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REVIEW ARTICLE

Addressing tuberculosis through complex community-based socioeconomic interventions in low- and middle-income countries: A systematic realist review

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ABSTRACT

The established relationship between poverty and tuberculosis has led to the implementation of complex socioeconomic interventions to address poverty as both a risk factor for and consequence of tuberculosis. However, limited research to date has examined the conditions that facilitate the successful implementation of these interventions. We conducted a systematic realist review to examine how complex socioeconomic interventions for tuberculosis treatment and care were defined, implemented, and evaluated in low- and middle-income countries. We used a systematic search to identify published work that implemented complex socioeconomic interventions for tuberculosis, followed by a realist analysis informed by existing programme theories. From a total of 2825 collected records, 36 peer-reviewed articles and 17 grey literature reports were included in this review. The realist analysis identified three main contexts (sociopolitical and cultural; relational and interpersonal; operational and administrative) and ten mechanisms that facilitated successful implementation of interventions. Overall, this review highlights the importance of political commitment in shaping sustainable programme delivery, the role of healthcare and community-based provider training in creating patient-centred treatment environments, and the opportunity to leverage operational research for evidence-based decision making to address the socioeconomic needs of tuberculosis patients experiencing poverty.

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Introduction

Tuberculosis continues to be the leading cause of death from an infectious disease, with an estimated 10.0 million people developing the disease in 2018 (World Health Organization, 2019). The global burden of tuberculosis disproportionately affects populations experiencing poverty in low- and middle-income countries (LMICs), where most tuberculosis cases in 2018 were geographically distributed in South-East Asia (44%), Africa (24%), and the Western Pacific (18%) (World Health Organization, 2019). Since the promotion of DOTS (directly observed treatment, short-course) in the 1990s as the primary approach to address the tuberculosis epidemic in low-resource settings, global strategies have evolved with increasing attention focused on addressing the social

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determinants of tuberculosis (Lönnroth et al., 2009, 2014; Rasanathan et al., 2011; Raviglione & Pio, 2002; Satyanarayana et al., 2020).

The relationship between the multidimensional aspects of poverty and tuberculosis has been well-established in the literature. More specifically, low educational attainment, financial limitations, and a lack of livelihood opportunities that contribute to food insecurity, transportation restrictions, and poor mental health have been shown to influence tuberculosis risk and cure rates (see Appendix A). Recognising the connection between the social determinants of health and tuberculosis, interventions have started to address poverty and tuberculosis concurrently. Previous systematic reviews have shown the effectiveness of social protection and poverty alleviation efforts in improving tuberculosis treatment outcomes (de Andrade et al., 2018; Richterman et al., 2018; van Hoorn et al., 2016). A meta-analysis assessing the potential of cash transfers to support the improvement of tuberculosis treatment outcomes showed that patients receiving cash transfers were more likely to have positive clinical outcomes (Richterman et al., 2018). This meta-analysis also noted that half the studies collected included some non-cash co-interventions, which may have had positive effects related to the pooled effects of cash and non-cash interventions (Richterman et al., 2018). Similarly, systematic reviews evaluating broader social protection interventions consisting of both socioeconomic and psychosocial support found that these interventions were associated with higher treatment success, in addition to a reduction in death, treatment failure, and loss-to-follow-up (de Andrade et al., 2018; van Hoorn et al., 2016). These existing reviews have begun to examine the interactions between different social risk factors and vulnerabilities which could be addressed in combination with tuberculosis treatment and care.

Building on this foundation, this review identifies and describes the influence of contextual factors and relevant mechanisms in the implementation of complex socioeconomic interventions to address tuberculosis. While research has established the links between poverty and tuberculosis, limited work has explored the underlying processes and mechanisms that influence the effective implementation of socioeconomic interventions to concurrently address poverty and tuberculosis (Wingfield et al., 2015). Thus, there is a gap in the understanding of why, how, and for whom socioeconomic interventions for tuberculosis are delivered. This review aims to address this gap through the application of a realist lens, which prioritises the elucidation of programme theories underlying health interventions (Pawson et al., 2005). Realist analyses focus on the contexts, mechanisms, and outcomes of interventions and consider the interactions among these intervention components to assess why and how interventions succeed or fail (Rycroft-Malone et al., 2012). Realist analyses can guide intervention adaptation to account for different contexts and resource availability to avoid unintended consequences and to learn from unsuccessful outcomes (Jagosh, 2019; Pawson et al., 2005).

Recognising the multidimensionality of poverty as a risk factor for tuberculosis, we have defined a complex socioeconomic intervention to include two or more of the following components: financial support, food security assistance, transportation, livelihood opportunities, social support, and health education. The aim of this review was to examine how complex socioeconomic interventions for tuberculosis treatment and care were defined, implemented, and evaluated. The objectives of this review were: 1) to identify published work that implemented complex socioeconomic interventions for tuberculosis in the peer-reviewed and grey literature; and 2) to conduct a realist analysis informed by existing programme theories to investigate the mechanisms that influence the effectiveness of included interventions under varying contexts.

Methods

First, we conducted a systematic literature search and extracted relevant information from both the peer-reviewed and grey literature. Second, we conducted a realist analysis which investigated the contexts in which interventions were set, and the corresponding mechanisms and processes that influenced intervention effectiveness. This review was informed by realist methods, which are

used to elucidate how, why, and in what contexts interventions were effectively implemented with successful outcomes (Pawson et al., 2005; Rycroft-Malone et al., 2012). This review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analysis for Scoping Reviews (PRISMA-ScR) to systematically identify relevant published literature (both peer-reviewed and grey literature) (Tricco et al., 2018).

Search strategy

In reference to earlier reviews that identified important concepts and definitions related to the social determinants of tuberculosis (de Andrade et al., 2018; Richterman et al., 2018; van Hoorn et al., 2016), and following consultations with a university librarian, the peer-reviewed literature search string included three main concepts: 1) tuberculosis as the disease of interest; 2) an evaluative study component; and 3) the incorporation of a complex socioeconomic intervention; (see Table 1). The terms used for the evaluation component of the search string captured a broad range of methodologies including both outcome and implementation research (Craig et al., 2008; Pawson et al., 2005). The terms used for the intervention component of the search string included concepts that would capture socioeconomic interventions that addressed multiple and interconnected dimensions of poverty. The search strings were adapted and used to search for peer-reviewed literature in four databases (PubMed, Scopus, PsycINFO, and Sociological Abstracts) on 31 October 2019 and updated on 2 April 2020 to capture relevant literature up to 31 December 2019. Mendeley citation management software was used to remove duplicate articles between databases.

