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Social determinants of tuberculosis: context, framework and the way forward to ending TB in

India

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Abstract

Introduction: Social determinants are involved in the causation of TB and its adverse outcomes.

This review was conducted to evolve a framework for action on social determinants with special reference to India in the context of the new END TB strategy.

Areas covered: We reviewed the social context of TB in India as a neglected disease of the poor, its emergence in epidemic form in the colonial period, and the factors that resulted in its perpetuation and expansion in post-independence India. We examined the role of social determinants in two key pathways – the pathway of TB causation and its outcomes, and the care cascade for patients with TB, and its consequences. We reviewed the most important social determinants of TB including poverty, membership of certain castes and indigenous population, undernutrition and poor access to healthcare, especially in rural areas.

Expert opinion: We suggest that TB elimination will require an optimal mix of enhanced biomedical and social interventions. TB elimination strategy in India needs a pro-poor model of patient-centred care inclusive of nutritional, psycho-social and financial support, universal health coverage and social protection; and convergence with multi-sectoral efforts to address poverty, under-nutrition, unsafe housing and indoor pollution.

Keywords: Tuberculosis , social determinants, End TB, poverty, universal health coverage, malnutrition, equity, paradigm shift

Article highlights

- TB continues to exact a high toll of disease and deaths in India, where it was a neglected disease of the poor being addressed with a poorly funded TB programme till the 1990s.
- The decline of TB in UK occurred in parallel with the increase of TB in India and both were linked to the colonial enterprise.
- A social determinants of health (SDH) framework explains the differentials in exposure, vulnerability, care and outcomes in TB. Access to care is an important social determinant.
- It is important to understand the role played by social determinants in the pathways of TB causation and cascade of TB care.
- Malnutrition, membership of certain 'castes' and indigenous communities, gender, stigma and discrimination are social determinants particularly relevant in India.
- An optimal mix of biological and social interventions could represent a paradigm shift in TB care and control, especially in India.
- India requires a pro-poor model of patient –centred care and prevention with nutritional, financial and psycho-social support, to address gaps in universal health coverage and social protection, and to launch multi-sectoral efforts to address poverty, undernutrition, unsafe housing and indoor pollution

“Tuberculosis is a social disease, its understanding demands that the impact of social and economic factors on the individual be considered as much as the mechanisms by which tubercle bacilli cause damage to the human body.

Rene.J. Dubos[1]

Tuberculosis is a social disease with a medical aspect

Sir William Osler [2]

There is a rich man’s tuberculosis and a poor man’s tuberculosis. The rich man recovers and the poor man dies.

Edward L.Trudeau[3]

The quotes by an eminent microbiologist who ushered in the era of antibiotics, and two great physicians of the pre-chemotherapy era draw our attention to the fact that social factors are fundamental to the prevention, care and control of tuberculosis. These factors explain why when nearly a quarter of the world’s population is infected with *M.tuberculosis*, the disease occurs in only a minority, around 10 million people in 2018, mostly in the poor in low and middle-income countries[4]. We may have modern molecular tools for diagnosis which probe the genome of *M.tuberculosis* in minutes but inequities in access produce months of delays in diagnosis in people living with TB in low-middle income countries. We have therapies with potential for 95% cure rate for tuberculosis (TB) within 6 months in patients with drug-susceptible TB (DS-TB), yet we had 1.2 million TB-deaths in HIV negative individuals in the year 2018[4]. While there are raising rates of drug resistant TB (DR-TB) which threaten the

treatment success, only 1 in 3 of the estimated patients with MDR-TB could access therapy in 2018 [4].

This article focuses on the social determinants of TB with a special focus on India, the country with the largest burden of TB. The first section of the article discusses the context for addressing the social determinants of TB: the relationship between TB and poverty, the neglect of TB as a disease of the poor, and the renewed global and national TB control efforts over the last nearly three decades which have improved case-finding, cure rates but failed to have a desired epidemiologic impact at the population level. The new END TB strategy and its targets are discussed with the need for a synthesis of biomedical and social interventions. We highlight the social origins of the TB epidemic in India in the nineteenth century, juxtaposing it against the decline in UK with improving socio-economic conditions. The second section uses the social determinants of health (SDH) framework to examine and understand two key pathways- the pathway of TB causation and its outcomes, the care cascade for patients with TB, from a SDH perspective. We then briefly review some of the most important social determinants of TB in India. In the final section we discuss the way forward and highlight action points for the National TB elimination programme (NTEP), using the SDH framework.

1. The Context

1.1. Poverty as a cause and effect of TB. Poverty creates an ecology where TB becomes more prevalent, more lethal and more difficult to treat. Poverty and its related factors in an individual affect the probability of getting infected with *M.tuberculosis*, the probability of further progression to active disease and its severity, the access to health care and its

quality, and the ability to adhere and complete treatment. The difference in TB incidence between the low, middle and high-income countries (LMICs and HICs) according to 2018 is 19 fold (206/100,000 vs. 11/100,000 in LMICs vs. HICs respectively); 95% of TB cases and 98% of TB-deaths also occur in the LMIC[5]. Patients and their households incur catastrophic costs due to the direct medical costs, indirect costs of lost income, wage loss for accompanying member, travel and food costs.

1.2. TB as a neglected disease of the poor, globally and in India:

The massive burden of disease and deaths in the high TB burden countries is related to the historical neglect of the disease and the diseased by health ministries, international health organisations and aid agencies, who had “virtually ignored TB” for decades [6]. The global TB control unit in WHO declined to a situation where it had only two people in Geneva in 1988[7]. Earlier in the 1980s, a highly influential article even advised against launching national TB programmes (NTP) in LMIC, because TB required prolonged treatment and even longer follow-ups[8]. The worsening of poverty and neglect of TB programs in HIC had disastrous consequences as well. In New York City between 1984 and 1991, the TB incidence rose from 23 to 50/100, 000[9]. Treatment completion rates were as low as 11% in some. In black men in the age group of 35-44 years in central Harlem, the TB incidence was 469/100,000, 45 times the national average[9].

The TB program was a low priority program in India with poor funding, low levels of case-finding, sub-optimal regimes and supervision with low cure rates and high death rates.

For an estimated 1.5 million patients, had an allocation of INR 20 million in 1981 (USD 2.6 million, then), which rose only up to INR 120 million in 1990,(USD 7 million, then)[10].The

only communicable disease program with a lower allocation was guinea-worm eradication [11]. The case finding efficiency was only 30% of the potential, most of it based on radiologic grounds [12]. The shortage of drugs was common, isoniazid and thiacetazone combination for 18 months was often used till early 1990s, with completion rates of only 30% [12]. As a result, the NTP was effectively curing merely 10% of the patients. The introduction of shorter regimes was expected to improve cure rates, but the completion rates remained under 50% [13]. The overall mortality was 28%, treatment failure was 22% on short course and 48% on conventional regimes and there was significant emergence of DR-TB [13]. A poor programme with poor funding support led to continuing transmission of disease, as well as promoted DR-TB.

1.3. WHO global strategies for TB control from 1994-2015: The WHO declared TB as a global emergency in 1994 in the face of doubling of notification rates in Africa with the HIV epidemic, and resurgence of TB in HICs with outbreaks of MDR-TB [7]. The WHO strategies for TB control in the LMICs from 1994-2015 were based on the biomedical model focusing on case finding, treatment, and chemoprophylaxis of eligible contacts. Further, its public health advocacy with government and funding agencies raised the financial allocation for the NTPs.

The Directly Observed Treatment Short-course (DOTS) strategy (1995-2005) relied on passive case detection by smear microscopy, introduced directly observed shorter regimes, regular drug supply and monitoring of outcomes. There were targets of 70% case detection of new smear positive cases and cure rates of 85%, which if achieved was expected to decrease the prevalence of disease by 50% in 15 years [14]. A modelling study

suggested (optimistically in hindsight) that the TB incidence could decrease by 11% per year, and TB-deaths by 12% per year if the above targets were achieved[15].

