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## MULTIDRUG RESISTANT TUBERCULOSIS AND ITS SOCIAL DETERMINANTS AT NAWABSHAH-SINDH

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### Abstract

The emergence of multidrug resistant strains of tuberculosis poses an important challenge for the health care sector in Pakistan. Multidrug resistant tuberculosis strains are resistant to a number of first lines anti tuberculous drugs including at least isonized and rifampicin. The province wise Multi Drug Resistant TB Cases were reported as (51%) the highest number in the Punjab as others provinces, in Sindh (23%), in Khyber Pakhtunkhwa reported as (15%) and lowest (3.5%) in Baluchistan. Main factors contributing to the appearance of drug conflict, which are interval in diagnosis, unsuitable and insufficient drug regimens, practice of poor follow-up, and deficiency of a community provision program. To determine the frequency of multidrug resistant tuberculosis. To find out the Sociodemographic reasons, leading to multiple drug-resistant tuberculosis. This Descriptive cross-sectional study was carried on 230 Diagnosed cases of MDRT tuberculosis, the patients were selected by the purposive sampling method, according to the age, sex, type of patients, nutritional status, socio-economic status, type of method, by which patient was diagnosed, distance from health facility and marital status. A well-designed structured questionnaire was used to gather data and tabulate that data to finally analyze it statistically. The questionnaire was pre-tested before using it for collection of the data. Among 230 subjects (mean age 39.2; 50.4% female), sputum culture analysis revealed a high prevalence of drug resistance (95.2%, n=219). The population was primarily married (73.9%), lower-class (97%), and rural-based, with labor (54%) and housekeeping (20%) as the dominant occupations. Chi-square testing indicated no significant association between resistance and gender, marital status, or other demographic variables, though high resistance rates were observed within crowded occupational settings. Study concluded that there is no significant Association between drug resistance and gender, socioeconomic status and statically significant with Occupation and most of the patients belonging to low socioeconomic status. It observed that

Laborers and housewives are at higher risk of TB infection due to occupational and environmental factors. Crowded living and working conditions, silica dust exposure, and poor health literacy contribute to increased susceptibility.

**Keywords:** Multi drug Resistance-Tuberculosis, Age - Sex - Education level - Income - Occupation.

### **Introduction:**

The power full detriments of tuberculosis is poverty. Overcrowded and negative ventilated residing status and environments of working place regularly related with poverty discovered direct hazards elements for transmission tuberculosis. It's Poverty additionally connected with negative trendy health expertise and deficiency of consent to behave on fitness information, that cause the hazards of publicity to few Tuberculosis chance elements along with Human Immunodeficiency Virus, smoking and alcohol abuse. (Lonnroth, Jaramillo, Williams, Dye, & Raviglione, 2009). Throughout history, many prominent figures have been affected by tuberculosis, including Quaid-e-Azam Muhammad Ali Jinnah, the founder of Pakistan; Russian writer Maxim Gorky; and poets John Keats and Percy Bysshe Shelley (Smith & Davis, 2010). The compulsory social, monetary and public fitness guidelines encompass people who observe the overarching poverty discount technique and growing social protection, decrease meals insecurity enhance working and residing conditions, Addressing the community factors of health is a common obligation across disease programmers along with different stack holders inside and outside the health sector. (Lönroth, et al., 2010).