A grey literature search was performed in the Google search engine on 29 November 2019. Informed by the initial peer-reviewed search string, a modified search string to search for grey literature was constructed to accommodate the technical features of the Google search engine including the 32-word limit (Godin et al., 2015). Moreover, the grey literature search used specific terms relating to different socioeconomic components to narrow down the relevant results from the search given the wide yield from the broader search string terms (see Appendix C). We placed an emphasis on financial interventions considering the high economic burden experienced by tuberculosis patients (Tanimura et al., 2014). To prevent the Google search algorithms from altering results due to browser history and cookies, M.B. conducted the search on Google Chrome Incognito. Duplicate records were not removed between search strings as this was not feasible given the large number of results generated by each search string; however, relevant records selected for further screening were bookmarked to mitigate duplication (Godin et al., 2015).

Determining eligibility

A comprehensive selection criteria was developed to capture the varying components of complex socioeconomic interventions (see Table 2) (Pawson et al., 2005; Rycroft-Malone et al., 2012; Tricco et al., 2018). Publications in languages other than English were excluded, and research was not restricted to any time period. Peer-reviewed literature was required to be primary research that

Table 1. Search strings used to identify relevant sources on complex socioeconomic interventions for tuberculosis*.

Main concepts	Expanded terms
Disease of interest terms	tuberculosis OR TB
Study design terms	evaluation OR study evaluat* OR observation OR 'randomized controlled trial' OR pilot project* OR 'treatment outcome' OR impact OR qualitative OR 'public policy'
Complex socioeconomic intervention terms	'socioeconomic support' OR 'socioeconomic intervention' OR 'socioeconomic program' OR 'socioeconomic assistance' OR 'socioeconomic status' OR socioeconomic factor* OR 'social protection program' OR 'social support' OR 'social assistance' OR 'social environment' OR 'economic support' OR 'economic assistance'

*This is a shortened list of search terms. See Appendix B for a full list of terms for each database.

Table 2. Eligibility criteria used to determine inclusion or exclusion of sources on complex socioeconomic interventions for tuberculosis.

Criteria	Inclusion	Exclusion
Publication Information	Published in English Peer-reviewed literature published in a journal and primary research was conducted Grey literature – conference proceedings, policy documents, government publications, NGO or civil society reports	Peer-reviewed literature – systematic, scoping, and traditional reviews; Grey literature – theses, magazines, newsletters, bulletins, maps, speeches, commentaries, news articles, fact sheets, websites, conference abstracts
Type of intervention	Intervention supporting tuberculosis treatment and care through the social determinants: 1) financial support 2) livelihood opportunities 3) food provisions 4) transportation support 5) social support or 6) health education	Intervention supporting tuberculosis treatment and care incorporates only one component of socioeconomic support
Type of study	Includes an evaluative component, either through clinical or socioeconomic outcomes or operational and process evaluations	Observational or exploratory study without an intervention involved
Setting	Low- and middle- income countries (LMICs)*	High-income countries Interventions set in specific institutional settings (e.g. prisons, schools, hospitals, sanitoriums)
Target population	Tuberculosis patients, tuberculosis affected individuals and/or households	Healthcare workers, community health workers, health professionals

*LMICs as classified according to the World Bank Classification (World Bank, 2020)

was conducted to evaluate an intervention through quantitative, qualitative, or mixed-methods (i.e. combination of quantitative and qualitative methods). To supplement the realist component of the analysis, operational and process evaluations from the peer-reviewed literature as well as grey literature reports were included. The grey literature was restricted to detailed conference proceedings, policy documents, government publications, and reports by relevant organisations. These records provided more comprehensive explanations regarding contextual factors and mechanisms to understand their influence on programme implementation (Craig et al., 2008; Pawson et al., 2005).

Interventions reported in the published literature were required to have two or more of the following socioeconomic components to be included in the review: financial support, livelihood opportunities, food provisions, transportation support, social support, or health education. These components were selected given the relationship between tuberculosis and multidimensional poverty, both as a risk factor for increased disease susceptibility and as a structural barrier to accessing care or completing treatment (Lönnroth et al., 2009; Munro et al., 2007).

Geographic location was restricted to low- and middle- income countries (LMICs) as classified by the World Bank (World Bank, 2020). LMICs were of specific interest as they experience a disproportionate burden of tuberculosis (World Health Organization, 2019). Additionally, the search included community-based interventions, as weaker health systems in LMICs have required a shift from institutional care delivery to community platforms for improved accessibility (Arshad et al., 2014). Consequently, a community-based approach to tuberculosis control has been emphasised as a way to decrease the demand on weak health service infrastructure in low-resource settings (Arshad et al., 2014; Bhutta et al., 2014; CORE Group TB Working Group, 2013).

Screening and selection process

Two stages of screening were conducted for peer-reviewed and grey literature. For peer-reviewed literature, M.B. and K.L. conducted title and abstract screening as well as full text review using the online platform Rayyan. Then, M.B. hand searched the reference lists of selected peer-reviewed literature to identify additional articles not captured in the database search. For grey literature, M.B. initially reviewed the results from the Google search by screening the title header, description, and webpage; and relevant results were entered into an Excel spreadsheet. Following this initial screening, both M.B. and K.L. conducted the second stage of full text review for grey literature on separate

Excel spreadsheets (Godin et al., 2015). M.B. and K.L. discussed their progress over the course of the screening process to clarify uncertainties, and to resolve conflicts through iterative discussion of the records. Interrater reliability for both the peer-reviewed and grey literature was assessed using Cohen's kappa (McHugh, 2012).

Data extraction and realist synthesis

The realist analysis was informed by methods outlined by Pawson et al. and Rycroft-Malone et al., as well as the Medical Research Council Framework for evaluating complex interventions (Craig et al., 2008; Pawson et al., 2005; Rycroft-Malone et al., 2012). To identify existing programme theories, we reviewed literature and systematic reviews that discussed the relationship between poverty and tuberculosis, as well as literature that assessed the effectiveness of socioeconomic interventions to address tuberculosis. Two main programme theories were identified. First, a framework by Ortblad et al. presented the relationship between tuberculosis and poverty as a cycle, where poverty is further exacerbated as a consequence of tuberculosis (Ortblad et al., 2015). These authors explained that while poverty is associated with tuberculosis, tuberculosis also exacerbates poverty due to the economic and social consequences experienced alongside the disease (Ortblad et al., 2015). Second, a framework by Boccia et al. mapped the potential of cash transfers to address the social determinants of tuberculosis. These authors showed that financial support can contribute to tuberculosis prevention and care by alleviating poverty associated risk factors, reducing barriers to accessing services, and mitigating socioeconomic consequences (Boccia et al., 2011, 2016).