The WHO employed the Stop TB Strategy between 2005-15, which led to the introduction of drug susceptibility testing and therapy for DR-TB and HIV, private sector involvement, and mandatory notification of TB in India in 2012. Globally the annual decline in TB incidence was 1.5% per year, while the case fatality rate in 2015 was still 17%[16]. A WHO document commented that the pre-2015 strategy while enhancing access to diagnosis and treatment remarkably improved outcomes in terms of reducing suffering and death, it had very little effect on achieving the desired impact in terms of reducing the incidence rates and driving down the TB epidemic, and that the END TB strategy with its mix of biomedical and social interventions would help end the epidemic[17].

1.4. India's TB burden between 1990-2015 and the upward revision of estimates:

India has the highest burden of TB, DR-TB and TB-deaths in the world, with an estimated 2.7 million incident cases (27% of the global incidence), 131,000 cases of DR-TB annually (approx 27% of global incidence) [4]. There are almost 440,000 (37% of global figures) TB-deaths annually[4], more than those killed immediately by the atomic bombs at Hiroshima and Nagasaki. There is a lot of uncertainty in estimates of disease and outcomes, due to lack of comprehensive TB surveillance system and a vital registration system for record of all deaths.

The estimates for TB incidence, prevalence and mortality have been revised upward for India, which has created uncertainty about its achievements in the period of 1990-2015. The Global TB report in 2015 mentioned that the country had met all the three targets of incidence, prevalence and mortality with a 55% reduction of TB prevalence and 58% reduction in mortality, which partly contributed to the successful achievement of the global targets[18]. However the following year, the previous estimates for 2015 were reconsidered based on new evidence emerging from other sources including a state prevalence survey[16]. The revised estimates increased from 2.2 million to 2.81 million; the estimates of mortality were revised from 220,000 to 480,000 per year (36/100,000) [16]. In 2016, it was estimated that only 56% of patients had been notified[16]. This suggests that the desired epidemiological impact of the DOTS strategy may not have occurred between the 1995- 2015 in India.

1.5. The new WHO END TB strategy and India's National Strategic Plan: welcome strategy but difficult targets

The END TB strategy has three pillars: integrated patient-centred care and prevention, bold policies and systems and intensified research and innovation[19]. It aims to end the TB epidemic by 2035 (defined as < 10 cases/million) in preparation for the elimination of the TB epidemic by 2050 (defined as < 1case/million). It has developed milestones for 2020 and 2025 and targets for 2035[17]. The END TB milestones of 2025 require a 75% and 50% reduction in TB-deaths TB incidence compared to 2015[17]. This will require a 10% decline every year in TB incidence between 2015-2025, and a drop in case fatality ratio to 6% compared to 20% in 2015[17]. The milestones for 2025 are quite difficult to

achieve based on the data in the annual global TB reports, the cumulative decline in TB incidence and mortality between 2015-2018 was only 5.3% and 8.3% as against the required reductions of 20% and 35% respectively for the 2020 milestone[16].

The National Strategic Plan (NSP) for 2017-2025, the adaptation of the END TB strategy in India has even more ambitious targets[20], which are being misinterpreted as plans for TB elimination by 2025[21]. India is aiming to achieve the Sustainable Development Goals for 2030 which have targets of 80% reduction in TB incidence and 90% reduction in TB-deaths by 2025 [22]. These translate into reduction of TB-deaths from 32/100,000 to 4 /100,000 and TB incidence from 217/100,000 to 44/100,000 by 2025[20]. TB elimination however is defined as < 1 new case of TB per million people per year [17], while if we achieve this target we would have still have 440 cases /million population, far away from the target for TB elimination. Even a pre-elimination phase of TB elimination is defined as less than 10 new cases per million people per year/million[17]. It would be more accurate to state that if the NSP achieves its target, India could become a low TB-burden country by 2025 by virtue of having less than 100 cases per 100,000 people per year.

1.6 The need for a synthesis of biomedical and social models in TB care and prevention: The emphasis in the END TB strategy for a mix of biomedical and social interventions is a welcome departure from the exclusive biomedical model as communicated in this statement from the International TB Congress in 1962: *“The social, economic and cultural measures which lead to a decline in tuberculosis are certainly prophylactic measures of fundamental importance, but these are outside the scope of medicine. Further, there are four major medical means for eradicating tuberculosis: case-finding; chemotherapy for*

pulmonary tuberculosis, vaccination; and chemoprophylaxis"[23]. The fact that even introduction of shorter, more effective therapy did not result in better completion rates in India,[14] is illustrative of the fact that only biomedical interventions without taking the context of the patients and the health system into consideration are unlikely to be effective. Even with high performing TB treatment programs as in Vietnam, the decline in TB incidence per year is about 4-5% per year, less than half of what is required[24]. The highest decline in TB incidence ever, of 10% per year, occurred in the 1950s-1960s in Western Europe with the combined effect of socioeconomic improvements, universal health coverage, and effective therapy. [24,25]

In the END TB era, we need an enhanced biologic model as new tools of diagnosis, treatment, and prevention will be required to reach the goals. However the understanding and action on the social determinants of TB will yield 'prophylactic measures of fundamental importance' in the TB epidemic[23], highlight persons and communities at a higher risk of the disease and poor outcomes, and facilitate the application of curative and preventive measures in an equitable, acceptable and effective manner. The dichotomy between biological and social model is artificial and detrimental to clinical medicine and public health[26]. The social model can both improve outcomes in the individual patient, and help to prevent the disease in the population.

1.7 The evolution of TB epidemics in the UK and India and lessons for the current strategy:

It may not be realised that countries with low incidence of TB like the UK were in fact the high TB burden countries in the 19th century, and the decline in TB in antedated but was accelerated by the introduction of chemotherapy of TB. In UK the incidence of TB was around 300/100,000 and almost one in four adults died of TB in UK in the 19th century[27]. Later this declined even in the pre-chemotherapy era largely due to improvement in the living and working conditions, higher wages, improved nutrition, and housing. The decline was at 3.3% annually from 1900 - 40 in UK due to socioeconomic and public health measures including isolation of affected persons[27]. McKeown after considering various explanations for this decline considered improved nutrition to be a key factor in the decline[28]. This explanation has been questioned by others[29], who have not taken into account two vital facts in support of McKeown's hypothesis. First, malnutrition impairs immunity and improved nutrition reduces the frequency and severity of many infections [30], including TB [31,32]. Second, there is evidence of a secular increase in calories supply per capita[33], as also of adult heights in the UK between 1850-1955 which reflect improvement in nutritional status[34]. The decline of TB incidence in countries like the UK was accelerated to 10% per year, with the advent of chemotherapy and the potential of cure of all patients. The current decline in TB incidence of 1.5% per year[16], largely reflecting the situation in the high burden countries is thus half of that of the developed countries in the pre-chemotherapy era.

It is also not realised that the countries with high burden of TB currently, had in fact much lower burdens in the 19th century. The increasing burden of TB in these countries (often colonized by the European powers) was a mirror image of the decline of TB in Europe, and

was brought about by the decline in the living conditions, including nutrition. For example, although TB is an ancient disease reported in Indian texts, it was not very common in India before the arrival of the British, a fact reported by British physicians themselves who were very familiar with the disease[35]. The following passages illustrate the origins of the current scale of the TB epidemic in India and Africa: *“Statistics prove that the degree of infection amongst natives is in ratio to the proximity and the numbers of Europeans immigrating, and varies according to the social and economic factors which prolong the contact with the latter. ...while the disease attains its maximum incidence in sedentary and massed communities living in more or less permanent contact with Europeans”*[36].

“They (referring to the colonists) brought tuberculosis into Africa. Highly mobile African labourers spread it to all corners of sub-Saharan Africa, where it smouldered in the slums of an expanding urban poor. The nutritional status of Africans fell sharply in the face of implementation of cash-crop economies...And despite the efforts of missionaries; colonial medicine was mostly aimed at preserving the health of the oppressors, and seldom reached the oppressed”[37].