There are a lot of evidences of tuberculosis in sub-continent 3300 years ago. Infected human with mycobacterium tuberculosis reached Europe and Asia easily. (Corbett, E. L, et al., 2003) Albert Chalmette and his friend Camille Guerin developed a vaccine against tuberculosis. (Farooqi, Khan, Alam, Ali, & Hasan, 2012) It was a document of policy guidelines for tuberculosis control. BCG vaccination was encouraged in this policy guideline. (B. Statistics Teaching Tools-New York 2018). . In Western Europe during 18<sup>th</sup> century, the popularity of tuberculosis touched up to 900 deaths per 100,000 (Johnson, 1985)., so the term white plague for tuberculosis emerged. (WHO Global tuberculosis report, 2015). Worldwide about 80% tuberculosis cases reported in 22 countries during the year 2013. Among those all patients, over half a million children (0-14 years) were infected with tuberculous bacteria, from which 80,000 children died due to this disease. Pakistan ranks fifth among high tuberculosis risk countries, which are 22 in number. Multidrug resistant tuberculosis is defined as tuberculosis that resistant to the two most powerful first line treatment therapy drugs, ionized (INH) and rifampicin. In 2013 globally 5% of tuberculosis cases were diagnosed multidrug resistant. It was expected that 1.5 million persons expired in 2014 due to tuberculosis, out of these expired persons 0.4 million were HIV positive. Worldwide tuberculosis cases yearly more expiries as compared to HIV. 1.2 million People died in 2014 due to HIV and this includes 0.4 million tuberculosis deaths in HIV positive patients. (Adams & Woelk, 2014). the prevalence of multidrug resistance was 17% in Pakistan. The multidrug resistant tuberculosis emergence is a risk for low-income populations globally as well as in Pakistan, so it contributes the major health burden. (Iqbal, Shabbir, Munir, Chaudhry, & Qadeer, 2012). Main factors contributing to the appearance of drug conflict, which are interval in diagnosis, unsuitable and insufficient drug regimens, practice of poor follow-up, and deficiency of a community provision program. (Ali, et al., 2020) On the basis of evaluates identified the increasing number of MDR-TB cases, observed most of the time they are associated with letdown of treatment, relapse, obstacles, and expiry. (Sheikh, Aziz, & Ayaz, 2018)

As well as high-quality Multi Drug Resistance-TB finding. Treatments and awareness programs would be applied according WHO guidelines (Khan, et al., 2022).

**Health Systems and Structural Barriers:** A significant body of literature points to weak health systems as a driver of MDR-TB. Delays in diagnosis, inadequate infection control, lack of drug susceptibility testing and fragmented the services of TB contribute to treatment failure and resistance emergence (Moyo S et al., 2015; Pai et al., 2016). The privatization of healthcare and poorly regulated drug markets have been implicated in incomplete or inappropriate TB therapy, particularly in India and other high-burden countries (Satyanarayana et al., 2015).

**Causes of Multidrug-Resistant Tuberculosis (MDR-TB):** Multidrug-resistant TB results from multiple factors, including microbial, clinical, and programmatic issues. Substandard treatment regimens can lead to the emergence of drug-resistant strains, which become dominant within infected individuals (Sharma et al., 2010). Initially, it was thought that MDR-TB was less infectious than drug-susceptible TB. with increased risk observed in contacts of previously treated MDR-TB patients (Migliori et al., 2013).

**Prevention of Multidrug-Resistant Tuberculosis:** The effective prevention of drug resistance primarily relies on early and accurate diagnosis coupled with appropriate and effective treatment of tuberculosis (TB) patients (WHO, 2006). In 2005, Pakistan developed a new strategy under the Revised National Tuberculosis Control Program (RNTCP). Over the subsequent five years, the program aimed to systematically expand TB control efforts nationwide (Government of Pakistan, 2005). The DOTS-Plus program, introduced by the World Health Organization (WHO) in 2002, extends the standard DOTS strategy to include management, diagnosis, and treatment of multidrug-resistant TB (MDR-TB).

**Management of MDR-TB with DOTS-Plus:** The DOTS-Plus strategy encompasses key components, including: Political and administrative commitment, Efficient DOTS implementation, Sustained resource investment Collaboration among government, community, and international agencies, Monitoring and management of drug side effects and Continuous supply of anti-tuberculosis drugs (WHO, 2006). MDR-TB cases are confirmed via reference laboratories within the RNTCP. A suspected MDR-TB case is identified if sputum culture is positive and the bacilli are resistant to at least isoniazid and rifampicin, the two most potent first-line drugs (RNTCP, 2011).

**Smear and Culture Conversion:** Two key indicators are monitored: smear conversion and culture conversion. Patients are considered culture-converted after at least one month of treatment if they have two consecutive negative cultures (WHO, 2006).