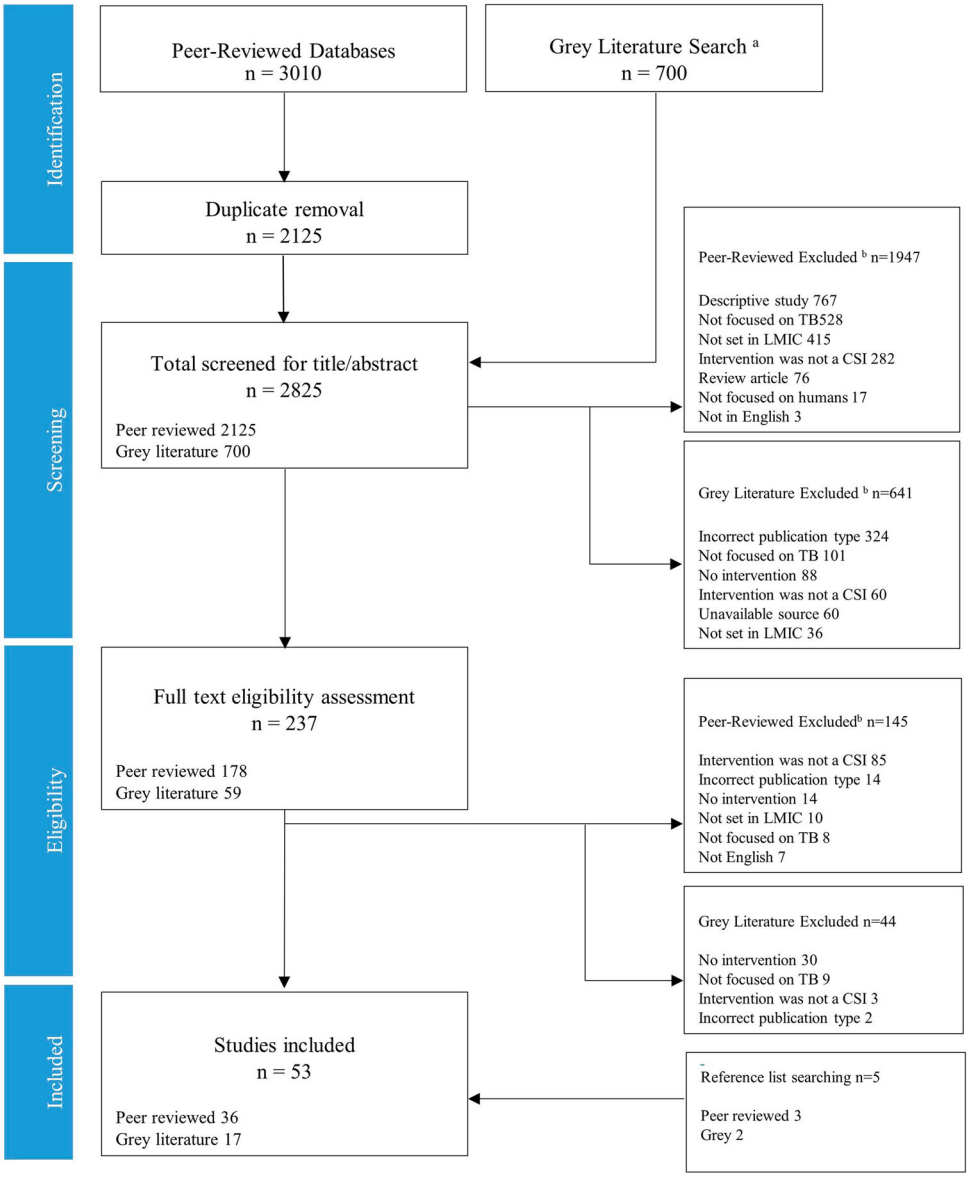
Informed by these programme theories, this systematic realist review was guided by the understanding that socioeconomic interventions can 1) reduce barriers to accessing tuberculosis services to improve tuberculosis treatment outcomes; and 2) mitigate the detrimental socioeconomic consequences associated with tuberculosis. Using these programme theories as a guiding framework, a hybrid inductive and deductive thematic analysis approach was conducted to assess the mechanisms by which these theories were successfully operationalised in the interventions described in the peer-reviewed and grey literature (Pawson et al., 2005; Rycroft-Malone et al., 2012). Data extraction and analysis was conducted using an Excel spreadsheet that was organised according to the different emergent themes. The thematic analysis was iteratively reviewed by M.B. and W.D. to ensure that connections between the contexts and mechanisms were appropriately identified, understood, and represented.

Results

The peer-reviewed database search resulted in 3010 articles, with 178 articles screened for full text eligibility (see Figure 1). Most excluded peer-reviewed articles were observational studies that described socioeconomic barriers in accessing tuberculosis care and did not include an intervention. Other excluded literature only mentioned tuberculosis as a comorbidity of other diseases. A total of 36 peer-reviewed articles were included for the realist review (see Appendix D). Among these 36 peer-reviewed articles, there were 27 unique 'project groups' (see Appendix E).

A total of 700 grey literature records were screened and 59 records were assessed for full text eligibility (see Figure 1). Most of the excluded grey literature did not fit the relevant publication types and were not focused on tuberculosis. A total of 17 grey literature sources were included in the realist review (see Appendix F). Of note, five grey literature sources corresponded with 'project groups' from the included peer-reviewed literature.

Interrater reliability was assessed through a calculation of Cohen's kappa. The peer-reviewed literature title and abstract and full text screening both had 'substantial' agreement at 0.73 and 0.63, respectively (McHugh, 2012). As M.B. independently conducted the title and abstract screening of the grey literature, Cohen's kappa was only calculated for the full text screening of grey literature. Grey literature interrater reliability had 'moderate' agreement at 0.59 (McHugh, 2012).



[a] Duplicates were not removed from grey literature as a modified search strategy was employed for the Google search engine
[b] Articles may have been excluded for multiple reasons

LMIC=low- and middle-income countries; CSI=complex socioeconomic intervention; TB=tuberculosis

Figure 1. Flow chart of the peer-reviewed and grey literature search strategy on complex socioeconomic interventions for tuberculosis.

Of the 27 projects identified in the peer-reviewed literature, most were conducted in upper-middle income ($n = 13$; 42.8%) and lower-middle income ($n = 8$; 29.6%) countries. The project with the largest number of published articles associated with it was conducted in Peru ($n = 5$ articles; 13.9% of all articles). More projects were conducted in urban contexts ($n = 14$; 51.9%), compared to rural areas ($n = 7$; 25.9%). Additionally, most projects were implemented in cities and towns (12; 44.4%) and districts (8; 29.63%). More than half of the projects were conducted in

one of the 30 countries considered to have a high tuberculosis burden, accounting for 87% of all estimated incident cases worldwide (n = 19; 70.4%) (World Health Organization, 2019; see Table 3).

Realist analysis

The realist analysis identified ten different mechanisms of action. The following realist synthesis is organised according to three main contextual levels (sociopolitical and cultural context; relational and interpersonal context; operational and administrative context) under which the mechanisms were operationalised in the development, implementation, and evaluation of the interventions (see Figure 2). In addition, relevant examples are drawn from the collected peer-reviewed and grey literature to exemplify the identified mechanisms (see Table 4).