The colonial experience produced a situation of contrasts. A substantial part of the improvement in the living conditions in UK, were a result of the surplus from African and Asia colonies. A leading Indian economist estimated the flow of money from India to Britain between 1757-1938 as USD 45 trillion or 9.2 trillion pounds[38]. While calories supply per capita improved in UK, the food security worsened in India. The most dramatic illustration of this was in the famines, of which 34 major famines were documented

during the British rule and 17 in the millennia before[39]. The problem was not of availability of food but the people were just too poor to buy already existing stores of food grains in the country[40]. The wages in the pre-independence India were poor; rural to urban migration occurred with increasing industrialisation in the large cities with resultant overcrowding, simulating conditions at the height of the TB epidemic in the west. The living conditions were poor and malnutrition was rampant. Also the access to basic healthcare was rudimentary and there were only a handful of sanatoria in the whole country[41]. Post-independence, India was left as a country with widespread poverty, malnutrition, illiteracy, poor health infrastructure, and an abysmal life expectancy of 32 years[42].

The burden of TB in post-independence India can be attributed was related to three factors; persistence of poverty, endemic chronic undernutrition, and poor access and quality of healthcare services for the poor. Poverty persisted after independence in a large part of the population, largely rural but also the poor urban migrants. The growth in per capita income was only 1% per year for many decades, with increasing income inequality which further increased post-liberalisation [43]. Poverty reduces best when economic growth occurs with economic equity. Secondly, while famines did not reappear in independent India, endemic hunger became entrenched and manifested as chronic undernutrition[44]. We lacked nationally representative data on child and adult nutrition before the National Family Health Surveys (NFHS) were launched in 1992-3. Successive surveys revealed poor nutritional indicators in the children and adults alike[45,46]. The national averages also obscure inequalities, since in NFHS-4; rural areas had higher rates

of undernutrition in adult women than urban (26.8% vs.15.5%)[47]. While 35.8 % women in the low standard of living index were underweight (Body mass index < 18.5 kg/m²) compared to 11.6% in the high standard of living index [47]. According to WHO, the situation is considered 'serious' when the prevalence of low body mass index (BMI) is 20-39%, and 'critical' if it is more than 40%[48]. India ranked 102nd among 117 qualifying economies in the Global Hunger Index in 2019 with a score of 30.3 (which was 32.5 in 1990)[49]. The high levels of undernutrition are a reflection of poor food security related to poor purchasing power, an unhealthy environment with overcrowding, poor air and water quality, and poor availability of healthcare services. Finally, although healthcare infrastructure expanded remarkably post-independence, universal healthcare coverage was still distant. There was no NTP for 15 years post-independence, and the subsequent poorly funded, weakly performing programme till 1997 led to continuing transmission, morbidity and high mortality. Lack of universal coverage and a poor TB programme also allowed the dominant provider of TB care. In the current programme there is a move to provide universal access to quality TB care and the private sector is being incentivised to participate in the NTEP.

2. The social determinants of health framework (SDH) in the context of TB

2.1. TB as a disease of health inequities: TB is a disease of poverty and few diseases reflect and express social inequalities in its distributions and outcomes in the same manner as TB. Health inequities are *avoidable* inequalities in health between groups of people within countries and between countries[50]. There is a stark difference between the incidence rates of TB in the HIC and LIC, as also within the low income countries. The

prevalence in a district in India with higher income individuals was 24/100,000[51], while that in an indigenous population was 1518/100,000[52]; a difference of 6300%. Though it may not be an infection exclusively of the poor, its burden of disease and adverse outcomes are predominantly seen in the poor. These differences are not due to genetic or biological reasons but because of material conditions of living and the healthcare system. Inequities in health are “systematic, socially produced (therefore modifiable) and unfair” [53].

2.1.1. The social determinants of health inequity: According to the WHO, SDH are “the conditions, in which people are born, grow, work, live, and age. These circumstances are shaped by the distribution of money, power and resources at global, national and local levels.” They play a major role in creating health inequities [50].

A conceptual framework of SDH adapted for TB is presented in Figure 1 with the pathway from various SDH to health inequities. The structural determinants of health include policies and processes which lead to uneven distribution and access to resources, education, income, and social protection. In the context of TB, the policies related to employment, poverty alleviation, ensuring equity with economic growth, UHC and social protection (including food security) are especially relevant. If poverty is a cause of TB, then structural determinants are those policies and processes which determine poverty, i.e. “cause of the cause.” The structural determinants (also called societal determinants) decide the socio-economic position; the stratification of society based on income, gender, education, and class. The socioeconomic position influences the material factors (housing, neighborhood, and quality of physical environment), psychosocial factors (stressful living

circumstances, social support), behavioral and biologic factors (alcohol, tobacco, HIV, nutrition), which together constitute the SDH.

Caste is a social grouping peculiar to India which is based on descent and it influences education, income, access to resources, and participation in political processes. We would like to emphasize that the health system of a country (accessibility, affordability, acceptability, and quality) is itself an important SDH, as highlighted in Figure 1. These factors do not interact in linear relationships but generate feedback loops, and lead to effects which are intergenerational.

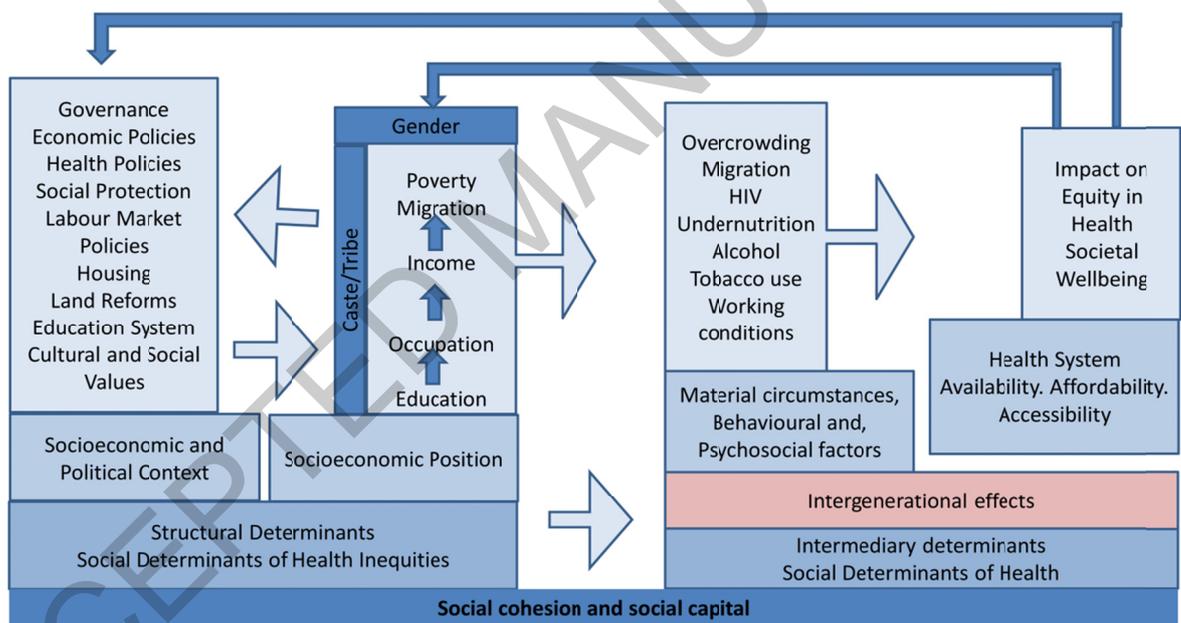


Figure 1: Conceptual framework of Social Determinants of TB in India (Adapted from ref[54]

An illustration of how structural and social determinants can lead to a devastating epidemic is offered by the example of the HIV epidemic in South Africa which in turn led to a secondary epidemic of TB.

“Historically, apartheid created deeply-entrenched structural conditions where hundreds of thousands of workers were forced to live in over-crowded, poorly ventilated single-sex city hostels served by commercial sex workers (euphemistically referred to as ‘town-wives’). The ‘oscillatory migration’ lifestyle where workers living temporarily in the cities and on the mines periodically visited their wives and families in rural ‘homelands’, was key to the spread of both TB and sexually transmitted infections in the last century. The social, economic and environmental conditions created by apartheid in the form of overcrowded squatter settlements, migrant labor and deliberately under-developed health services for Blacks created the milieu for HIV and TB to flourish”[55].