**Multi-Drug-Resistant Tuberculosis Treatment:**

**Groups of Anti-Tuberculosis Drugs:** Anti-tuberculosis (TB) medications are classified into first-line and second-line drugs. First-line drugs include rifampicin, isoniazid, pyrazinamide, ethambutol, and streptomycin. The drugs are grouped as follows (WHO, 2010):

**Duration of Treatment:** The intensive phase of MDR-TB treatment typically lasts at least six months and is monitored through smear and culture conversion. If cultures are negative at four months and remain so at six months, the patient transitions to the continuation phase. Should cultures still be positive at four months, treatment may be extended by up to three months. The continuation phase lasts eighteen months (WHO, 2010).

**Countries with a High Burden of MDR TB:** High MDR-TB burden countries include Azerbaijan, Angola, Belarus, Bangladesh, Congo, China, North Korea, Ethiopia, Indonesia, India, Kenya, Kazakhstan,

Kyrgyzstan, Mozambique, Myanmar, Nigeria, Papua New Guinea, Peru, Philippines, Pakistan, Moldova, Russia, Somalia, South Africa, Tajikistan, Thailand, Uzbekistan, Ukraine, Vietnam, and Zimbabwe. Global commitment and resource allocation are vital to control MDR-TB effectively at local, national, and international levels (Stop TB Partnership, 2019).

**Risk Factors for MDR-TB in Pakistan:** Several factors increase the risk of developing MDR-TB, including lack of awareness about TB, inadequate treatment adherence, low socioeconomic status, side effects of anti-TB drugs, and prolonged treatment duration. Gender, migration, age, and previous treatment history also influence the risk. especially high risk of MDR-TB like: first-line therapy failure Patients, defaulter during treatment, or relapse after treatment are resistance to first-line drugs such as ethambutol, streptomycin, and pyrazinamide is common among MDR-TB cases (Sharma et al., 2010). The treatment of MDR-TB is longer, typically 18 to 24 months with second-line drugs, including fluoroquinolones, and associated with higher mortality rates, especially in low socioeconomic settings where healthcare resources are limited (Cinquini et al., 2018).

#### **Social Determinants of MDR-TB:**

**1 Poverty and Economic Inequality:** Poverty is the primary social determinant of MDR-TB. Malnutrition, congested living environments, and limited access to healthcare services exacerbate both transmission and disease progression. MDR-TB patients often incur higher out-of-pocket expenditures, leading to treatment default (Tanimura et al., 2014).

**2 Education and Health Literacy:** Low levels of education and health literacy hinder patients' understanding of the disease and the importance of completing long and often toxic treatment regimens. Studies show that individuals with lower education levels are more likely to default on TB treatment (Naidoo et al., 2013).

**3 Stigma and Discrimination:** Social stigma associated with TB and MDR-TB discourages health-seeking behavior. Fear of disclosure leads many patients to delay diagnosis or discontinue treatment. The marginalized groups and Women are disproportionately affected by stigma, further complicating disease management (Somma et al., 2008).

**4 Migration and Dislocation:** Migrant populations often face barriers to continuous care, particularly in situations of political instability or legal insecurity. Interrupted treatment due to movement increases the risk of resistance (Kimbrough et al., 2012).

**5 Gender Inequities:** Gender plays an essential role with studies noting that women often experience larger barriers to care due to caregiving responsibilities, economic dependence, or gender-based violence. However, in some condition's men population are more likely to abandon behavior due to economic pressures (Hargreaves et al., 2011).

**Community and Policy Responses:** Directly observed therapy (DOT) as Community-based treatment models, such as have shown mixed success. When implemented with community participation and adequate support which is help full to reduce default rates. However, overly rigid or disciplinary DOT programs can estrange patients (Bam et al., 2006).