Sociopolitical and cultural context

Strengthening political commitment through existing National Tuberculosis Programs (NTPs) and governmental health agencies

The collected literature frequently described the importance of political commitment to tuberculosis control to establish interventions for broader and long-term implementation (Getahun & Maher, 2000; Khanal et al., 2017; Rogers et al., 2018; Shin et al., 2004; Soares et al., 2013; van

Table 3. Characteristics of complex socioeconomic interventions described in the collected peer-reviewed literature.

	FREQUENCY (n = 27)	PERCENTAGE
NTP INVOLVEMENT*		
DOTS	18	66.67%
Existing NTP structures	12	44.44%
INTERVENTION PARTICIPANTS*		
DS-TB	20	74.07%
MDR-TB	15	55.56%
XDR-TB	3	11.11%
TB contacts or household members	13	48.15%
People living with HIV	17	62.96%
LEAD PROVIDERS*		
Non-governmental organization	13	48.15%
Regional or local government	11	40.74%
Research group	8	29.63%
DIRECT PROVIDERS*		
Community health workers	17	62.96%
Psychologists or physicians	11	40.74%
Community volunteers	8	29.63%
Nurses	7	25.93%
Faith-based partners	6	22.22%
Civil society organisation	4	14.81%
SCALE		
City/Town	12	44.44%
District	8	29.63%
State/Province	6	22.22%
Regions	1	3.70%
SOCIOECONOMIC COMPONENTS (n=29)**		
Social support	26	89.66%
Health education	19	65.52%
Financial support	17	58.62%
Food/nutrition	15	51.72%
Transportation	14	48.28%
Livelihood/vocational training	6	20.69%

*The total is not equal to 27 projects as interventions could incorporate more than one of the indicated categories.

**There were 29 articles where socioeconomic components were calculated, as some projects changed socioeconomic components at different phases of the project (e.g. change in socioeconomic components between pilot study and main intervention).

NTP = National Tuberculosis Program; DOTS = Directly Observed Treatment, Short-course; DS-TB = Drug-susceptible tuberculosis; MDR-TB = Multidrug resistant tuberculosis; XDR = Extensively drug resistant tuberculosis

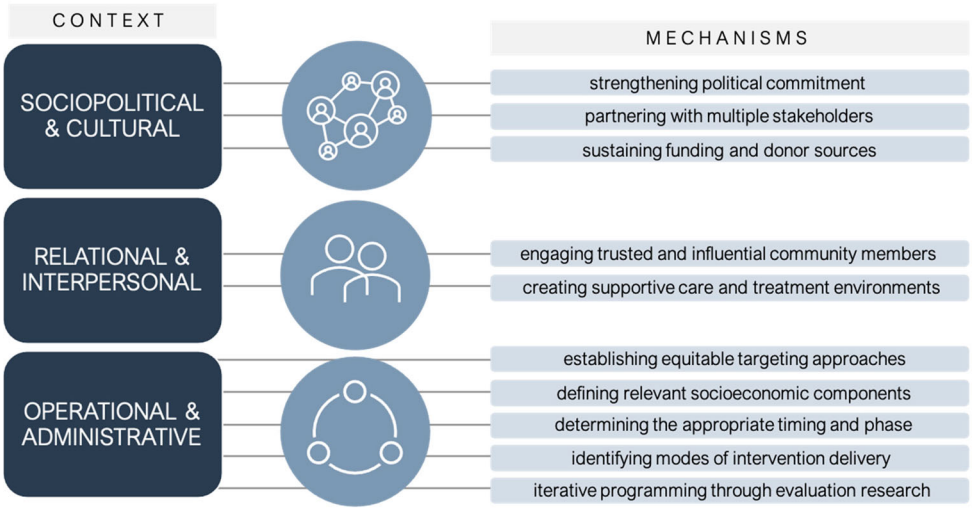


Figure 2. Summary of main contexts and mechanisms derived from realist analysis of complex socioeconomic interventions for tuberculosis.

den Hof et al., 2014; Walker et al., 2018; Wickett et al., 2018; Wingfield et al., 2015). The presence of a National Tuberculosis Program (NTP) often indicated there was existing political commitment to address tuberculosis. Involving the NTP in a complex socioeconomic intervention expanded tuberculosis services beyond medical treatment and care, and provided opportunities for governments to address the social determinants of tuberculosis. For example, in Nepal, researchers partnered with the NTP to develop a psychosocial package which was to be added to the existing DOTS programme (Khanal et al., 2017; Walker et al., 2018). The involvement of the NTP promoted government ownership for potential scaling of the programme beyond the feasibility study (Khanal et al., 2017; Walker et al., 2018). Moreover, involving NTPs allowed for larger scale implementation of interventions. For example, community mobilisation efforts and cash transfers in multiple regions in India were made possible through a centralised NTP structure (*Revised National TB Control Programme: Annual Report*, 2019). In addition, providing joint socioeconomic and tuberculosis care interventions through NTPs can ensure the continuation of essential resources such as health workers and staff, community clinics, and free treatment and services through programmes such as DOTS (Bhatt et al., 2019; Soares et al., 2013).

National, regional, and local government health agencies also displayed political commitment towards addressing tuberculosis. For example, in Liberia and Peru, municipal governments and public health ministries established formal partnerships with community-based NGOs to collaboratively develop and improve the sustainable delivery of tuberculosis services and socioeconomic assistance (Contreras et al., 2017; Rogers et al., 2018; Wickett et al., 2018). Similarly, in Ethiopia, the Ministry of Health and Regional Health Bureau provided educational materials for an intervention focused on raising tuberculosis awareness and establishing social support groups (Demissie et al., 2003; Getahun & Maher, 2000).

Partnering with multiple stakeholders for programme development and implementation

During programme development, consultations with different stakeholders were important for implementors to gain an accurate assessment of the setting where programme implementation was planned (Baral et al., 2014; Bhattacharjee, 2012; Contreras et al., 2017; Kamineni et al., 2011; Khanal et al., 2017; Rogers et al., 2018; Shin et al., 2004). To assess the feasibility of a complex socioeconomic intervention, it was important for implementors to consult with community members, healthcare providers, and policymakers at a local, regional, and national scale. For example, in the

CRESIPT Study, community-based researchers laid out an explicit stakeholder consultation plan which involved meetings with civil society groups, varying levels of government, academic researchers, and community members (Wingfield et al., 2015). Similarly, researchers implementing social support programmes in Nepal conducted interviews with patients, household members, healthcare workers, and NTP staff members to assess the relevance and feasibility of the proposed intervention (Khanal et al., 2017). The consultation process provided practitioners with a well-informed picture of the available resources and intended target population to facilitate the development of a feasible and relevant intervention. Additionally, the consultation process facilitated the formation of potential partnerships and collaborations between other stakeholders and groups for programme implementation and delivery. These eventual collaborations among multisectoral stakeholders broadened the scope of the intervention to reach larger tuberculosis affected groups (Atkins et al., 2012; Bhatt et al., 2019; Bond et al., 2005; Contreras et al., 2017; Rocha et al., 2011; Rogers et al., 2018; Shin et al., 2004; The Union, 2016). For example, Project Axshya, a large social support and health promotion intervention in India, included multisectoral partnerships among different levels of government, NGOs, community-based organisations, and various civil society groups to ensure collaborative development and implementation of tuberculosis efforts across different areas (*Revised National TB Control Programme: Annual Report*, 2019; The Union, 2016). Integrated into the larger national strategy of tuberculosis, Project Axshya created partnerships with multiple stakeholders and increased the scale of provided interventions across different areas and populations.

