

**The influence of upstream forces on health: a multi-method investigation of tuberculosis
among healthcare workers in South Africa**

by

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Abstract

Empirical evidence is lacking on the degree to which structural or upstream forces contribute to tuberculosis (TB) incidence in the general population, and in healthcare workers, a group known to be at high-risk for this disease, let alone on how these forces are addressed in policy.

Methods

This dissertation used a multi-method design to examine the link between upstream forces and TB. First, it utilized a linear mixed-effects regression to investigate the association between globalizing processes and TB incidence in the 22 high burden countries. Secondly, semi-structured in-depth interviews were conducted in South Africa to explore how macro-level determinants of TB incidence in the general population and among healthcare workers are perceived by key stakeholders, identifying barriers and facilitators to the implementation of effective prevention and control measures. South Africa's current National Strategic Plan was then examined to ascertain how these factors were being addressed. The World Health Organization (WHO) Health Systems Building Blocks framework was also applied to assess interventions for protecting healthcare workers.

Results

Globalization was found to be associated with higher TB incidence in high burden countries. In the South African context, a history of colonization, the migrant labour system, economic inequality, poor shelter, health system challenges, the HIV epidemic, and pertinent socio-cultural factors were all perceived to be the major drivers of the epidemic. Although South Africa's current National Strategic Plan makes a firm discursive commitment to addressing the structural drivers of TB, analysis from this dissertation revealed that this commitment was not clearly reflected in projected budgetary allocations.

Conclusion

As many low and middle-income countries continue to integrate their economies into the global market, there is a need to consider ways to address unintended inequities that accompany this integration. In South Africa, while funding allocation to improve diagnostic procedures and investment in more efficacious drugs are laudable, attention to structural drivers of TB is deficient. Although a national TB policy for healthcare workers will soon be launched, it is perceived that implementation and adherence to such policies may well remain problematic unless the policy explicitly addresses the drivers of this scourge.

Lay Summary

This research was conducted to look beyond known risk factors directly related to tuberculosis (TB) disease and focus rather on the understudied structural influences that drive the disease and create barriers to its effective prevention and control in an increasingly connected world. Using South Africa, a country with one of the highest TB burdens as my research setting, I examined how structural forces influence TB in the general population as well as its prevention and control, with particular attention to healthcare workers who constitute a high-risk population. I found evidence of an association between these structural forces and TB disease. I also found considerable health system barriers perceived to be facilitating the high incidence of TB among healthcare workers and the general South African population but little concrete attention to addressing these barriers. I conclude that efforts in TB prevention and control should be complemented by funded structural interventions.

Preface

This multi-method research dissertation was completed entirely by the PhD Candidate.

Identification and design of the research project was done in cooperation with the supervising committee. Data collection and analyses were conducted entirely by the Candidate. Ethics approval was obtained from the Behavioural Review Ethics Board at the University of British Columbia in Vancouver, Canada (Certificate number H16-01330).

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List of Abbreviations

- (AIDS) Acquired Immunodeficiency Syndrome
- (AIC) Akaike's Information Criterion
- (ARV) Antiretroviral Drugs
- (BIC) Bayesian Information Criterion
- (BMI) Body Mass Index
- (GDP) Gross Domestic Product
- (GNI) Gross National Income
- (GNP) Gross National Product
- (HBC) High Burden Countries (HBCs)
- (HCW) Health Care Worker
- (HIV) Human Immunodeficiency Virus
- (IFF) Illicit Financial Flow
- (IMF) International Monetary Fund
- (KOFGI) Konjunkturforschungsstelle Globalization Index
- (KIs) Key Informants
- (LME) Linear Mixed Effects
- (LMICs) Low and Middle-Income Countries
- (NCDs) Non-Communicable Diseases
- (NDP) National Development Plan
- (NSP) National Strategic Plan
- (OHS) Occupational Health and Safety
- (OLS) Ordinary Least Squares

(PPE) Personal Protective Equipment

(SA) South Africa

(SSA) Sub Saharan Africa

(STI) Sexually Transmitted Infection

(TB) Tuberculosis

(TRIPS) The Agreement on Trade-Related Aspects of Intellectual Property Rights

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Dedication

My aunt, Maame Adwoa Agyeiwaa

Chapter 1: Introduction

1.1 Introduction

In the post-Cold War era, globalization has received increasing attention as a wave of forces that shapes our world, both positively and negatively. In a period when attention has been concurrently drawn to profound health inequities worldwide (Krieger et al., 2010; Ruckert & Labonté, 2017), this prompts us to question how relationships commonly regarded in a proximal manner could or should be reconsidered in the context of such forces. Due to the complexity of this phenomenon and the nature of its impacts, it is unavoidable that any attempt to provide a satisfactory definition of “globalization” will be open to contestation (Rennen & Martens, 2003). There are, after all, diverse economic, political, technological, socio-cultural, environmental and many other facets intertwined in this process. In this dissertation, I adopt Dreher’s definition of globalization as:

“the process of creating networks of connections among actors at intra- or multi-continental distances, mediated through a variety of flows including people, information and ideas, capital, and goods. Globalization is a process that erodes national boundaries, integrates national economies, cultures, technologies and governance, and produces complex relations of mutual interdependence” (Dreher, 2006, p.1092).

The rationale for this choice will be explained later in this chapter.

In this study, I wish to examine how globalization generates impacts by reviewing the mechanisms and pathways involved when two identified global health priority issues (tuberculosis [TB] and human resources for health) intersect in the South African setting, considering not only the intensity of effects but also the capacity to autonomously respond. South Africa experiences one of the world’s highest rates of TB incidence and rates among

healthcare workers (HCWs), a group already noted to be in severe shortage in this country, are estimated to be three times that of the general population (O’Hara, 2016), and it remains unclear how this matter will be successfully resolved.

TB is an infectious disease caused by *Mycobacterium tuberculosis* (*M.tuberculosis*). It primarily affects the lungs (pulmonary TB) but can also spread to other organ tissues (extrapulmonary TB). Despite a worldwide fall in incidence and mortality over the past two decades, TB continues to affect many and results in a substantial number of deaths. As the leading cause of death from a single agent, TB affects 10 million people each year and was responsible for 1.6 million deaths in 2016 (World Health Organization [WHO], 2017). Although over 95 percent of TB cases and deaths occur in low and middle-income countries (LMICs), the disease is prevalent in every part of the world and mostly affects adults in their reproductive ages (WHO, 2018). Recognizing the persistence of TB, the unprecedented convening of the United Nations High-Level Meeting on TB in September 2018 explicitly addressed the challenges presented by this situation (United Nations, 2018).

TB has long been recognized as both a social and occupational disease (Stuckler, Steele, Lurie, & Basu, 2013; Rensburg, 2012). As a disease of poverty, TB is subject to being driven by structural or upstream forces and affects the economically disadvantaged and marginalized in society. As an occupational disease, miners, HCWs and migrant labourers are all at increased risk of TB, largely through mechanisms inextricably related to economic processes. According to the WHO (2015), 80 percent of the global TB burden is concentrated in what is commonly referred to as “the 22 high burden countries”. These countries are: Afghanistan, Bangladesh, Brazil, Cambodia, China, Democratic Republic of Congo, Ethiopia, India, Indonesia, Kenya, Mozambique, Myanmar, Nigeria, Pakistan, The Philippines, Russian Federation, South Africa,

Thailand, Uganda, Tanzania, Vietnam and Zimbabwe. Among these, one of the countries hit hardest by TB is South Africa, with an incidence rate of 781 per 100,000 population compared to a global average of 140 per 100,000 in 2016, according to the 2017 WHO Global tuberculosis report. This is in sharp contrast to the rate of 6 per 100,000 present in a high income country like Canada (World Health Organization, 2017b). Even among the high TB burden countries there is considerable variation. Table 1.1 lists all 22 high burden countries and their respective TB incidence rates in 2016, the year for which the most current data are available.

For the purposes of this dissertation, structural, upstream, distal, globalizing or macro-level forces refer to processes that modify or affect traditional proximate risk factors of TB disease. Notwithstanding the debates and nuances each of these terms holds, these terms are used interchangeably throughout this dissertation. Proximate factors are those circumstances related to direct exposure to infectious droplets (including what are sometimes referred to as “meso-level” factors such as hospital infection control measures) and/or individual level factors (“micro-level”) that impair the host’s defense against TB (such as human immunodeficiency virus (HIV), malnutrition, tobacco smoke, alcohol, silicosis, diabetes and others) (Lönnroth, Jaramillo, Williams, Dye, & Raviglione, 2009).

Despite extensive general discussion of the effects of upstream forces on health, there has been limited empirical examination let alone systematic evidence documenting specific effects of or responses to such pathways. Evidence of the impact of upstream forces on HCWs, a group known to be particularly at increased risk of TB disease, is even more limited. Therefore, in this dissertation, I endeavour to provide insight into *how upstream forces are associated with the presence and impact of a health challenge such as TB and also with the adoption and implementation of policies to address this epidemic*. This dissertation specifically delves into

how these forces influence HCWs in the high burden country of South Africa. Indeed, South Africa offers a unique natural experiment considering that the post-apartheid era (1994 onward) ushered in a greater integration within global systems coincidentally at a time when HIV/AIDS was taking a great toll on the population, signaling a particular need for attention.

By identifying and examining policies and processes that can contribute to addressing this particular health challenge in South Africa, I hope to offer insight that is also relevant to other countries, as reliance on a healthy health workforce in moments of crisis is a worldwide need (WHO, 2006). By concentrating on the “natural experiment” presented by South Africa, I hope to contribute insights to policy directions that will be of relevance in this setting and beyond.

The following section discusses the conceptual frameworks and the methodological approaches used in the study of globalization and health.

1.2 Globalization and health

Although changing patterns of diseases and other health-related states have always accompanied the evolution of human societies beginning with the migration of the early human species, *Homo erectus* from Africa, and the subsequent formation of societies elsewhere (Lee, Yach, & Kamradt-Scott, 2011), the intensity of social transformations in recent decades has justified particular attention to effects on health. The literature on globalization and health is growing exponentially as lives continue to be shaped by rapid technological and economic developments. However, contemporary literature on globalization and health focuses mainly on events following the second half of the twentieth century, a period when an unprecedented expansion of international trade and greater regional integration have been observed. As

attention to this subject evolved, the first open-access global health journal *Globalization and Health* was established in 2005 to advance the field (Martin et al., 2016), reflecting growth in awareness of this phenomenon. Subsequently, in its major report entitled “*closing the gap in a generation: health equity through action on the social determinants of health,*” the *WHO Commission on Social Determinants of Health* drew specific attention to the role of globalization in achieving health equity (Commission on Social Determinants of Health, 2008; Globalization and Health Knowledge Network, 2008). The report argued that “structural drivers operate within countries under the authority of governments, but also, increasingly over the last century and a half, between countries under the effects of globalization” (World Health Organization, 2008, p.26).

In the next section, I provide an overview of the general literature that discusses globalization and health, with emphasis on the major conceptual frameworks that have been proposed. This is followed by a review of methodological approaches to researching globalization and health pathways. The purpose of this review is to map out the methodological landscape in the field, identify challenges and knowledge gaps and to provide a solid foundation for the conceptual framework adopted for this dissertation.

1.2.1 Conceptualizing the link between globalization and health

Various attempts have been made to characterize the complex links between globalization and health (Pang & Guindon, 2004). One of the earliest attempts to provide a comprehensive conceptualization was by Woodward et al. (2001). Recognizing the lack of an agreed-upon framework characterizing this relationship, the authors proposed examining the impact of globalization with reference to three dimensions: 1) cross-border flows; 2) openness;

and 3) rules and institutions. Then the authors proceeded to illustrate how these components impact health through world markets, population-level health influences, health-related sectors, national economy, politics and society, individual health risks, household economy, and the healthcare system. The main strength of such framing lies in the level of detail it can reveal, providing a useful way to posit and investigate various related research questions. However, this conceptualization has been critiqued for over-relying on the health effects of the economic dimension of globalization to the neglect of other aspects of globalization (Martens, Akin, Maud, & Mohsin, 2010).

At an early stage in developing conceptual approaches, Labonte & Torgerson (2003) provided a review of different frameworks for analyzing the links between globalization and health building on the above-mentioned approach. This WHO-supported systematic review produced a detailed conceptualization. Their diagrammatic synthesis is hierarchically organized around different levels of influence, ranging from supranational to household level with strong emphasis on the effects of economic globalization and international governance.

Huynen and colleagues also provide a conceptualization of the health implications of globalization (Huynen, Martens, & Hilderink, 2005). Their framework illustrates how globalization processes affect the institutional, economic, socio-cultural and ecological determinants of population health. At the same time, they emphasize that these factors produce effects on contextual, distal and proximal levels. The main strength of Huynen and colleagues' multi-nature and multi-level framework is that it is holistic. Also, it successfully organizes a rather complex relationship into a simple one by providing insight into how future research can easily disentangle and model subsets of the relationship.

It must be noted that this is not an exhaustive list; the literature in this area is quite expansive and a thorough review is not within the scope of this study. However, these are some of the major frameworks in the field of globalization and health upon which other frameworks have been developed. In the following sub-section, I will discuss the methods that have been employed in research on these pathways.

1.2.2 Approaches to researching pathways

Labonte & Torgerson (2002) contend that all literature (at least as at the time of their study) on globalization and health is incomplete in terms of how it captures the complex pathways through which globalization impacts specific health conditions. This is one of the primary challenges in modeling such a complex relationship. Table 1.2 provides an overview of notable studies and the approaches used to investigate the pathways between globalization and various health related states.

Review of the literature on the pathways through which globalization affects health and health equity reveals both empirical examinations of specific circumstances and non-empirical approaches that rely on critical syntheses of available evidence and theorizing about relevant relationships. The empirical approaches typically involve ecological studies where researchers use macro-level data to investigate the association between proxy measures of globalization and other health related conditions (Chaloupka & Laixuthai, 1996; Goryakin, Lobstein, James, & Suhreke, 2015; T. K. Lin, Teymourian, & Tursini, 2018; Schram et al., 2015; Schram, Labonté, & Sanders, 2013; Tausch, 2015; Umaña-Peña et al., 2014; Vogli, Kouvonen, Elovainio, & Marmot, 2014). A dominant theme in this area of inquiry has been the effect of trade (including The Agreement on Trade-Related Aspects of Intellectual Property Rights [TRIPS]) on health.

However, themes like HIV, nutrition, obesity, non-communicable and chronic diseases in general, are also featured consistently in the literature. In these types of investigations, researchers typically employ bivariate and multivariate statistical or econometric analyses to investigate the myriad of complex pathways. Also noteworthy are empirical qualitative approaches which rely on case study examinations that consider a range of forces at play in a specific context (Bandara, Ananda, Wickramage, Berger, & Agampodi, 2014; Brown & Labonté, 2011; Labonté, Cobbett, et al., 2015). The non-empirical approaches are normally reflective of conceptual models and take the form of debates, commentaries or critical perspectives (Spiegel, Labonté, & Ostry, 2004; Thow & Snowdon, 2010).

Apart from these two broad approaches, there are also fundamental differences in perspectives as to *what* and *how* processes should be studied to capture the concept of globalization. In other words, there are different methodological traditions in the field. Brown and Labonté (2011) have identified four major methodological traditions in the study of the globalization pathways. According to these scholars, one tradition focuses solely on the economic and financial dimension of globalization to the exclusion of other aspects such as cultural, technological and political globalization. While acknowledging the importance of the other dimensions of globalization, this tradition primarily views economic globalization as the main driver of the other dimensions; therefore, this tradition focuses mainly on the economic aspect of globalization.

Per the second tradition, scholars rely primarily on macro-level quantitative data analysis to ascertain a connection between globalization and its impacts and processes while the third tradition relies on deductive methodological approaches. According to the deductive methodological approaches, a theory is first produced, and then a hypothesized relationship

based on the theory is generated and examined re the effect of globalization. Finally, the fourth methodological tradition features a fundamental failure to accurately capture the dialectical nature of globalization. In other words, globalization is viewed by some scholars narrowly as either negative or positive and their investigations are geared towards making a judgment on either of these.

It must be noted, however, that other innovative approaches are adopted; usually reflecting a mix of the aforementioned traditions. For instance, Brown and Labonté (2011) used what they call a *contextual* and *differentiating approach* to analyze how the different dimensions of globalization influence different social groups within different contexts. In this innovative approach, the authors used three case studies in the area of HIV/AIDS to illustrate the influences of globalization in these contexts. This dissertation follows this path (Chapters 3 & 4) and also includes an empirical investigation (Chapter 2).

As noted earlier, I adopt Dreher's definition of globalization (Dreher, 2006) which has a multifaceted orientation. However, Woodward and colleagues argue that the overall globalization process itself is largely driven by economic globalization (Woodward et al., 2001). This view is further supported by Labonté & Schrecker (2009) who assert that even the manifestations of globalization that do not appear to be economic in nature are actually driven by economic forces in the global marketplace. Although I agree with these perspectives, my choice for a more multifaceted orientation, especially for the sake of analysis, was made in cognizance of the fact that TB as a social disease is influenced by a multitude of forces. Therefore, limiting globalization's influence on TB to only one dimension risks a biased perspective. Spiegel and colleagues (Spiegel et al., 2004) explain that even the economic influences can be traced through five different dimensions which Appadurai called "scapes" (Appadurai, 1990). These five scapes

include: 1) ethnoscapesc-the flow of people including tourists, refugees, immigrants, guest workers, etc.; 2) technoscapes-the export of technology; 3) finanscapes-global capital transfer; 4) mediascapes-mass media images, and 5) ideoscapes-images invested with political-ideological meaning. It is for these reasons that I used the overall Konjunkturforschungsstelle Globalization Index (KOFGI) to operationalize the concept in this study as opposed to relying on any other specific dimension of globalization (see Chapter 2).

The next section provides an overview of the literature on globalization and TB focusing on the methods used in the investigations.

1.3 TB risk factors

The primary purpose of this section is to map out the methods employed to determine the risk factors associated with TB, while also further examining the nature of findings from these studies. In this regard, two main categories of studies are examined: 1) studies looking at general determinants, and 2) those looking at the structural forces. This approach encompasses consideration of driving forces (associated with globalization), as examined by [O'Hare \(2015\)](#), that impact the capacity for effective responses to the risk of TB that is more nuanced and difficult to observe. Further, it calls for a consideration of what is driving incidence and prevalence and hence what merits being addressed. Table 1.2 outlines some of the literature in these two categories noting their analytic procedures.

1.3.1 Discussing general determinants

As an old disease, although with new challenges, TB's massive reduction in nineteenth century England and Wales and in many parts of Europe has been attributed to the public health revolution of the nineteenth and early twentieth centuries which resulted in improvement in the

socioeconomic conditions, sometimes referred to as the social determinants of health (Rasanathan, Sivasankara Kurup, Jaramillo, & Lönnroth, 2011). This evidence, central to McKeown's thesis on the limited public health benefits of medical treatment alone (McKeown, 1976, 1979; McKeown & Brown, 1955; McKeown & Record, 1962) has shaped the literature on the risk factors of TB. These determinants are usually a wide range of proximate factors that are reinforced or generated by more upstream forces. Examples of these social determinants include food insecurity, malnutrition, poverty, poor housing, cultural, economic and geographic barriers to healthcare access and other behavioural and biological risk factors.

Dye and colleagues (Dye, Lönnroth, Jaramillo, Williams, & Raviglione, 2009) used a multivariate linear regression model to investigate trends in TB incidence and their determinants in 134 countries with data from 1997-2006. Thirty-two independent variables related to the economy, population, behavioural and biological risk factors, health services and TB control programmes were explored. Results showed a general decline in TB incidence rate over the study period in the 134 countries. However, it was observed that the rate of decline was more pronounced in countries with higher human development index (HDI), lower child mortality and access to improved sanitation, greater health expenditure, high-income countries with lower immigration, and countries with lower HIV infection rates.

Quantile regression modeling was used to investigate the association between the macro-level determinants of TB and TB incidence in Europe in a prospective ecological study (Ploubidis et al., 2012). Confounders included gross domestic product (GDP) per capita, the Gini coefficient measuring inequality of wealth distribution, trust index, net migration and smoking prevalence. Findings showed that national wealth and level of egalitarianism accounted for about

50% of the variation in TB incidence. Income inequality was associated with increased TB whereas logged GDP was associated with reduced TB rates.

Munayco and colleagues used random effects modeling to identify key social determinants of TB among 20 Latin American countries from 1995-2012 (Munayco, Mújica, León, del Granado, & Espinal, 2015). Selection of variables for the model was guided by the literature (Lönnroth et al., 2009). After adjusting for socioeconomic, demographic and health services factors, the variables that were significantly associated with TB incidence trends included access to improved sanitation facilities, health expenditure per capita and TB detection rate.

As noted in the beginning of this section, the concept of “determinants”, usually framed as social determinants of health, feature prominently in the literature on the risk factors of TB. Spiegel and colleagues (Spiegel, Breilh, & Yassi, 2015) however, caution that language matters in our conceptualization of the risk factors of disease and propose the term “social determination”. They argue that “the language of social determinants lends itself to research that is more reductionist and beckons the development of different skills than would be applied when adopting the language of social determination”. In the next section, I discuss the literature that focuses on these processes that influence our predisposition to TB, referred to as social determination by Spiegel and colleagues and herein referred to as structural forces.

1.3.2 Focusing on structural forces

Most of the studies that examine the structural influences on TB feature themes like trade, macro-economic policies, economic recession, mining activities and other similar upstream processes.

