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Review Article

Applying the socioecological framework as a methodological approach to combat chronic diseases challenges: a case-in-point illustration using a narrative review of factors for tuberculosis medication non-adherence in India

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ABSTRACT

The "slow-moving disaster" of chronic diseases has wide-ranging social implications. While prevention of chronic diseases has shifted from individual behavioral interventions to broad socio-ecological interventions, an organizing framework for complex chronic disease situations could prove to be valuable. In this article, we proposed the socio-ecological framework as one solution to identify gaps at multiple levels and guide further research, intervention efforts, and policy direction for individual chronic diseases. We illustrate this through a case-in-point example in the form of a narrative review of factors of nonadherence to therapy for tuberculosis in India. A literature search was conducted within PubMed, Scopus, Cinahl, Medline, and the Penn State Harrell Library Resources to identify peer-reviewed articles emanating from India describing factors associated with nonadherence to tuberculosis medications. The factors for non-adherence to tuberculosis medication were reported and described as individual (age, gender, religion, socioeconomic status, etc.), interpersonal (patients, family, & friends, stigma & discrimination, patient-provider relationship, etc.), organizational, community and policy levels of the socioecological model. Furthermore, gaps in the literature pertaining to these factors of nonadherence were also identified and categorized at each level of the socioecological model. The socio-ecological framework has the potential for broader and more comprehensive application to other chronic diseases and the problems associated. Integrating and conceptualizing these contributors organizes the complexities around chronic diseases that may, in turn, inform various policymakers, researchers, program implementation experts, and field personnel in formulating the desired strategy to combat the challenges.

Keywords: Socioecological, Tuberculosis, Medication adherence, Chronic diseases

INTRODUCTION

Chronic diseases as global burden

Chronic diseases are responsible for the majority of global mortality and morbidity, with three out of five global deaths attributable to four major chronic diseases: cardiovascular disease, cancer, chronic lung diseases and diabetes.[1,2] According to the World Health Organization (WHO), annual non-communicable deaths are projected to rise substantially, to 53 million in 2030.[3] A myriad of common and preventable risk factors such as high blood pressure, high blood cholesterol, overweight, unhealthy diet, physical inactivity, and tobacco use provide a multifactorial challenge. Furthermore, chronic diseases remain the major cause, of death and disability in the world, and these illnesses also contribute towards enormous healthcare costs for societies and

governments.[4] While there are compelling frameworks that exist for strengthening health care and public health systems, there are no practical frameworks to describe, assess, and strengthen systems for chronic disease prevention using complex systems approaches.[5]

Table 1: Description of levels of socioecological model.

Socioecological level	Description
Individual	Characteristics of an individual that influence behavior change, including knowledge, attitudes, behavior, self-efficacy, developmental history, gender, age, religious identity, racial/ethnic identity, sexual orientation, economic status, financial resources, values, goals, expectations, literacy.
Interpersonal	Formal (and informal) social networks (patient-family/friends/provider) and social support systems that can influence individual behaviors, including family, friends, peers, co-workers, religious networks, customs or traditions and stigma.
Community	Relationships among organizations, institutions, and informational networks within defined boundaries, including the built environment, village associations, community leaders, businesses, and transportation.
Organizational	Organizations or social institutions with rules and regulations for operations that affect how, or how well, for example services are provided to an individual or group.
Policy/enabling environment	Local, state, national and global laws and policies, including policies regarding the allocation of resources for access to healthcare services, restrictive policies (e.g., high fees or taxes for health services), or lack of policies.

Complexity of chronic diseases management

The chronicity of chronic diseases can be understood as the increased time required to evaluate and treat health care conditions (in terms of patient behavior and self-regulation, involvement of family in care, office visits to physicians, visits for diagnostic tests, appointments to allied health care professionals, and filling prescriptions) and increased information that must be mastered to understand how to manage these conditions.[6] This shows that the challenge to manage chronic diseases goes beyond the disease and symptoms. It is the chronicity which makes the chronic disease management a complex problem and challenges the healthcare system across the globe.[7] The chronic nature of the condition requires an extended relationship with the health system, including quite probably an extended financial relationship.[8] This complexity also incorporates the risk factors and social determinants surrounding these chronic diseases.