2.1.2. The SDH framework: a clarification of certain terms and an important omission. It is

clear that many social determinants are the outcomes of structural determinants. Terms like ‘downstream determinants’ or ‘proximal risk factors’ indicate those which are linked in the immediate causal pathway (undernutrition, HIV as a contributory cause of TB for example) and structural determinants (e.g. policies) are termed ‘upstream or distal

determinants’ to indicate factors considered less amenable to immediate

intervention[24]This distinction is in a sense artificial as proximal risk factors are the result

of structural determinants and socioeconomic position and require policy responses. Also

many of the underlying structural and their linked social determinants are common to

many public health problems. As an example, food security and nutrition would not only impact TB but also under-five mortality, life expectancy, growth and cognitive development, morbidity and mortality due to many other infectious diseases. A key social determinant that influences TB care and outcomes is population level access and quality of healthcare, which has failed to feature in some authoritative reports[56].

2.2. Social determinants of TB pathogenesis and outcome

The pathogenesis of TB is marked by sequential steps of exposure to infection, development of infection which results either in LTBI or active disease, outcomes of disease which may be favorable or unfavorable, and consequences of the disease (physical, economic, social). The social determinants lead to differential exposures to the infection (due to higher prevalence of active TB in poor communities, and overcrowding), differential vulnerabilities of development of disease following infection (higher prevalence of malnutrition, HIV, smoking for example), and differential access to healthcare. This ultimately results in differential outcomes as a result of active TB. We have listed 12 outcomes related to the disease and its socioeconomic impact which have relevance for the program, for the patient and their families. (Figure 2) This figure illustrates how the social and structural determinants including poverty predispose to tuberculosis and its adverse outcomes.

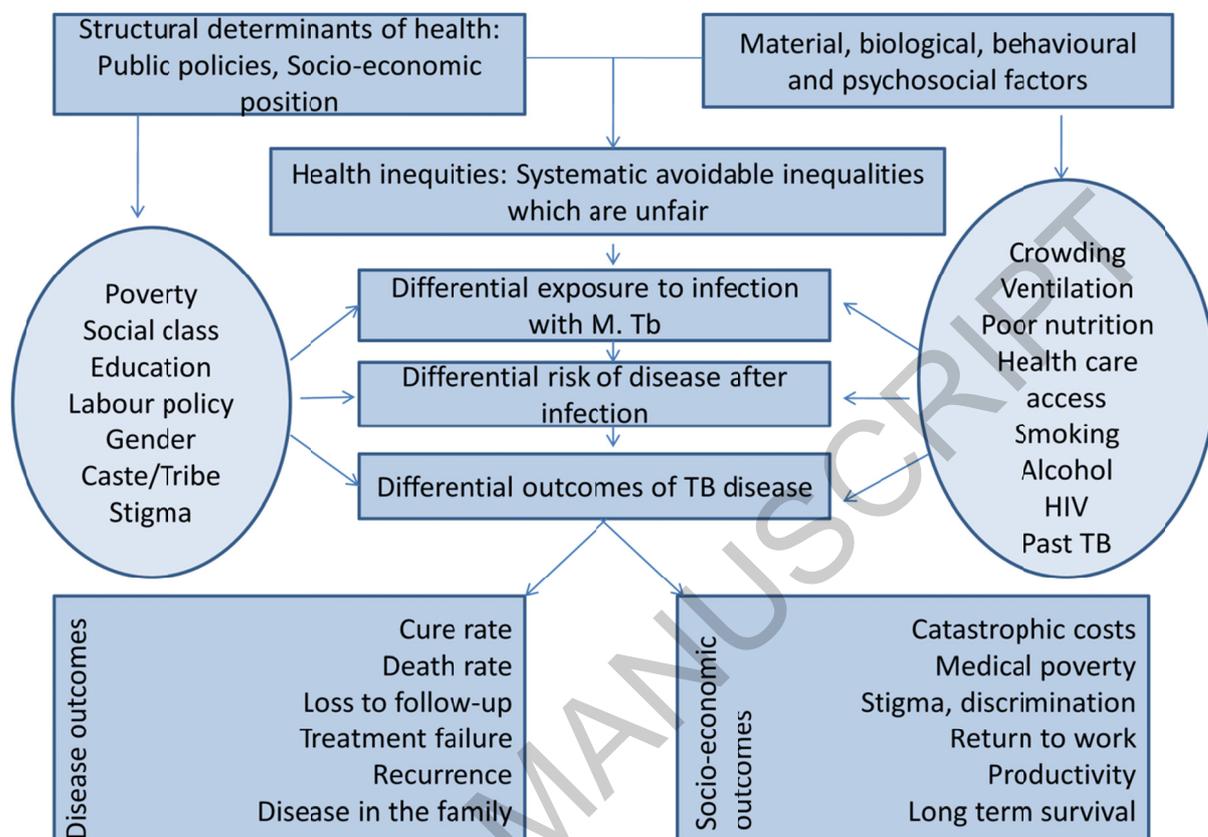


Figure 2: Impact of social and structural determinants in TB pathogenesis and outcomes

2.3 SDH and the TB care pathway in India: The current END TB strategy emphasizes UHC, patient-centered care and quality of care. The stages of care of a patient begins with accessing a health facility and diagnostic services, being diagnosed with TB, registering for treatment, adhering to treatment, completing treatment successfully, and recurrence free survival . The care cascade is a model which describes these sequential stages and evaluates the quality across the continuum of care. It has been used in evaluation of HIV care and recently in the case of TB (Figure 3) [57,58].

We briefly discuss the care cascade in India through the lens of the social determinants, which again highlights the avoidable nature of adverse outcomes which could improve with UHC [57]. A generic care cascade for patients with TB is illustrated in figure 3 (part A) A care cascade of patients with TB in India in the year 2013 is illustrated in figure 3 (part B) which suggests that in that year only 50% of the incident cases were registered for treatment[57]. The major losses were due to suboptimal access to diagnostic services and only 43% of the incident cases were successfully treated[57]. The care cascade for patients with DR-TB reveals that only 19% were registered for treatment and only 7% had treatment success[57]. The poor are most affected by the gaps and delays in the care cascade and estimates suggest that TB incidence can decline by 31% (95% credible interval: 27-43) by 2035 if these gaps and delays could be minimized[59].

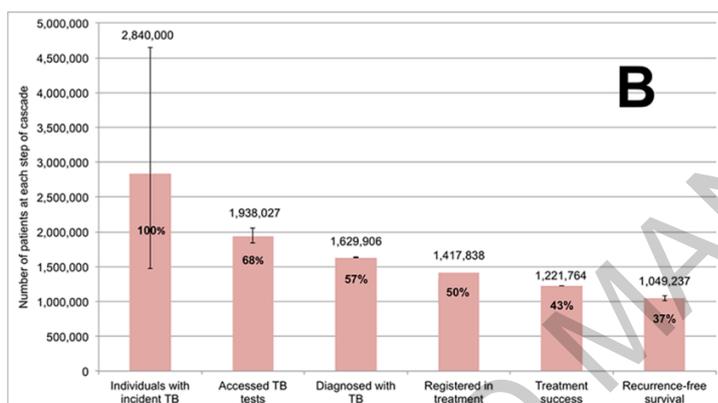
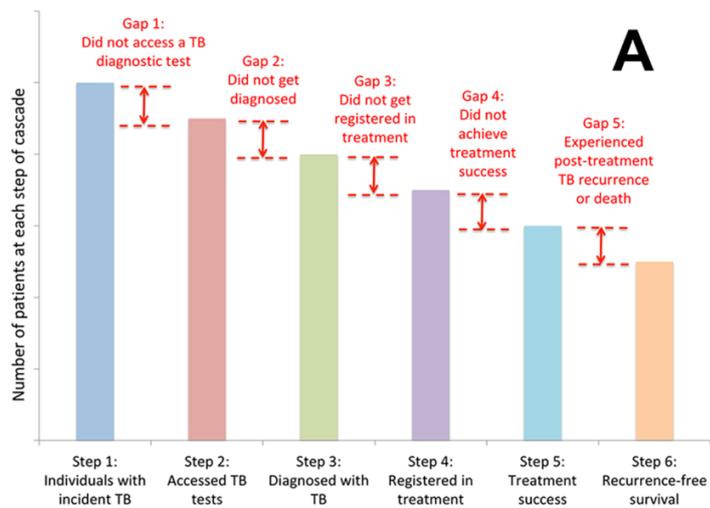


Figure 3: TB care cascade in India: Steps and Gaps [57]

2.3.1 Step 1: Reaching the facility and the diagnostic service

The major delay in India is at the level of the patient presenting to the TB service, and is a reflection of physical, economic and cultural barriers to access and the healthcare seeking behavior. The health seeking behavior is a function of awareness of TB and this is a function of income and literacy. In a nationally representative survey in patients with self-reported TB, 20% of those without education had never heard of TB, one third of them did not know that TB can be cured[60]. The barriers to seeking care are amplified in the

rural poor, those who live in difficult areas, and belong to marginalized communities.