Bozorgmehr & San Sebastian (2014) used a longitudinal multi-level linear regression analysis to investigate the association between trade liberalization and TB incidence in the 22 high-burden TB countries between 1990 and 2010. Choice of confounders was guided by the literature and causal diagrams. The confounders included: HDI, Gini coefficient, debts, polity patterns, conflict, overcrowding, population stage transition, health system financing, case detection rates, HIV prevalence, age dependency ratio (% of working-age population), and armed conflict. The study found a significant association between World Trade Organization (WTO) membership and higher TB incidence although the implications of this and the pathways that could explain the observed relationship are only marginally discussed.

Reeves et al. (2015) used fixed effects modeling to investigate whether recent economic recession and associated reductions in public health spending resulted in declining rates of case detection and treatment success for TB in the European Union, using data from 1991-2012. The authors adjusted for time trends and country fixed effects. Findings showed that recession was projected to result in long-term increase in TB incidence, prevalence and mortality.

In a more recent article, Pedrazzoli et al. (2017) review studies that employ different mathematical modeling techniques to investigate the epidemiological effect of structural determinants on TB. They propose a framework that builds upon Lönnroth and colleagues' (Lönnroth et al., 2009) earlier conceptualization. Their review notes the paucity of literature in this area, acknowledging that there are many challenges in modeling such complex relationships. This is in sharp contrast to studies that evaluate the impact of proximal risk factors (general determinants) on TB (Cegielski & McMurray, 2004; Cohen & Mehta, 2007; Corbett et al., 2003; H.-H. Lin, Ezzati, & Murray, 2007; Lönnroth, Williams, Stadlin, Jaramillo, & Dye, 2008; Stevenson et al., 2007). Pedrazzoli et al. (2017)'s review identified only eight studies published

between 2008 and 2015 that used mathematical modelling to investigate the epidemiological impact of structural determinants of TB (Ackley, Liu, Porco, & Pepperell, 2015; Andrews, Basu, Dowdy, & Murray, 2015; Bhunu, Mushayabasa, & Smith, 2012; Christopher Dye, Trunz, Lönnroth, Roglic, & Williams, 2011; H.-H. Lin et al., 2007; Odone, Houben, White, & Lönnroth, 2014; Oxlade, Huang, & Murray, 2015; Reeves et al., 2015). The authors recommend building relatively simple models as a starting point to fill the knowledge gap.

Macroeconomic policies especially those dictated by the International Monetary Fund (IMF), feature predominantly in the literature on globalization and TB. Stuckler and colleagues used multivariate regression to investigate the effect of IMF programmes on TB incidence, prevalence and mortality in the 21 post-communist countries using data from 1992-2002 (Stuckler, King, & Basu, 2008). The choice of confounders was guided by the literature and included gross GDP, democracy, war, urbanization, population dependency ratio and education. IMF programs were found to be associated with increased TB incidence, prevalence and mortality providing evidence around the link between structural force and a health-related state.

The relationship between mining and TB among sub-Saharan African countries was also investigated by Stuckler and colleagues (Stuckler, Basu, McKee, & Lurie, 2011) using pooled ordinary least squares with data from 2001-2005. These researchers were interested in the incidence, prevalence, and mortality associated with TB. Mining activity as a globalizing activity was the explanatory variable. Confounders included GDP per capita, export as a fraction of GDP, percentage of the population living in urban settings, and population size. Results showed that mining activity had a significant association with TB among sub-Saharan African nations.

1.4 Healthcare workers

The health care workforce is recognized as one of the essential building blocks of a health system (World Health Organization, 2007), but notably, this population has been flagged by the WHO as being in crisis and in urgent need of greater attention and action (WHO, 2006). The shortage of HCWs in South Africa has been noted as a particular priority to be addressed in a healthcare system acknowledged to be under great stress (Breier, 2007; Labonté, Sanders, et al., 2015a). HCWs, as used in this dissertation, refers to any persons whose main activities are aimed at enhancing health (World Health Organization, 2006). This includes clinical staff (nurses, doctors, midwives etc.), paramedical staff (laboratory personnel, pharmacists, radiographers, etc.), support staff (cleaners, orderlies, security porters, etc.), administrative staff and community health workers.

In South Africa, HCWs are at increased risk of infectious diseases, including TB, due to the nature of their work and the population they serve (Adams et al., 2015; Engelbrecht et al., 2015; Kompala, Shenoi, & Friedland, 2013; L. O'Hara, 2016; Yassi et al., 2013). Already faced with workplace stress due to a severe shortage (Rensburg, 2012), healthcare workers serve a TB burdened population which puts them at risk of infection. Several studies have been conducted on other high-risk groups or occupations, particularly mine workers (Dharmadhikari, Smith, Nardell, Churchyard, & Keshavjee, 2013; Girdler-Brown, White, Ehrlich, & Churchyard, 2008; Stuckler et al., 2013) and indeed, there are international efforts underway to address TB in the mining sector (The World Bank, 2016). However, while there is some literature on TB among HCWs (Adams et al., 2015; Engelbrecht et al., 2015, 2015; Joshi, Reingold, Menzies, & Pai, 2006; Menzies, Joshi, & Pai, 2007; L. M. O'Hara et al., 2017), the literature does not adequately address the upstream or systemic factors that drive their risk of TB infection. Further, there are

no similar international efforts underway to address TB among HCWs let alone the upstream processes underlying the increased risk faced by this population. A retrospective study conducted in a TB referral hospital in KwaZulu-Natal, South Africa, revealed a five-fold and six-fold risk of MDR-TB and XDR-TB respectively among healthcare workers compared to the general population (O'Donnell et al., 2010). Additionally, a recent historical prospective study in the Free State Province of South Africa also found that HCWs in South Africa have three times the risk of TB compared to the population they serve (O'Hara, 2016). However, neither of these studies explored the reasons for the underlying increased risks or policy initiatives in this regard.

1.5 Research context: South Africa

South Africa is a country whose greater integration into the global economy following the fall of Apartheid in the early 1990s came precisely at the moment when globalization was being recognized as a powerful force. This time period was also marked by the emergence of HIV/AIDS as a serious threat. In the ensuing 20 years, HIV and tuberculosis, as an opportunistic infection taking advantage of compromised immune systems, produced devastating effects resulting in rates of infection and mortality at or near the highest in the world. South Africa, therefore, presents a unique context for this investigation as a country confronted with a significant TB burden at a moment when greater penetration of globalization was occurring so as to either enhance or hinder the ability to address the epidemic.

Post-Apartheid South Africa has been marked with the implementation of neoliberal economic policies. One such policy was the Growth Employment and Redistribution (GEAR) policy, a neoliberal economic strategy grounded on the principles of the Washington Consensus (Habib & Padayachee, 2000). According to Baker (2010), GEAR's birth was orchestrated

through a complex negotiation by both national and international players. These policies were designed to achieve economic growth through cuts in public spending, removal of tariffs, deregulation and massive privatization of public assets, among others (Baker, 2010). The years that followed the implementation of GEAR saw a significant assault on public health. The privatization of health services increased the already existing health inequities. According to Bond (2000), the years following GEAR saw annual job losses of 1 to 4 percent, as a result of spending cuts. Evidence further suggests that the economic restructuring induced the migration of South African health workers to other countries (Connell, Zurn, Stilwell, Awases, & Braichet, 2007). Internal migration has also resulted in a high concentration of healthcare professionals in urban areas of South Africa compared to the small numbers in rural parts of the country. Given this trajectory, a contentious surmise is that the deterioration of social determinants of health (Ataguba, Akazili, & McIntyre, 2011; Nattrass & Seekings, 2001; The World Bank, World Development Indicators, 2017), as a consequence of globalization, might be seen to better explain South Africa's poor health outcomes in the post-Apartheid era, despite evidence of considerable economic growth.

1.6 Study objectives

The overall objective of this dissertation is to bring insight on the upstream factors that drive TB within the general population and HCWs and how these are being addressed in policy initiatives (i.e. to answer the research question "*how are upstream forces associated with the presence and impact of a health challenge such as TB and also with the adoption and implementation of policies to address this epidemic*"). The following sub-objectives have been formulated to achieve the broader objective:

1. To determine the association between globalization and TB incidence, with a focus on the 22 high-burden TB countries.
2. To investigate how macro-level drivers of TB in South Africa are perceived by key experts, and to ascertain how these processes are being addressed in a current policy document.
3. To identify underlying forces influencing occupationally-acquired TB among HCWs in South Africa and the actions perceived to be needed at structural levels to enhance the capacities to prevent and control TB infection in the healthcare workforce.

1.7 Study justification

It has long been acknowledged that the contexts that give rise to diseases are global in nature (Labonté & Spiegel, 2003). However, most studies focus on what is being done or should be done at the proximal level but not at the structural level in spite of calls to examine the structural factors influencing health (Marshall, Kerr, Shoveller, Montaner, & Wood, 2009; Yang, Mamudu, & John, 2018). Understanding how integration in global systems contributes to or undermines health is indeed critical as it points to policy directions needed to mitigate global health disparities that emerge from or are aggravated by such processes.

As already noted, while attention to working conditions involves direct attention to individuals at the micro-level, and their interactions with their workplace environment (meso level), consideration of macro-level forces tends to be ignored. With growing attention to the effect of global forces that can have great consequences for facilitating the promotion of health equity, this study is important as it contributes to the literature related to the priority areas mentioned above. It contributes to filling the particular gap within what is still relatively scanty

research on barriers and facilitators to implementing interventions needed to reduce TB in HCWs in South Africa (Grobler et al., 2016). Furthermore, while the general area of globalization's impacts on occupational health and safety (OHS) has received some attention, this study will make a unique contribution examining how these impacts play out for the health workforce, providing an example of how studies of other specific circumstances could be conducted.

Additionally, it is becoming increasingly important to understand how globalization impacts different social groups as well as the need to inculcate an approach that uses both quantitative and qualitative data approaches. Further, it has been suggested that the traditional approaches to the study of globalization (which involve econometric analysis of macro-level data) be supplemented with more contextual and qualitative methods (Brown & Labonté, 2011). This dissertation is a direct response to this call.

1.8 Dissertation conceptual framework

An important consideration in framework development involves maintaining a balance between comprehensiveness and feasibility. This is a major dilemma for researchers. In this regard, it has been argued that “comprehensiveness, in the absence of available data, is not necessarily a virtue” (Labonte & Torgerson, 2002, p.7) suggesting that a framework incorporating variables that have no data jeopardizes its usefulness. Therefore, while I recognize that there are limitless mediating variables within the link between globalization and TB, attempting comprehensiveness risks creating a model for which data may not even be available to test empirically. At the same time, a model that is overly simplistic would be insufficient and could lead to misleading results because important factors may not be considered. The

conceptual framework adopted in this dissertation addresses both issues; it is simple but captures all the relevant variables.

The overarching conceptual framework for this dissertation is built around the three main objectives of this study and is presented as Figure 1.1. The overarching framework illustrates how upstream forces impact the general population as well as the HCW population whose exposure draws directly from a hazardous working environment due to the increased incidence of TB in the general population. Upstream forces impact health through many variables herein regarded as barriers or promoters (investigated for objective 1 in chapter 2). Programs that have been established to mitigate the effects of TB greatly influence the impact of TB on the general population (investigated for objective 2 in chapter 3). In the case of this dissertation, TB policy was analyzed with respect to factors identified by key stakeholders as important drivers of TB. The framework also indicates how a targeted OHS sub program can be applied to reduce occupational TB (investigated for objective 3 in chapter 4). The parameters identified as central to this program correspond to broader system criteria referred to as “building blocks” that will be described further in chapter 4.

1.9 Study design and methods

This dissertation employs a multi-methods approach to achieve the three related objectives. This methodology combines the strengths of both quantitative and qualitative approaches to answering research questions.

In chapter 2, a linear mixed effects regression technique is used to provide quantitative evidence on the impact of globalization as an upstream force on TB incidence among high TB incidence countries. The justification for this technique is detailed in chapter 2.

In chapters 3 and 4, key informant interviews are used to investigate macro-level drivers of TB among HCWs and the general South African population. As this research primarily questions the underlying causes of TB incidence and the rationale behind the failure to pursue implementation of effective and efficient TB prevention and control policies, I explore key stakeholders' perceptions of this matter to identify factors and processes that can subsequently be the subject of further examination. The key informants method (Marshall, 1996) has been deemed to be particularly appropriate for such an inquiry where an established evidence base is not recognized. This method also provides a way to consider the existence of potential biases or omissions in perceptions by those who may be in a position to contribute to such decisions (Hughes & Preski, 1997). Questionnaire items were developed through a series of formal and informal discussions and consultations with key experts in TB prevention and control. Although chapters 3 and 4 answer different research questions, a single questionnaire instrument (Appendix D) was used to address both research questions during the same interview. Therefore, a key informant could serve as a participant in the study presented in chapters 3 and 4 depending on their expertise.

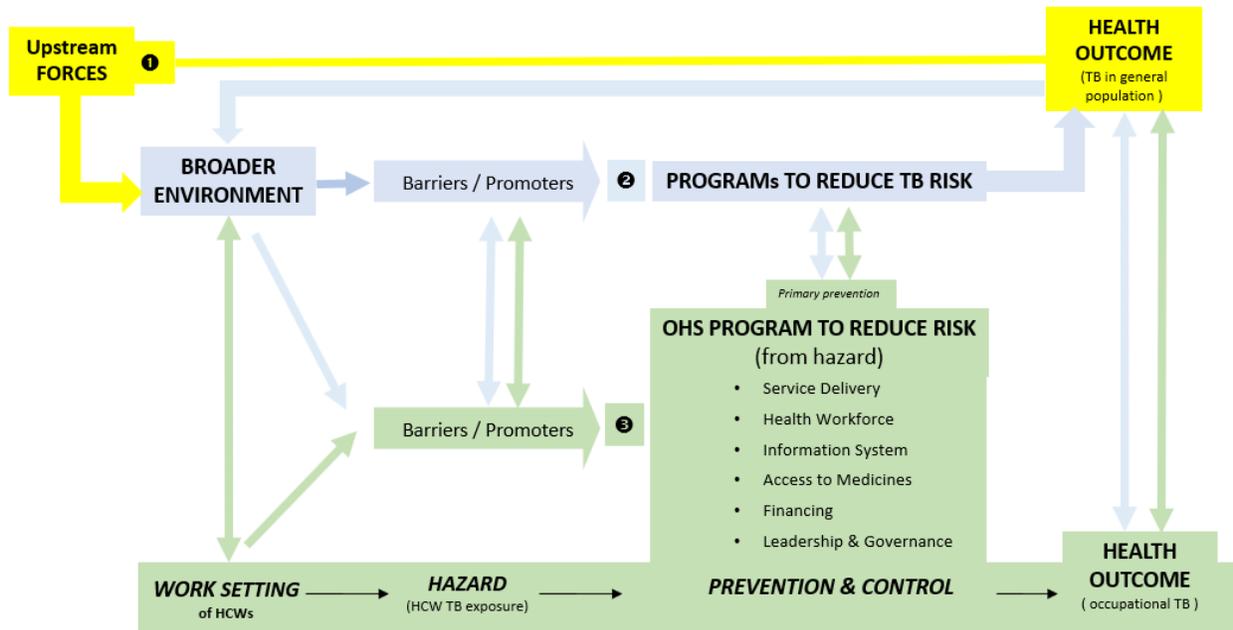
Specifically, in chapter 3, in addition to the key informant interviews, the policy document that guides TB prevention and control in South Africa, was reviewed to assess congruence between what key stakeholders perceive *should be addressed* and what policy documents or practices *actually do* address.

Then in chapter 4, the World Health Organization (WHO) Health Systems Building Blocks (World Health Organization, 2007) was applied as a guiding framework to conceive a system that could enhance the capacities to prevent and control TB infection among HCWs.

1.10 Organization of the dissertation

This dissertation is composed of the following separate, yet interconnected objectives and corresponding methods, results and discussion of findings:

- Chapter 1 presented an overview of the burden of TB and provided the rationale for the focus on HCWs and the choice of South Africa as a research setting. A literature review on conceptual approaches on globalization and health, as well as a review of notable methodologies employed in the investigation of the impact of globalization on TB were discussed. Justification for the study, the conceptual framework and the study design employed in this dissertation were also presented in this chapter.
- Chapter 2 will look at the evidence regarding the association between globalization and TB incidence, focusing on the 22 high-burden TB countries, using data collected between 1990 and 2016.
- Chapter 3 will investigate how the macro-level drivers of TB in South Africa are perceived by experts and ascertain how these are being addressed in recent policy statements.
- Chapter 4 will provide insights on the underlying forces influencing occupationally-acquired TB among healthcare workers in South Africa and the actions perceived to be needed at structural levels to enhance the capacities to prevent and control TB infection in the healthcare workforce.
- Chapter 5 will then synthesize the key findings and study implications. Description of key methodological strengths and limitations, unique contributions, and recommendations for further research will also be presented in that chapter.



Legend	Related study objective
1	To characterize the evidence regarding the relationship between upstream forces and health through an investigation of the association between economic globalization and TB incidence
2	To investigate how macro-level drivers of TB in South Africa are perceived by key experts, and to ascertain how these processes are being addressed in recent policy statements.
3	To identify underlying forces influencing occupationally-acquired TB among HCWs in SA and the actions perceived to be needed at structural levels to enhance the capacities to prevent and control TB infection in the healthcare workforce.

Figure 1.1: Dissertation conceptual framework

Table 1.1 List of 22 TB high burden countries and TB incidence in 2016

Country	Incidence of TB (per 100,000 people)
Brazil	42
China	64
Russian Federation	66
Vietnam	133
Thailand	172
Ethiopia	177
Afghanistan	189
Uganda	201
Zimbabwe	208
India	211
Nigeria	219
Bangladesh	221
Pakistan	268
Tanzania	287
Congo, Dem. Rep.	323
Cambodia	345
Kenya	348
Myanmar	361
Indonesia	391
Mozambique	551
Philippines	554
South Africa	781

Source: World Health Organization, Global Tuberculosis Report (2017)

Table 1.2 Approaches to researching globalization and health pathways

Study	Study Type	Theme	Globalization measure	Health Issue	Method	Setting (Period)
<u>Lin, Teymourian, & Tursini (2018)</u>	Quantitative	Trade & health	Food imports	Overweight and obesity	Fixed effects models	172 countries (1995-2010)
<u>Goryakin, Lobstein, James, & Suhrcke, (2015)</u>	Quantitative	Trade & health	Globalization index (KOF index)	Overweight and obesity	Ordinary least squares (OLS) regression	56 LMICs (1991-2009)
<u>Labonté et al. (2015)</u>	Qualitative	NA	Globalization-related pathways: labour markets, housing markets, social protection measures	Self-reported health status	Semi structured interviews	Canada
<u>Schram et al. (2015)</u>	Quantitative	Trade and health	Trade liberalization	Diet	Natural experiment (Difference-in-difference models)	Vietnam and The Philippines (1999-2013)
<u>Tausch (2015)</u>	Quantitative	Trade and health	Globalization index (KOF index)	Mortality	OLS regression	99 LMIC (1970-2005)
<u>Bandara, Ananda, Wickramage, Berger, & Agampodi (2014)</u>	Qualitative	Global travel and health	Global travel and eco-tourism	Leptospirosis	Review	South Africa
<u>Umaña-Peña et al. (2014)</u>	Quantitative	Trade and health	Trade liberalization	Mortality	Multivariate linear regression	WTO member countries (1995-2010)
<u>Vogli, Kouvonen, Elovainio, & Marmot, (2014)</u>	Quantitative	Trade & health	Globalization index (KOF index)	BMI	Random effects models	127 LMICs (1980-2008)
<u>Schram, Labonté, & Sanders (2013)</u>	Quantitative	Urbanization and health	Economic globalization subscale of KOF index & Urbanization	Overweight, Obesity, cardiovascular diseases	Structural Equation Modeling	SSA (1995-2012)
<u>Brown & Labonté (2011)</u>	Qualitative	Globalization and HIV/AIDS	Economic globalization, consumption of designer goods, global HIV funding,	HIV	Critical analysis	Case studies in Peru, Madagascar and South Africa
<u>Martens, Akin, Maud, & Mohsin (2010)</u>	Quantitative	Globalization index and health	Maastricht Globalization Index	Mortality	Multiple linear regression	117 countries (2000-2008)

<u>Thow & Snowdon (2010)</u>	Qualitative	Trade and health	Trade Policy	Diet	Discussion/perspective	Honduras, Costa Rica, Guatemala, El Salvador, Nicaragua (1990-2006)
<u>Spiegel & Yassi (2004)</u>	Qualitative	Globalization and health determinants	NA	Health in general	Critical perspective	NA
<u>Chaloupka & Laixuthai (1996)</u>	Quantitative	Trade & health	US trade policy	Cigarette smoking	Fixed effects models	10 Asian countries (1970-1991)

Table 1.3: Mapping the literature on TB risk factors

Study	Aim	Category	Explanatory variable	Confounders	Choice of confounders	Analytic Procedure	Setting
<u>Reeves et al. (2015)</u>	To investigate whether recent economic recession and associated reductions in public health spending resulted in declining rates of case detection and treatment success for TB in the EU	Structural forces	Economic recession and associated reductions in public health spending	None. Adjusted for time trends and country fixed effects	NA	Fixed effects modeling	European Union (1991-2012)
<u>Munayco, Mújica, León, del Granado & Espinal (2015)</u>	To identify key social determinants of TB among countries in (LAC)	Determinants	GDP, GNP, health expenditure per capita, access to improved sanitation facilities, life expectancy, TB detection rate, HIV/AIDS prevalence, urban population growth, unemployment rate and incarceration rate	NA	NA. Selection of variables for model was guided by the literature (Lönnroth 2009).	Random effects modeling	20 LAC (1995-2012)
<u>Bozorgmehr & San Sebastian (2014)</u>	To determine the association between trade liberalization and TB incidence in 22 high-burden TB countries between 1990 and 2010	Structural forces	Trade liberalization	HDI, GINI, debts, polity patterns, conflict, overcrowding, population stage transition, health system financing, case detection rates & HIV prevalence, age dependency ratio, armed conflict, case detection rate	Guided by the literature and causal diagrams	Longitudinal multi-level linear regression analysis	22 HBC (1990-2010)

<u>Ploubidis et al. (2012)</u>	To investigate the prospective association between the determinants of TB and TB incidence in Europe	Determinants	GDP per capita, GINI, trust index, net migration, Smoking prevalence	NA	NA	Quintile regression models	Europe (44) [2000-2009]
<u>(Stuckler, Basu, McKee, & Lurie (2011))</u>	To investigate the relationship between mining and TB among SSA countries	Structural forces	Mining activity	GDP per capita, export as a fraction of GDP, percentage of the population living in urban settings, and population size	Not stated	Multivariate regression (Pooled ordinary least squares)	SSA (2001-2005)
<u>Dye, Lönnroth, Jaramillo, Williams, & Raviglione (2009)</u>	To investigate the association between TB incidence trends and 32 independent variables	Determinants	Economy, population, behavioural and biological risk factors, health services, TB control programmes	NA	NA	Multivariate linear regression model	134 Countries (1997-2006)
<u>Stuckler, King, & Basu (2008)</u>	To investigate the association between IMF programs and TB incidence, prevalence and mortality	Structural forces	IMF programs	GDP, democracy, war, urbanization, pop dependency ratio, education	Conceptual (Literature)	Multivariate regression/xtreg with the fe and cluster options in STATA version 9.2.	21 Post communist countries [1992-2002]

Chapter 2: The association of globalization and tuberculosis incidence: evidence from the 22 high burden countries

2.1 Introduction

In an increasingly interconnected world, the consequent impact on the health of populations propelled by the wave of globalization merits examination. On the one hand, intensified interactions can produce effects through recognized proximal factors; on the other hand, globalization can affect local capacities to respond to health-relevant developments by positively accelerating access to valuable resources or negatively undermining local capabilities to act. Neoliberal economic arrangements which often underpin contemporary globalization have, after all, been observed to place emphasis on reliance on unfettered markets to promote economic growth. These measures encourage the adoption of austerity measures which may include the promotion of private investment and other fiscal policies leading to a growth in private health services at the expense of a weakening public sector. This has been the experience of many low- and middle-income countries whose economies were subjected to the Structural Adjustment Policies promoted by the World Bank and International Monetary Fund (IMF) in the 1980s (Adepoju, 1993; Labonté & Schrecker, 2007).

