and preventive practices among MDR-TB patients: An experience from a tertiary care setting. IOSR J Dent Med Sci. 2014; 13:16.

34. Mukherjee P, Karmakar PR, Basu R, Lahiri SK. Socio-demographic and clinical profile of multi-drug-resistant tuberculosis patients: A study at drug-resistant tuberculosis centers of Kolkata. IOSR J Dent Med Sci 2015; 14:52-8.

35. Bhatt G, Vyas S, Trivedi K. An epidemiological study of multi-drug-resistant tuberculosis cases registered under the Revised National Tuberculosis Control Programme of Ahmedabad City. Indian J Tuberc. 2012 Jan;59(1):18-27. PMID: 22670507.

36. Adarsh N, Harsha DS, Chanda S, Sharma MV. Risk factors for primary drug resistance among newly detected pulmonary tuberculosis patients presenting to a tertiary care teaching hospital in South India. PULMON 2023; 25:49-53.

37. Parashuram Rao, Kiran Chawla, Vishnu Prasad Shenoy, Chiranjay Mukhopadhyay, Vishwanath Brahmavar, Asha Kamath, Aswini Kumar Mohapatra (2015). Study of drug resistance in pulmonary tuberculosis cases in south coastal Karnataka, Journal of Epidemiology and Global Health 5:3, 275–281, DOI: https://doi.org/10.1016/j.jegh.2015.01.002.

38. Porwal C, Kaushik A, Makkar N, Banavaliker JN, Hanif M, et al. (2013) Incidence and Risk Factors for Extensively Drug-Resistant Tuberculosis in Delhi Region. PLOS ONE 8(2): e55299. Doi: 10.1371/journal.pone.0055299.

39. Dholakia YN, Shah DP. Clinical profile and treatment outcomes of drug-resistant tuberculosis before directly observed treatment strategy plus: Lessons for the program. Lung India 2013; 30:316-20.

40. Shivekar SS, Kalia Perumal V, Brahmacharini U, Chakravarthy A, Raj CV, Alagappan C, Muthaiah M. Prevalence and factors associated with multidrug-resistant tuberculosis in South India. Scientific reports. 2020 Oct 16;10(1):17552.

41. Kulkarni GS, Telkhade AJ, and Dugad S. Drug Resistance Patterns among XDR-TB Patients

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visiting a TB Centre at a Tertiary Health Care Facility. MVP J. Med. Sci. 2020; 7(1):53-59.

42. Maharjan, S., Singh, A., Khadka, D.K., and Aryal, M. (2017) Drug Resistance Pattern in Pulmonary Tuberculosis Patients and Risk Factors Associated with Multi-Drug-Resistant Tuberculosis. Journal of Tuberculosis Research, 5, 106-117. https://doi.org/10.4236/jtr.2017.52012.
43. Pandhi N, Dadra R, Malhotra B, Prasanth P. Scholars Journal of Applied Medical Sciences. DOI: 10.36347/sjams. 2020.v08i07.027.
44. Gupta S, Bandyopadhyay D, Sadhukhan S, Banerjee S. A sociodemographic study of multidrug-resistant tuberculosis cases from DOTS clinics of Kolkata. Journal of the Indian Medical Association. 2012 Oct;110(10):723-5.
45. Rupani MP, Dave JD, Parmar VB, Singh MP, Parikh KD. Adverse drug reactions and risk factors for discontinuation of multidrug-resistant tuberculosis regimens in Gujarat, western India. Natl Med J India. 2020 Jan-Feb;33(1):10-14. Doi: 10.4103/0970-258X.308234. PMID: 33565479.
46. Swamy, P. N., & Kumar, V. S. (2021). Prevalence of adverse drug reactions among MDR-TB patients with different anti-tubercular regimens. International Journal of Health Sciences, V5 (S2), 693–702. https://doi.org/10.53730/ijhs.v6nS4.11964.
47. Patil S, Bhoir P. Adverse Drug Reactions in Multidrug and Extensively Drug-Resistant Tuberculosis Patients with Diabetes Mellitus. Ann. Int. Med. Den. Res. 2018; 4(5): TB01-TB04.
48. Mahata G, Kumar RTA, Sen P, et al. A study on adverse drug reaction profile of 2nd line drugs in multi-drug resistant (MDR) and extensively drug-resistant (XDR) tuberculosis cases registered under DR-TB center in a tertiary care hospital. J. Evolution Med. Dent. Sci. 2020;9(05):280-283, DOI: 10.14260/gems/2020/63.
49. Gupta S, Jangid VK, Khangarot S, Saxena A, Kameliya K. A study of adverse drug reactions in patients receiving treatment for multidrug-resistant tuberculosis in a tertiary care center. Natl J Physio Pharm Pharmocol 2022;12(08):1125-1130.
50. Ahmed A, Gudagunti AK, Shylendra, Nayak VH, Swamy HM. Frequency and type of adverse drug reactions related to multidrug-resistant tuberculosis therapy. Int J Adv Med 2021; 8:1086-91.
51. Fatima S, Syeda MF, Adla N, Devi R. Ambispective study of adverse drug reactions in multi-drug resistant tuberculosis patients in Warangal, Telangana. Lung India 2021;38: 330-7.
52. Shinde MP, Halasawadekar NR, Ramanand SJ, Pore SM, Ramanand JB, Patil PT, et al. A study of adverse drug reactions in patients receiving treatment for multi-drug-resistant tuberculosis. Int J Basic Clin Pharmacal 2017;6: 354-8.
53. Gaude GS, Hatti Holli J, Kumar P. Risk factors and drug-resistance patterns among pulmonary tuberculosis patients in northern Karnataka region, India. Niger Med J 2014; 55:327-32.
54. Latha S, Somashekara SC, Ghatage S, Suraj B. Adverse reaction monitoring in drug-resistant tuberculosis patients in a Northern Karnataka district. Natl Journal of Pharmacy, Physiology and Pharmacology 2024;14 (Online First). DOI: 10.5455/njppp 2023.13.07345202324072023.
55. Maharia D, Saini SK, Garg M, Chaturvedi M. A Hospital-Based Prospective Observational Study to Evaluate the Various Factors Associated with Drug-Resistant Tuberculosis among Presumptive Drug-Resistant Tuberculosis Patients. J Adv Med Dent Scie Res 2020;8(11):213-218.
56. Historical Perspectives Centennial: Koch's Discovery of the Tubercle Bacillus [Internet]. [assessed 2024 July 19]. Available from: https://www.cdc.gov/mmwr/preview/mmwrhtml/00000222.htm.
57. Lohiya A, Abdulkader RS, Rath RS, Jacob O, Chinnakali P, Goel AD, Agrawal S. Prevalence and patterns of drug-resistant pulmonary tuberculosis in India—A systematic review and meta-analysis. Journal of Global Antimicrobial Resistance. 2020 Sep 1; 22:308-16.
58. Anandakrishnan R, Jeyaraj A, Palani G, Sathiyasekaran B. Socioeconomic impact of TB on patients registered within RNTCP and their families in the year 2007 in Chennai, India. Lung India 2012; 29:221-6.