Sustaining funding and donor sources

Funding was essential to the sustainability of programmes, and was often sourced from development agencies, international NGOs, or government agencies, which then channelled the funding through community-based NGOs (Ngamvithayapong-Yanai et al., 2013; Nsutebu et al., 2001; Richardson et al., 2019; Skiles et al., 2018; Yin et al., 2018; Zachariah et al., 2006). In a *favela* in Rocinha, Brazil, the municipal government formally funded and employed community health workers (CHWs) through a signed contract, which increased the stability of the team and overall programme (Soares et al., 2013). In contrast, Center for Sharing, a patient fund in Thailand that provided financial and transportation support to tuberculosis patients, was initially funded by the Stop TB partnership (Ngamvithayapong-Yanai et al., 2013). Once the grant funding ended, Center for Sharing recruited local high-income women to organise fundraising efforts to sustain the patient fund (Ngamvithayapong-Yanai et al., 2013). Similarly, in Zambia, food supplements for participants were first provided by the World Food Programme (WFP). When the home-based care (HBC) programme placed a fee on the food supplements to fund livelihood programmes for participants, the WFP donations were retracted. In response, the German HELP Food Project took over the provision of food supplements to the HBC programme to continue providing food support to participants (Nsutebu et al., 2001). These mechanisms exemplify the potential for precarious funding, which can compel organisations delivering socioeconomic interventions to find alternative funding opportunities. In contexts where NGOs are the main providers of socioeconomic interventions, the need to continuously explore new opportunities for funding can present a challenge for the sustainability of interventions. Overall, government supported programmes provided avenues through which interventions could receive sustainable funding. As such, this finding underscores the importance of core funding among governments for tuberculosis control efforts (i.e. through government programmes or through channelling governments funds through NGOs and other community-based organisations).

Relational and interpersonal context

Engaging trusted and influential community members in delivering interventions

Community engagement ensured that the intervention was acceptable and relevant for programme participants and patients. Community engagement was often operationalised through the work of

CHWs or through involving community members and volunteers. CHWs were often lay people who were familiar with the community where the intervention was taking place, and were trained to support tuberculosis control efforts (Alva & Cloutier, 2019; Bond et al., 2005; Demissie et al., 2003; Farmer et al., 1991; Gandhi et al., 2009; Getahun & Maher, 2000; Rachmawati & Syafar, 2019; Shin et al., 2004; Taneja et al., 2017; Wickett et al., 2018; Zachariah et al., 2006). As CHWs were often members of the community themselves, trust in CHWs was an important component of many interventions, especially in contexts where an intervention provided HBC, active contact screening, or promoted treatment adherence (Baral et al., 2014; Demissie et al., 2003; Li et al., 2018; Shin et al., 2004; Taneja et al., 2017).

In contrast to formal CHWs, community members also supported the provision of complex socioeconomic interventions in some settings. In Malawi and Peru, community members and local businesses were mobilised to provide resources for community farming and to support vocational training among tuberculosis patients and their household members (Rocha et al., 2011; Zachariah et al., 2006). In contexts where participants and patients resided in remote communities, engaging influential community members to implement the intervention was an effective mechanism to promote intervention engagement. For example, in Thailand, high-income women were mobilised to provide social and financial support to low-income tuberculosis patients (Ngamvithayapong-Yanai et al., 2013). In Ghana and Burkina Faso, community leaders were recruited to facilitate community sensitisation workshops, promote awareness, and encourage referrals as they were able to influence community beliefs and behaviours through their existing networks (World Health Organization, 2015). Similarly, in India, community sensitisation workshops that reached traditional healers and alternative medical practitioners in tribal areas enabled these influential actors to refer individuals suspected of tuberculosis infection for microscopy testing (Kamineni et al., 2011).

Creating supportive care and treatment environments

The relationship between the direct programme providers and programme participants was consistently highlighted as an important factor that contributed to patient empowerment. Strong relationships also prevented poor mental health that could contribute to intervention drop-out or treatment failure. CHWs, nurses, and volunteers were often the frontline providers of interventions, especially when interventions provided social support and health education (Bond et al., 2005; Gandhi et al., 2009; Shin et al., 2004; Taneja et al., 2017; Wickett et al., 2018; Zachariah et al., 2006). Specifically, when lay persons were recruited to be CHWs, treatment supporters, or counsellors, these individuals were most prepared to provide effective and dignified care when they received adequate training, resources, and managerial support (Bond et al., 2005; Shin et al., 2004; Soares et al., 2013; Walker et al., 2018). In Peru, prior to working as independent CHWs, recruited community members were required to participate in a training day and shadow experienced health promoters (Shin et al., 2004). Additionally, incorporating a standard for respectful behaviour towards tuberculosis patients during training allowed CHWs to have a better understanding of compassionate care and a rights-based approach to patient support (Shin et al., 2004). Other studies have shown that a lack of training could result in stigma against tuberculosis patients experiencing poverty as well as inefficient delivery of services (Wingfield et al., 2015; Yin et al., 2018). Overall, the mechanisms by which these CHW programmes were implemented may be replicable in similar contexts where there are strong managerial structures that can provide leadership for training and oversight of lay community members.