The link between TB and its proximate risk factors like smoking, diabetes, malnutrition and alcoholism have been well established through epidemiological studies (Cegielski & McMurray, 2004; Lönnroth et al., 2009, 2008; Odone et al., 2014; Stevenson et al., 2007). However, its association with upstream factors, like globalization, remains minimally documented and in need of greater attention (Lönnroth et al., 2009; Pedrazzoli et al., 2017). Admittedly, the relationship between upstream variables and TB incidence is very complex and

can be methodologically challenging. There are several intermediary variables involved in the relationship, and issues of collinearity, confounding, effect modification and lack of appropriate data present serious methodological challenges. This complexity makes it difficult to develop appropriate models for assessing this link. Given the lack of studies in this area, I undertook this investigation with the intention of responding to the call for simple but robust models that enhance our understanding regarding the potential effects of systemic forces on TB outcomes (Pedrazzoli et al., 2017).

Specifically, the primary purpose of this research question was to investigate the association between globalization and TB burden using macro-level data from the 22 high burden countries (HBCs). Guided by a modified version of Lönnroth et al.'s framework for proximate risk factors and upstream determinants of TB (Lönnroth et al., 2009) as the analytical framework (Figures 2.1 & 2.2), a linear mixed-effects regression model was fitted to investigate the association between globalization and TB incidence, accounting for relevant confounding variables.

2.2 Conceptual framework

Lönnroth and colleagues' framework for examining drivers of TB epidemics (Fig. 2.1) hypothesizes how the proximate risk factors of TB are linked to other understudied or less recognized upstream determinants (Lönnroth et al., 2009). To empirically examine this framework, which Lönnroth and colleagues propose but do not test, upstream variables were operationalized or captured with the following macro-level measures in the modified version as shown in Fig. 2.2: globalization, health systems financing, economic strength, urbanization and human development index (HDI).

The adapted framework suggests the influence of globalization on TB incidence through various mechanisms. Globalization, while characterized by many dimensions, directly affects the intensity of economic activity (referred to as economic strength in this framework), the creation and growth of urban centres, and changes in governance in many sectors of the economy including the health sector. In the health sector, changes in governance and the capacity to act in response to challenges could be reflected in the nature of healthcare financing. In turn, these indicators affect the general well-being of the population, as captured by the human development index of a country (United Nations Development Programme, 1990), which can, in turn, be regarded as a measure of people's capacities to respond to specific risks. Therefore, globalization's association with diseases such as TB is suggested to take place through upstream determinants such as urbanization, economic strength, health expenditure and HDI. These upstream factors then influence the proximate factors such as crowding, poor ventilation, tobacco smoke, air pollution, HIV, malnutrition, lung diseases, diabetes, alcoholism, age, sex and genetic factors.

Although not all the pathways can be captured in a single framework, this model provides a way to consider critical pathways and factors to enable a robust analytical process.

2.3 Methods

2.3.1 Study design and observation period

This ecological study used publicly available data from 1990 to 2016 for the 22 HBCs. This entailed 27 time points per country yielding a total of 594 country-years. The study variables were extracted from different sources (Table 2.1) and merged into a single Excel file for the analyses.

2.3.2 Explanatory variable: KOF Globalization Index

The explanatory variable for this study was the revised version of the Konjunkturforschungsstelle Globalization Index (KOFGI), which is a composite measure that captures globalization along economic, social and political dimensions (Gygli, Haelg, & Sturm, 2018). This index defines globalization as

“the process of creating networks of connections among actors at intra- or multi-continental distances, mediated through a variety of flows including people, information and ideas, capital, and goods. Globalization is a process that erodes national boundaries, integrates national economies, cultures, technologies and governance, and produces complex relations of mutual interdependence” (Dreher, 2006, p.1092).

This definition underpins the design of this index. KOFGI was originally introduced by Dreher (2006) and later updated by Dreher, Gaston, & Martens (2008). It measures the intensity of globalization for over 200 countries and territories spanning 1970 to 2015, on a scale of 1-100 with higher values denoting higher globalization. As noted in chapter 1, most measures of globalization in the literature rely exclusively on the economic dimension but as Goryakin and colleagues argue, globalization is not only an economic process (Goryakin et al., 2015) but a multifaceted phenomenon that has other dimensions including social and political aspects as captured in Dreher’s definition (Dreher, 2006). The three main subscales of KOFGI are explained in the following paragraphs.

Economic globalization is characterized by “long distance flows of goods, services, capital as well as information and perceptions that accompany market exchanges” (Nye & Donahue, 2000, p.4). This sub-scale of the KOFGI captures the extent of cross-border trade, investment and revenue flows in relation to GDP, as well as the impact of trade and capital

transaction restrictions in each country. The sub-scale is further divided into trade and financial globalization. The trade sub-category captures the exchange of goods and services using measures like the sum of imports and exports of goods and services as a share of GDP and trade partner diversification. The financial sub scale is captured by the capital flows and stocks of foreign assets and liabilities.

Social globalization expresses the spread of ideas, information, images and people. There are three sub categories of this measure. The first is personal contacts, which captures the direct interaction among people living in different countries. This construct is represented by measuring international telecom traffic, the degree of tourism and stock of foreign population. The second sub-category is information flows, which measures the flow of ideas and images. Indicators like internet use, cable television subscribers, number of radios and televisions and others are used as proxy measures to capture how a country contributes to the global spread of ideas. The third sub-category is cultural proximity and is perhaps the most controversial construct in this sub-scale. It basically captures the dispersion of American cultural products (Saich, 2000) with the rationale that the global socio-cultural realm is set or led by the United States (Rosendorf, 2000). Indicators used here include the number of McDonald's restaurants in a country; it is argued that many people consider the proliferation of McDonald's to be synonymous to globalization itself (Dreher, Gaston, Martens, & Boxem, 2009).

Political globalization characterizes the diffusion of government policies. Indicators used to capture this construct include the number of embassies and high commissions in a country, a country's membership in international organizations and participation in UN peace missions (Dreher et al., 2009; Rosendorf, 2000).

The current version of KOFGI introduces *de facto* and *de jure* measures along the different components of globalization and also introduces additional variables in the calculation of the index. Whereas the *de facto* measures include variables that capture actual flows and activities, the *de jure* measures include variables that capture policies that enable flows and policies in principle. This distinction has become necessary because it has been shown that different characterizations yield different findings (Quinn, Schindler, & Toyoda, 2011). The *de facto* and *de jure* indices were combined to calculate the overall KOFGI which was the primary explanatory variable used in this study's analyses.

A breakdown of the structure of KOFGI including the different variables or sub-constructs and weights used to derive the index is presented in Figure 2.3. Further details about the KOFGI and the methodology for its calculations are provided in Gygli, Haelg, & Sturm (2018).

The validity and reliability of KOFGI have been tested, and it is the most widely applied and cited globalization index in the literature (Bozorgmehr & San Sebastian, 2014; Can & Gozgor, 2018; Dreher, 2006; Dreher et al., 2008; Gozgor Giray, 2017; Potrafke, 2015; Schram et al., 2013). KOFGI is published annually by the KOF Swiss Economic Institute (Dreher, 2006; Gygli et al., 2018).

2.3.3 Outcome variable: TB incidence

The outcome variable was the estimated TB incidence (all forms) in the 22 high burden countries from 1990-2016, extracted from the WHO global TB database.

2.3.4 Confounders

The adapted conceptual framework guided the selection of confounders (Lönnroth et al., 2009) (Figure 2.2) consistent with the approach taken to examine the influence of globalizing forces on TB in previous studies (Bozorgmehr & San Sebastian, 2014; Stuckler et al., 2008). Again, confirmation of the appropriateness of the variables in improving the model was determined statistically and explained in Appendix A. The following confounders were included in the analysis: urbanization (Hargreaves et al., 2011), economic strength (Stuckler et al., 2008), health expenditure (Maynard, Shircliff, & Restivo, 2012), human development (Taylan et al., 2016) and HIV (Bozorgmehr & San Sebastian, 2014). To examine their individual effects, the different sources of health expenditure (public, private and external resources for health) were also investigated. Details about each confounding variable, including a justification of its inclusion in the model, are provided in the following sections and summarized in Table 2.1.

2.3.4.1 Urbanization

Urbanization has been found to drive many epidemics (Alirol, Getaz, Stoll, Chappuis, & Loutan, 2011; Prasad, Ross, Rosenberg, & Dye, 2016). The upsurge in informal settlements or slums, that accompany the growth of urban centers make people share small spaces; an increase in the population density, also increases the probability of transmitting and contracting infections, including TB. In this study, the annual percentage growth of the population living in urban areas, as defined by national statistical offices was used as the urbanization variable. The data are collected and smoothed by the United Nations Population Division.

2.3.4.2 Economic strength

To account for countries' economic strength, gross domestic product (GDP) per capita was chosen as a confounder. GDP has been known to be associated with TB (Siroka, Lönnroth, & Ponce, 2016) and also with globalization (Samimi & Jenatabadi, 2014). The figures are based on purchasing power parity (PPP) and have been converted to international dollars using purchasing power parity rates. More information about this variable is available in Table 2.1.

2.3.4.3 Health expenditure

Total health expenditure, expressed as a percentage of GDP, was included in the analysis to account for differences in health system performance (Bozorgmehr & San Sebastian, 2014). To a large extent, this variable also reflects healthcare governance structures in the various countries. Due to differences in how different populations pay for healthcare and how countries fund TB programmes, three main health system financing indicators were also assessed in a separate analysis. These health system financing indicators included: private health expenditure, public health expenditure and external resources for health. Private health expenditure includes direct household (out-of-pocket) spending, private insurance, charitable donations, and direct service payments by private corporations. Public health expenditure consists of health spending from the government, including external borrowing and grants and social health insurance funds. External resources for health consist of funds provided by sources not part of the country or government.

2.3.4.4 Human Development Index

To account for other factors related to human development and standard of living that may not be captured by housing, health status and economic development (variables that are

already included in the analysis), the HDI composite measure was included in the model. The HDI was developed in 1990 to shift the orientation of development economics from a purely income-based orientation to people-centered policies (Haq, 1995; United Nations Development Programme, 1990). HDI has been found to be associated with TB (Taylan et al., 2016) and globalization (Bahadur, 2011). This composite measure captures life expectancy, education and standard of living, factors related to both globalization and TB incidence.

2.3.4.5 HIV

HIV has been known to be a main driver of TB. Its association with TB and with globalization has been established in many studies (Bozorgmehr & San Sebastian, 2014; Brown & Labonté, 2011; Corbett et al., 2003; Weyer, Fourie, & Nardell, 1999). Even though HIV is considered a proximate determinant (only upstream factors were considered in the analysis), it was included in the analysis for its special contribution as a major risk factor for TB.

2.3.5 Regression analysis

Linear mixed effect models were fitted in R (R Core Team, 2018) using the lmer function of the lme4 package (Bates, Mächler, Bolker, & Walker, 2015). The nested nature of the data suggested that there could be potential clustering effect which when unaccounted for, could undermine the validity of the study results. The mixed-effects technique combines the characteristics of both random and fixed effects and accounts for the clustering in the data. The technique also has the advantage of handling unbalanced and missing data (Lindstrom & Bates, 1988; Schafer & Yucel, 2002).

Model assumptions were checked and presented in Appendix A. Random intercept-only models and random intercept and slope models were fitted and compared to determine the more

appropriate model structure. Random intercept and slope model was selected as the model of choice based on two criteria: 1) examination of the scatterplot of the incidence versus globalization variables and 2) comparison of the Akaike's Information Criterion (AIC) and the Bayesian Information Criterion (BIC) values of both models. The penalized-likelihood information criteria, which includes the AIC and BIC are widely used criteria for model selection (Dziak, Coffman, Lanza, Li, & Jermiin, 2018). Further detailed information about this process is presented in Appendix A.

2.3.6 Missing data

The outcome variable (TB incidence) had no missing data but the primary explanatory variable (globalization) had 22 missing cases, which represented 3.70% of cases. For the variables that had missing data, the percentage missing ranged from 2.53% to 31.99%. The missing data were assumed to be missing at random. Given the linear mixed-effects model's ability to provide unbiased results even with incomplete or missing data (Lindstrom & Bates, 1988; Schafer & Yucel, 2002), there was no need to address this. Table 2.2 contains detailed information on the proportion of missing data, missing patterns, and manipulations.

2.4 Results

2.4.1 Descriptive results

Of the 22 HBCs, South Africa consistently recorded a very high incidence rate over time, which peaked around the years 2007 and 2008 (Figures 2.4a & 2.4b) when the rate was 977 per 100, 000 (World Health Organization, 2017b). Over the study period, incidence rates in Afghanistan, Bangladesh, Brazil, China and Russia remained low compared to the other countries (Fig. 2.4b). While the overall trend line for the 22 HBCs indicates a stagnant rate over

this time frame as shown in Figure 2.4a, increases were particularly observed in South Africa, Mozambique, Kenya and the Philippines. Figures 2.5a and 2.5b show globalization trends for the 22 countries from 1990 to 2016. In almost all the countries, there seems to be a steady increase in globalization from 1990 to 2016 (Figures 2.5a and 2.5b). However, the relationship between globalization and TB incidence is different for each country as shown in Figure 2.6. Overall, it appears as if globalization is only slightly correlated with TB incidence for all 22 HBCs in the fitted unadjusted model. However, after accounting for the hypothesized confounders, globalization appears strongly positively correlated with TB incidence (Fig. 2.7).

2.4.2 Regression results

Tables 2.3a and 2.3b show the results of the mixed effects regression model. Regression coefficients (β) are presented as a measure of association between TB incidence and globalization or confounders.

Table 2.3a includes HIV as a confounder; therefore, the adjusted model in this table excludes data for China for which there was no reported data on HIV prevalence. The results presented in Table 2.3b excludes HIV as a confounder. This adjusted model therefore had all 22 HBCs and the results were similar to those obtained in Table 2.3a.

In the unadjusted models, only HIV ($\beta=16.886$, $p=0.092$) and total health expenditure ($\beta= -18.372$, $p=0.011$) were significantly associated with TB incidence.

The unadjusted association between globalization and TB incidence was not significant ($\beta= 0.937$, $p= 0.684$). After correcting for differences in economic strength, health expenditure, HDI, urbanization and HIV prevalence, however, the association was observed to be significant ($\beta=9.79$, $p<0.006$). To put this into perspective, one unit increase in the globalization index was

associated with an increase of almost 10 TB cases per 100, 0000 per year on average, adjusting for the relevant confounders.

In the analysis that excluded HIV from the model (Table 2.3b), the adjusted effect size was slightly diminished but still significant ($\beta=9.077, p<0.01$).

2.4.3 Supplementary analyses and results

Results from the supplementary analyses including model outputs, figures and other details are presented in appendix A.

As a sensitivity analysis, the model was refitted using three variables representing the three main different sources of health funding: public health expenditure, private health expenditure and external resources for health. This did not significantly change the results obtained when total health expenditure was used instead. The adjusted association was still significant ($\beta=10.33, p<0.003$).

Based on the suspicion that the data from South Africa could be skewing the results (an outlier), the analysis was repeated by excluding data from South Africa. In this analysis, globalization was still significantly associated with increased TB ($\beta=7.67, p=0.027$), although with a slightly diminished effect size compared to the model that included this data.

2.5 Discussion

Globalization and its impact on our daily lives is still a hotly debated topic. Many agree that globalizing factors indeed impact health conditions. However, there is little consensus on the direction of impact i.e. whether globalization has a positive or a negative impact on health. Also, evidence of the specific mechanisms through which globalizing forces impact health conditions remains, poorly documented. This study therefore sought to contribute to the characterization of

the pathways through which globalization affects TB incidence and to add empirically to the determination of the association between these two. Results showed that globalization is indeed significantly associated with increased TB incidence.

In discussing the findings of this study, I recognize the limitations of using *p*-value as a “decision maker”. As it has been argued, “excessive concern with avoiding false positive findings can supply, as in other contexts, a credible and convenient rationale for doing nothing” (Labonté & Schrecker, 2007a). There is the temptation to discount an effect simply because the *p*-value associated with an effect size did not make the conventional 0.05 threshold. Indeed, more recently, the American Statistical Association has warned that “scientific conclusions and business or policy decisions should not be based only on whether a *p*-value passes a specific threshold” (Wasserstein & Lazar, 2016, p.131).

This study has provided evidence that globalization is associated with increased TB incidence. Specifically, it was found that a unit increase in globalization was associated with an increase of almost 10 TB cases per 100, 000 per year on average, adjusting for the relevant confounders. This is an increase that itself is almost double the TB rate in the high-income country of Canada (World Health Organization, 2017b). Although it is challenging to decipher anything beyond knowledge of the magnitude of this non-causal relationship due to the nature of the explanatory variable (KOFGI), this evidence prompts us to re-examine the consequences of globalization on health conditions, especially TB incidence.

Globalization may potentially influence TB incidence through various pathways as depicted in the conceptual framework (Figure 2.2). Although the weakening of borders that accompany the interaction of economies may facilitate migration and the propensity for the transmission of infectious diseases including TB (Dhavan, Dias, Creswell, & Weil, 2017; Pareek,

Greenaway, Noori, Munoz, & Zenner, 2016), there are other several important pathways by which globalization can impact TB incidence. Importantly, reduced tariffs may increase the importation of processed foods, leading to malnutrition and/or diabetes which are known risk factors for TB (Cegielski & McMurray, 2004; Christopher Dye et al., 2011; Odone et al., 2014; Stevenson et al., 2007). Economic globalization increases foreign direct investments in many sectors including the mining sector. The link between TB and mining has been established by many studies (Stuckler et al., 2011, 2013). In addition, globalization spurs urban growth and the development of slums around urban centres. These highly populated areas with poor housing and living conditions make TB transmission thrive. Globalizing forces may also affect the epidemiology of TB through the responsiveness of the health system in terms of availability and distribution of human resources for health, affordability and access to effective treatment.

Although, globalization may be associated with many benefits, it should be noted that the process of integration which promotes austerity-focused macroeconomic policies could create disastrous health effects (Kentikelenis, King, McKee, & Stuckler, 2015; Maynard et al., 2012) through complex pathways, including potential weakening of local capacities to deal with health challenges. There were an estimated 10.2 million incident cases of TB globally in 2015 (Kyu et al., 2018). Although this represents a slight decline from previous years, the slower than expected rate of decline and the continued high burden of TB, coupled with the poor response to drug resistant strains show a major failure of global public health (Cox & Nicol, 2018). This failure warrants rethinking of current strategies. This study provides support for the call for attention on the structural forces behind TB (Pedrazzoli et al., 2017). Current programmes are unable to overcome the poverty-related forces that continue to drive the TB epidemic (Ortblad, Salomon, Bärnighausen, & Atun, 2015).