Perceived stigma related to tuberculosis also leads to delay in seeking diagnosis [61].

The designated microscopy centers are currently sanctioned for every 80,000-120,000 population. There are no diagnostic facilities for TB at sub-centers (SC) which serve a population of 5000; and primary health centers (PHC: 1/20,000 -30,000 population) which are now being upgraded as health and wellness centers. So a poor patient has to travel to the community health centers (CHC) leading to loss of wages and direct costs.

Notifications increased by 84% when community based health workers screened for symptoms and transported sputum specimens[62]. Similarly in urban slums inhabited by migrants, case notifications increased by 30% when non-formal health providers who are often the first point of call were involved [63].

Nearly half of patients in India seek private care [60]. A large community based survey found that those who did not access the government services were 2.5 times likely to be from rural areas, poor households, and who paid for treatment despite its high costs [64].

This is a reminder that “because a TB program operates in a poor country does not necessarily mean that it is adequately addressing poverty” [65]. The reasons that have emerged for poor patients seeking private care are lack of awareness of government services, convenience, concerns about confidentiality and wish for personalized care [66].

In states with a better functioning public health system like Kerala, 78% of patients took treatment from public sector whereas in Bihar the proportion was 36%[60].

2.3.2 Step 2: Diagnosis

The diagnosis of TB depends on the availability of diagnostic tests and trained manpower in the facility. Patients may require another sputum examination. A positive sputum test may require a CB-NAAT and LPA test to rule out DR-TB. Currently there are 1180 CB-NAAT machines in the country, with an average of one machine for each of the 718 districts, and a larger number in some districts and metropolises[67]. There are plans to make these available at the level of community health centers, which will be a welcome move. Patients with smear negative TB or extrapulmonary TB (EPTB) might require other procedures like X-ray, ultrasounds, examination of body fluid or tissue which may require referral. Another health system issue is shortage of staff and absenteeism. The states with suboptimal program performance reveal gross shortage of laboratory and supervisory staff in treatment units, and absenteeism up to 45% leading to suboptimal care by unqualified personnel[68,69].

2.3.3 Step 3: Linkage to treatment

In the NTEP there is a referral from the TB diagnostic facility to the treatment facility. This might mean referral from a medical college or the district TB center to a PHC/CHC. A sizeable number of patients diagnosed in urban areas are from the rural areas because of poor functioning of peripheral health institutions. Almost 17% of patients diagnosed in public sector health facilities in Chennai were from outside the city[70]. The NTEP data shows that 7% are diagnosed but not initiated on treatment[67]. The pre-treatment loss to follow-up is often due to administrative factors, adverse interactions with the health care worker apart from patient factors [71]. Among those with self-

reported TB, 3.6% in Bihar did not start any treatment and this was 0.5% in Kerala[60].

Migrant workers face delays in initiation of treatment if they travel back to their usual place of residence. Thus, rural patients, migrant workers and those in low performing states face problems in getting linked to treatment.

2.3.4 Step 4: Retention in treatment or adherence:

Inability to adhere to therapy is often considered as a major barrier to the success of TB treatment. The rate of loss to follow up in the NTEP is 4% in the new patients in the public sector and about 19% in the private sector[67]. The term used earlier “default or defaulter” lays the blame largely on the patient’s “ignorance or uncooperativeness, or poverty”[72], exaggerates the agency of the patient, while the organization of TB services, the quality of care rendered is ignored [73]. It is important for the provider and the program to realize that “they least comply, who are least able to comply” [73].

There are only a few studies which capture the structural barriers the poor face in accessing and adhering to treatment in India[74], and most are retrospective studies which are unhelpful in capturing the human and social dimensions of the problem[75].

In a study to investigate incomplete treatment rates, a number of problems like distance, inability to afford repeated visits, the waiting time, behavior of staff members, non-availability of drugs and adverse effects were identified in 40% patients[76].

Moreover, 15% recorded as lost to follow up were found to have actually died[76].

Ironically it was concluded to undertake “behavioral studies” Instead of addressing programmatic issues[76]. Non-completion of treatment can be addressed by more

flexible hours, allowances for poor patients to reach the clinics and training the health care staff for respectful communication and monitoring drug side-effects

[77]. PierreChaulet reminded that TB programs need to be compliant themselves before ascribing non-compliance to the patient[72]. In developing countries, non-compliance with anti-tuberculosis therapy is less often due to the patient's failure to comply with treatment but due to health system shortcomings [72]. Patients with tuberculosis also face stigmatising and discriminatory attitudes at home, in the neighbourhood, in healthcare facilities and at work, which can affect adherence. A large survey in 30 districts of India among very high prevalence of stigmatising and discriminating attitudes in the general population, and this was independent of knowledge of TB[78]. These attitudes can manifest as social isolation, neglect, abandonment, difficulty in re-employment [79]. Their adverse impact on patients can result in non-disclosure and often serious mental health issues [80].

2.4. Social determinants relevant to TB in India

Globally, while income, education, occupation, gender, social class and health care access create stratification in society, there are some additional features in India which introduce additional complexity and merit discussion. While social class is a fluid entity, caste system in India is a rigid social stratification based on birth and descent leading to discrimination, indignity, untouchability, denial to education and resources. Indigenous people called tribals and described as the scheduled tribes (STs), have much higher levels of poverty and poorer health indicators in all age groups and both sexes. Also the

wide prevalence of malnutrition, the urban-rural divide and the inequality in development and health indicators across different states leads to wide range of income inequality between states. These categories overlap and interact producing cumulative risks. The poorest health indicators would be in poor, illiterate, undernourished woman belonging to the scheduled tribes living in a remote rural area in central and eastern India. It is hardly surprising to find the prevalence of TB at 2870/100,000 in such a group, one of the highest in India [81].

2.4.1 Socio-demographic groups: Poverty, gender, caste and indigenous population

TB is a poverty driven social disease, and poverty is multidimensional involving income, education, access to a healthy environment and healthcare. Sixty four percent of those treated in NTEP were from poor socio-economic strata, and 77% were earning below US \$1 per day[82,83]. Self-reported TB was four times higher in the poorest quintile[60]. The Stop TB partnership has classified some key populations as those with increased vulnerability to exposure, limited access to care and higher risk of disease due to impaired immune function[84]. The poor are represented in all the three groups but yet poverty has not found an explicit mention. Poverty is linked to higher TB exposure due to overcrowding and higher risk of disease due to coexisting malnutrition, HIV, smoking, alcohol intake or occupational exposures. Slum dwellers with low standard of living index were found to have prevalence as high as 5150/100,000 in a slum in Mumbai[85]. Also in a slum in Delhi, tuberculosis constituted 24.8% of all deaths almost reminiscent of 19th century UK[86]. The poor are more likely to lack education and awareness of

symptoms, and face barriers in the TB care cascade (physical, economic and cultural), and adherence. Poverty may worsen despite accessing free public health services due to the money spent before the diagnosis. In one of the studies from an urban area, 77% of TB patients were from household with a per person income of less than USD 1/day, the average treatment cost was USD 145 (approximately annual per person income), and USD 121 had already been spent before the diagnosis[83]. The average loss of income was around USD 500 per person in rural patients irrespective of income groups [87].