Operational and administrative context

Establishing equitable approaches towards targeting participants and patients

The mechanisms used to reach and target intended participants influenced the equitable delivery and provision of socioeconomic interventions across populations. As the interventions included

in the review were intended to reduce barriers to treatment or to mitigate socioeconomic consequences associated with tuberculosis, intervention participants were tuberculosis affected individuals and households who were experiencing poverty. These participants were identified through referral systems, standardised assessments, or existing tuberculosis surveillance systems. Referral systems were effective mechanisms for community-based organisations and tuberculosis health centres collaborating to address patient needs (Bond et al., 2005; Demissie et al., 2003; Farmer et al., 1991; Getahun & Maher, 2000; Nsutebu et al., 2001; Shin et al., 2004; Taneja et al., 2017). Additionally, screening and assessment procedures ensured that the limited resources for socioeconomic interventions were provided to patients and households most in need of support. In Peru, Thailand, Liberia, and India, tuberculosis patients were systematically assessed using questionnaires with varying socioeconomic indicators to determine whether they qualified for socioeconomic provisions (Bhatt et al., 2019; Contreras et al., 2017; Ngamvithayapong-Yanai et al., 2013; Rogers et al., 2018; Shin et al., 2004). In Peru and Liberia, questionnaires were administered by social workers or social protection officers (Rogers et al., 2018; Shin et al., 2004), while a panel of medical officers and programme coordinators evaluated patient needs in India (Bhatt et al., 2019). In Peru, where the CRESIPT Study was implemented in peri-urban shantytown communities among marginalised populations in Lima, it was more difficult to reach high risk and vulnerable populations who were previously incarcerated, or who were experiencing mental illness, substance use, and homelessness (Wingfield et al., 2015). To address this challenge, extra effort was taken to reassure potential participants about the legitimacy of the project and its independence from the judiciary system.

Defining relevant socioeconomic components to include in the intervention

The socioeconomic components included in the interventions often had to be relevant to the needs of the patients and participants to effectively reduce barriers to treatment or to alleviate socioeconomic consequences. Needs assessments were implemented in the form of qualitative and exploratory studies to assess barriers towards accessing care and the social and economic consequences of tuberculosis (Baral et al., 2014; Khanal et al., 2017; Ngamvithayapong-Yanai et al., 2013). For example, in Nepal, to inform the development of a psychosocial programme for multi-drug resistant tuberculosis patients, a qualitative study was initially launched through holding interviews and focus groups with patients, family members, and healthcare practitioners (Khanal et al., 2017). The study emphasised the importance of addressing the mental health, financial, and livelihood related needs of patients, which formed the foundation for subsequent programming (Khanal et al., 2017; Walker et al., 2018). Other studies also indicated that initial exploratory studies formed the basis for the development and delivery of socioeconomic interventions for tuberculosis patients (Baral et al., 2014; Demissie et al., 2003; Ngamvithayapong-Yanai et al., 2013).

Once patient needs were identified, they were addressed in a variety of different ways depending on the socioeconomic support being provided. For example, home visits in China were conducted through a culturally relevant psychotherapy intervention that addressed depression and anxiety for older adult patients with tuberculosis (Li et al., 2018). Alternatively, in Ethiopia, social support was fostered through 'TB clubs' to encourage treatment adherence among TB club members (Demissie et al., 2003; Getahun & Maher, 2000). Additionally, family and household members as well as broader community members were occasionally involved in social support and tuberculosis awareness activities to enable them to support patients. For example, in Nepal, family members were provided with informational pamphlets (Walker et al., 2018) and in China, family members were invited to attend psycho-educational workshops in order to better support patients (Li et al., 2018). In Liberia, tuberculosis awareness among the broader community was promoted through door-to-door awareness raising initiatives, community outreach, and radio health education broadcasts to improve case identification through facility referrals and follow- up (Rogers et al., 2018).

Where individuals with tuberculosis were unable to access services due to geographical barriers, transportation support was also provided in different forms depending on participant and patient needs. In Zambia and Pakistan, transportation support was provided through directly

accompanying contacts to testing centres when active contact investigation was taking place (Bond et al., 2005; Shah et al., 2013). Alternatively, when financial barriers were the upstream cause of transportation challenges, transportation support was provided through regular stipends, vouchers, subsidies, or reimbursements (Bhatt et al., 2019; Contreras et al., 2017; Farmer et al., 1991; Ngamvithayapong-Yanai et al., 2013; Shin et al., 2004; Skiles et al., 2018).

As a long-term consequence of tuberculosis, studies from Peru and Nepal noted that patients had difficulty establishing livelihoods and generating income after treatment (Khanal et al., 2017; Shin et al., 2004). In Peru, *Socios en Salud* addressed this challenge by providing employment to family members of patients, or by providing family members with capital for self-employment (Shin et al., 2004). In other interventions where opportunities for direct employment could not be offered, providers would link patients with career counselling services or vocational training for skill development and potential income generation (Bhattacharjee, 2012; Rocha et al., 2011; Skiles et al., 2018; Taneja et al., 2017; Zachariah et al., 2006).

Determining the appropriate timing and phase to deliver socioeconomic interventions with tuberculosis services

The timing and phase when the socioeconomic provisions were provided relative to tuberculosis treatment influenced the achievement of programme objectives and outcomes. For example, if an intervention aimed to improve adherence to treatment, socioeconomic provisions were often delivered as aids or reimbursements, where patients would receive food or financial aid upon arrival to a health facility for services (Baral et al., 2014; Bhatt et al., 2019; Farmer et al., 1991; Khanal et al., 2017; Lu et al., 2015; Yin et al., 2018). In contrast, the CRESIPT Study provided conditional cash transfers that required patients to participate in both social support and health promotion activities as well as tuberculosis treatment (Wingfield et al., 2015). Participant feedback revealed that patients preferred meeting immediate needs instead of delayed cash transfers for attending the conditional activities; consequently, researchers provided food incentives during the social support and health promotion programmes (Wingfield et al., 2015). When interventions aimed to alleviate the social and economic consequences caused by tuberculosis infection, a long-term and continuous relationship was established with patients. Subsequently, organisations and providers would often take the role of advocates, and connect previous patients with relevant services and resources. For example, CHWs and nurses in Peru and South Africa advocated on behalf of tuberculosis patients to find and access additional socioeconomic resources from government sources and social services (Contreras et al., 2017; Cremers et al., 2018; Medecins Sans Frontieres, 2011b, 2011a; Shin et al., 2004).

Identifying modes of intervention delivery that addresses patients' needs and optimises existing resources

Varying contexts and conditions where socioeconomic interventions were provided resulted in distinct resources available to implementors to deliver the intervention. Additionally, diversity in intended participant groups required adaptation to patients' preferences and characteristics (Bond et al., 2005; Farmer et al., 1991; Ngamvithayapong-Yanai et al., 2013; van den Hof et al., 2014). As tuberculosis often occurs among low-income populations residing in low-resource settings, interventions must be flexible and resourceful in their approach to programme planning and implementation. For example, the CRESIPT Study delivered cash transfers through direct bank deposits after considering the availability, accessibility, and safety of partnering with local bank agencies in contrast to cash disbursements or mobile cash transfers through phones (Wingfield et al., 2015). Moreover, to improve the accessibility of cash transfers for participants, the CRESIPT Study partnered with a bank that had satellite locations in local shops which were able to administer transactions (Wingfield et al., 2015). In Nepal, social support sessions with counsellors had to be improvised due to limited rooms and space in the treatment centre resulting in a lack of privacy for one-on-one sessions (Walker et al., 2018).