The current global burden of TB, despite diagnostic and treatment advancement, suggests the need for innovative thinking beyond the current approaches in order to more effectively address the disease. Innovative thinking can find new pathways for preventing and controlling the disease as well as monitoring the effectiveness of these efforts.

Implications of this study lie not in a call to stop the globalization processes in these countries (it may be a fruitless venture anyway), but to identify specific entry points for appropriate intervention. Improving socioeconomic conditions is key to TB control (Harling, Ehrlich, & Myer, 2008) irrespective of the influence of globalizing forces.

Specific targets in the *End TB Strategy* include a 90% reduction in TB deaths and an 80% reduction in TB incidence by 2030, using 2015 figures as a baseline (World Health Organization, 2016). These targets would not be achieved if TB care and prevention efforts do not address underlying conditions that drive the epidemic and mitigate these efforts. A recent study showed that social protection spending led to a significant reduction of TB incidence, prevalence and mortality (Siroka et al., 2016). Interventions need to tackle the basic conditions that predispose people to TB infection.

From an analytical point of view, although evidence suggests that alcohol use, tobacco smoke, and malnutrition are associated with TB, these variables were not included in the analysis because they are considered proximal risk factors and are downstream (Siroka et al., 2016). This study focused on the social and economic processes that are upstream and considered those factors as driven by underlying social processes. However, as already explained, HIV was treated as an exception because of its special role as a major risk factor for TB epidemiology (Corbett et al., 2003; Karim, Churchyard, Karim, & Lawn, 2009). Nevertheless, the results did not change significantly even with the inclusion or exclusion of HIV in the model.

Limitations associated with the choice of variables used in this study need to be noted. First, all the confounding variables were proxy measures of certain constructs or processes; therefore, it is possible that the intended attributes may not have been accurately captured by these proxy measures. For instance, it was assumed that health expenditure reflects TB funding. Although specific funding for TB would have been more accurate, these data were not available. Also, a measure of economic inequality (measured by GINI index) would have more accurately captured the structural violence (Farmer, Nizeye, Stulac, & Keshavjee, 2006) in the countries as opposed to GDP per capita as a measure of poverty, but again there was insufficient data on this variable. In fact, it is possible that the findings from South Africa are affected by this problem given the notable economic inequality in the country.

Another limitation is inherent in the model fitted to the data. A linear model was fitted to the data although not all the relationships between globalization and TB incidence were linear as shown in Figure A3 of the appendix.

Labonté and Schrecker argue, modeling relationships in this area is such that “rarely will it be possible to state conclusions with the degree of conclusiveness that may be possible in a laboratory situation or even in many epidemiological study designs, where almost all variables can be controlled”(Labonté & Schrecker, 2007) . Therefore, findings from this study are also constrained by other known and unknown potential confounders that could not be accounted for.

2.6 Conclusion

There has been limited systematic discussion to date of evidence concerning the association of globalization on TB. The purpose of this study was not simply to determine whether globalization is beneficial or detrimental with respect to TB incidence, but rather to

explore pathways through which globalizing forces may be associated with health conditions (Lönnroth et al., 2009), and to estimate the size of this link or effect. The evidence found in this study regarding an association between globalization and TB, has two major implications. First, it suggests there is something inherent in the globalization process that drives TB. Whatever this driver is (perhaps something that alters the social determinant of health) cannot be directly ascertained due to the nature of the indicators used in this study. KOFGI is a composite measure that includes many other variables. It is therefore difficult to single out a particular variable that may be responsible for this link. The second implication has to do with the effect that globalization processes have on local capabilities to respond to an issue such as a TB epidemic.

Nevertheless, the evidence generated from this study suggests that the impact of upstream forces merits greater attention. Attention to structural determinants should, therefore, complement actions focused on diagnosis and treatment, with attention needed for strengthening prevention and control.

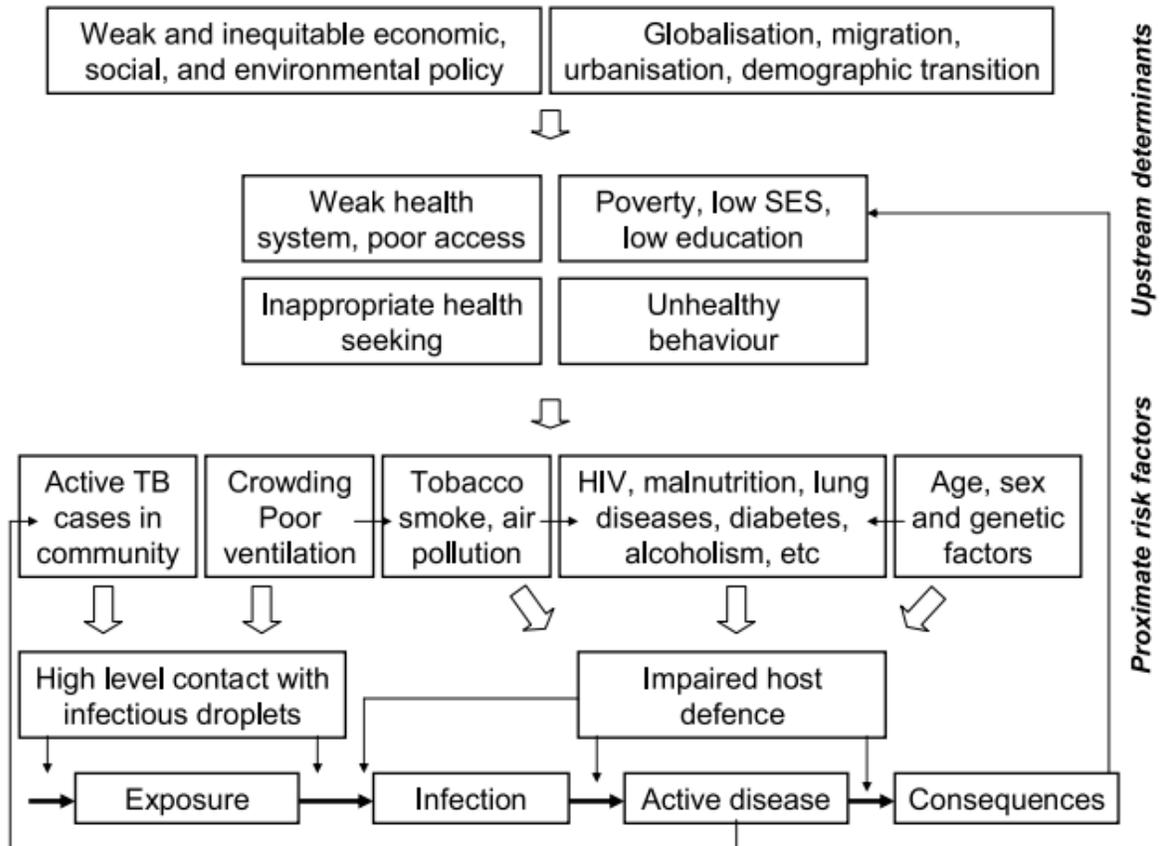


Figure 2.1. Framework for proximate risk factors and upstream determinants of TB. Reprinted from “Drivers of tuberculosis epidemics: The role of risk factors and social determinants” by Lönnroth, et al., 2009. *Social Science & Medicine*, 68(12), p.2244. Copyright 2009 by Elsevier Ltd.

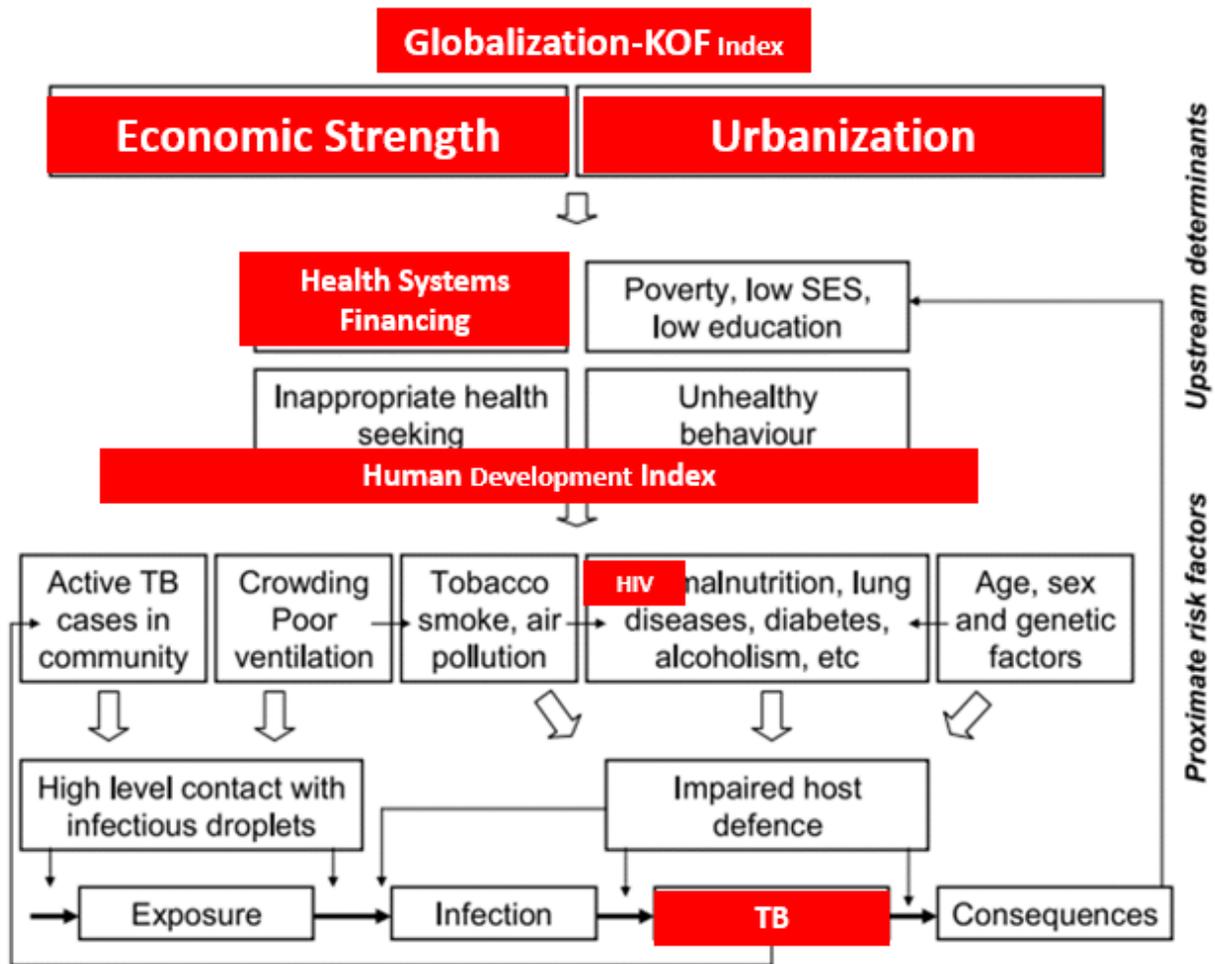


Figure 2.2. Framework for proximate risk factors and upstream determinants of TB. Adapted from “Drivers of tuberculosis epidemics: The role of risk factors and social determinants” by Lönnroth, et al., 2009. *Social Science & Medicine*, 68(12), p.2244. Copyright 2009 by Elsevier Ltd. Variables shaded in red boxes highlight the adaptations and/or variables that were included in the analysis.

Globalisation Index, de facto	Weights	Globalisation Index, de jure	Weights
<i>Economic Globalisation, de facto</i>	33.3	<i>Economic Globalisation, de jure</i>	33.3
<i>Trade Globalisation, de facto</i>	50.0	<i>Trade Globalisation, de jure</i>	50.0
Trade in goods	40.9	Trade regulations	32.5
Trade in services	45.0	Trade taxes	34.5
Trade partner diversification	14.1	Tariffs	33.0
<i>Financial Globalisation, de facto</i>	50.0	<i>Financial Globalisation, de jure</i>	50.0
Foreign direct investment	27.5	Investment restrictions	21.7
Portfolio investment	13.3	Capital account openness 1	39.1
International debt	27.2	Capital account openness 2	39.2
International reserves	2.4		
International income payments	29.6		
<i>Social Globalisation, de facto</i>	33.3	<i>Social Globalisation, de jure</i>	33.3
<i>Interpersonal Globalisation, de facto</i>	33.3	<i>Interpersonal Globalisation, de jure</i>	33.3
International voice traffic	22.9	Telephone subscriptions	38.2
Transfers	27.6	Freedom to visit	31.2
International tourism	28.1	International airports	30.6
Migration	21.4		
<i>Informational Globalisation, de facto</i>	33.3	<i>Informational Globalisation, de jure</i>	33.3
Patent applications	35.1	Television	25.2
International students	31.2	Internet user	31.9
High technology exports	33.7	Press freedom	13.2
		Internet bandwidth	29.7
<i>Cultural Globalisation, de facto</i>	33.3	<i>Cultural Globalisation, de jure</i>	33.3
Trade in cultural goods	22.6	Gender parity	31.1
Trademark applications	13.3	Expenditure on education	30.9
Trade in personal services	25.6	Civil freedom	38.0
McDonald's restaurant	23.2		
IKEA stores	15.3		
<i>Political Globalisation, de facto</i>	33.3	<i>Political Globalisation, de jure</i>	33.3
Embassies	35.7	International organisations	37.0
UN peace keeping missions	27.3	International treaties	33.0
International NGOs	37.0	Number of partners in investment treaties	30.0

Notes: Weights in percent. Weights for the individual variables are time variant. Depicted are the weights for the year 2015. Overall indices for each aggregation level are calculated by the average of the respective de facto and de jure indices.

Figure 2.3: Structure of the KOF Globalization Index. Reprinted from *The KOF Globalization Index – Revisited (Working Paper)*” by Gygli, S., Haelg, F., & Sturm, J.E., 2018. Retrieved from <https://doi.org/10.3929/ethz-b-000238666>

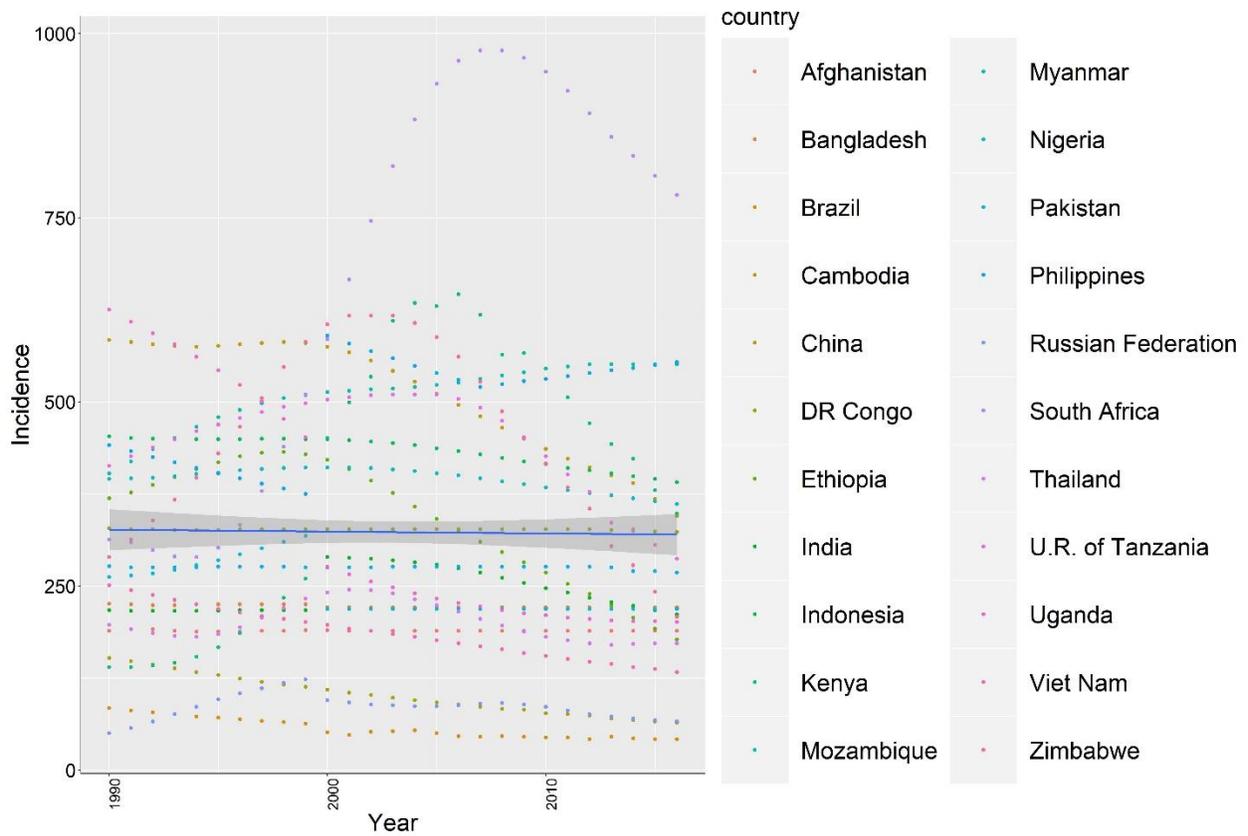


Figure 2.4a: Graph showing overall TB incidence for all 22 HBCs (1990-2016)

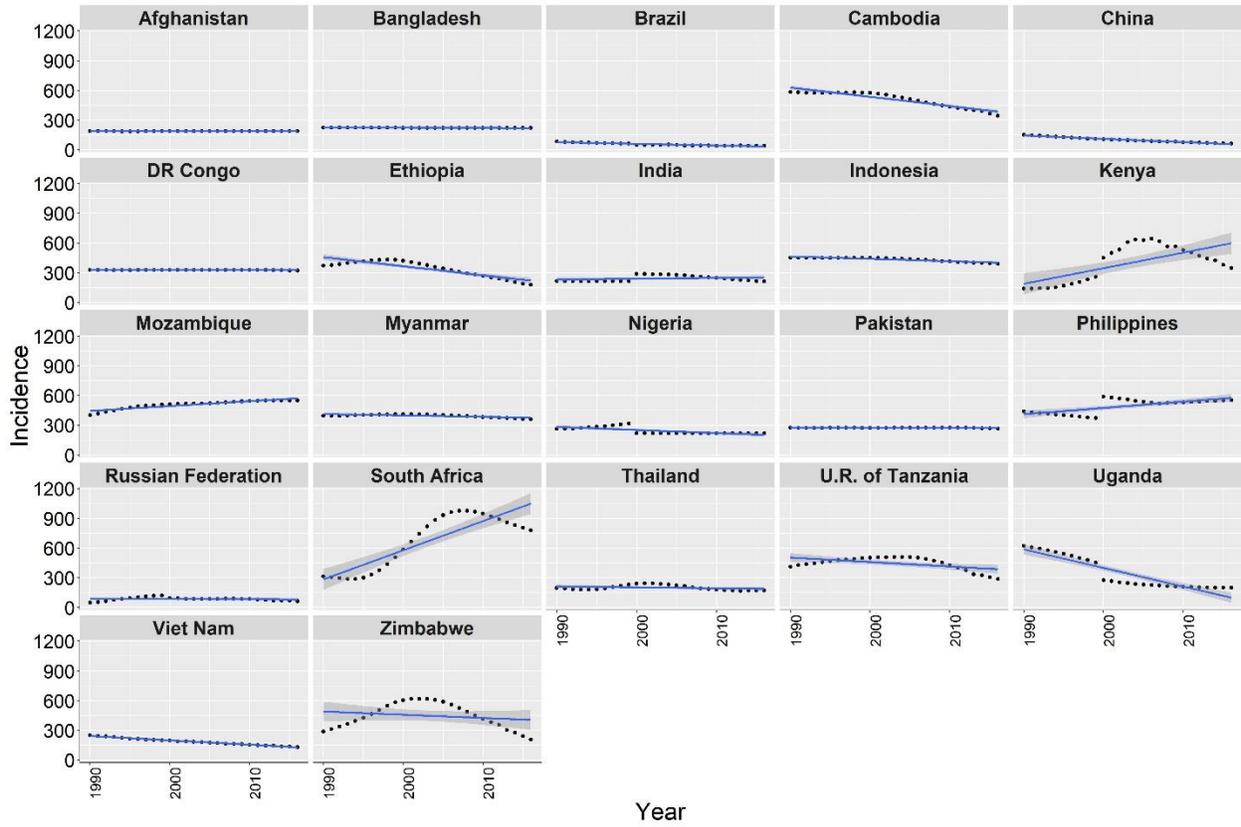


Figure 2.4b: Graphs showing each country's TB incidence across time (1990-2016)