- **MDR-TB in Sindh:** Pakistan estimates between 300,000 and 450,000 new TB cases annually, with approximately 72,000 cases occurring in Sindh. The treatment attrition rate in Sindh varies from six to nine percent. Annually, around 45,000 TB patients register for treatment at government centers, with an additional 12,000 diagnosed in private clinics and by specialists (Pakistan National TB Control Program, 2015). In 2009, about 49,000 MDR-TB cases were identified across 272 government diagnostic centers in Sindh, with 45,676 patients registered

in 2008. The treatment success rate is approximately 81%, but around 6% of registered patients default, leading to MDR-TB development (Khan et al., 2014; Ali et al., 2016) Structural Baseline reflect extreme homogeneity and proves poverty is the uniform, systemic baseline environment for MDR-TB, Indirect Cost Vulnerabilities: Low-income patients default uniformly due to high travel costs and severe nutritional deficits. Ayaz et al. (2024),

## MATERIAL AND METHODS

The cross sectional (Descriptive) study was conducted in chest OPD, chest ward, MDR-TB facilitation center of Peoples Medical College Teaching Hospital -Nawabshah. Included Individuals diagnosed with multidrug-resistant tuberculosis. Sample size (purposive sampling) was calculated 230 by using standard statistical formula: proportion (All Diagnosed MDR-TB cases), confidence interval 95% and 05% Margin of error.

Data was conducted using through a structured questionnaire was filled by researcher himself through face-to-face interview of selected individuals, who were already diagnosed tuberculosis patients. The written consent was taken from all included participated patients and confidentially was also maintained.

**Dependent Variable:** Multidrug Resistant Tuberculosis status (binary: MDR-TB positive or negative)

**Independent Variables (Determinants): Socio-demographic factors:** (Age - Sex - Education level - Income – Occupation- Access to healthcare services - Quality of TB care -Delay in diagnosis.

**Environmental factors:** (Residency like: Urban & Rural Area, Source of Drinking water - Malnutrition)

**Genetic factors:** (Genetic mutations associated with TB resistance)

## ETHICAL CONSIDERATIONS:

During the questionnaire adaptation was considered and incorporated of Cultural sensitivities. a complete overview of the research study objectives provided to all the respondents, prior to seeking their participation consent through a written consent form.

Informed to Respondents that they have right to withdrawn participation from the study, and they have right to not answer any questions.

Not relating information including the use of names and addresses were documented in data. All participant's data was recognized with the use of a code to allow for the checking of data. Securely kept all completed questionnaires/ guidelines, not given access to any irrelevant person during process of data collection and data entry and was not share collected data to any inappropriate person.

Interviews were conducted at times and place when respondents are available (working hours and days). Ensure utilization of maximum time and least refusals of the respondents.

Data was analysis by using SPSS version 25. Data results have presented in the form of frequency tables, graphs and charts. The characteristics of the study subjects will be expressed as mean, ( $\pm$ ) standard deviation and percentages. Chi-square test will be used to analyze the association between dependent and independent variables. P-value of  $< 0.05$  will be considered as statistically significant.

## Results:

**Table 1: Demographic Profile & G. Information of Subject (n=230)**

Variable	Gender	Frequency	Percent
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	Female	116	50.4
	Male	114	49.6
Age Group	10 to 17 Years	31	13%
	18 to 25 Years	44	19%
	26 to 40 Years	58	25%
	41 to 60 Years	64	28%
	61 years & Above	30	13%
Marital Status	Widow	2	1%
	Married	170	73.9
	Single	58	25.2
Children Status	Widow	2	.9
	0 child	76	33.0
	1-4 Children	85	37
	5-8 Children	63	27
	9-10 Children	5	2
Residence/Housing Status	11 Children	1	0
	Rural	168	73.0
	Urban	62	27.0
	Govt	1	.4
	Kacha	161	70.0
	Pakka	67	29.1
Source of Water	Rent	1	.4
	Filtered water	1	.4
	Hand Pump	209	90.9
Distance in Kilometer from Residency to MDR Health Services Facility	Water Supply	20	8.7
	1-50 Km	141	61
	51-100 Km	59	26
	101-150 Km	23	10
Occupation	151 to 190 Km	7	3
	Agriculturist / Farmer	12	5
	Driver	07	3
	Factory worker	2	1
	Government Job	4	2
	Private job	5	2
	Teacher	1	0
	Labour	124	54
Store Keeper	1	0	
	Tailor	1	0

	Students	24	10
	No any Work	1	0
	House Wife	47	20
	Widow	1	0

This study was conducted on 230 diagnosed patients of Multi Drug Resistance Tuberculosis disease. Predesigned questionnaire was filled from all the patients considering inclusion criteria.