TB is higher in men by a ratio of 3.1:1 in six sub-national prevalence surveys[88]. However this may not be true at all ages and population groups. In a study based on programmatic notification, the rate of TB was equal in both sexes in those below 20 years [89]. The prevalence of TB in some marginalized populations like STs was highest in women[81]. Some exposures like alcohol or smoking are higher in men, while undernutrition, exposure to indoor pollution due to biomass fuel is more in women. The pregnancy and postpartum period are associated with higher susceptibility to developing tuberculosis and pregnancy with tuberculosis is associated with adverse fetal-maternal outcomes[90]. The clinical presentation of women is also different as they are more likely to have smear- negative disease (which may delay diagnosis) and EPTB [89]. It is a leading cause of infertility due to tubal factors in India[91]. Female gender has also been found as a predictor of MDR-TB in Maharashtra [92]. Access to health care in women is affected by diverse factors like household priorities, poor health literacy, and lack of mobility, inadequate resources and decision-making ability[93].The age at

death in a cohort study in rural India was only 32 years in women[94]. Women suffer more social consequences than men, like stigma, discrimination and abandonment, and there are consequences for the survival of children and family welfare[93].

Castes, a historical system of social stratification based on birth and descent, is unique to India, and affects all the conditions of living, growing, working which constitute the SDH. Caste is linked to income, education, occupation, social class, political power. The 'scheduled castes' (SC) in India constitute 19% of population are marginalized, are the focus of affirmative action, but continue to face discrimination. According to the NFHS-4, 51% of the SC households belonged to the lowest wealth quintile and many being landless laborers [47]. In the Indian context, caste may be considered a proxy indicator for socio-economic status and poverty[95]. Caste affects health status, health indicators and access to health care including preventive care. There are persistent inequities in indicators like infant mortality, levels of childhood and adult malnutrition, immunization coverage[47]. The risk of self-reported TB was 20% higher for patients belonging to SCs [60]. In other six sub-national prevalence surveys the information on both economic and caste status is lacking[88]. Adult undernutrition in SCs was higher than the national average, 25.3% of women and 22.9% of men had BMI < 18.5 kg/m²[47]. Patients belonging to SCs are also likely to face additional barriers due to discriminatory practices in the healthcare system [96].

Indigenous population, officially called scheduled tribes (STs), are a historically marginalized group in India, geographically, socially, politically[97], and remain outside

the caste hierarchy. They have the poorest health indicators, highest levels of poverty, illiteracy, infant and maternal mortality, childhood, maternal and adult undernutrition, and lowest levels of access to healthcare[97]. Ninety percent of tribals live in India's rural areas, often in the most difficult terrain requiring special needs within rural healthcare system. They live in areas rich in natural resources and often suffer displacement due to mining, irrigation or power projects. Seventy one percent of ST households in the NFHS-4 belonged to the two lowest wealth quintiles[47]. The prevalence of TB in tribal population in India ranged from 146 to 1500/100,000 (in Saharias) and the pooled prevalence was 703/100,000 (95% CI: 308, 1011) [98], compared to a pooled prevalence of 300.7 (223.7–377.5) in sub-national surveys[88]. They also have higher prevalence of smoking and alcohol compared to general population (smoking 34.3% vs. 11.9%; alcohol 12.9 vs. 10.3%)[99]. Preference towards traditional healers as the point of first call often leads to delays in diagnosis[100]. The tribals are a key population for NTEP, and there is a separate tribal action plan with enhanced incentives for providers and patients. However a review of the performance of the NTEP in tribal districts reveals suboptimal case detection and cure rates[101], and poor utilization of funds(<50%) of the tribal action plan[102].

2.4.2 Behavioral risk factors

Smoking and alcohol are known to influence TB disease and the outcomes. Smoking can increase the risk of TB by almost 2-2.5 times and even DR-TB by (OR: 1.57, 95%CI: 1.33, 1.86) [103,104]. Similarly the risk of TB in persons with high or any alcohol consumption

was 1.9 times (95% CI: 1.63, 2.23) and this risk increased by 12% with every 10-20 gm daily intake[105]. It has also been associated with poor treatment outcomes like death, treatment failure, loss to follow-up[106].

2.4.3 Undernutrition, an important biological risk factor

Undernutrition is the most prevalent risk factor for TB progression at the population level in India[47,107], and the most widely prevalent comorbidity in patients with TB and adverse outcomes[94]. More than 22% and 19% of adult women and men respectively are underweight, and this proportion is higher in rural areas, in those belonging to SCs and STs[47]. It was estimated that 55% (95% CI: 27.4, 75.9) of annual TB incidence could be attributable to adult undernutrition and potentially preventable by addressing adult undernutrition in India[107]. Undernutrition, defined as a BMI of less than 18.5 kg/m² had a Hazard Ratio (HR) of 12.43(95% CI: 5.75, 26.95) for development of TB in a cohort study [32]. An inverse exponential relationship between BMI and TB incidence has been seen in a systematic review and it is suggested that TB incidence could decline by 13.8% per unit increase in BMI[108]. At the Papworth village settlement in the pre-chemotherapy and pre-BCG era where patients with tuberculosis lived with their families, social interventions during their stay at Papworth, of which adequate nutrition was considered the most important, was associated with an 84% decline in TB incidence among child contacts [109]. The median BMI in women and men in a large cohort from rural India were 15 kg/m² and 16 kg/m²,^{and} this was associated with two-four fold risk of mortality[94]. Median weights of adult patients in NTEP are 42

kg in men and 38 kg in women in India, indicating a need for nutritional support [110].

Undernutrition also leads to more severe TB disease, higher risk of adverse effects, and higher risk of relapse after cure [111]. The NTEP India has guidelines on nutritional assessment and care of patients with TB, and recommends a nutritious food basket (dry rations) and a daily micronutrient supplement for patients[112].

2.4.4 Access to care and the urban-rural divide:

India has a predominantly rural population (69%) where the prevalence of TB is also high. The prevalence of self-reported TB was 331/100,000 in rural India compared to 252/100,000 in urban[60]. There is a great urban-rural divide in terms of income, literacy, access to education and health facilities, and political participation, and this is worsening[113]. It is reflected in indicators of life expectancy, childhood and adult malnutrition, and preventive care. The situation regarding healthcare is illustrative of the inverse care law “*the availability of good medical care tends to vary inversely with the need for it in the population served*[114]. Almost 80% of health facilities are concentrated in the urban areas, with a dominance of the private sector which has two-thirds of all functional hospital beds and 85-95% of medical doctors[115]. On the other hand in rural areas, 81% of specialist posts remain vacant in CHCs[116].

3. Conclusion

An understanding and action on the SDH is critical to improving TB-outcomes, reducing TB incidence and its adverse financial consequences in the affected households. Social

determinants translate into biologic risk factors such that TB infection progresses to disease and often adverse outcomes in vulnerable populations. Social determinants, including the access to healthcare, gaps and delays influence the TB care cascade. These can be addressed for better outcomes. The program needs to be a stronger advocate for improved population health which will have a powerful effect on TB incidence. The determinants of population health including poverty, malnutrition, unsafe housing and a polluted environment have to be addressed as part of the socio-economic development of the country, and fulfillment of the SDG goals. Social determinants have long been invisible and marginal in the efforts to control TB. Their continued neglect in the NTEP will only be at our collective peril.

4. Expert opinion

4.1. We suggest an optimal mix of biomedical and social interventions to achieve TB elimination. We outline a paradigm shift in seeing, thinking and acting on TB care and prevention by weaving SDH perspectives into TB care and control

We suggest that TB causation and outcomes be viewed with a binocular vision of social and biomedical perspectives. **Table 1** shows the interventions based on biomedical interventions and the possibilities of interventions based on the SDH framework within the pathway of TB causation and outcomes. This would constitute the optimal mix of interventions for the implementation of the END TB strategy in India.