Illustration: non-adherence to tuberculosis medications in India

To understand this chronicity and multifactorial problems surrounding the management of chronic diseases, the paper will discuss tuberculosis (TB) and its problem of nonadherence to medications in India as a case-in-point. This case-in-point was selected because what appears to be a straight-forward problem is anything but simple to solve, with multidrug resistant tuberculosis as one important and fatal outcome of nonadherence. Furthermore, nonadherence to TB therapy in India is highly consequential because India shares the highest TB burden in the world, accounting for 27% of the global TB cases.[9] In 2022, there were an estimated 2.4 million cases of active TB in India.[9] India also shares the highest global burden of multi-drug resistant TB (MDR-TB) including rifampicin resistance cases, with an estimated 63,801 cases in 2022.[10] As per the WHO, drug resistance emerges when anti-TB medicines are used inappropriately, through incorrect prescription by health care providers, poor quality drugs, and patients stopping treatment prematurely.[11]

Compliance vs. adherence: concepts and ideology

'Compliance' and 'Adherence', both these terms are often used synonymously with treatment of chronic diseases. Both these terms share the property of being quantifiable parameters, which detail when doses are taken and how much drug each dose provides.[12] However, there is an important difference between them.

The word 'compliance' derives from the Latin word 'complire', meaning "to fill up," and hence to complete an action, transaction, or process or to fulfil a promise.[13] Furthermore, the term compliance is often debated because of its clinician-centric perspective.[14] It suggests yielding complaisance and submission. Adherence, on the other hand, comes from the Latin word 'adhaerere', which means to cling to keep close, or remain constant.[13] It includes the extent to which the patient may follow the therapeutic regimen and this pattern of adherence may change with various disease conditions and treatment stages. Also, patients' reasons for deviating from the (agreed upon) treatment plan are diverse and may be intentional or unintentional.[15] Non-adherence to TB medications is accounted for the emergence of multidrug resistant strains of TB bacillus in India.[16] While challenges to adherence are often assumed to reside with the patient, adherence to TB treatment is challenging on many fronts and is not limited to the patients themselves, but rather includes factors which are interpersonal,

community-based, organizational, or policy-centric in nature, and requires a complex model to study & reason it.

Applying the socioecological model

Utilizing multilevel frameworks in complex disease situations proves to be necessary because it integrates social and biological factors along with dynamic social and ecological perspectives to develop new insights and interventions.[17,18] The socioecological framework is a theory-based model which can be used to describe the multifaceted and interactive effects of personal and environmental factors that determine behavior and for identifying behavioral and organizational leverage points and intermediaries for health promotion within organizations.[19] The Socioecological Model emphasizes multiple levels of influence (individual, interpersonal, organizational, community, and public policy); thus, linking the idea that behaviors both shape and are shaped by the social environment (insert table 1 here).[20] To apply the socioecological framework to the challenge-at-hand (e.g., contributors to TB therapy nonadherence), we undertook a literature search, constructed a table, and then identified potential gaps in literature.

METHODS

Literature search

PubMed, Scopus, CINAHL, Medline and Penn State Library Resources databases were searched because of their broad collection of literature focusing on TB medication non-adherence in India. A combination of search terms was included as follows: (*medication adherence OR medication compliance) AND (non-compliance or non-adherence*) AND (*DOT* OR *DOTS OR TB Treatment*). To gather the most recent collection of factors for TB medication adherence, searches were focused on scholarly articles published between January 2000 and December 2022 and written in English. We exported the results (title and abstract) and removed duplicates. As a first step in the screening process, we excluded records that were not related to TB, non-adherence to medications, and not based on India. Two authors then separately reviewed the results (title and abstract) against the inclusion/exclusion criteria, thus resolving any discrepancies. Following this initial screening process, the two authors read and reviewed the full text of each research article, further resolving discrepancies between them.

Eligibility criteria

Studies were included in this narrative review if they met the following criteria: described the factors for medication adherence, described the factors of medication non-adherence, the country of origin of the participants in these studies was limited to any state, district, city, or village in India, Studies of adults over the age of 18 were included. Studies which did not identify the factors for nonadherence to TB treatment in India were excluded. The studies included in this review were cross-sectional studies, randomized controlled trials, systematic reviews, brief reports, news articles, published program evaluations, policy briefs, and government and non-government organization reports. Study selection was performed manually using this set of eligibility criteria.