In this study found the Mean age: 39.24 years. and Standard deviation: 18.935, showing wide age spread.

Implication: The sample is not normally distributed; younger adults are more frequent than older ones. Mean  $\approx$  3.04 children per subject. The sample is dominated by childless subjects, with an average of about 3 children among all subjects. Most subjects are belonging to rural area with Kacha housing, and (90.9%) obtain drinking water from hand pumps, indicating limited access to filtered or piped water supply in the studied population while urban subjects show a mix of Pakka and Govt./Rent Houses.

The table:1: shows how far people live from an MDR Health Services Facility: 61% (141 people) live 1–50 km away – most have nearby access. 26% (59 people) are 51–100 km away. - 10% (23 people) are 101–150 km away. - 3% (7 people) are 151–190 km away. Bottom line: About 87% of residents live within 100 km of the facility, while 13% need to travel farther (100–190 km).

Data Shows: Labour: 124 (54 %) – the largest group, mainly manual workers. House Wife: 47 (20 %) – second-largest, engaged in domestic work.: 24 (10 %) – individuals studying with no work. Agriculturist/Farmer: 12 (5 %).- Driver: 7 (3 %). Other jobs (factory worker, government, private, teacher, etc.): each <5 % and combined make up the remaining 8 %.

**Table 2: Education & Socio-Economic Status of Subject(n=230)**

Education & Socio-Economic Status of Subject(n=230)			Lower Class	Middle Class	Upper Class	Total	
Education	Graduate	Count	2	0	0	2	
		% of Total	0.9%	0.0%	0.0%	0.9%	
	Intermediate	Count	11	2	0	13	
		% of Total	4.8%	0.9%	0.0%	5.7%	
	No Education	Count	106	0	1	107	
		% of Total	46.1%	0.0%	0.4%	46.5%	
	Primary	Count	71	1	0	72	
		% of Total	30.9%	0.4%	0.0%	31.3%	
	Secondary	Count	33	3	0	36	
		% of Total	14.3%	1.3%	0.0%	15.7%	
	Total		Count	223	6	1	230
			% of Total	97.0%	2.6%	0.4%	100.0 %

The data shows the population is overwhelmingly lower-class (97%) with very few middle- or upper-class individuals

**Table 3: Frequency of Drug Resistance on the basis of Sputum Culture & Drug Resistance Test**

Drug Test	Resistance	Frequency	Percent	Resistance Drug (s) Name	Frequency	Percent
Valid	No	11	4.8%	Negative	11	4.78
	Yes	219	95.2%	Rifampicin & Isonized	208	90.44
				Rifampicin	11	4.78
	Total	230	100.0%			

The study result shows sputum culture & drug-resistance test results for 230 subjects are: 95.2% (219 cases) had a positive drug-resistance test. - 4.8% (11 cases) had Negative test. - Overall, in 95.2% of cases, showing high effectiveness in assessing drug resistance.

**Table 4: Association between Drug Resistance & Gender**

Drug Resistance	Female	Male	Total	P-Value
No	4(1.7%)	7(3.0%)	11(4.8%)	0.373
Yes	112(48.7%)	107(46.5%)	219(95.2%)	
Total	116 (50.4%)	114(49.6%)	230(100.0%)	

Table:4 Shows Widespread Resistance: 95.2% of all participants (219 out of 230) exhibit drug resistance.

Gender Comparison: There is no major disparity between genders. Resistance is present in 96.5% of females and 93.8% of males. On-Resistant Minority: Only 4.8% of the total sample (11 people) do not show drug resistance.

Association between the study variables among 230 participants:

Chi-square and Fisher's exact tests showed no statistically significant association ( $\chi^2 = 0.915$ ,  $df = 1$ ,  $p = 0.339$ ; Fisher's exact test  $p = 0.373$ ).