Table 1: Interventions in the TB causation and outcomes pathway in the biomedical and Social Determinant Health framework

We suggest weaving SDH perspectives to evolve a paradigm shift on thinking about TB care and control (**Table 2**). The table illustrates the complementary nature and power of this paradigm shift, where host resistance in a population due to undernutrition will demand as much attention as drug resistance, where new tools will be complemented by health system strengthening, where a molecular understanding of TB will be complemented by behavior change in health care providers.

Table 2: Weaving SDH perspectives into TB care and control to achieve a paradigm shift in TB care and prevention

4.2. We suggest that this is an opportune time to address SDH in the NTEP in India.

The END TB strategy framework which has been accepted by the NTEP has enlarged the scope of actions for care and prevention of TB with a view to ending the epidemic by 2035. There is a renewed clinical, public health, and ethical imperative, and an opportunity for a holistic mix of social and biomedical interventions. There is also a current momentum for implementation of the sustainable development goals for addressing poverty, hunger, housing, livelihoods, and clean environment which will complement the TB control efforts.

4.3. We suggest three key interventions based on the SDH framework for the END TB strategy in India.

There are three key interventions in the END TB strategy which can help achieve favorable clinical and public health outcomes, especially if implemented within SDH framework. These include evolving patient centered model of TB care, providing UHC in

the context of TB services and social protection, and addressing social determinants relevant to the TB epidemic in theSDGs like poverty, hunger, good health and well-being, livelihoods, clean energy and sustainable cities and communities.

4.3.1. Patient centered approach to care and prevention:

The END TB strategy advocates a patient –centered approach to TB care and prevention. The components of the patient-centered approach need to be locally contextual and appropriate, with a focus on the poor on grounds of equity. There is also an epidemiological advantage in targeting tuberculosis control preferentially at the poor [117]. An eight- step approach has been suggested to make any health service pro-poor [118](**Table 3**). Poor patients in India often face a social distance, asymmetries of power when they seek care, especially in the backdrop of illiteracy, rural background and marginalized social class[96]. There is a need for sensitizing healthcare providers to communicate respectfully with patients regardless of class, gender, and residence. An indifferent, unfriendly, rude behavior on part of healthcare providers leads to preference of private care provider over government facilities for TB care[77].

Table 3: Eight steps to making a pro-poor and effective health service and TB programme. Source: Based on concepts in ref[118].

Another still unmet need of patients, especially those with low income and education is reliable information concerning the TB disease, its treatment and adverse effects, screening and treatment for comorbidities (including undernutrition), infection control, and contact evaluation. This can be supplemented by leaflets, videos, reminders, all of

which can increase adherence rates irrespective of drug resistance status. Added challenges in India are the diversity of languages, varying levels of literacy, and misconceptions and myths about disease compounded by poor communication by the care givers [119,120].

We also suggest following enablers, during the treatment which may also serve as incentives:

- a) Nutritional support: This is essential in India in view of the severity of undernutrition in patients with TB and its implications. Household food insecurity is common in patients with TB in India [121], which increases the risk of TB in household contacts[122]. Nutritional support reduced the rate of unfavorable outcomes by 50% in programmatic settings[123]. The NTEP has launched Nikshay Poshan Yojana, a direct benefit transfer of INR 500 per month (approximately USD 7) to enable patients access a nutritious diet. There are however several challenges in its implementation, coverage, and the adequacy of amount [124,125].
- b) Financial support: There are indirect costs during treatment due to lost wages and significant expenditure (mean INR 3386) in the pre-diagnosis phase which is not accounted in WHO recommended cost surveys[126]. In a nationally representative survey 21% of patients resorted to selling assets or borrow money so as to finance care and this is even higher in case of hospitalization and drug resistant TB (DR-TB) [127]. The incentives earmarked for tribal patients needs to be disbursed to them, as noted earlier.

- c) Travel support: This is currently being provided to patients with DR-TB, but should be expanded to patients with drug-susceptible TB (DS-TB).
- d) Psychosocial support: Patients suffer from worry, fear, disbelief, embarrassment, depression, stigma and discrimination, apart from the stress of poverty and loss of income; and these need to be addressed by specific counseling, and psychosocial support. A novel initiative of a TB support group in Kerala succeeded in promoting social inclusion and eliminated loss to follow up[128].

3.3.2 Improving access and outcomes of TB care by UHC and social protection measures

The new END TB strategy emphasizes universal health coverage and social protection measures as part of the bold multisectoral policies that need to be adopted to reduce TB incidence and TB related deaths. [19]It is important to address the gaps in TB care cascade in India, and these are of particular concern for the poor, the migrants, those from rural areas and those with DR-TB. Inpatient care for patients with TB is another issue as while there are beds earmarked for initial admission and evaluation of DR-TB in India, there is a remarkable paucity of hospital beds for DS-TB patients. This is against the backdrop of already low bed strength availability of 0.9beds/1000 population[129,130].

Universal health coverage in the context of TB care in India includes engagement of private care providers. A major initiative in the TB program is the public-private mix where private care providers are incentivized to refer patients for sputum tests and treat patients with the free drugs from the NTP. In 2018, 25% of the 2.1 million cases of

TB notified in India were from private care providers[67].However this notification alone does not ensure UHC as it may lead to high costs of diagnosis and treatment. Moreover, there is also a gap in evaluation of the treatment outcomes in nearly 57% of the patients notified by the private sector [67].

Social protection systems are all public measures providing benefits to guarantee income security and access to essential health care, such as unemployment insurance, disability benefits, old-age pensions, cash and in-kind transfers, and other contributory and tax financed schemes. While UHC allows for coverage of direct medical costs, *social insurance*/disability insurance covers income losses during treatment. Similarly the *social assistance* schemes (cash transfers, income security scheme, food support, travel support) could be either generally available or linked to TB patients (TB inclusive) or targeted to TB patients (TB specific). UHC in India is a work in progress and requires increased allocation from the current 1.4% of GDP to prevent high out-of-pocket expenses for people in India[115]. The social insurance schemes are available only for 9% of the workforce who work in the organized sector. However, there are many social assistance schemes at the state level for the vulnerable and marginalized populations but are often underutilized due to lack of awareness (Table 4). These schemes are either TB-specific and are targeted to persons living with TB, or are TB-inclusive which can also address the needs of persons living with TB. The state level initiatives for patient support in the form of nutritional support, linkages to social welfare schemes and psycho-social support have been documented recently [131].The scale up of these initiatives and dissemination and awareness generation in the patient community can

be a big facilitator towards patient centered care. The NIKSHAY Poshan Yojana is a universal TB-specific social assistance scheme sponsored by the Union Government.

Table 4: Schemes and initiatives relevant to persons living with TB, at state and national level in India [131]

3.3.3 Action on key social determinants of health in India.

The primary responsibility of the NTEP is to act on the key social determinants of accessibility, affordability, quality, and acceptability of TB services, and address the gaps in the TB care cascade. The secondary responsibility of the health system is to advocate for action on the social determinants in the TB pathogenesis pathway. These key determinants are poverty, undernutrition, overcrowding and indoor air pollution in India. These are part of the SDG initiatives and can be addressed by multi-sectoral efforts. While the NTEP may not implement action on these determinants but can definitely act as a champion to link social determinants to TB incidence and outcomes.

- a) Rural poverty: The prevalence of poverty and malnutrition is higher in rural areas and lack of income opportunities is a key driver of rural to urban migration. The Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) passed in 2005, is the world's largest employment scheme that provides 100 days of assured employment to men and women in rural areas at a minimum wage rate. The minimum wages in this scheme are often significantly higher than the prevailing local wages. It was found to significantly reduce poverty (32%) in socially vulnerable households [132]. Better implementation of this scheme, with assured work and timely payments holds great

promise in improving poverty levels. A mapping of districts with poor TB outcomes and linkage with effective MGNREGA can be a concrete inter-sectoral effort that can have tangible outcomes. This would be in alignment with the aim of SDG1 of reduction of extreme poverty, which according to a recent modeling study has the potential of reducing TB incidence by 84% [133].