Data extraction and information synthesis

Analysis involved 'charting' the review results. The literature selected reported factors responsible for nonadherence to treatment for tuberculosis and/or treatment completion for tuberculosis as a primary or secondary outcome. Data concerning factors for medication non-adherence were manually extracted from the reviewed articles by the first author (NA) and discussed with the second author (FN). The descriptive analysis of the characteristics of the selected studies was conducted and the elements arising from these articles were categorized into five thematic areas based on the socioecological model. This process allowed us to identify factors at each level and consider if it increases or decreases medication non-adherence among TB patients in India. All identified factors for non-adherence under each level of socioecological model were discussed and evaluated between the two researchers until a consensus was reached. The final criteria were organized and presented in a table. The findings on factors for nonadherence to TB medications in India identified from the literature search were contextualized, segregated, and described at multiple levels of the Socioecological Model (Table 2).

Table 2: Contextualizing Socioecological Model to Non-adherence to TB Treatment in India.

Socioecological model	Risk factors for non-adherence to tb medications in India	Factor increases or decreases non-adherence
Individual	**Demographic risk factors**	
	Age: >30 years of age[21–25]	↑*
	Gender: Males are more than Females[21,26,27]	↑*
	Marital Status: More likely among single, separated or widow patients[21]	↑
	Religion: More likely among Hindus[21,23]	↑
	More likely among patients from middle class, lower middle	↑*

Continued.

Socioecological model	Risk factors for non-adherence to tb medications in India	Factor increases or decreases non-adherence
	Class and lower class[25,86]	↑
	Illiteracy[21,24,25,29]	↑*
	Income and expenses	
	Family Income and Expenses status[21,24,30,34]	↑*
	Knowledge, perception, and belief	
	Lack of knowledge and perception[24,25,29,34]	↑*^
	Lack of belief in TB treatment[30]	↑*^
	Medication related	
	Side effects[28,34,37]	↑*
	Long duration of treatment[21]	↑
	Pill burden[34,37,43]	↑^
Interpersonal	**Patient-Family/Friends Interrelationship**	
	Lack of family and friends support[27,28,34,93]	↑*^
	Stigma and Discrimination[47,51–53]	↑^
	Patient-Provider Interrelationship	
	Lack of patient-provider interaction and communication[14,54]	↑^
	Lack of compassion and support from the provider[33,34,54]	↑^
Organizational	**Government Organizations**	
	Lack of access to healthcare facility[21,55,57,59,60]	↑^
	Lack of adequate supply of medications[34]	↑^
	Dissatisfaction with the health facility[31,34,35,58–60]	↑^
	Non-governmental organization	
	Presence of any local community level, national or international organization does affect TB treatment adherence[61,62,94]	↓
Community	Poverty[27,34,86–89]	↑*
	Slum environment[27,33,63–65,74]	↑
	Presence of community network[57,67]	↓
Policy	Lack of funding[68,70,95]	↑
	Private sector engagement and multisector coordination[96,97]	↓
	Migration[73,74]	↑^
	Research and Innovation[70,71,75,95]	↓

*p<0.05, ^Qualitative Studies

INDIVIDUAL LEVEL FACTORS

Demographic

Several studies reported that age, gender, socioeconomic class, and literacy were significantly associated with nonadherence to TB medications and majority of the non-adherent patients belonged to the age group of 30 years and above.[21–25] Women were more adherent when compared with men.[21,26,27] Being single, separated, or widowed was reported as one of the risk factor for non-adherence.[21,28] For socioeconomic status, non-adherent behavior was found to be common among patients belonging to middle class, lower middle class, and lower class.[25] Illiteracy was also reported to be a significant factor affecting the adherent behavior of TB patients in India.[21,24,25,29]

Education, knowledge, perception, and belief

Several studies attributed lack of knowledge about the disease, the importance of its treatment procedure, and duration of treatment as major reasons for non-adherence among TB patients.[24,25,29] Furthermore, patients who believed in the seriousness of their problems and reported their symptoms in a timely manner were likely to be adherent.[14,30–33]