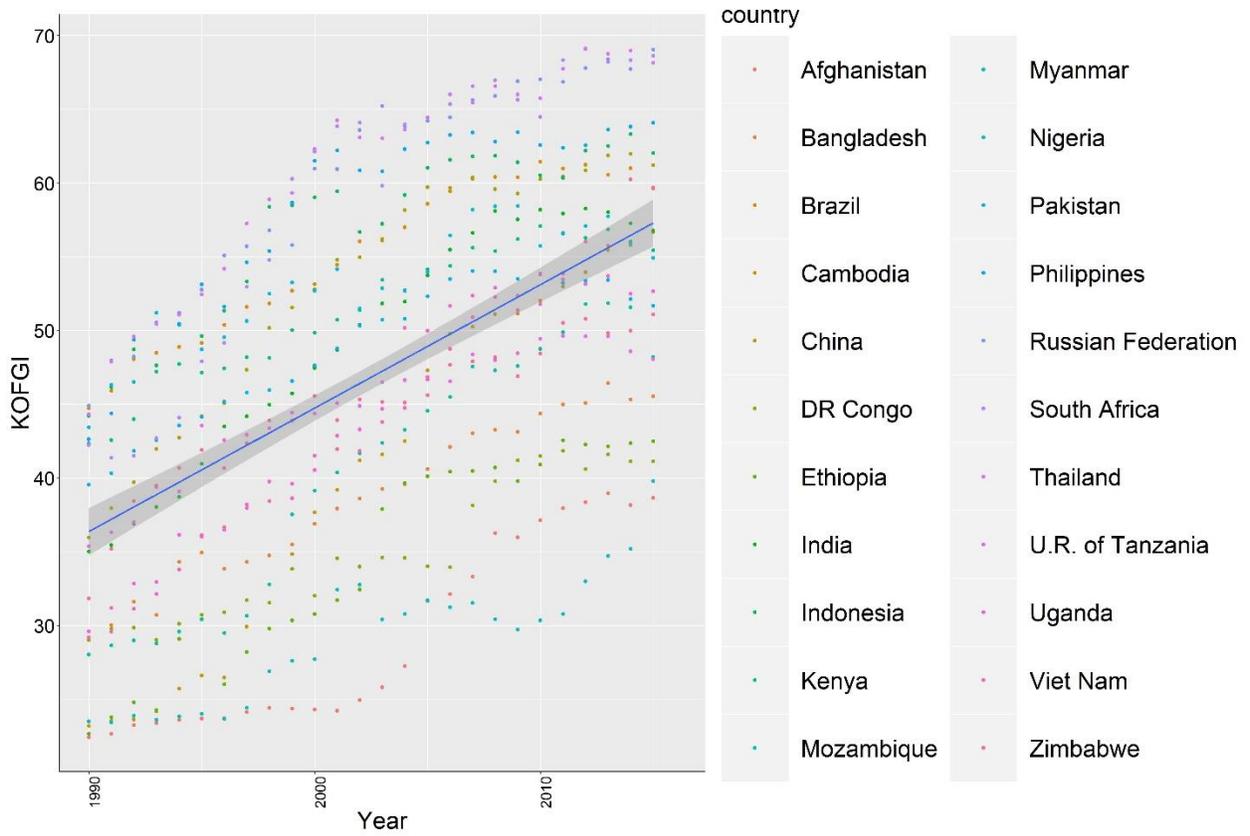


Figure 2.5a: Graph showing overall globalization trend for all 22 HBCs (1990-2016)

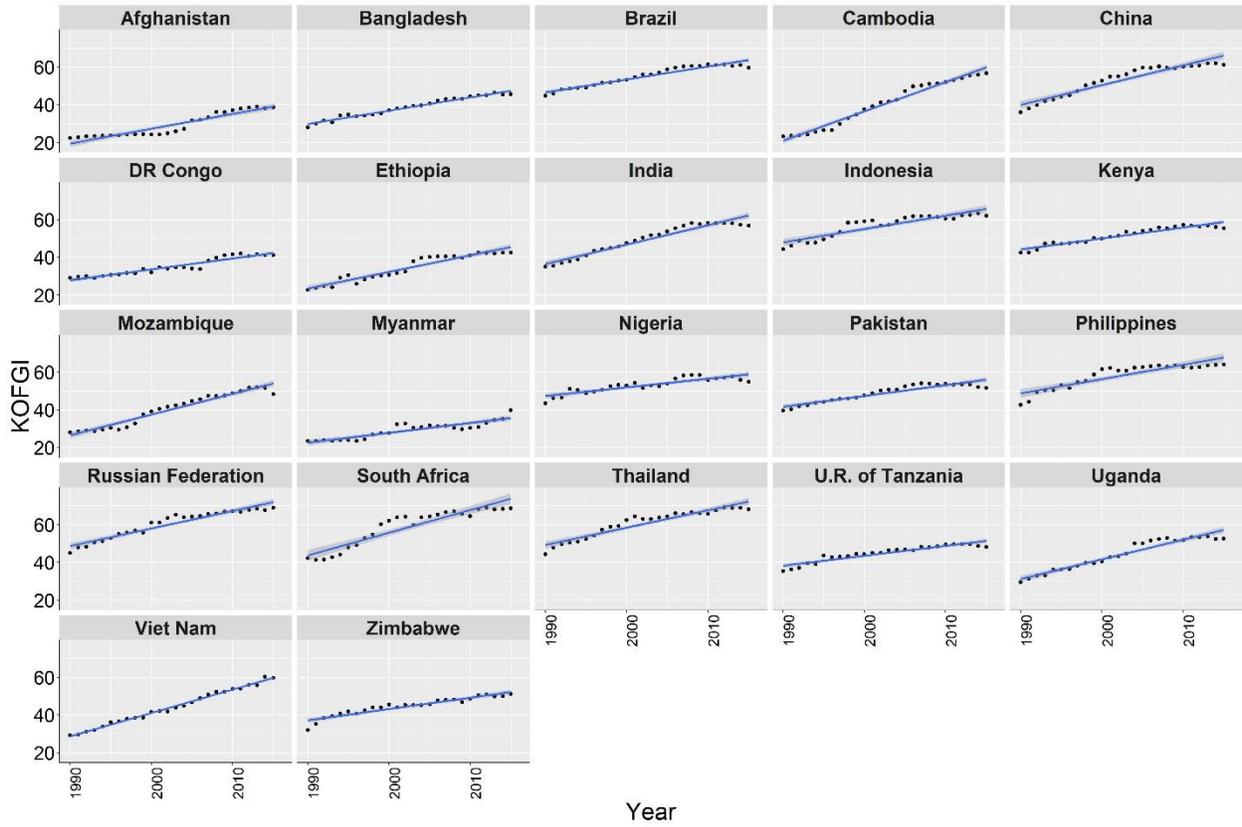


Figure 2.5b: Graphs showing globalization trends for each HBC (1990-2016)

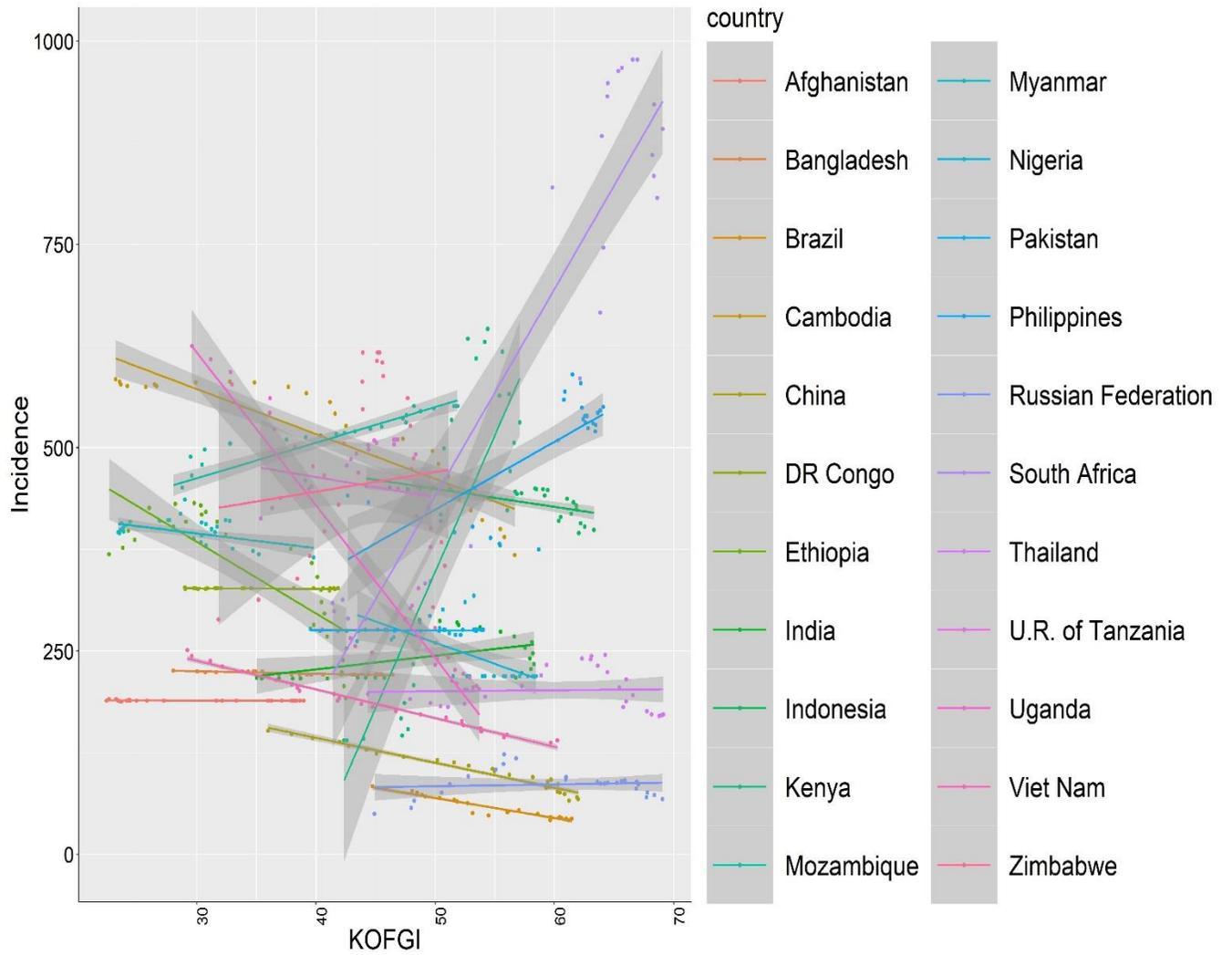


Figure 2.6: A scatterplot of TB incidence versus globalization for each country (1990-2016)

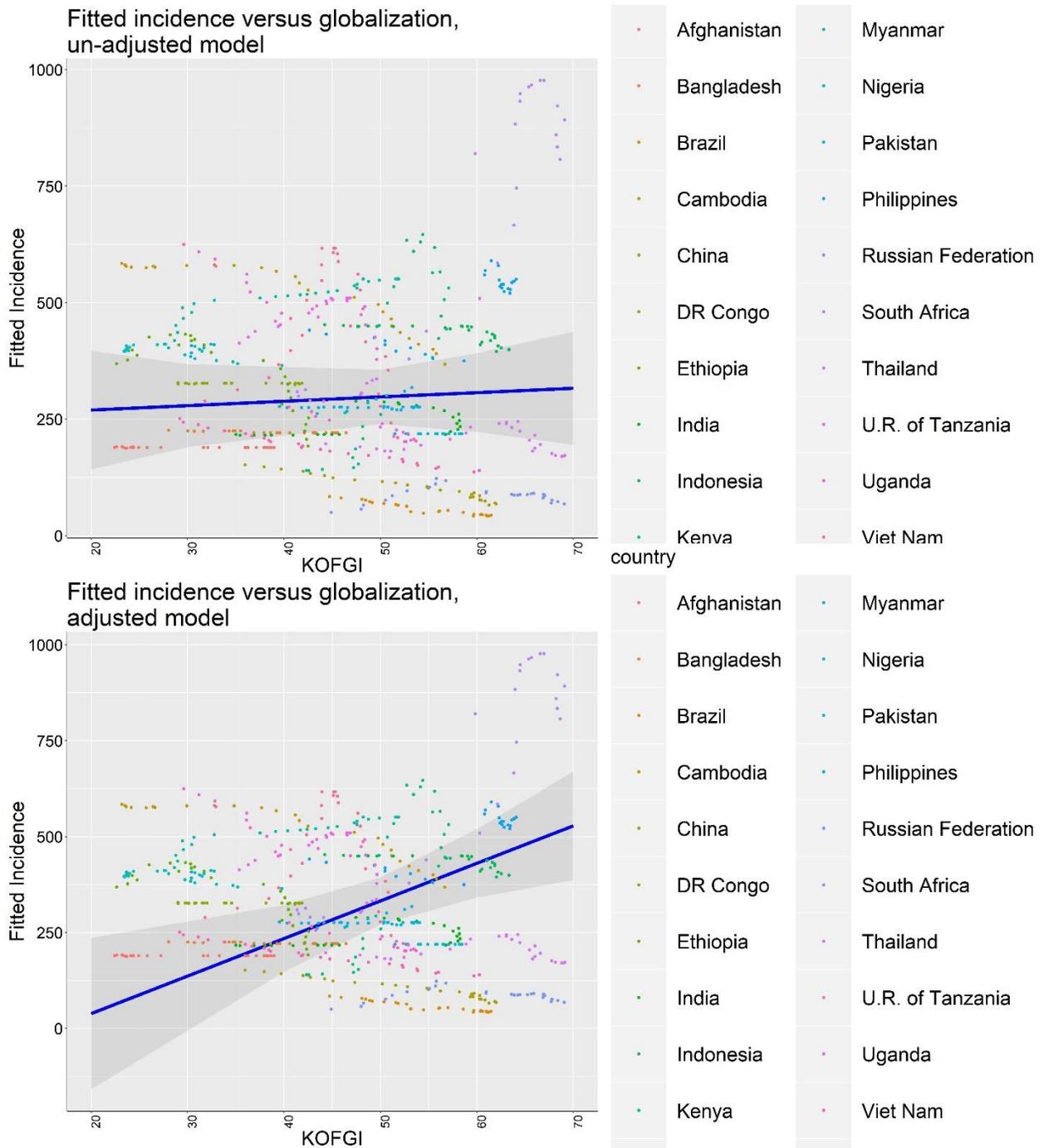


Figure 2.7: Fitted adjusted and unadjusted model

Table 2.1: Summary, definitions and sources of study variables

Concept	Variable	Definition	Source	Date Accessed
TB incidence	TB incidence (all forms), per 100 000	<i>The number of new and relapse cases of TB (all forms) occurring in a given year. Relapse cases are defined as a new episode of TB in people who have had TB in the past and for whom there was bacteriological confirmation of cure and/or documentation that treatment was completed.</i>	WHO global TB database.	March 2016 & November 2017
Globalization	KOF Globalization index	<i>A composite index that reflects the extent of economic, social and political dimensions of globalization of a series of countries over a long-term period.</i>	KOF Swiss Economic Institute	November 2018
Economic strength	GDP per capita, PPP (current international \$)	<i>GDP per capita based on purchasing power parity (PPP) is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current international dollars based on the 2011 ICP round.</i>	World Bank WDI Database/World Bank, International Comparison Program database.	November 2017
External resources for health	External resources for health (% of total expenditure on health)	<i>Funds or services in kind that are provided by entities not part of the country in question. The resources may come from international organizations, other countries through bilateral arrangements, or foreign non-governmental organizations. These resources are part of total health expenditure.</i>	WHO Global Health Expenditure database (see http://apps.who.int/nha/database for the most recent updates).	November 2017

Human development	Human Development Index (HDI)	<i>HDI is a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living. The HDI is the geometric mean of normalized indices for each of the three dimensions. The health dimension is assessed by life expectancy at birth, the education dimension is measured by mean of years of schooling for adults aged 25 years and more and expected years of schooling for children of school entering age. The standard of living dimension is measured by gross national income per capita.</i>	United Nations Development Programme: http://hdr.undp.org/en/data	November 2017
Private health expenditure	Health expenditure, private (% of GDP)	<i>Private health expenditure includes direct household (out-of-pocket) spending, private insurance, charitable donations, and direct service payments by private corporations.</i>	WHO Global Health Expenditure database (see http://apps.who.int/nha/database for the most recent updates).	November 2017
Public health expenditure	Health expenditure, public (% of total health expenditure)	<i>Public health expenditure consists of recurrent and capital spending from government (central and local) budgets, external borrowings and grants (including donations from international agencies and nongovernmental organizations), and social (or compulsory) health insurance funds.</i>	WHO Global Health Expenditure database (see http://apps.who.int/nha/database for the most recent updates).	November 2017
Total health expenditure	Health expenditure total (% of GDP)	<i>Total health expenditure is the sum of public and private health expenditure. It covers the provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health but does not include provision of water and sanitation.</i>	World Bank WDI Database	November 2017
Urbanization	Urban population growth (annual %)	<i>Urban population refers to people living in urban areas as defined by national statistical offices. It is calculated using World Bank population estimates and urban ratios from the United Nations World Urbanization Prospects.</i>	World Bank staff estimates based on the United Nations Population Division's World Urbanization Prospects.	November 2017

HIV

HIV prevalence

Prevalence of HIV refers to the percentage of people ages 15-49 who are infected with HIV.

UNAIDS estimates.

November
2017

Table 2.2: Proportion of missing data, missing patterns and manipulations

Variables	Missing observations (n)	Total observations (N)	% missing	Variable category	Missing pattern for country & year (before manipulation)	Manipulations
TB incidence	0	594	0	Outcome	NA	None
Globalization	22	594	3.7	Explanatory	ALL: 2016	None
Economic strength	15	594	2.53	Confounder	AFG: 1990-2001; CAM: 1990-1992	None
External resources for health	190	594	31.99	Confounder	ALL: 1990-94, 2015-16; AFG: 1995-2002; ZIM: 1995-2010 & 2012; RUS: 2007-14; UGA: 2014	None
HDI	45	594	7.6	Confounder	ALL: 2016; ETH:1990-99; NIG: 1990-2002	None
Private health expenditure	166	594	27.95	Confounder	ALL: 1990-1994 & 2015-16; AFG: 1995-2001; ZIM: 1995-1999	None
Total health expenditure	166	594	27.95	Confounder	ALL: 1990-1994 & 2015&2016; AFG:1995-2001; ZIM: 1995-99	None
Public health expenditure	166	594	27.95	Confounder	ALL: 1990-94, 2015-16; AFG: 1995-2001; ZIM: 1995-99	None
Urbanization	22	594	3.7	Confounder	ALL: 2016	None
HIV prevalence	27	594	4.55	Confounder	CHI:1990-2016	None

Table 2.3a: Summary result from the linear mixed effects regression analysis of TB incidence and globalization in the 22 HBC, 1990-2016 (incl. HIV as a confounder)

	Unadjusted (bivariate models)			Adjusted (multivariable model)			
	Beta coefficient (β)	Standard error	<i>p</i> -value	Beta coefficient (β)	Standard error	<i>p</i> -value	
Globalization	0.937	3.645	0.684	9.790	3.208	0.006	***
Economic strength	-0.018	0.018	0.325	0.006	0.002	0.001	***
HIV prevalence	16.886	9.015	0.092	22.280	3.470	0.000	***
Human Development Index	-408.090	245.760	0.115	1131.000	131.800	0.000	***
Total health expenditure	-18.372	6.691	0.011	-14.500	3.408	0.000	***
Urbanization	-42.000	28.820	0.161	4.782	4.902	0.330	

Legend: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 2.3b: Summary result from the linear mixed effects regression analysis of TB incidence and globalization in the 22 HBC, 1990-2016 (excl. HIV as a confounder)

	Unadjusted (bivariate models)			Adjusted (multivariable model)		
	Beta coefficient (β)	Standard error	<i>p</i> -value	Beta coefficient (β)	Standard error	<i>p</i> -value
Globalization	0.937	3.645	0.684	9.077	3.238	0.010 ***
Economic strength	-0.018	0.018	0.325	0.009	0.002	0.000 ***
Human Development Index	-408.09	245.76	0.115	-1378	123.4	0.000 ***
Total health expenditure	-18.372	6.691	0.011 **	-13.65	3.463	0.000 ***
Urbanization	-42	28.82	0.161	1.952	4.922	0.692

Legend: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Chapter 3: Perception of health system and social factors influencing tuberculosis: how does this mesh with policy initiatives?

3.1 Introduction

TB remains among the top ten causes of death worldwide, killing about 1.8 million people each year (World Health Organization, 2017a), despite being a preventable and curable condition. Even though there have been reductions in morbidity and mortality, globally and particularly in South Africa in recent years, these achievements have been slower than expected (Lönnroth et al., 2009; Rasanathan et al., 2011). Rates in South Africa remain exceptionally high. In 2016, South Africa reported an incidence of 781 cases per 100,000 population, and mortality rate of 101 per 100,000 (World Health Organization, 2017b). These data prompt the need for researchers and other stakeholders to re-examine current approaches to tackling the epidemic.

Historically, the South African TB programme has mainly focused on traditional curative approaches, with particular attention to investment in more modern rapid diagnostic tests for drug susceptible and drug resistant TB such as the GeneXpert test (Knight et al., 2015). Efforts have also been geared towards the development of new treatments for multi-drug resistant (MDR) and extremely drug resistant (XDR) TB. Others include: primary healthcare re-engineering and the adoption of efficient models of community based treatments (Wood, Lawn, Johnstone-Robertson, & Bekker, 2011). Although these approaches have had some success in reducing TB mortality, the high burden of this disease persists in South Africa, despite its almost elimination in many other comparable middle-income countries. Attention to upstream forces on TB is largely ignored in most TB policy discussions. A recent article detailing evidence-

informed policy-making of a South African TB think tank (White et al., 2018) did not even consider these factors.

It is widely agreed that TB rates reflect the economic and socio-cultural conditions within a country, as well as other macro-level or structural determinants of health (Lönnroth et al., 2009; Prats-Uribe, Orcau, Millet, & Caylà, 2019; Rasanathan et al., 2011). Recognizing that no evidence base of recognized macro-level indicators exist at a subnational level to enable analysis of trends and relationships, this qualitative study was conducted to investigate perceptions of macro-level drivers of TB among South Africa's experts, and to ascertain how these are being addressed in the South African *National Strategic Plan (NSP) for HIV, TB and STIs 2017-2022* (South African National AIDS Council (SANAC), 2017).