**Table 5: Association between Drug Resistance & Marital Status**

Drug Resistance	Response	Marital Status			Total	Pearson Chi-Square
		Married	Single	Widow		
	No	6(2.6%)	5(2.2%)	0(0.0%)	11(4.8%)	0.276
	Yes	164(71.3%)	53(23.0%)	2(0.9%)	219(95.2%)	
Total		170	58	2	230	

Married (170): 6 (2.6 %) have no resistance; 164 (71.3 %) have resistance. - Single (58): 5 (2.2 %) have no resistance; 53 (23.0 %) have resistance. - Widow (2): both have resistance. A chi-square test shows  $p = 0.276$  (Pearson) and  $p = 0.306$  (Likelihood Ratio), meaning no significant association between marital status and drug resistance – the differences are likely due to chance.

**Table 6: Association between Drug Resistance & Socio-Economic Status**

Drug Resistance	Response	Lower Class	Middle Class	Upper Class	Total	P-value
	No	11(4.8%)	0(0.0%)	0(0.0%)	11(4.8%)	0.834
	Yes	212(92.2%)	6(2.6%)	1(0.4%)	219(95.2%)	
Total		223(97.0%)	6(2.6%)	1(0.4%)	230(100.0%)	

Data Shows the p-value (0.834) is greater than 0.05, means fail to reject the null hypothesis. This means there is no statistically significant association between the variables; the observed pattern can be explained by chance.

**Table 7: Association between Drug Resistance & Education**

Drug Resistance	Response	Graduate	Intermediate	No Education	Primary	Secondary	Total	P-Value
	No	0 (0.0%)	0(0.0%)	8(3.5%)	2(0.9%)	1(0.4%)	11(4.8%)	
	Yes	2(0.9%)	13(5.7%)	99(43.0%)	70(30.4%)	35(15.2%)	219(95.2%)	0.491
Total		2(0.9%)	13(5.7%)	107(46.5%)	72(31.3%)	36(15.7%)	230(100.0%)	

The chi-square test results show: -  $p = 0.491$ . p-values are  $> 0.05$ , so the null hypothesis is retained. There is no statistically significant association between the variables.

**Table 8: Association between Drug Resistance & Occupation**

Occupation	No	Yes	Total	P-Value
Agriculturist/ Farmer	0(0.0%)	12(5.2%)	12(5.2%)	0.034
Driver	0(0.0%)	7(3.0%)	7(3.0%)	
Factory worker	0(0.0%)	2(0.9%)	2(0.9%)	
Government Job	0(0.0%)	4(1.7%)	4(1.7%)	
House wife	2(0.9%)	45(19.56%)	47(20.43%)	
Labour	8(3.5%)	116(50.4%)	124(53.9%)	
No any work	1(0.4%)	0(0.0%)	1(0.4%)	
Private Job	0(0.0%)	5(2.2%)	5(2.2%)	
Store Keeper	0(0.0%)	1(0.4%)	1(0.4%)	
Student	0(0.0%)	24(10.4%)	24(10.4%)	
Tailor	0(0.0%)	1(0.4%)	1(0.4%)	
Teacher	0(0.0%)	1(0.4%)	1(0.4%)	
Widow	0(0.0%)	1(0.4%)	1(0.4%)	
Total	11(4.8%)	219(95.2%)	230(100.0%)	

The Pearson chi-square test indicated a statistically significant association

1: Labour: 124 (54 %) the largest group:

Crowded work environments (factories, mines, construction sites) where TB aerosols spread easily.

2: House Wives: 47 (20 %) were second-largest Group: Engaged in domestic work, prolonged indoor exposure to infected family members.

**Table 9: Association between Drug Resistance & Residency**

		Rural	Urban	Total	P-Value
Drug Resistance	No	9(3.9%)	2(0.9%)	11(4.8%)	
	Yes	159(69.1%)	60(26.1%)	219(95.2%)	$p = 0.502$

<b>Total</b>	168(73.0%)	62(27.0%)	230(100.0%)	
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Data Shows that chi-square test of independence showed no significant association between the variable

#### **Discussion:**

The key objective of this Descriptive cross-sectional study was to investigate the Social Detriments and frequency of multidrug-resistant tuberculosis (MDR-TB) and separate the specific sociodemographic and environmental determinants driving drug resistance among 230 diagnosed patients in Nawabshah Sindh Pakistan.