Family income and expenses

Various studies reported that low family income was significantly associated with non-adherent behavior among TB patients in India.[21,24,30,34] Additionally, the disease also potentially affects their work status (missed work, being fired, lost job due to treatment and side effects, threat of being fired from the job etc) which can lead to loss of income and financial burden on the patient and their family, which in return, affects the adherent behaviour.[24,25,34-37] Furthermore, it was also reported that although TB treatment is free in India, the disease can lead to indirect or direct non-medical expenses.[38] These expenses could be in the form of cost of food, transportation costs, and additional medications for managing side effects.[38]

Medication related

Long duration of treatment, pill burden, and strong side effects of TB medications was reported to contribute to non-adherence to treatment.[34] The duration of treatment (6 months, minimum and 2 years or more for MDR patients) was reported to interfere with patients' daily lives and this resulted in discontinuation of therapy once symptoms ceased.[39,40] A MDR-TB patient swallows about 14,600 pills in two years of treatment duration and undergoes 8 months of painful injections.[41] The burden of such considerable number of pills also affects the patient's adherence and influences health seeking behavior, with adherence rates dropping to as low as 20% among patients who must take thirteen or more pills each day.[42]

Two qualitative studies on barriers to TB treatment adherence observed that taking too many pills is perceived as lethal by TB patients and they start to worry about whether their body would be able to handle such substantial pill burden, which, eventually results in non-adherent behavior.[37,43] Forgetfulness and mix-up of drugs due to high pill burden was also identified as another contributor to non-adherence of TB medications.[37,43] In addition to the pill burden, side effects of TB medications lead to intentional nonadherence where the patient might cut his number of pills without informing the provider.[44] Lack of energy due to medications is also common and can affect the patient's travel to the clinic for regular treatment and lead to non-adherence.[37,45]

INTERPERSONAL LEVEL FACTORS

Patient, family and friends

Several studies reported that family members, friends, and caregivers play a vital role in the success of the treatment as they understand the above elements and ensure the following; accompanying patients in treatment and follow-up visits, reminding medication doses, recording of doses on the charts and taking care of their nutritional as well as emotional needs.[46-49] Negatively, self-neglect and neglect by the family were commonly observed as one of the reason for default,[23] whereas being with the family during treatment made patients more adherent.[27] Further, some studies also reported instances where family members may condemn TB patients, and as a result, the patients develop low self-esteem and a negative attitude towards their condition, which resulted in non-adherence.[48] In addition, the interpersonal constraints in the form of isolation, discrimination, and rejection by family members were found more among women, mainly due to the patriarchal culture of the society.[47,50]

Stigma and discrimination

Stigma was found to be an integral factor for non-adherence.[47,51-53] Interestingly, men had to deal with stigma at their work place and at the community level, whereas, women were faced with ostracism within the household and in the immediate neighborhood.[51] Disclosure of TB status, irregularities at work due to treatment, and harsh side effects were some of the reasons for stigma which further resulted in loss of jobs and wages among daily wage earners.[52] These reasons also contributed towards the premature halt of treatment as earning the daily living was more important for these participants than completing their treatment.[52]

Patient-provider inter-relationship

Treatment adherence not only reflects the active role of TB patients in self-management of treatment, but also the extent of patient-provider interaction.[14] A qualitative study highlighted the problem of receiving inadequate information on the management of side effects or problems which resulted in losing to follow up and non-adherence.[54] The study also noted lack of compassion and indifference from staff at treatment sites which contributed towards non-adherent behavior.[54] Similarly, two other studies reported about unpleasant behavior where the patient was laughed at by the provider along with others in the clinic and some personal remarks were also made to the patient which resulted in patient leaving the treatment.[33,34]

ORGANIZATIONAL FACTORS

Long distance and poor access to health care facilities especially in rural or tribal areas are few of the factors which encourages nonadherence to treatment among TB patients in India.[21,31,55–57] Dissatisfaction with the health facility was reported reason for the delay in treatment and non-adherence.[31,35]

The major reasons behind this dissatisfaction with health facilities include long waiting hours, lack of privacy, inconvenient appointment times or clinic hours, provider absenteeism, and the poor upkeep of clinics.[34,58] Furthermore, lack of adequate supply of TB medications in the government health set-up has also been found to be one of the contributing factors for non-adherence to TB medications.[34] Overall, this lack of access to government health facilities in the area, additional travel burden, and dissatisfaction with the government health facilities when clubbed with harsh side effects of the medications, further forces patients to drive out of the treatment and approach a private physician or traditional healer (Homoeopathy,