Specifically, this sub-study aimed to ascertain the extent to which the perspectives of key experts, managers and stakeholders in this area are indeed reflected in the policy guiding their work. The premise is that discordance between stakeholders' perspectives and policy directions may point out gaps and suggest the need for further policy considerations.

3.2 Methods

3.2.1 Design

Twenty-three (23) potential key informants (KI) were purposively identified based on their knowledge, expertise and role in developing and/or implementing TB-related policies in the South African context. They were sent letters requesting their participation in the study. Of the 23 potential participants, 20 agreed to participate. Fifteen semi-structured interviews were conducted in person, four by telephone and one by Skype, with interview questions provided to the participants in advance. Interviews lasted between 40 and 90 minutes. Questionnaire items

were aimed at eliciting the key informants' perception of the structural forces that drive TB infection in the general population. See Appendix D for the interview guide.

3.2.2 Participants

The key informants were recruited from five major categories of expertise: 1) provincial and national government officials with a TB related portfolio; 2) academic experts in the field of public health or occupational health; 3) professional bodies/non-governmental organizations; 4) TB hospital head; and 5) a legislator. These were professionals who have a good understanding of the epidemiology of TB and the issues around it. Table 3.1 contains demographic information of the KIs.

3.2.3 Data analysis

All interviews were audio recorded, transcribed by hand and exported into NVivo 11 (*NVivo qualitative data analysis Software, 2015*) for analysis, following standard informed consent procedures to ensure confidentiality for respondents. Each transcript was read several times and *a priori* coding was conducted on the transcripts using predetermined themes that were developed from the objectives of the study. Recognizing the limitations of *a priori* codes, emergent codes were also identified within each interview and aggregated into categories. To ensure credibility, inter-coder agreement and internal validity, a secondary data analyst recoded the raw transcript data to seek agreement on coding.

In South Africa, five-year National Strategic Plans (NSPs) are drafted periodically to coordinate and direct national efforts in the prevention, treatment, management and control of HIV, TB and STIs (Sexually Transmitted Infections). Like the previous NSPs, the purpose of the current NSP is to provide a common roadmap for all the stakeholders working in HIV, TB and

STIs. After completion of the analysis of the interviews, the current South African NSP for HIV, TB and STIs was then analyzed to determine the extent to which the themes identified by the KIs were reflected both in the focus areas and goals of the NSP. For the purposes of this study, I focused on sections of the NSP that deal with TB.

3.3 Results

3.3.1 Interview Themes

The perceptions of key informants reflected eight major themes, namely: colonization, the political and economic system; the mines and migrant labor system; racial and economic inequality; infrastructural challenges; health system challenges; treatment related factors; the HIV epidemic, and socio-cultural factors. The text is presented with quotes from the respondents or key informants to highlight the main points.

3.3.1.1 Colonization, political and economic system

Historical events and the current socio-economic environment were cited as instrumental in driving the TB epidemic in South Africa. Four KIs identified European miners as the source of the epidemic. According to their account, the native Black Africans lacked immunity to TB because they had never been previously exposed to the disease. A KI further blamed the epidemic on the impact of colonialism:

“let me tell you what the major contributor of TB in South Africa is. TB is foreign in Southern Africa. It is from the northern hemisphere. South Africa had the highest number of White people and therefore the highest dose of TB.” (N4).

This point was further supported by the situation in the Western Cape where a relatively well-off province with a comparatively better health system has ironically one of the highest TB disease burdens in the country. The KI who made this argument explained:

“The Western Cape has one of the highest rates of TB in South Africa, historically and it is because people will move from Europe when TB was not curable [and] will come to South Africa, it was a sanatorium for TB. Western Cape has the second highest GDP after Gauteng province but the rates there (Western Cape) are highest, and I believe it is because of the high number of people who went there 200 years ago.” (N4).

Some KIs asserted that the political system of South Africa made it conducive for TB to thrive especially in the Black communities because the political system segregated Black people into poor living conditions, which increased transmission.

3.3.1.2 The mines and migrant labour system

Several KIs indeed noted that migratory patterns significantly affect the TB epidemic in South Africa. They explained that the migrant labour system (where miners go back and forth between their communities and mining areas) was a major contributor to the spread of TB. KIs expressing this perspective noted that the mining sector causes their workers to congregate in stuffy settings where there is little ventilation, thus exposing miners to infectious diseases such as silicosis and TB.

Although migration (both internal and external) was cited as a contributing factor, the direction of impact was noted to be multidirectional because of the large number of miners from neighbouring countries that go to work in South African mines. Whereas many KIs talked about migrants bringing TB into the country, one KI observed that: *“We are known as a country that*

exports HIV and TB to labour serving countries like Swaziland, Mozambique, Lesotho and to some extent, Zambia and others because mine workers come to SA as migrant workers, get TB in the mines, go home to their wives and families.” (G8).

3.3.1.3 Racial/economic inequality, poverty & malnutrition

Racial and health related socio-economic inequality in South Africa was cited as a driving factor in the TB epidemic in South Africa. A government official noted:

“[The health system] is deeply an unequal one. There is deprioritization particularly of public health services divided along racial lines. If you look at the percentage of GDP expenditure on health as a whole, it is about 8.5 percent, but 4.4 percent is in the private sector and only 4.1 percent in the public sector. You have a broken, fragmented health system because of the deprioritization of public health services in the past. If you look at the spatial distribution particularly high-density areas, people are divided along racial lines.” (L1).

The structural inequality created by the apartheid system, and which continues to exist in the country, was further emphasized by a key informant as follows:

“Socioeconomic issues like poverty, unemployment, overcrowding, poor housing are the traditional structural drivers which have been there because of Apartheid which have now perpetuated in the post-Apartheid settings. We have Apartheid special developments so Black people only stay in Alexandra¹, White people would never stay in such situations. So, you have traditional structural inequalities that have been engineered because of the previous Apartheid system which has been perpetuated in the new

¹ Alexandra is one of the poorest urban areas in South Africa, located in the Gauteng province.

democracy. Some of the public services to get people out of the vulnerability as a result of this structural drivers have to be incremental.” (G8).

Almost every KI (17 out of the 20) noted that TB is driven by poverty, drawing attention to the fact that TB is often referred to as a disease of the poor. Poverty leads to poor nutrition, which reduces the immune response to infections including TB. An academic expert pointed out that *“a lot of people don’t have the finances to go to [health] facilities. There are competing challenges; if you want to put food on the table or go to the clinic.” (A3).*

Another official also explained that:

“People in poverty [acquire TB] in the sense that they would not have the right nutrition status that would prevent them from getting diseases or the immune system they require, or they would find themselves in environment that do not protect them from respiratory conditions.” (A4).

3.3.1.4 Density, shelter, infrastructure

Poor shelter compels people to share spaces with poor ventilation. Overcrowded areas prevent free air circulation and increase TB transmission, constituting what most KIs expressed to be one of the most important environmental drivers of TB. Key informants also expressed that the government had an important role to play in addressing this. A KI explained in the following quote:

“In terms of environmental factors, I don’t think our government [agencies] talk to each other or talk about it. In terms of housing, we are building all these RDP [Reconstruction and Development Programme] houses. Nobody is paying attention to ventilation. We still

have a lot of overcrowding in informal settlements where rate of transmission is high.”
(A3).

3.3.1.5 Health system challenges

Many KIs noted that the South African healthcare system suffers from many systemic challenges which cause TB to thrive. Understaffing in health facilities, mismanagement, lack of funds, noncompliance with basic infection control and poor TB surveillance were some of the health system factors pointed out by the KIs. A government official who acknowledged poor infection control practices as a driver of the TB epidemic explained that:

“when we do our inspections, we find gross noncompliance with basic infection control, basic things that are needed like PPE [personal protective equipment] and this is because the employer does not provide resources. There is no permanently appointed person looking after infection control in some of the institutions.” (G7).

Patient non-disclosure of TB status to HCWs was also cited by a KI. A healthcare worker who was once a victim of nosocomial TB transmission noted that *“the patients don’t always honestly tell us they have TB. I was working in a private dialysis unit. I knew of HIV status but not TB.”* (N1).

Resource allocation was also often mentioned as a health system factor that impacts the healthcare system’s ability to combat TB. Many KIs explained that the public sector which serves the majority of the population, is not adequately resourced. Infection control in health facilities is therefore affected by this shortage of resources. A KI explained that *“in South Africa, we didn't have a huge response [to the TB epidemic] so I don't believe the public system has*

been adequately funded.” (N4). Many key informants also noted that the health sector in general, was inadequately staffed.

Opinions on access to treatment were mixed. Every KI noted that TB treatment was provided free of charge in South Africa, which suggests that the government is trying to address the TB crisis. However, some KIs drew attention to the fact that other related costs like transportation limited access; therefore, the efforts of the government to respond to the increased burden of TB were mitigated by the aforementioned challenge. But a hospital head disagreed that transportation cost was a barrier explaining that:

“the only slight factor might be two things: transport might be one. But even that it shouldn't be a problem because we offer transport to our patients to our facility and from our facility to the community. So, although I say transport, it should be limited. The other thing is the issue of the socioeconomic thing...you need to take the medicine with food and if there is no food then there is a problem”. (H1).

An academic expert pointed out that *“in this country, there are no barriers [to TB treatment], yours is to be willing to go for treatment. Where there is a barrier, I would say is we are not pampering our patients enough.”* (A2). This KI compared HIV care to TB care in the following quotation:

“It might sound strange to you but in this country people on HIV treatment are really pampered. Until recently they were so pampered. They will do all the counselling, the pretest counselling, post-test counselling, counselling for treatment etc. You go through a lot of steps to make them feel everything will be all right for them because the focus is on adherence. But we've never had time for TB. Because if you do it for HIV why not TB because it is the same person who has both TB and HIV? Access to drugs itself is not a

problem, it is people's willingness to take the treatment". [A2].

A representative of an NGO also emphasized that *"there are barriers to accessing treatment. We don't bother to counsel patients for TB treatment. [Also] we do not have TB treatment in the private sector."* (N3).

Defaulting on treatment was repeatedly identified as a reason why South Africa continued to be burdened by TB and the rise of drug resistant strains. Having a high default rate means there will always be an infectious pool. A key informant explained that:

"You find that there is high transmission in communities mainly because people come in late. They ignore the cough. By the time you find the person, it is an advanced disease that has been transmitted and now we must go and find the other people who are out there. It ends up being a vicious cycle because even those that we find and treat, they go back to the same environment". (G6).

This KI further explained that infected people who have medical insurance are usually captured within the healthcare system but *"those without medical aid especially are lost to tracing. Others simply don't trust the care at the [public]clinics and would go to their own doctors[private]."* (G6).

A KI who had been cured of MDR TB cited the side effects of TB medications as a barrier to treatment adherence. The respondent explained:

"It's hard to take the medication; the side effects of the drug. You go through the day awful and you go to bed and can't sleep. I couldn't drive because of joint pain. The second reason is it a long-term treatment. Also, the drugs cause terrible depression. I was on treatment for 17 months because my joint shoulder ceased completely. Can't hear very well". (N1).

In refuting allegations of reported shortage of medications, a government official explained that

“[There is] no stock out. If there is stock out, it will be supplier problem nationally. For the past 2 cycles (4 years) we haven’t had any stock out. There may be stock out in a clinic if they did not order on time, but the patient can always have treatment. They won’t turn a patient away.” (G6).

The lack of investment in new drugs also came up in the interviews. A key informant explained:

“So, you have a major epidemic, you have essentially an old regimen which hasn’t changed in 50 years, you have pressure to produce resistance and the spread of resistance in communities”. (G8).

3.3.1.6 The HIV epidemic

The contribution of HIV as a driver of TB was widely stressed by the KIs. Almost every KI noted that the HIV epidemic reversed any medical or health system gains made in the management of TB, especially around the time when South Africa’s political system was improving (post-1994). The rates of co-infection of TB and HIV have been very high. A KI explained: *“You could say that for the last two decades the high TB rates have been driven by HIV. Rates were still high prior to this period though.”* (A1).

Another KI explained that *“there was TB for a long time and then when the political system was changing or getting better, the HIV epidemic made it worse.”* (G6).

3.3.1.7 Socio-cultural factors

TB infection is associated with many socio-cultural factors including masculinity, stigma, HCW attitude and poor risk perception. Masculinity was blamed for driving TB among men. Per this account, men often delayed seeking care until their condition became very serious. A KI

explained that the people at risk of TB are migrant workers, including those who work in the mines, agriculture, construction and other industries where men are the majority. A government official explained: *it is just a masculinity issue. So, to the African man, the clinic is for the women and children. Men don't go to the clinic.*" (G8).

The existence of stigma continues to heighten TB in South Africa. There is a profound stigma associated with TB because of its association with poverty and with HIV/AIDS. Because HIV is highly stigmatized, its association with TB makes TB a candidate for stigmatization. Key informants explained that this stigma prevents self-disclosure and care seeking behaviour. A key informant explained that:

"[there is] still delay in patients seeking treatment. One of those reasons is there is still a stigma. No one wants to be diagnosed of TB. That might be a reason why there is a delay. If you are employed, you don't know how that might affect your employment and you don't want to be unemployed." (H1).

A KI who had been cured of TB disease in the past recounted: *"...the stigma...I had TB and acquired treatment, and no one knew about it because I was ashamed."* (G2).

Risk perception was also cited as a major social determinant of the TB epidemic in South Africa. It was mentioned that people were not intensely concerned about the risks and impacts of TB as they were for other conditions such as HIV. A KI asserted that: *"People are aware of HIV not TB. Half may know. Majority will care less. It has never been in the public domain."* (A2).

Patients' attitude towards the wearing of personal protective equipment also impacts their risk of infection. An academic expert explained that: *"researchers, including myself at one point wanted to interview TB patients. A patient will not be willing to talk to me if I am wearing N95."*

They will think...is something wrong with me.” (A3). This was the patient’s response to health care workers wearing PPE.

An official also reiterated that although patients do not have to pay any fees at the clinic, some people prefer hospitals where marginal fees may be charged. It was explained that those patients believe the services in the clinics are sub-standard compared to those offered in hospitals. *“They [the patients] don’t believe so much in clinics”* (G6), the official explained.

3.3.2 Review of the NSP for HIV, TB and STIs 2017-2022

The current South African NSP sets out eight goals accompanied by specific objectives and interventions for the achievement of these goals. A key feature of the NSP is a strong focus on HIV prevention among adolescent girls and young women. Table 3.2 contains the eight goals of the current NSP, corresponding focused areas of intervention, the scale of focus and the concurrent themes from the interview responses.

The NSP hopes to reduce TB incidence by at least 30 percent. This would reduce the incidence from 834 cases per 100 000 population in 2015 to less than 584 cases per 100 000 by 2022. The NSP identifies high impact TB interventions as those that include social and behaviour change among healthcare professionals communicating important information to the community about the TB transmission. Other interventions include contact tracing of TB patients and provision of preventive therapy to all people living with HIV who have close contacts with TB patients. The Plan also calls for the following system-level changes: integration of HIV, TB and STI (Sexually Transmitted Infection) interventions and services, stronger procurement and supply chain systems and sufficient, appropriately trained human resources (South African National AIDS Council (SANAC), 2017).

The three key interventions identified by the NSP for reducing TB infection include:

1. Exhaustive tracing of close contacts of patients undergoing TB treatment.
2. The provision of preventive doses of TB medication to contacts and to all people living with HIV, as per protocol.
3. The stronger application of infection control measures in places where TB is likely to spread, including health facilities, correctional facilities, other crowded residential settings, and homes of TB patients. (South African National Aids Council [SANAC], 2017).

Of the eight goals set out in the NSP, goal #4 four specifically talks about the social and structural drivers of TB. According to the Plan, this “goal responds to the reality that the health of individuals is shaped by economic, social and environmental factors, such as poverty, gender discrimination, substance and alcohol use, and poor housing”. Specific objectives of this goal include: scaling up access to social protection for people at risk of and living with HIV and TB in priority districts, implementation of economic development programmes for youth in priority areas, addressing barriers to prevention and treatment that arise from the design and construction of public housing etc. (South African National Aids Council [SANAC], 2017). Despite a seemingly strong structural approach, the NSP’s projected cost estimates does not reflect this commitment. Goal number 4 which specifically addresses the structural drivers has a significantly lower budgetary allocation compared to the other meso and micro level focused goals (Figure 3.1).

3.4 Discussion

As a social disease, experts and researchers largely agree on TB's systemic underpinnings. Karim and colleagues assert that the social, economic and environmental conditions that were created as a result of the Apartheid system favoured the growth and transmission of TB (Karim, Churchyard, Abdool Karim, & Lawn, 2009). Weyer and colleagues identified the legacy of neglect of the disease, its poor management and the fragmented health services as three main drivers of the TB epidemic in South Africa (Weyer, Fourie, & Nardell, 1999). Other barriers to effective TB control in South Africa have been identified as the HIV epidemic, poor socioeconomic conditions and the shortage of human resources for health (Karin Weyer, 2007). These assertions were consistent with the views of the key informants.

Many of the key informants had similar views regarding the origin of TB in South Africa. This consensus parallels the *virgin soil theory* which posits that TB was introduced by contact with Europeans (Packard, 1989a, 1989b). Some KIs recounted this historical event as important in the discussion around the drivers of the South African TB epidemic. Although considerable practical evidence supports this position which gained prominence in the early 1900s (McVicar, 1908), one needs to be mindful of interests served by the propagation of this narrative. As Packard notes, this narrative has been used as "...a means of deflecting attention from the appalling conditions under which Africans lived and worked" (Packard, 1989c, p.32). The poor living and working conditions were largely driven by the industrial expansion, particularly in the mining sector from the late 1800s to the early 1900s.

The inextricable link between TB and mining which has received a lot of attention in the literature (Dharmadhikari et al., 2013; Girdler-Brown et al., 2008; Stuckler et al., 2011, 2013) was highlighted by the KIs of this study. There seemed to be a consensus that the mining

industry is a significant driver of the epidemic. Indeed, only few TB experts would disagree with the mining industry's enduring reputation of poor working conditions. Although KIs largely agreed that the risk of TB infection may be high among miners, many also concurred that the mining companies provide better occupational health services, including TB treatment, to miners compared to what the general population receives. The problem therefore, centres on the health of ex-miners and contract workers whose compensation provision is often fraught with challenges (Ehrlich, 2012; Ehrlich & Rees, 2016). As a step in addressing this issue, on 19 March 2014, the Council of the South African Chamber of Mines approved a standard that, "*the management and treatment of TB for long-term contractors should be similar to that of permanent employees. Companies should review their protocols to ensure full implementation of the position/standard by the end of 2014.*" (Balfour-Kaipa, personal communication, October 17, 2016). There is also a major Global Fund initiative underway to combat TB in this sector (The World Bank, 2016).

Racial and economic inequality was the major theme from the interview that was not explicitly addressed in the NSP. As a social disease, TB is highly sensitive to structural violence (Farmer et al., 2006). With South Africa's overall state of economic development, the country should not be burdened by TB at this rate but for its massive income and health related inequalities (Ataguba et al., 2011; Nattrass & Seekings, 2001), the disease persists. Income inequality has worsened over the years with South Africa's Gini coefficient increasing from 0.59 in 1993 to 0.63 in 2011. About half of the population (53.8%) live below the national poverty line (The World Bank, 2017). In addition, the chronically underfunded public sector which serves about 84% of the population, is staffed by only 30 percent of doctors in the country (Mayosi & Benatar, 2014). In fact this persistent structural violence (Farmer et al., 2006) might

explain South Africa's poor health outcomes in the post-Apartheid era despite considerable evidence of economic growth (Coovadia, Jewkes, Barron, Sanders, & McIntyre, 2009; Mayosi & Benatar, 2014).

It was agreed that TB largely affects the poor and/or marginalized in society, a sub-population that also receives a lot of attention in the NSP. Interestingly, the point about socioeconomic status and the mining sector accounting for TB is weakened by the case of the Western Cape Province. The Western Cape Province is a relatively well-off province with comparatively better health services, yet this province has one of the highest TB rates in the country even in the pre-HIV era. It should also be noted that there are no mines in this region, assuming the hypothesis that mining drives TB (Stuckler et al., 2013) was valid. Reasons for this paradox are inconclusive; they are speculative at best. One hypothesis is the high rate of migration of foreign farm workers from other areas to this area. A more plausible explanation for this could be the huge economic inequality in this area despite its overall wealth. It is important that future NSPs take a jab at addressing this inequality, not only in this region but the country as a whole.

One key goal of the End TB strategy is a zero catastrophic cost for patients and families due to TB (World Health Organization, 2016). This shows that the socioeconomic needs of those patients and their families need to be appropriately addressed in order to reduce the high rates of infections. One of the socio-economic barriers is access and affordability of transportation to get to the facilities; some patients report late at health facilities because they do not have the money for transportation. Although some facilities provide transportation for patients, as articulated by a hospital head, this is still a major barrier for accessing TB care for many. Therefore, patient cost surveys need to be conducted to understand the financial needs of patients as it pertains to their

healthcare. Additionally, we need a more comprehensive understanding of the barriers that patients face beyond mere conjecture. Even though we lack a comprehensive view of all the barriers that prevent access to TB treatment, we do know that socioeconomic deprivation, poor housing, overcrowding, and malnutrition continue to drive the epidemic in South Africa.