The presence of different comorbidities and risk factors often required openness to modifications and utilising available resources. For example, to adapt to the concerns of individuals with a history of substance use in India, cash handouts were transferred to family members who could support the patient (Bhatt et al., 2019). Overall, ongoing feedback collection followed by subsequent programme revisions was an effective mechanism to ensure that interventions were relevant and accessible for participants, and that any unintended negative consequences could be addressed (Alva & Cloutier, 2019; Cremers et al., 2018; Soares et al., 2013; Wingfield et al., 2015; Zachariah et al., 2006).

Using operational and evaluation research to inform future programme development and implementation

A commitment to evaluating the feasibility of an intervention and an openness to revise or change programme components based on evaluation findings were important mechanisms for successful intervention implementation. For example, through an iterative evaluation approach, the ISIAT and CRESIPT studies revised their interventions to make the targeting mechanisms more inclusive of marginalised populations (Wingfield et al., 2015). Additionally, immediate food incentives, as opposed to delayed cash transfers, were disbursed to participants after consultations (Wingfield et al., 2015). Using implementation research methods, the ISIAT and CRESIPT studies were able to balance their understanding of the nuanced needs of their target population with the corresponding operational implications for their interventions.

Alternatively, assessing effectiveness, as opposed to operational feasibility, was achieved through utilising randomised controlled trials (RCTs), cohort studies, and quasi-experimental designs. In China, a RCT was conducted by assigning two different cities as control and intervention groups and patient information was gathered from the national infectious disease surveillance system (Chen et al., 2019; Li et al., 2018, 2019). In addition, when NGOs or local government offices

Table 4. Examples of mechanisms that facilitated the implementation of complex socioeconomic interventions for tuberculosis as identified in the realist analysis.

Context	Mechanism	Example of Mechanism	Example of Potential Challenges
Sociopolitical & cultural 	Strengthening political commitment	In Peru, municipal governments and public health ministries established formal partnerships with community-based NGOs to develop and improve the sustainable delivery of tuberculosis services and socioeconomic assistance (Contreras et al., 2017).	In a community-led intervention in Malawi, the lack of strong government support was a barrier towards scalability and sustainability, as this lack of support limited wider adaptation of the programme (Zachariah et al., 2006).
	Partnering with multiple stakeholders	In the CRESIPT Study (Peru), community-based researchers laid out an explicit stakeholder consultation plan which involved meetings with civil society groups, varying levels of government, academic researchers, and community members (Wingfield et al., 2015).	
	Sustaining funding and donor sources	In Brazil, a contract between hired CHWs and the local municipality's tuberculosis programme ensured long-term funding support for the intervention that provided compensation and limited employee turnover (Soares et al., 2013).	In Zambia, a home-based care programme initially received food supplements for participants donated by the WFP. When the programme placed a fee on the food supplements to fund livelihood programmes for participants, the WFP donations were retracted (Nsutebu et al., 2001).

(*Continued*)

Table 4. Continued.

Context	Mechanism	Example of Mechanism	Example of Potential Challenges
Relational & interpersonal 	Engaging trusted and influential community members	In Thailand, women with high income were mobilised to lead fundraising efforts and provide social and financial support to low-income tuberculosis patients (Ngamvithayapong-Yanai et al., 2013).	The CRESIPT Study (Peru) identified that local banks held stigma against participants experiencing poverty. This stigma was a barrier to the provision of financial assistance through cash transfers (Wingfield et al., 2015).
	Creating supportive care and treatment environments	In Peru, incorporating a standard for respectful behaviour towards tuberculosis patients during training enabled CHWs to have a better understanding of compassionate care and a rights-based approach to patient support (Shin et al., 2004).	In China, despite financial compensation for treatment supporters, a lack of training among treatment supporters prevented effective delivery of DOTS, and led to negative views about DOTS by patients, families, and treatment supporters themselves (Yin et al., 2018).
Operational & administrative 	Establishing equitable targeting approaches	In Liberia, an NGO that provided socioeconomic support to tuberculosis patients employed Social Protection Officers to assess patients' additional socioeconomic needs (Rogers et al., 2018).	In China, the economic status of patients was subjectively determined by treatment supporters instead of using objective indicators of income and financial status. The absence of a systematic assessment could have missed patients in need of financial support (Yin et al., 2018).
	Defining relevant socioeconomic components	Among older adults with tuberculosis in China, home visits were conducted through a culturally relevant psychotherapy intervention that addressed depression and anxiety (Li et al., 2018).	In Peru, to find employment for patients who finished treatment, an NGO would either lend capital for the start of a business or find livelihood opportunities for the relatives of patients (Shin et al., 2004). However, it was noted that unemployment continued to be a difficult challenge (Shin et al., 2004).
	Determining the appropriate timing and phase	In South Africa, long-term relationships were established with intervention participants to alleviate the social and economic consequences of tuberculosis infection through social grants and food supplementation (Cremers et al., 2018; Medecins Sans Frontieres, 2011b)	The CRESIPT Study (Peru) found that some intervention participants preferred meeting immediate needs (e.g. food) during intervention activities rather than receiving delayed conditional cash transfers. Responding to this preference, the programme augmented their approach by providing food incentives during social support programmes (Wingfield et al., 2015).
	Identifying modes of intervention delivery	To adapt to the concerns of tuberculosis patients with a history of substance use in India, cash handouts were transferred to family members who could support the patient (Bhatt et al., 2019).	In Nepal, social support sessions provided by counsellors for tuberculosis patients had to be improvised due to limited rooms and space in the treatment centre, which contributed to a lack of privacy during one-on-one sessions (Walker et al., 2018).
	Evaluation research to inform programming and future practice	In Peru, the ISIAT study was an in-depth preliminary operational study that informed the development of a wider scale programme, CRESIPT (Rocha et al., 2011; Wingfield et al., 2015).	A retrospective cohort study in Ukraine identified patient populations at higher risk of default in a social support programme but had limited insight into implementation details that may have contributed to drop out (Skiles et al., 2018).

NGO = non-governmental organisation; CHWs = community health workers; CRESIPT = Community Randomized Evaluation of a Socioeconomic Intervention to Prevent TB; WFP = World Food Program; DOTS = Directly Observed Treatment, Short-course; ISIAT = Innovative Socioeconomic Interventions Against Tuberculosis

had existing administrative data, it was possible to conduct retrospective cohort studies (Bhatt et al., 2019; Rogers et al., 2018; Skiles et al., 2018; Wickett et al., 2018; Yin et al., 2018). While experimental and outcomes-focused research designs provided a foundation to assess whether interventions worked or not, operational research often provided a more holistic picture of the programme by considering treatment outcomes together with patient and provider perceptions of the intervention.