Ayurveda, Unani, Naturopathy practitioners) in search of better treatment and management of side effects.[59,60] As per the Government of India report, the presence or absence of any local community level, national or international non-government organizations does contribute towards better and effective implementation of TB control services.[61] Several programs on community-based work, technology involvement, improved coordination, and referral system with private doctors are

examples which highlight the role of non-government organizations. For example, the Foundation for Research in Community Health (FRCH), a non-government research organization based in Mumbai and Pune, through its initial ten-year community-based health care project at Mandwa in rural Maharashtra revealed the great potential of semi-literate women who could optimally combine knowledge and technology and work for TB awareness activities which potentially contributes towards improved adherence among TB patients. Similarly, in another non-government organization's hospital-based program in Hyderabad, through its 3 year intervention project, it reported an approximately 30% increase in private practitioners' referral.[61]

Additionally, the WHO report also highlights the work of international organizations and their contribution towards the fight against TB and treatment adherence.[61] For example, ACTIONAID India, which works primarily in partnership with about 275 local NGOs throughout the country, in a study reported that only 15% of local leaders in Gujarat, 17% in Tamil Nadu, and 30% in West Bengal were aware of the duration of anti-TB treatment and less than 10% of leaders in Maharashtra, Odisha and Rajasthan had access to printed educational materials by the government. Addressing this issue, the organization developed a booklet about TB to help community-level health workers and decision makers communicate the main messages about TB more effectively which potentially helped in improving adherence. In another example, the "99 DOTS" program of USAID is one such low-cost approach for monitoring and improving TB medication adherence.[62] Using 99DOTS, each anti-TB blister pack is wrapped in a custom envelope, which includes hidden phone numbers that are visible only when doses are dispensed. After taking daily medication, patients make a free call to the hidden phone number, yielding high confidence that the dose was "in-hand" and has been taken.[62]

COMMUNITY FACTORS

There have been studies which show that a structured environment which is conducive for living, be it away from home, could facilitate adherence.[34] Living standards, place of residence, and unfavorable dense living conditions in the slum areas in major cities in India are factors associated with TB prevalence.[63] A secondary research evidence based on the National Family Health Survey (NFHS) III data for four metropolitan, namely, Delhi, Mumbai, Kolkata, and Chennai revealed that the prevalence of TB in slums of Mumbai was three times high in urban slum (informal settlements) areas when compared with non-slum areas of Mumbai.[63] Poverty in these communities creates a challenging environment which is not structured and unfortunately, the patient has little control over it. However, the unstructured environment in these slums makes the individual vulnerable and susceptible to TB and potentially contributes towards non-adherence to treatment.[64]

Lack of support of the system and opportunities in these slum areas also play a key role in their decision making towards continuation and discontinuation of treatment.[63-65] In addition, the status of being a migrant within a community also plays a vital role in the decision making of complying with the treatment. Many of the individuals living in urban slums migrate to rural areas in search of work.[66] A study conducted in Mumbai states that migration affects the stability of residence, and it can adversely affect adherence.[27] The study also reveals that many patients initiate the treatment in the health center close to the urban slum and due to economic or job consequences shift back to their village and get disconnected from the treatment. Additionally, migration may also force them to live alone or without family, to get minimal social support, and to live in an overcrowded and unhygienic environment. This lack of social support does contribute towards non-adherence of TB medications.[49,57,67]