If the battle against TB will be won, the many health system challenges confronting the South African health sector need to be tackled. Currently, treatment for TB is not offered by the private sector. It was suggested treatment be extended to the private sector to give more people access. In the post-HIV era, HIV is arguably the significant driver of TB in SA. It is estimated that people living with HIV have between 16 and 27 times the risk of developing TB than non-HIV patients (World Health Organization, n.d.). This fact proves that the war on TB cannot be won without addressing HIV/AIDS. Considering this, the NSP is evidently more focused on HIV/AIDS than TB and other STIs.

Many sociocultural factors continue to drive the TB epidemic in South Africa. The impact of stigma on TB-related care was well highlighted in the results of this study and confirmed the findings of several studies (Courtwright & Turner, 2010; Cremers et al., 2015; Edginton, Sekatane, & Goldstein, 2002). The problem however as noted by one official is the difficulty in measuring this construct accurately to know the extent to which it is a barrier.

Globally, the WHO End TB Strategy aims to reduce the mortality and morbidity of TB by 90 to 95 percent respectively (Lönnroth & Raviglione, 2016; Uplekar et al., 2015). The South African NSP for HIV, TB and STIs 2017-2022 also aims to reduce TB incidence (including HIV+ TB) from 450, 000 to 315, 000 by the year 2022 (South African National AIDS Council (SANAC), 2017). To meet these ambitious goals, the conditions that enable TB to thrive need to be effectively addressed. However, addressing these cannot be done without a firm financial

commitment. Researchers have previously argued that attention to these drivers has been downplayed, as evidenced in the curative nature of the South African TB programme as opposed to an emphasis on prevention (Wood et al., 2011).

This sub-study focused on how upstream and systemic factors are perceived by stakeholders to drive TB incidence, and how the South African NSP, the current policy instrument guiding TB prevention, management and control in the country, responds to these influential factors. Not surprisingly, there was strong concordance between the accounts of the KIs and the discourse in the NSP, spanning the political, socio-economic to health system and treatment-related factors.

Interviewees identified funding as a major issue in the fight against TB. There have been calls for increased funding. However, it can be observed that although the NSP appears to prioritize structural or macro-level approach, its projected cost estimates show otherwise. Of the eight goals, goal number 4 which specifically addresses the structural drivers has a significantly lower budget compared to goal number 2 which contains the most curative elements (Figure 3.1). This shows that South Africa's approach is still heavily built on case management of TB although the results from this approach have been less than desired (Wood et al., 2011).

Overall the NSP recommends multi-sector interventions and indeed the eight goals of the NSP have macro-level elements as shown in Table 3.2. This is laudable and consistent with its focus of prioritizing prevention.

3.5 Conclusion

Strategies that focus solely on effective case management of TB have not yielded the desired results; thus, it is somewhat disconcerting that investment in newer treatment and

technologies to meet national targets continue to by far outstrip funding allotment to address macro-level drivers of TB. Indeed, the healthcare system has been unable to control the epidemic through the medical treatment model alone. Even though there appears to be a shift in direction per the current policy prescriptions, funding allocation and other tangible commitments need to demonstrate this. Despite some progress, TB mortality is still very high in South Africa, suggesting the need for a rethinking of current approaches to tackling this deadly but preventable and curable disease.

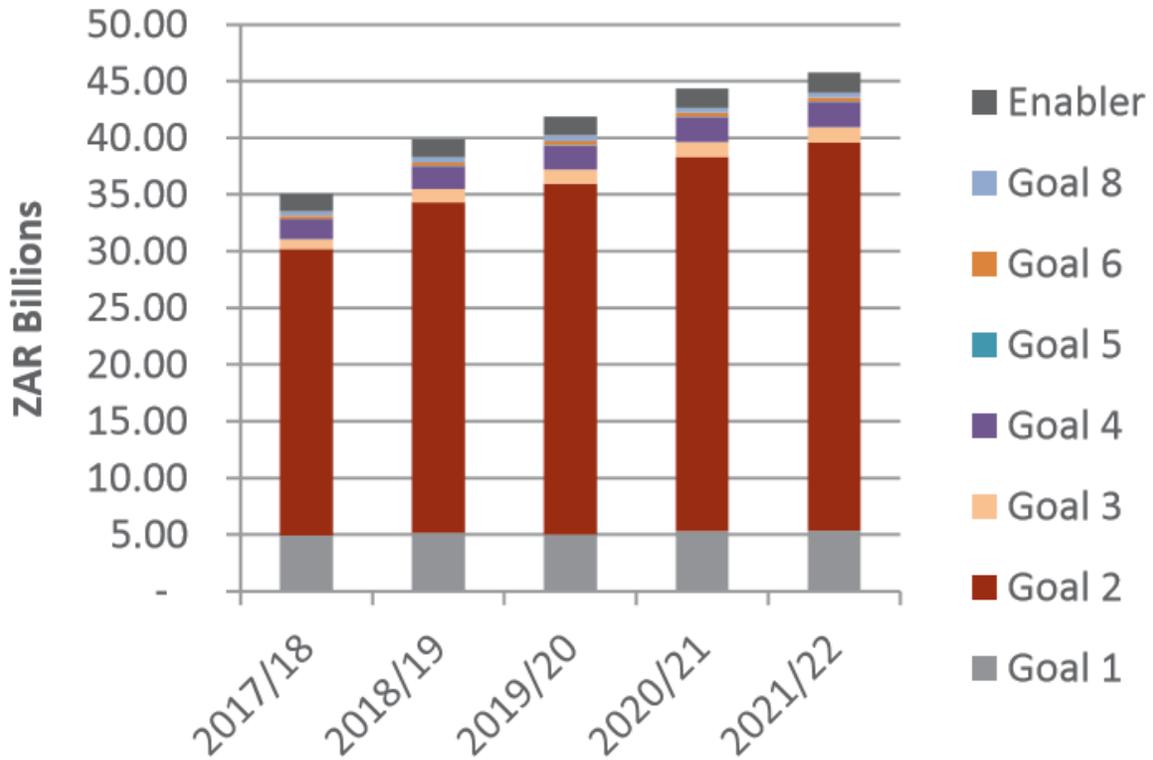


Figure 3.1: Total annual cost estimates by NSP Goal-2017/18 – 2021/22 (R billions). Reprinted from “National Strategic Plan on HIV, STIs and TB 2017–2022” by South African National AIDS Council (SANAC), 2017. Copyright 2017 by South African National AIDS Council.

Table 3. 1 Key informants' demographic information (identifying information has been removed to protect KIs' anonymity)

Reference	KI Category	Designation	Mode of Interview
G1	Provincial and national government authorities	Senior level manager in charge of occupational hygiene in a provincial health department	In person
G2		Mid-level manager in charge of occupational hygiene in a provincial health department	In person
G3		Mid-level manager in charge of occupational hygiene in a provincial health department	In person
G4		Mid-level manager in charge of occupational hygiene in a provincial health department	In person
G5		Senior level manager in charge wellness program in a provincial health department	In person
G6		Senior manager in charge of TB, national department of health	In person
G7		Senior manager in charge of hygiene and health, national labour department	In person
G8		Senior manager, national department of public service	In person
G9		Senior manager, national institute of occupational health	In person
G10		Occupational medicine specialist of a national institute	In person
A1	Academic experts	Professor emeritus of occupational medicine	Skype
A2		Professor in occupational health in a public university	In person
A3		Professor in a public university	In person
A4		Professor in a public university	In person
N1	Occupational TB Advocacy Group	Survivor of MDR TB and TB advocate/former HCW	Telephone
N2		Survivor of MDR TB and TB advocate/HCW	Telephone
N3		NGO official	
N4		Professional group official	
H1	Hospital heads	Head of a large TB referral hospital	In person
L1	Health Legislator/Politician	Legislator	Telephone

Table 3.2: Summary of the NSP 2017-2022 and concurrent themes from interviews responses

The goals of NSP 2017 - 2022	Focus areas of intervention	Scale of focus	Concurrent themes from interview responses
#1: Accelerate prevention in order to reduce new HIV and TB infections and new STIs. – Breaking the cycle of transmission	Biomedical preventive methods; sex education and environmental intervention for TB infection control	Micro, Meso, Macro level	The HIV epidemic
#2: Reduce morbidity and mortality by providing treatment, care and adherence support for all. – Reaching 90-90-90 in every district	Treatment	Meso, Macro	Treatment related factors
#3: Reach all key and vulnerable populations with customised and targeted interventions. – Nobody left behind	Barriers of access to HIV, TB and STI treatment & prevention programmes by vulnerable populations	Macro	The mines and migrant labor system
#4: Address the social and structural drivers of HIV, TB and STIs, and link these efforts to the NDP-multi-department, multisector approach	Social and Structural drivers of HIV, TB and STIs	Meso, Macro	Colonization, political and economic system; infrastructural challenges
#5: Ground the response to HIV, TB and STIs in human rights principles and approaches. – Equal treatment and social justice	Human rights and stigma reduction	Meso, Macro	Socio-cultural factors
#6: Promote leadership at all levels and shared accountability for a sustainable response to HIV, TB and STIs. – Mutual accountability	Diverse leadership	Macro	NA
#7: Mobilise resources and maximise efficiencies to support the achievement of NSP goals and ensure a sustainable response. – Spend now to save later	Increased funding	Macro	Health system challenges
#8: Strengthen strategic information to drive progress towards achievement of NSP goals – Data-driven action	Monitoring and evaluation	Micro, Meso, Macro level	NA

Chapter 4: Barriers to tuberculosis prevention and control among health workers: a qualitative study

4.1 Introduction

It is well documented that healthcare workers (HCWs), due to the nature of their work in providing care for patients with infectious diseases, are at increased risk of *Mycobacterium tuberculosis* (TB) (Cuhadaroglu, Erelel, Tabak, & Kilicaslan, 2002; Grobler et al., 2016; Joshi et al., 2006; Menzies et al., 2007; Tudor et al., 2014; Yassi, Adu, Nophale, & Zungu, 2016). South Africa has one of the worst HIV-TB epidemics in the world; and in high burden settings like South Africa, the risk of TB among HCWs ranges from two to fivefold compared to the general population (Joshi et al., 2006; Menzies et al., 2007; Naidoo & Jinabhai, 2006; Tudor et al., 2014; Yassi et al., 2016). Rates as high as 1, 133 per 100, 000 HCWs have been reported in the Kwazulu-Natal province, compared to an incidence of 497 per 100 000 among the general population in this area over the study period (Naidoo & Jinabhai, 2006).

Attending to the needs of HCWs - a workforce that is already in short supply - has been identified as a vital element in the strengthening of health systems (World Health Organization, 2006), particularly in LMICs where disease burden is greatest. TB transmission in the workplace has prompted the international dissemination of a number of guidelines aimed at TB infection prevention and control (IPC) and at improving HCWs' access to HIV and TB prevention, treatment, care and support services (Kisting, Wilburn, Protsiv, & Hsu, 2010; World Health Organization, 2010). Nevertheless, implementation of actions to prevent nosocomial transmission of TB has largely remained insufficient in LMICs including South Africa (Jones-

López & Ellner, 2005; Joshi et al., 2006). Accordingly, a fundamental question is: *why, given the many available guidelines, implementation remains inadequate in settings like South Africa?*

Similar to the method employed in Chapter 3, a qualitative approach with key informants was employed to identify underlying forces influencing occupationally-acquired TB among HCWs in SA. This method was also used to identify actions perceived to be needed at structural or systemic levels to enhance the capacities to prevent and control TB infection in the healthcare workforce

4.2 Methods

4.2.1 Conceptual framework

The question of TB transmission among HCWs is commonly addressed from the perspective of specific professional perspectives, for example, infection prevention and control (IPC), occupational health or clinical medicine (Ehrlich, Spiegel & Yassi, 2019). Within occupational health, an occupational hygiene approach tends to focus on a hazard in a particular work setting and the technical measures that can be used to prevent and control the risk. However, to answer this research question, I focus on *what processes influence the pursuit or non-pursuit* of widely recommended measures for managing this occupational health risk. In line with Figure 1.1 introduced in Chapter One to explain the organization of the research questions being examined in the dissertation, this chapter further examines the systemic forces that are perceived to influence actions to prevent and control TB transmission in the healthcare workplace. Noting that there is generally a bias towards perceiving proximal factors at the expense of more distal forces, sometimes characterized being “prisoners of the proximate”

(McMichael, 1999), this framework (Fig 1.1) provides a basis for considering how driving forces *influence* TB prevention and control.

4.2.2 Key informants

Semi-structured interviews were conducted with 18 KIs whose position at the time of the study entailed the care, prevention, control and/or management of occupational TB or were indirectly involved in TB prevention or policy. They included 10 government employees with responsibility for TB control, four academic experts, two TB advocacy group members, a legislator, and a hospital leader. All were presumed to have in-depth knowledge of occupationally acquired TB through their professional careers or activism. Table 4.1 gives key informants' basic demographic information, category of expertise, designation and mode of interview. All the interviews were conducted by the author of this dissertation.

Two main approaches were used to recruit participants for the study. First, purposive sampling was used to identify a minimum of 14 potential KIs prior to the interview. Then, subsequent recruitment was conducted using snowball sampling technique after a preliminary analysis of the gathered data. Participants were recruited until data saturation was reached. All key informants were sent letters of recruitment by e-mail (Appendix B) with details of the study and written consent forms (Appendix C).

Fifteen (15) semi structured interviews were conducted in person, two were conducted over the telephone and one via Skype. Participants were reminded before the interview that participation in the study was completely voluntary and that they could withdraw at any time. Interviews lasted 35-60 minutes. The interview guide was first pre-tested with two of the key informants and minor changes were made on the wording of two questions to improve clarity.

See Appendix #D for the interview guide. Interviews were audio recorded and transcribed verbatim.

4.2.3 Analysis

The Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist (Tong, Sainsbury, & Craig, 2007) guided the analysis and report of this sub-study. To consider potential influences on the implementation or non-implementation of protective practices, this sub study was conducted to address two major questions which were posed to the key informants: 1) what are the macro level barriers to implementation of effective occupational health and infection control programs?, and 2) what policies or practices could enhance the capacities to prevent and control TB infection among health workers?

The NVivo® Version 11 qualitative data management software (*NVivo qualitative data analysis Software*, 2015) was used to organize the data collected from the interviews. *A priori* themes were developed based on the objectives of the study. Recognizing the limitations of *a priori* codes or themes, emergent codes were identified within the transcribed data and aggregated into new categories. Where applicable, these categories were combined with the *a priori* themes. To ensure reliability of the findings, the themes were cross-checked with two other researchers. After each interview, the researcher (interviewer) repeated the responses (from the field notes) to the participant for the participant to correct or confirm any point.

To provide a coherent framework for analyzing the data, the WHO Health Systems Building Blocks (World Health Organization, 2007) was applied as a guiding framework (as illustrated in Table 4.2) in organizing the responses to the second question: *what policies or practices could enhance the capacities to prevent and control TB infection among health workers?*

The WHO building blocks framework considers six distinct but complementary dimensions: service delivery, health workforce, health information systems, access to essential medicines, financing and leadership & governance. The framework offers a useful conceptual guide for understanding the components of a health system herein applied in the prevention and control of occupational TB in HCWs.

4.3 Results

The themes from the study responses have been organized into two sections per the objectives or research questions of this sub-study: 1) drivers of nosocomial TB transmission and barriers to prevention and control, and 2) strategies for occupational TB prevention and control.

4.3.1 Perceived barriers to implementation

4.3.1.1 Downplaying the importance of occupational compared to community exposure in explaining TB in HCWs

The high TB burden in the South African general population was identified by key informants as a cause of skepticism about occupational causation and the need to focus more on the community. An academic expert was

“...very convinced that more than half of our HCWs acquire their TB from the community. It is good to look at the workplace factors, but you need to look beyond the workplace and think of the primary sources of community acquired sources of TB.” (A2).

A key informant also explained that *“there were two support staff who were diagnosed [with MDR TB] but they contracted it from the community; we found out that the source was not the hospital.” (H1).*

4.3.1.2 Lack of priority for occupational health and safety (OHS)

Key informants generally agreed that OHS was not prioritized in many health facilities in South Africa and that an important cause was lack of leadership in this area. Explaining that administrators and managers of health facilities do not prioritize the health of workers in general, a key informant pointed out that “*[there is] a shortage of resources and a lack of involvement of the CEOs because it [OHS] is not a priority.*” (A1).

Another academic expert was more explicit:

“Occupational health has been neglected right at the top [authorities in the Department of Health]. If there is an opportunity to save face for them, I think the National Institute of Occupational Health (NIOH), [a parastate agency with a service and research mandate] has been covering their backs for them, but I think it has been rendered useless or non-existent. There is nobody driving OH in the country. There is nothing happening at that level.” (A2).

Another key informant explained that:

“The biggest problem is nobody thinks it [OH] is important. I think the ministers; the policymakers are aware of workers’ health. We have IC (infection control) policy, but do not prioritize it. They are more focused on maternal health, HIV and others. Who cares for the health workers? Who cares for the people who care for patients? There’s very little that goes into caring for healthcare workers.” (A3).

The lack of prioritization of occupational health services for employees is reflected in the understaffing with respect to occupational medicine specialists in many health facilities (discussed also in a later section). An academic expert explained:

“When you go to the hospitals, you will find an occupational health practitioner. The biggest problem is they are not creating posts for occupational medicine specialist or clinicians with at least a diploma in occupational health in the district hospitals, to be able to provide a lot more than what is being provided.” (A3).

Recounting a meeting with a hospital chief executive officer (CEO), a government official explained:

“One CEO said to me, if we had to choose between an Intensive Care Unit (ICU) nurse and infection control nurse the CEO will take an ICU nurse. The public is more important than the HCW. Because there aren’t enough resources, they would rather channel resources to serving the public than those people assisting the public.” (G7).

Indeed, the prioritization of infection prevention and control (IPC) to protect patients, over OH measures to protect staff was also pointed out. This long-standing issue was articulated by a government official:

“Generally, the [health] organizations do not prioritize employee workplace services. When people talk about IC they think only of patient infection. So, they look at the patient side. They don’t focus on managing their human resources. Even if they manage their human resources, it may be the issue of resignation and people leaving but they don’t look at why people may be leaving. If it may be OHS issue that make people leave, it may be unknown.” (G6).

4.3.1.3 Governance of occupational health and safety (OHS)

The poor governance of OHS matters was mentioned as a major enabling factor for occupational TB transmission. It was explained that OHS governance usually falls under the

Human Resources (HR) department. It was explained that this creates problems because the HR officials do not have a clinical understanding or knowledge of HCWs' health issues.

When asked whether HCWs themselves had any influence on the governance of TB in the workplace, there were mixed perspectives, although most key informants contended that involvement from HCWs was minimal. According to an academic expert, those being served were until recently not involved in decisions regarding the systems which served them:

“...Traditionally in health, we are old guys in healthcare, we have never given space for patients to be involved in their care, these are newly-emerging areas. What has made it beautiful is the role of advocacy played by people living with HIV. They have become the agents, very instrumental in making patients have a role to play in their care. But we've never had that kind of opportunity for TB. Advocacy for TB has been down. Advocacy for TB used to be done by NGOs but those NGOs are inactive now or non-existent.” (A2).

Another key informant said *“they [HCWs] don't [get involved]. There are Health and Safety Committees (HSC), but from what I've seen this is an exercise in futility. The attention is on human resource development not on occupational health.” (A3).*

An advocacy group member stressed that:

“there is no direct access to the decision makers around TB implementation policy in South Africa. There is no open-door policy from the TB directorate at the national level and from previous interactions we've had, they have not been particularly receptive to advice from outside but as I said with our new Minister of Health, he's really taken the issue up and he's formed TB national consensus group and he's got a TB ambassadors program and has been very active in the space and has invited participation from the community represented by NGOs as well as academics. It shows that politicians if you

have the right ones with the open-mindedness, can be absolutely key in OH and IC in the health system.” (N2).

A government representative had a different opinion:

“HCWs are involved. The HCWs are having influence.... the HCW has been represented by the trade unions. So, the HCW has been at the core of the decision making in the policy development and compensation including the treatment”. (G8).

Key informant G8 however added that this involvement was not for preventative measures because:

“their concern come in very late when they are already infected and need to be compensated. The health worker is not empowered with high risk perception in the beginning. We don’t hear that voice. We hear the voice later on in the decision-making loop when the disease sets in and there is discomfort and there is the need for compensation and so on.” (G8).

An academic expert who had experience in occupational health policy pointed out a crucial problem, regarding governance in occupational health:

“It’s not like there is no structure in place. There is. In terms of policy development and implementation, here is the process. We will get a small committee to draft the policy. Then that draft will be circulated to provinces. Then provinces will consult on it widely because at the end of the day, they are going to implement the policy. So, they will determine if this is implementable or just theoretical academic exercise kind of thing. Then we modify based on it. Then we have a broader consultation, provinces and other key stakeholders and then finalize it. But we find that when we send this to the provinces they don’t consult. They just sit on the document and when you call to say we are waiting

for your inputs then they come back and say you didn't cross your T's etc. and not look at content.” (A4).

4.3.1.4 Budgetary constraints

Key informants identified the lack of financial resources as one of the major barriers to effective implementation of OHS guidelines or practices. A government official noted that *“budget is an enormous factor because you cannot implement proper IC at a healthcare institution [without adequate funds].” (G5).* Another key informant added that *“OH has always suffered from a shortage of funding, not just TB control.” (A1).*

Asked whether OHS services were influenced by political forces, a government official believed *“there is political will. The barrier is with resources.” (G9).* Another government official explained that *“insufficient allocation of resources, budgeting, issues of commitment and accountability”* accounted for the inadequate OH services. (G4).