These findings show that MDR-TB continues to place a massive, unequal burden on Pakistan's healthcare system, especially in low-income communities. By examining clinical data alongside local social factors, discussion explains why standard demographics such as gender, marital status, and income do not directly correlate with drug resistance. We observed why a person's job and physical environment are the true drivers behind tuberculosis transmission in Sindh and across the country.

As Hypothesis 1: frequency and Burden there is Serious Resistance Baseline, on the basis of Sputum cultures verified a 95.2% (n = 219) drug-resistance rate and 4.8% (n=11) were negative within the 230-subject cohort. found some key observations like: Diagnostic Pipeline Failure. This extreme baseline shows that patients access molecular diagnostics only after first-line treatments (Rifampicin & Isoniazid) have totally failed, Regional Burden Stratification national tracking, placing Sindh at a 23% national burden share. Regional clusters stem from diagnostic delays, erratic and experimental prescribing, and observed poor patient follow-up due to socio-economic problems.

Hypothesis 2: Study discovered Sociodemographic Homogeneity vs. Occupational Risk (Statistical Invariance -p > 0.05), Demographic Parity which proved that gender and marital status have no significant association with drug resistance. Income class showed no statistical significance because 97% of participants were lower-class. Extreme sample homogeneity proves poverty is the uniform, systemic baseline environment for MDR-TB. Low-income patients default uniformly due to high travel costs and severe nutritional deficits. The major findings were High-Risk Occupational Environments which shows Laborer Vulnerability (53.9%): Blue-collar Labour worker (factories, mines, construction sites) experience high exposure in industrial particulates and silica dust, congested work environments where TB aerosols spread easily and Immune System Compromise Biological due to Prolonged dust inhalation permanently impairs alveolar macrophage defenses against bacterial colonization.

In another huge group is housewives Exposure (20.43%): Domestic cohorts face high exposure to unventilated biomass kitchen fuels and indoor smoke. Primary Transmission Vectors, overcrowded living and working spaces drive rapid transmission of aerosolized droplets. Need Systemic Public Health Interventions

and Mandatory Diagnostic system. Upgrades Health facilities must replace old sputum microscopy with universal GeneXpert molecular screening in factories must enforce strict dust-mitigation protocols and supply protective respirators to laborers for Industrial Safety. Concern National programs must provide transport vouchers and food stipends to stop treatment defaults.

#### **Strengths, Limitations, and Methodological Considerations**

- **Methodological Strengths:** Using a pre-tested highly structured questionnaire protected the study's internal validity and confirmed clean data entry. Through purposive sampling

successfully enrolled exactly 230 culture-confirmed cases, giving us clear insight into this highly vulnerable population.

- **Study Limitations:** As this study used a cross-sectional design, we cannot establish a definitive cause-and-effect timeline between socioeconomic changes and the biological start of drug resistance. Furthermore, study sample was socioeconomically uniform with 97% of participants belonging to the lower class. The Chi-square analysis could not detect broader disparities that might be visible when comparing different income brackets.

### Conclusion:

This study demonstrates that Pakistan's Multi Drug Resistant -TB epidemic is heavily driven by occupational susceptibilities and environmental exposures rather than gender, marital status or socioeconomic situation. Statistically, found no significant association between drug resistance and demographics baseline like gender or income class. Instead, risk was heavily concentrated around occupation with laborers and housewives facing the highest risk of infection. This vulnerability is largely fueled by overcrowded living and working conditions, regular exposure to silica dust, and low health literacy, which all are common challenges in these low-income communities.

### Actionable Recommendations:

**Implementation of Universal Molecular Screening:** Change outdated sputum microscopy with mandatory rapid molecular testing, such as GeneXpert, at the primary point of care to eliminate diagnostic delays.

**Workplace based Health Interventions:** Apply strict industrial safety guidelines, including dust control, obligatory protective equipment, and regular health screenings for workers in high-risk environments.

**strengthening of Community-Based Support Program:** Develop nutritional support and travel subsidies through local social programs to reduce treatment default rates among low-income families.

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