Discussion

The key mechanisms in the delivery of complex socioeconomic interventions for tuberculosis occur across three different contextual levels. First, macro-level factors that exist in the broader sociopolitical and cultural context of where an intervention is set influences the scale and sustainability of interventions. Overall, political commitment, collaboration across multiple stakeholders, and stable funding sources were mechanisms that determined whether socioeconomic interventions were feasible, and once implemented, could be further integrated with tuberculosis control services in the long-term. As the interventions collected in this review varied in implementation and operations, we were able to assess the role of government agencies in potentially adopting and integrating NGO services and existing research programmes into national frameworks for tuberculosis control (Contreras et al., 2017; Rogers et al., 2018). Moreover, collaborations with multisectoral partners such as local and international NGOs and other community-based organisations could be further explored by NTPs, as these partnerships may bridge gaps in human resources, technical assistance, and infrastructure development in the short-term (Shin et al., 2004; Ullah et al., 2006; Zachariah et al., 2004). These findings demonstrate that the World Health Organization's call for increased political commitment and multisectoral collaboration to eradicate tuberculosis is indeed critical to strengthen the sociopolitical and cultural context where complex socioeconomic interventions are implemented (Hargreaves et al., 2011; World Health Organization, 2013).

This review showed that engaging community members and fostering an empathetic and compassionate treatment environment (relational and interpersonal context) was critical in reducing stigma associated barriers experienced by tuberculosis patients. Campaigns have been widely implemented to deliver health promotion and awareness initiatives to reduce tuberculosis related stigma, but these must be paired with necessary social support services for tuberculosis patients and appropriate training for health workers (World Health Organization, 2015). In addition, previous research has indicated that social trust and cohesion, especially among relatives and family members, are integral to ensuring that patients and their households are able to access appropriate care (Lau et al., 2020; Li et al., 2018). Effective implementation of the mechams in the relational and interpersonal context enhances patient empowerment, which enables patients to possess a clear understanding of the disease, adhere to treatment, support others with tuberculosis, and engage in advocacy and activism (Macq et al., 2007).

A challenge for developing and implementing socioeconomic interventions for tuberculosis control, treatment, and care involves the tension between managing operations while simultaneously addressing the complex and immediate needs of tuberculosis patients and their households (Hargreaves et al., 2011; Wingfield et al., 2015). Findings from this review indicate that the proper selection, timing, and modes by which components of complex socioeconomic interventions are delivered must be considered alongside the availability of contextual resources to ensure that an intervention is feasible, accessible, and relevant for intended participants. As these components are highly variable depending on contextual conditions, this finding demonstrates the need for further implementation research to better understand these underlying mechanisms. We advocate for the prioritisation of well-designed process evaluations and operational research to provide practical instructions on the development, implementation, and evaluation of complex socioeconomic interventions for tuberculosis. Research conducted by projects such as the ISIAT and CRESIPT studies provide strong examples of operational research that can prove useful for policymakers and implementors (Rocha et al., 2011; Wingfield et al., 2015). We encourage future research to

embed mixed-methods process evaluations in RCTs, build capacity for operational research within NTPs, and partner with NGOs and local programmes to engage in process and operational research to improve the implementation of socioeconomic interventions for tuberculosis in low-resource settings (Oakley et al., 2006; Shete et al., 2018; Zachariah et al., 2009).

The multiple and interconnected social and economic factors that prevent access to treatment and exacerbate poverty among tuberculosis affected populations has been well-established in the literature (Fuady et al., 2018; Lee et al., 2019; Singh et al., 2002; Sweetland et al., 2018). Importantly, tuberculosis affected populations are often communities already experiencing poverty and marginalisation (Lönnroth et al., 2009). As such, interventions that address both the social risk factors that lead to tuberculosis, as well as the socioeconomic needs that arise from tuberculosis infection are necessary to limit disease transmission, support access to services, and prevent the exacerbation of existing vulnerabilities (Rasanathan et al., 2011). While work has been conducted to understand the effectiveness of socioeconomic interventions and social protection programmes to support tuberculosis control (de Andrade et al., 2018; Richterman et al., 2018; van Hoorn et al., 2016), there is limited discussion on the multidimensionality and complexity of the needs of these populations. This review presented interventions that addressed the diverse socioeconomic barriers and consequences experienced by tuberculosis patients and highlighted the importance of embracing these complexities to acquire the necessary resources to support tuberculosis control. Overall, context-specific socioeconomic interventions that recognise the multidimensionality of the social determinants of tuberculosis must be concurrently implemented with the delivery of clinical and medical treatment.

This review has several limitations. First, the use of broad terms in our search string may have missed some records that described interventions differently. Second, interventions that provided only one component of our adopted definition of a complex socioeconomic intervention would have been excluded. For example, interventions that only provided cash transfers or only provided food support were excluded in the screening process. Additionally, since we were interested in the direct provision of socioeconomic assistance, we did not include DOTS, universal health coverage, and free-of-charge tuberculosis services as part of our definition for complex socioeconomic interventions; however, these elements were described as part of the existing NTP structures in some studies. Third, we focused on community-based interventions and excluded facility-based programmes that were held in institutional settings (e.g. prisons), which may have provided additional details on contextual factors that influence the relationship between complex socioeconomic interventions and tuberculosis control. Fourth, collected interventions may have been subject to reporting bias, meaning that more emphasis may have been placed on positive implementation experiences and overcoming challenges. Consequently, the presence of reporting bias may have limited our understanding of the barriers associated with delivering complex socioeconomic interventions for tuberculosis. Finally, this review did not consider specific mechanisms within each socioeconomic component (i.e. financial aid, food security, social support, health education, livelihood opportunities, transportation services), as we focused on broader mechanisms that influenced the implementation of complex socioeconomic interventions. Future research could take a more granular approach and assess mechanisms relative to each socioeconomic component to better understand the influence of individual programme components on the implementation of interventions.

Conclusion

With the need to address the association between tuberculosis and multidimensional poverty in LMICs, we identified how mechanisms in the sociopolitical, relational, and operational contexts can influence the success of complex socioeconomic interventions for tuberculosis. In countries with coordination between NTPs and health systems, this existing infrastructure can be leveraged to lead the integration of socioeconomic interventions for tuberculosis control in order to sustain and scale interventions in the long-term. Moreover, fostering supportive relationships through

recruiting and providing effective training to CHWs, volunteers, and influential community members can be an effective approach to strengthen rapport with intended participants and to enhance patient empowerment. Lastly, selecting relevant intervention components, in addition to aligning programme planning and implementation with contextual resources and participant needs, can contribute to accessible, effective, and feasible interventions. Moving forward, process evaluations and implementation research should prioritise and interrogate the sociopolitical, relational, and operational contexts that influence the implementation of complex socioeconomic interventions to concurrently address tuberculosis and poverty.

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Declarations of interest

The authors declare no conflicts of interest.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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