- b) **Undernutrition:** Undernutrition is the major driver of the TB epidemic in India and nutritional interventions in the states with high prevalence of undernutrition could reduce the TB incidence by 48-71% over a 20 year period [134]. India has created a whole ecosystem of programs aimed at addressing nutrition. This includes distribution of food ration (largely cereals) at highly subsidized prices through the public distribution system, free cooked meals to children (Integrated Child Development Services Scheme), free mid-day meals at school, and maternity entitlements. The National Food Security Act (NFSA) 2013, a historic act born of a civil society campaign for the Right to Food, provides 5 kg cereal/person at Rs. 2-3/kg; covers two thirds of the households at a cost of 1.3% of GDP at an incremental cost of 0.2% over existing food subsidies[135]. It can result in significant income transfer to households and thereby promote dietary diversity. However the NFSA is cereal centric and low protein intake is a risk factor for TB[32,136]. Pulses are a source of good quality protein in India but repeated national surveys have shown their deficient intake in poor households. This has worsened due to volatility in their prices with mean intakes being 27-31 g per day or lower in poorer households [137].

- c) Overcrowding and housing: Slums are associated with high prevalence of TB in cities[85]. Presence of a window in these houses was associated with 50% decreased odds of prevalent TB[85]. The PM Awas Yojana (PMAY) was launched in 2015 and aims to provide affordable housing for the urban poor by 2022, which includes in-situ slum redevelopment[138]. Attempts to relocate the urban poor to lands which are far from their place of employment however can be unpopular and counterproductive.
- d) Indoor pollution: The PM Ujawala Yojana launched in 2016 provides liquefied petroleum gas (LPG) connections in below poverty line households. Biomass fuel is commonly used for cooking in rural households and penetration of LPG is low. This is a laudable initiative which could have a significant impact on burden of respiratory diseases including TB[138]. But the high refilling costs and freely available biomass fuels leads to continued use biomass fuels alone or in combination with LPG.

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ACCEPTED MANUSCRIPT

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Table 1: Interventions in the TB causation and outcomes pathway in the biomedical and Social Determinant Health framework

Pathogenesis Pathway	Intervention in the Biomedical model	Intervention in the SDH framework	Illustrative examples
Exposure and transmission	Treatment of active cases in the community	Improved ventilation, reduction in overcrowding	Economic policies to reduce rural-urban migration Affordable housing for urban poor
Progression from LTBI to active TB	Vaccine	Address risk factors like malnutrition, alcohol, HIV	Minimum wage floor, strengthen National Food Security Act, ICDS, mid-day meals. Policies related to agriculture, livelihoods, education.
Progression to severe disease and death	Early diagnosis and treatment	Enable early diagnosis and treatment Address comorbidities like malnutrition, HIV diabetes.	Health system strengthening and Universal health coverage with diagnostic services at point of first contact, Health literacy, Measures to address comorbidities.
Catastrophic costs	Free diagnosis and treatment	Universal Health Coverage and Social protection for direct and indirect costs	Social protection floor Ayushman Bharat should cover outpatient costs and cover inpatient costs for all forms of TB.

SDH=Social Determinants of Health; LTBI=Latent TB infection; ICDS=Integrated Child Development Services Scheme is a large feeding program in India for under-five children and pregnant and lactating mothers in India

Table 2: Weaving SDH perspectives into TB care and control to achieve a paradigm shift in TB care and prevention

	Current Focus	Suggested additional focus
1	Disease of individuals	Disease affecting families and communities
2	Bacterium	Structural and social determinants of health
3	Infection	Immunity
4	Drug resistance	Host resistance, Susceptibility to disease
5	Diagnostic tests /Point of care tests	Universal health care/Making tests available or accessible at point of first contact
6.	Private sector engagement	Health system strengthening in public sector
7	Quality of treatment	Equity
8	Health seeking behavior	Behavior of healthcare providers
9	Adherence to therapy/DOT	Ability to adhere to therapy/ Social protection
10.	Bacteriologic cure	Normal functional status/Rehabilitation
11	Vaccines	Addressing drivers of the epidemic
12	Mass LTBI treatment	Improve Population health

DOT= Directly Observed therapy

Table 3: Eight steps to making a pro-poor and effective health service and TB programme.

Source: Adapted from ref [131]

Step	Feature	Comments relevant for TB programme
Step 1	Physical accessibility	Distance to center, travel time
Step 2	Availability of human resources	Staff shortages, including laboratory technicians, treatment supervisors,
Step 3	Availability of material resources	Diagnostics (smear microscopy, X-ray , molecular diagnostics), medicines
Step 4	Organizational quality	Working hours, waiting time, behavior, gender-sensitivity, perception of quality of care, corruption
Step 5	Relevance of services	Services in keeping with the needs of poor patients: provide information, nutritional, financial and psychosocial support. Avoid stigma and discrimination
Step 6	Timing and continuity	Timely delivery of continuum of care, supervision and referral
Step 7	Technical quality	Competence, compliance with guidelines
Step 8	Social accountability	Decrease “social distance” Rights based programme. Implement patient charter, and grievance redressal mechanism

Table 4: Schemes and initiatives relevant to persons living with TB, at state and national level in India.

National Level			Comments
1	Livelihoods	Mahatma Gandhi National Rural Employment Guarantee Act	TB inclusive
		Linkage with skill development programmes	TB inclusive, needs greater integration with NTEP
2	Social insurance	Unemployment benefits	Not available in India
		Illness benefits: For organised sector employees	Employee State Insurance Scheme
		Pradhan Mantri Jan Arogya Yojana: Cashless cover of INR 5 lakh per annum to eligible disadvantaged households of inpatient care	TB inclusive, only certain types of TB included
		Silicosis: Work related injury (Factory Act of India 1948)	TB inclusive
		Jan Shree Bima Yojana: death other than by accident of member, an amount of INR 30,000 payable	TB sensitive/inclusive
3	Social assistance	Linking Pradhan Mantri Jan-Dhan Yojana, Aadhar and NIKSHYA for Direct Benefit Transfer (INR 500 per month)	TB specific, but probably in adequate for required nutrition support
		Travel cost for treatment and diagnostics: Travel vouchers or specific allowance	Not specifically mentioned, aspirational in nature
		National Family Benefit Scheme on death of a bread-winner (18-60 years)	TB inclusive. An amount of INR 20,000
		Food security for families earning less than INR 250 per month: Antyodaya Anna Yojana (35 Kg rice at INR 3/Kg)	TB inclusive
State level initiatives			
1	Food support as monthly dry rations	16 States: Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Goa, Gujarat, Himachal Pradesh, Jharkhand, Kerala, Maharashtra, Meghalaya, Madhya Pradesh, Punjab, Tamil Nadu, and Telangana	TB specific. Largely for the MDR and those from weaker sections
2	Linkage to existing health and social welfare	<ul style="list-style-type: none"> - Chhattisgarh (MDR package under Mukhyamantri Swasthya Bima Yojana) - Gujarat: Cash support to SC, ST, de-notified tribes and nomadic tribes 	Either TB inclusive or specific, need to be studied for evolving consensus measures

	schemes	<ul style="list-style-type: none"> - Jharkhand: Chikitsa Sahayata Yojana under Dept of Social Welfare in the form of economic support to marginalized and vulnerable communities - Kerala: The Pension Plan under Dept of Revenue, provides economic support to families with annual income < INR 1 Lakh - Maharashtra: Free transport in state transport buses - Tamil Nadu: Uzhavar Pathukappu Thittam which provides financial support to small and marginal farmers with TB - Telangana: Under-six are provided enhanced ration via ICDS 	across all states
3	Economic support	Goa: TB Association gives INR 600 to patients for full treatment	TB specific. No data available on uptake and impact
		Tamil Nadu, Telangana, Kerala and Delhi: In-kind support, livelihood trainings like tailoring, livestock, housing facilities and blankets	TB inclusive. No data on uptake and success
		Rajasthan: National Human Rights Commission has fixed a compensation of INR 300,000 for deaths of victims of silico-tuberculosis	TB specific
4	Psychosocial support	Assam, Chhattisgarh, Kerala, Tamil Nadu, and Telangana among others focus on counselling and community mobilization to address psycho-social aspects of the disease	TB specific