POLICY LEVEL FACTORS

TB, is a curable and preventable disease, costs India $32 billion/year, which is 3.5 times its 2019 health budget.[68] Ending TB and achieving the Sustainable Development Goals (SDGs) requires intensified action across government ministries, communities, the private sector, and civil society.[69] India is trailing on 4 out of the 12 most important global indicators affecting TB medication adherence, namely; drug and MDR TB, national public health financing, social protection system, and health expenditure.[68] However, considering India's share of the global TB burden, it is largely insufficient and even the highly cost-effective programme like India's Revised National TB Control Program (RNTCP) has struggled to receive funding that is commensurate with the scale of India's epidemic and the budget needs.[70] In addition, there has also been underutilization of resources and coordination at the ground level, which certainly calls for improvements in TB control policy and implementation. Furthermore, as the End TB strategy speaks about patient-centered care and its importance, like good business models, even the success of such public health programs depends on providing a complete and customer-centric (patient) solution.[71] With this current infrastructure and expenditure, India is bound to suffer from inadequate staff, training resources, equipment's to run health facilities, and research, which would surely impact TB control programs and non-adherence among patients.[72] Another national level policy issue which was highlighted in the literature and that affects adherence to TB treatment in India is internal migration. In India, the urban slums are dominated with migrant population.[73] A study conducted in urban slums of Delhi indicated that, since the patients stay in rented informal settlements in slums, they are often not permitted by their landlords to get their local ration card (social protection document) made, which is mandatory to avail TB treatment in a local public health centre.[74] Furthermore, the study also reports that patients who are unable to provide any of these documents nor evidence of regular employment are asked

to find someone from the community to guarantee their completion of treatment. In terms of TB control, this situation is problematic in and of itself because, in the absence of any kind of network within the community or due to reluctance to disclose the TB status within the community, these patients find it difficult to access or complete the treatment. Finally, ending TB will not be possible without research and innovation. As a country, India needs to invest in research and innovation especially under TB control activities and programs. The formation of the 'India TB Research Consortium (ITRC)' initiative in 2016 by the Indian Council of Medical Research (ICMR), is a key step to bring together all major national and international stakeholders to enhance TB research and develop new tools for TB.[75] However, these initiatives now require sustainable funding which can harbor innovative research to improve adherence among patients.

GAPS IN THE LITERATURE AT EACH LEVEL

In addition, some of the gaps in the literature were also identified and categorized at each level of the socioecological model (Table 3).

Table 3: Identified gaps in the literature on non-adherence to TB Treatment in India

Socioecological model	Gaps identified
Individual	Lack of comprehensive data on association of religion and non-adherence to TB treatment across India. Since pill burden is a huge concern, more studies on choice of new drug delivery methods could be beneficial and would promote further research and development.
Interpersonal	Not enough literature exists on social support and its impact on non-adherence to TB medications.Limited literature on understanding the provider's perspective and their issues with the system. This data may contribute towards developing policy level strategies for improving interaction with the patients.
Organizational	Not enough literature exists on satisfaction of TB patients with the existing facilities provided by the government. This could benefit in improving the health services. Comparative studies where good coordination between private doctors and government facilities is observed could be useful for policy directions.
Community	Lack of literature on faith-based and community-based interventions in improving TB medication adherence.
Policy	More allocation of funds for TB programs, research, and innovation. Shift in policy perspective where policy makers and researchers must emphasize more on social and economic environment. Lack of multisector coordination.

DISCUSSION

This model provides a very useful theoretical framework for understanding and addressing the numerous and varied obstacles when exploring a chronic health challenge. The assessment suggests that an individual TB patient's behavior is integrated in a dynamic network of interpersonal characteristics, processes, organizational/ institutional factors, community features, and policy issues at the local, national, and international level. The model assumes the presence of multilevel interaction between TB patients and social and ecological environment. However, this interaction is reciprocal, implying that a TB patient's non-adherent behavior is influenced by his/her environment and the environment is influenced by the TB patient. Hence, the model highlights the need to understand the complexity of the problem at every level of the socioecological model. Furthermore, this application provides an opportunity to explore the unexplored at every level of the model and gives us an opportunity to dig deeper and possibly unravel the unknown factors for nonadherence to TB medications. This narrative review by using socioecological model attempts to capture broad aspects and so may not provide insight into how much an effect has over another.[76] This makes it hard to uncover which aspect of the model to address and more on to bring about a change.[76] Nonetheless, the socioecological framework is also one such multilevel framework which could provide a common language, typology, building blocks, and terms for managing complex chronic disease challenges like TB.[77] Additionally, the implementation of the socioecological model into communities can be difficult because of its humongous coverage, cost and labor.[76] Moreover, it also does not take the time factor into account. However, we argue that these cumbersome processes involved should be conducted stepwise, with the socioecological framework providing a landscaping exercise.