Volume 8, Issue 4; July-August 2025; Page No 391-414

59. Morris MD, Quezada L, Bhat P, Moser K, Smith J, Perez H, Laniado-Laborin R, Estrada-Guzman J, Rodwell TC. Social, economic, and psychological impacts of MDR-TB treatment in Tijuana, Mexico: a patient's perspective. The International Journal of Tuberculosis and Lung Disease. 2013 Jul 1;17(7):954-60.

60. Mohanty, Manjeet; Patle, Rupali Amarkantak; Narlawar, Uday Wasudevrao. Modified BG Prasad and Modified Kuppuswami Socio-economic Status Scales: Revision and Updates for January 2024. Preventive Medicine Research & Reviews 1(3): p 166-167, May–Jun 2024. | DOI: 10.4103/PMRR.PMRR-28-24.

61. Dhinwa, M., Jha, N., Jyani, S., Chandra, R., Kumar, S., Lachyan, A., & Chauhan, A. (2022). The journey of tuberculosis control, conceptual changes, and implications of the shift from NTP to RNTCP to NTEP: A review. *International Journal of Health Sciences*, *6*(S1).

62. 12269–122814504484964TB Annual Report 2021 210321 High Resolution.pdf. 2020.

63. Ladha N, Bhardwaj P, Chauhan NK, et al. Determinants, risk factors, and spatial analysis of multidrug-resistant pulmonary tuberculosis in Jodhpur, India. Monaldi Arch Chest Dis Doi: 10.4081/Monaldi. 2022.2026.

64. Atre SR, Desiree TD, Vira TS, Chatterjee A, Mistry NF. Risk factors associated with MDR-TB at the onset of therapy among new cases registered with the RNTCP in Mumbai, India. Indian journal of public health. 2011 Jan 1;55(1):14-21.

65. More, Sudhakar W.1; Parande, Malangori Abdulgani2, Kamble, Sanjeev W.3; Kamble, Manjunath S.4. Profile of drug-resistant tuberculosis in Western Maharashtra. Journal of Family Medicine and Primary Care 6(1): p 29-33, Jan–Mar 2017. | DOI: 10.4103/2249-4863.214954.

66. Jeyashree K, Shanmugasundaram P, Shanmugasundaram D, Priya G SL, Thangaraj JWV, Ts S, Pandey S, Ramasamy S, Sharma R, Arunachalam S, Shah V, Nagaraj V, Sundari S, Chadwick J, Shewade HD, Chowdhury A, Iyer S, Rao R, Mattoo SK, Murhekar MV. Direct benefit transfer for nutritional support of patients with TB in India-analysis of national TB program data of 3.7 million patients, 2018-2022. BMC Public Health. 2024 Jan 25;24(1):299. Doi: 10.1186/s12889-024-17777-7. PMID: 38273246; PMCID: PMC10811802.

67. Begum J, Neelima Y, Ali SI, Patnaik S, Sharma D. Utilisation of nutritional support scheme among the patients of tuberculosis: A myth or a truth. J Family Med Prim Care. 2020 Dec 31;9(12):6109-6114. Doi: 10.4103/jfmpc.jfmpc_1229_20. PMID: 33681048; PMCID: PMC7928111.

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