Furthermore, the model assumes the presence of multilevel interactions between the subject and its social and ecological environment but fails to capture the causal linkages and multilevel interactions within the model.[76] Moreover, the interaction between the subject and the socioecological environment is reciprocal, implying that a patient's behavior is influenced by his/her environment and the environment is influenced by the patient. Hence, while applying this model, it becomes imperative to consider the reciprocal nature of this model. Additionally, the socioecological model does not, for example, provide guidance on which areas are to be prioritized as there is

no ranking of gaps/barriers identified for non-adherence to TB medications. At every level, there were noticeable gaps in the literature and future studies are required to fill those gaps. For example, religion as an individual factor is still unexplored in a diverse country like India and global literature shows that it plays a vital role in medication adherence.[78] Future research on understanding how religion contributes towards TB medication adherence behavior could give rise to some faith-based interventions which could potentially contribute towards improving adherent behavior. Additionally, pill burden is also found to be an important individual factor which has been associated with the non-adherent behavior of the TB patient.[34,37,43] Future research on new drug delivery methods in the form of inhalants, syrups, or some new combinations could be beneficial and contribute towards reducing this pill burden.[79]

Patient's family, friends, and health care providers comprise important components at the interpersonal level. This section of the model also highlights the social interaction in the form of social support or social network of the individual. There have been numerous studies outside India which established a significant relation between social support and its impact on management of chronic illnesses.[80-85] However, there is not enough literature in India exploring the role of social support in TB medication adherence.[49] Further research on understanding the association of social support and TB medication adherence behavior in India could potentially lead to patient-centric intervention strategies. In addition, the healthcare institution's rules, regulations, and the general attitude toward research shape the institutional level within the model. The literature shows that lacking of patient-provider interaction and dissatisfaction with health facilities are factors for TB medication non-adherence.[33,34,54] However, it is equally important to further explore the reasons for this lack of interaction and dissatisfaction among health providers and facilities. This could potentially reveal the organizational/policy level challenges which might be the contributing factors for this behavior among healthcare professionals or providers.

Poverty was also a common theme in nonadherence of subjects and lack of resources and means posed serious contingency problems continuing the treatment.[27,34,86-89] An estimated 70 million Indians still live in extreme poverty and earn less than US $1.90 per day.[90] Thus, it becomes imperative to address this problem from a socioeconomic perspective, which would not only contribute towards reducing TB burden but could potentially have a positive impact on treatment adherence. Social protection programs like cash transfer schemes and employment opportunities have shown to be significantly associated with TB control.[91] According to a scoping study on social protection, impact evaluation studies of social protection programs provide useful information on the current and direct impacts of these interventions but do not provide insights into deeper causalities or broader developmental implications.[92] There is a need for future research on social protection needs to be linked to the analysis of poverty and vulnerability in different contexts. Furthermore, this structure also provides us with an understanding of why community plan, policies, funding, pathways for research, and organizational spheres of influence are extremely relevant to this challenge.

Limitations

There are some limitations in this narrative review. Foremost, our database selection and search strategies were not extensive, and we might have failed to capture all published literature. Further, we limited the studies to those published in English, potentially excluding other existing factors related to medication non- adherence in TB from non-English sources. Additionally, the elements identified from the articles in our literature review and synthesis might also be subject to further validation and evaluation. Finally, given that this was a narrative review, and the scope was focused on factors for medication non-adherence in India, it not be generalizable to factors in different parts of the world.

CONCLUSION

In this piece, we have articulated the background, structure, and application of the socioecological models towards the understanding of the complex chronic disease challenge of nonadherence to TB medications in India. There is an agreement over the factors related to TB nonadherence in India which was already scattered in the literature. However, there was a need to aggregate it into a framework. The socioecological approach provides a valuable methodological step in moving from a hyper-focus on implementation perspective towards a planned, sustainable, and comprehensive multilevel perspective on handling complex chronic diseases. This case-in-point example of TB could serve as a blueprint for approaching other complex chronic diseases and can contribute towards a paradigm change. Applied to other chronic illnesses, it could provide a pathway for information input and synthesis. Future research will need to test the framework's general applicability by customizing it to specific contexts of chronic disease, which could potentially offer new insights towards global health and well-being.

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