4.3.1.5 Staffing barriers

The shortage of well-trained human resources dedicated to OHS is one of many health system challenges affecting occupational TB in the health sector. It was noted that health facilities do not have the needed OH personnel. One consequence is that staff may take time off to seek care from their private doctors in other health facilities, further straining an already depleted workforce. A government official explained: *“one person does a lot of things and this increases the volume of exposure.” (G10).*

Explaining the limitations of good policies in a human resource constrained environment, a key informant noted that:

“You can have wonderful policies but if you don’t have the human resources do it, you are going to be stuck. So, a lot depends on appropriately trained personnel. To retain your health professionals within health institutions, there are really serious health system changes that are needed in terms of conditions of service, workload, safety etc.” (L1).

It was also pointed out that IPC and OH are largely nurse-driven in SA and that particularly, there was a shortage of occupational medicine practitioners in the public sector. This sometimes leads to personnel being appointed without adequate training. It was mentioned that it is very difficult to have a public-sector career path in OH and IPC, making these fields less attractive.

4.3.1.6 Infrastructural and equipment barriers

The precarious physical environment in which HCWs work was pointed out by many informants as a driver for nosocomial TB transmission. A former HCW who had suffered nosocomial MDR TB lamented that *“the air-conditioning [at the health facility where I acquired the MDR TB] was not working properly. We didn’t have windows. No proper ventilation.”* (N1). Apart from noting the poor environmental controls, the KI explained that personal protective equipment (PPE) were either unavailable or not worn by HCWs who worked in this high-risk environment: *“we weren’t using N95s. Infection control wasn’t good at all.”* (N1).

The problems in the use of technologies in IPC was also highlighted in the interviews. It was explained that ultraviolet (UV) light germicidal irradiation, although effective when appropriately installed and used, could offer a false sense of protection to healthcare workers, or increase their poor risk perception. A key informant explained that:

“Another thing we like to do in SA is that when we hear of something, we are not even sure of its efficacy, but everyone rushes to do it. What is the efficacy of the UV light? What is the evidence of it? You go to the hospital and you see UV lights all over the place. We need to make sure it’s not giving a false sense of safety. I’ve been to a few places the UV lights don’t even work.” (A2).

Another KI shared a similar opinion on the application of this technology

“Sometimes it’s not so much of the technology but how it is applied. They [UV lights] were wrongly administered from an engineering point of view. Others at the wrong angle, not maintained, others the bulb not at the right UV emissions, wavelength.... what may appear as a blue light but may not have the therapeutic effect that is meant to have. So, infrastructure development and maintenance are big problems”. (G8).

4.3.1.7 Information Systems

There is also the lack of the necessary information infrastructure or system to accurately capture TB cases among HCWs. This deficiency hampers planning and other efforts to address the TB burden. An academic expert explained that *“the true risk [of TB among HCWs] is not known because cases are not properly identified. There is uncertainty and this uncertainty feeds into the organizational response.” (A1).* Thus, a hospital director or provincial director would not prioritize this problem. This reinforces the lack of awareness of OHS issues by top management. *“The senior managers and the political heads may not know or understand occupational health, not that they don’t want to do it, but they are not aware.” (A4).*

Another reason for the under-reported TB cases among HCW relates to confidentiality, in the sense that HCWs fear their personal health records could be assessed by their colleagues. A KI noted that: “*confidentiality is [indeed] a big barrier.*” (G10).

4.3.1.8 Poor implementation culture/non-compliance

TB IC policies were perceived to be poorly implemented in health facilities. A hospital leader complained about staff attitude towards PPEs, for instance. “*Staff do not want to use it [PPE]. Non-compliance is a problem. One other thing we shouldn't say because it sounds bad is staff attitude. It is something that needs to be discussed.*” (H1).

However, key informants stressed that this culture spans top management to the frontline workers. A government official noted that “*there is a barrier of non-compliance from high up within the healthcare sector... there is no management authority behind it [implementation]*”. (G5). Managerial, administrative, environmental and personal protective controls were perceived to be poorly implemented in health facilities due to poor risk perception.

A KI explained that “*they've got the attitude that they are not at risk. If they have not developed TB over the 10 years that they've been working in that specific hospital, then they have the perception that they will never develop TB, so they think it doesn't apply to them.*” (G5).

4.3.1.9 Stigma

Due to TB's association with HIV, suspected TB patients may be stigmatized in society. As a result, HCWs may fear seeking care and treatment from the facilities where they work due to issues of confidentiality. It was reported that, even in health facilities which may have a well-functioning occupational health unit, these services may be underutilized for these same reasons.

As a key informant explained: *“there is still fear of reporting because of fear of losing your job, or people gossiping about you.”* (A1).

4.3.1.10 The complexity of preventive practices

The multi-layered approach of IPC around TB was perceived to serve as a barrier in that HCWs are unable to directly see the impact of a preventative or protective action. As a KI noted, *“the requirements for IC, there are a whole lot of things that need to happen. The more things that need to happen to achieve a goal, the less likely for staff to be able to see the whole package as a priority. There are just too many things to worry about in a day. So, that’s on top of the organizational factor. The package of interventions that is required- keeping windows open, making sure the patients are separated, putting your own respirators on, it’s too much. Fatigue sets in. It establishes the norm and you can’t easily change norms. If the norm is if I take MDR patients, I will take precautions but others I will take my chances”.* (A1).

4.3.2 Perceived strategies to prevent and control occupational TB

Key informants provided varying perspectives on strategies that could strengthen the occupational health system and improve the implementation of practices to protect HCWs from occupational TB. These perspectives are grouped within the WHO’s six health systems building blocks as modified for the purposes of this study.

4.3.2.1 Service delivery

KIs expressed the need for comprehensive occupational health services in health facilities in addition to general IPC. It was stressed that these services be provided to staff under strict confidentiality. Provision of these services would require the availability of the other building

blocks. Informants emphasized the importance of qualified personnel in the provision of these services. *"We need enough OH and IC HCW to deliver the needed occupational health services"*. (G7). Key informants also stressed the importance of education to make HCWs more aware of their risk of TB infection.

4.3.2.2 Health workforce

KIs stressed the need for capacity building and strengthening in the control and prevention of nosocomial TB. A well-functioning OHS system requires that the workforce be adequately trained in occupational health protection which, of course, requires appropriately trained OH professionals to conduct or at least oversee such training. This was especially echoed by a policymaker: *"For a very effective health system, you need a sufficient number of HCW who are adequately trained, you need appropriate diagnostic labs, you need isolation areas, a treatment specialized unit."* (L1).

A government official also noted that *"HCWs must be trained on IC and OH from the time that they are students."* (G5). A hospital head further stressed that OHS programs *"need a dedicated person. In our facility for instance we have someone who focuses on OHS, infection control, waste management which is very broad. You need a person designated for OHS."* (H1).

A government official suggested that *"more education is needed on risk perception among individual employees so that they can accept that they are at higher risk than the general population."* (G8).

A KI raised the issue of protection for non-clinical support staff, a sub-population who do not receive much attention on issues around protecting themselves from infectious diseases, although they are also at increased risk of nosocomial TB. *"We need to pay attention to the*

porters, the administration clerk, the cleaners, the ward clerks. They are the first contacts. That's where you need proper ventilation.” (G1).

4.3.2.3 Health information systems

Decision-making processes require good evidence, which in turn means a reliable information system. It was suggested that there should be a system in place to capture, store and analyze health data for effective planning and intervention. The need for timely and accurate reporting by HCWs of their TB status was also noted. A key informant said that *“the true risk of TB among HCW is not known”* (G5) due to deficiencies in data collection.

4.3.2.4 Access to essential medicines, products and technologies

KIs expressed the need for an environment where treatment for HCWs is not just free but also given under confidential conditions. A government official expressed concern about HCWs' preference to seek care at non-workplace sites versus occupational health units (OHU) in their facility due to confidentiality issues. It was explained that *“the HCW won't want to go back to the clinic where he/she works so would want to go to the private clinic, but they don't treat TB”* (G8).

A KI also mentioned other issues around infection control, explaining that *“the UV lights are also not maintained. They put UV lights but no funding to maintain them. There are also lots of misperceptions around UV lights. You talk about infection control and they think UV is enough.”* (A2).

A KI further explained that *“we never had investment in modern-day technologies and pharmaceutical products to have new TB drugs. Some of the diagnostics to diagnose TB have*

been over 50 years. The world never invested in TB because it is not a problem for the developed world.” (G8).

4.3.2.5 Financing

The need to make OHS a priority was closely tied with funding. It was explained that funding was important to hire and train the needed personnel to fill occupational health posts and procure treatments. The key informants called for the need to allocate more resources to health and safety issues. It was suggested that *“there should be an increase in funding at hospital levels.”* (A2). Another key informant noted that *“there is obviously constrained investment by the country in social sectors such as health...all the [health] facilities are short of funding.”* (A1).

4.3.2.6 Leadership and governance

KIs noted that improving and strengthening OHS should begin with making it a priority, and this should come from the people in authority especially at the national level. An academic expert recommended:

“We need a champion at the national level to say this is a problem for us and we need to deal with it. They are aware of the problem in terms of the number of HCWs with TB seen at the facility, the number of cases submitted for compensation. It is a matter of what are our priorities in terms of allocating into our budget.” (A3).

Implementation of and adherence to OHS policies was a dominant theme tied with the need for improved leadership for OHS in SA. The majority of the key informants were of the view that the knowledge about policies and guidelines was not the problem; it was the implementation of these policies and effective leadership that prioritize OHS which were crucial.

A hospital head further suggested that *“to reduce your barriers, you need your policy of OHS and IC very close together in place so that they will explain your resources, the networks, the monitoring and implementation.”* (H1).

A key informant also suggested that *“you actually need clinicians running [OHS in health facilities], not the HR department. In some provinces, OH is not under HR.”* (A1).

Acknowledging that decisions around OHS have predominantly been a top-down process, it was suggested that TB governance be more inclusive. The key informant explained that the TB governance *“...is a top-down approach. But with the current TB HCW policy [yet to be launched], we made sure that we had representation. Labour unions and nurses’ representation are included. We have inputs from civil society.”* (A4).

4.4 Discussion

This study was conducted to provide insight into why the many guidelines in South Africa to protect health care workers from occupational TB are inadequately implemented. Key informants emphasized the significance of several factors which are both systemic and structural in nature such as lack of priority for OHS, weak governance of OHS, budgetary and staffing constraint, infrastructural challenges, weak implementation culture, noncompliance, and various social factors. They also noted that, despite the evidence strongly indicating the occupational dimension of the risk, many still perceive that workplace acquisition of TB is less important than community exposure. Although HCW shortage is generally acknowledged as a major problem in the South African healthcare system (Coovadia et al., 2009; Labonté, Sanders, et al., 2015), protecting HCWs as a strategy to retain the much-needed human resources has not received much explicit attention (Yassi et al., 2016).

The WHO health systems building blocks framework (embedded in Figure 1.1 and elaborated on in Table 4.2) was used to organize the key informant perspectives. This widely applied framework (Manyazewal, 2017; Mounier-Jack, Griffiths, Closser, Burchett, & Marchal, 2014; Mutale et al., 2013), was modified to suit the purposes of this study by conceptualizing the health workforce (as opposed to the general public) as a target population to be served.

As in many LMICs, South Africa suffers from a shortage of healthcare professionals especially in the public sector. This shortage is worse in the OH specialties where lack of prioritization for this field makes it unattractive for young people to pursue. In such a stressed work environment, addressing nosocomial transmission would benefit from an adequately trained workforce dedicated to OH and IPC. This would include training more occupational medicine specialists, occupational health practitioners, and infection control officers. It would also include having well-functioning health and safety committees in health facilities (Yassi et al., 2013, 2009).

According to the WHO, a health information system provides a process “that ensures the production, analysis, dissemination and use of reliable and timely information on health determinants, health systems performance and health status” (WHO, 2007). A well-functioning OHS system accordingly relies on accurate, timely and well-protected health information for evidence-based decision making. Creating the necessary awareness of HCWs’ increased risk of TB comes with the need for data that support this claim. Accurate reporting of TB disease in HCWs in a high burden setting like South Africa is an important goal (Nathavitharana et al., 2016). The informants interviewed believe that HCWs were not sufficiently aware of the increased risk of TB, at least partly due to underreporting of occupational TB by their co-workers, as well as the failure to assemble the information or evidence. Underreporting may, in

turn, be due to both stigma and the lack of an effective system for accurate data capture. Remedying this situation calls for three things: periodic screening of HCWs for active TB disease and for latent TB infection for HIV positive HCWs, encouraging self-disclosure, and keeping an efficient management information system for operational monitoring and evaluation (Yassi et al., 2016).

The “access to essential medicines, products and technology” component of the framework can be conceived as the availability of diagnostic tools like GeneXpert, UV lights and the need for free TB treatment (and new drugs for drug-resistant TB) to be available onsite occupational health units and provided with strict confidentiality. But it also relates directly to the chronic shortages of basic personal protective equipment such as N95 respirators and persistently inadequate ventilation.

There is ample evidence that inadequate funding continues to be a major issue in TB prevention and control. In a fiscally challenging environment, the health sector in general, continues to suffer from insufficient resource allocation. Also, investments in OHS have been insufficient. A well-functioning OHS system needs to have the necessary financing mechanism to ensure that OH services can be provided without undue financial burdens on the HCW or the health facility. There also has to be more political commitment to TB from both the national and global actors (Billo, 2016). Nevertheless, although key informants spoke repeatedly of chronic underfunding, none spoke of upstream fiscal circumstances that could be contributing to this.

Effective leadership is necessary to drive all the other components of the system. Appropriate and supportive regulations and policies with inputs from all stakeholders should be in place in a well-functioning system meant to protect the health of HCWs. While service delivery depends on the amount of funds made available to the sector, leadership equally plays a

significant role in TB control in the health facilities. The top-down leadership approach in TB governance needs to be addressed. Key informants noted that traditionally, workplace safety policies are developed and driven by the employer with minimal HCW influence. It was also explained that workers may be invited but only as ‘junior partners’ in most decision-making processes. Opinions from this study were that workers’ unions are generally weak when it comes to OHS in South Africa in contrast with other issues such as salaries. It was suggested that healthcare workers should have a voice in TB policy and governance. This involvement would encourage employee participation, as well as putting pressure on employers to comply with OH policies.

The results from this study shed light on the factors underlying poor implementation of programmes to prevent occupational TB in South Africa. More recently, a revised form of the traditional IPC approach prioritizing active case finding, safe separation and effective treatment initiation of patients based on drug susceptibility testing has been argued (Nardell, 2016). Although this “FAST approach” is laudable, it should be complemented with approaches that address the above-mentioned systemic forces more directly (Ehrlich, Spiegel & Yassi, 2019).

Notwithstanding the fact that there were other key informants (whom I was unsuccessful in arranging interviews with) who could have further diversified the data (for example the trade unions), no new information was being surfaced and hence data reached saturation. Because the key informants were recruited through snowball sampling through network of people with responsibility for occupational health, this presents an occupational health bias. Other stakeholders who could have been included are infection control practitioners, human resource system managers, labor unions and representatives from joint health and safety committees of hospitals. Further research is needed to elucidate these other perspectives.

As noted earlier, this study relied on key informants due to the limited evidence base and related indicators for answering the research question. Notwithstanding the inherent bias and areas of omission, this study suggests indicators that could be more systematically tracked and monitored.

4.5 Conclusion

Results from this study have shown that the failure to adequately implement measures to protect HCWs, such as through inadequate health resources allocation to occupational health, is rooted in many systemic factors which need to be addressed. Human resource challenges, case notification, technological or infrastructural challenges, budgetary constraint, lack of leadership/governance, community exposure, poor implementation culture and various social factors are all perceived to drive the high incidence of TB among HCWs.

Interventions geared towards making the healthcare workplace a safe environment should begin with appreciating these systemic factors forces and the need for implementation of measures to address them directly or indirectly. The South African health care system must do this to demonstrate its commitment to responding to the burden of TB among its HCWs.

Table 4.1 Basic demographic information about key informants (identifying information has been removed to protect KIs' anonymity)

Reference	KI Category	Designation	Mode of Interview
G1	Provincial and national government authorities	Senior level manager in charge of occupational hygiene in a provincial health department	In person
G2		Mid-level manager in charge of occupational hygiene in a provincial health department	In person
G3		Mid-level manager in charge of occupational hygiene in a provincial health department	In person
G4		Mid-level manager in charge of occupational hygiene in a provincial health department	In person
G5		Senior level manager in charge wellness program in a provincial health department	In person
G6		Senior manager in charge of TB, national department of health	In person

G7		Senior manager in charge of hygiene and health, national labour department	In person
G8		Senior manager, national department of public service	In person
G9		Senior manager, national institute of occupational health	In person
G10		Occupational medicine specialist of a national institute	In person
A1	Academic experts	Professor emeritus of occupational medicine	Skype
A2		Professor in occupational health in a public university	In person
A3		Professor in a public university	In person
A4		Professor in a public university	In person
N1	Occupational TB	Survivor of MDR TB and TB advocate/former HCW	Telephone
N2	Advocacy Group	Survivor of MDR TB and TB advocate/HCW	Telephone
H1	Hospital heads	Head of a large TB referral hospital	In person
L1	Health Legislator/Politician	Legislator	Telephone

Table 4.2: Application of the WHO Health System Building Blocks

WHO Health System Building Blocks	As applied to providing systems to support the health of:	
	The general population	Healthcare Workers
Service Delivery	Encompassing quality, access, safety and coverage of services e.g. diagnostic, curative general health services	Encompassing quality, access, safety and coverage of services at the workplace e.g. for prevention & control of risk
Health Workforce	Human resources management, skills and policies e.g. health professionals	Human resources management, skills and policies e.g. occupational health professionals
Information System	Production, analysis, dissemination use of timely & reliable information e.g. health status & service use; general trends and associations	Production, analysis, dissemination use of timely & reliable information e.g. status of HCWs and workplace risks; trends and associations
Access to Medicines (essential supplies)	Procurement to ensure access to adequate supplies generally e.g. drugs, other supplies	Procurement to ensure access to adequate supplies for occupational health and safety e.g. protective equipment, infrastructure
Financing	Raising adequate funds for needed resources, good and services e.g. all health systems	Raising adequate funds for needed resources, good and services e.g. for occupational safety and health
Leadership & Governance	Existence of policy frameworks & oversight, design, and accountability e.g. across professions, institutions	Existence of policy frameworks & oversight, design, and accountability e.g. across different disciplines and within the health system to ensure attention to prevention and control of risks

Chapter 5: Conclusion

5.1 Introduction

While the interaction between distal and proximal factors has always been a matter of interest, the intensification of global integration in the late twentieth century has made such consideration central to how health concerns can be best understood and addressed. In response to calls for more research into the linkages between health and its global economic and political drivers (Labonté & Spiegel, 2003; Pedrazzoli et al., 2017) this dissertation aimed to examine how upstream processes, through various mechanisms and pathways, influence TB incidence in the general population and specifically among HCWs. In particular, it sought to consider how globalized systems could be affecting the way that global health crisis such as high TB rates are addressed, for both the general population and specific at-risk subpopulations.

South Africa provided a unique context for an investigation of this nature. Particularly, the country's history of gross health inequities despite strong economic strength compared to other African countries, the unique history of discrimination, and its entrenched income disparities altogether illustrate the complexity of the interplay among different determinants of health within the country (Coovadia et al., 2009). In addition, South Africa's appropriateness for this investigation is justified by it being a country whose integration into the global system after years of isolation occurred at a time when globalization was intensifying and the threat from HIV and TB was emerging and reaching emergency proportions. Thus a "natural experiment" presented an opportunity allowing observation of how integration with global systems could impact the health of the general population and a high-risk population like HCWs.

To examine associations and effects that could be present among all countries experiencing manifestations of a global health crisis such as TB and distinguish ways in which

South Africa could be considered as a distinct context, first, quantitative evidence was sought on the association between globalization and TB incidence in the 22 HBCs. Secondly, a qualitative study was conducted, with two analytic objectives, first to deepen understanding of macro-level factors perceived to be affecting TB incidence overall and secondly to assess the forces perceived to be driving TB among HCWs in South Africa as well as the perception of how these two sets of processes are each being addressed. Such a multi-method approach is very much in line with the methodological reflection that:

“...to say that macro-level quantitative analysis is a necessary component to understanding globalization is not to say that such analysis is by itself sufficient. This is because macro analysis is best suited for locating global trends, broad global interconnections and large-scale networks, but is insufficient in telling us about how these phenomena specifically affect local communities or how these trends are interpreted and encountered by various social groups and communities” (Brown & Labonté, 2011, p4).

This concluding chapter presents and discusses the major findings from the previous chapters regarding the overriding question: *how are upstream forces associated with the presence and impact of a health challenge such as TB and how are these forces associated with the adoption and implementation of policies to address the epidemic?* This chapter also reflects on the dissertation’s contributions to world knowledge. The strengths, limitations, policy implications of the study’s findings, as well as recommendations for future research, are also discussed.

5.2 Discussion of key findings

This dissertation has provided an opportunity to study the effect of globalization as an upstream force on TB, a disease whose burden provoked the convening of an unprecedented special United Nation General Assembly session in September 2018. In this section, I provide a synthesis of the findings from this dissertation's three sub-studies and consider implications of this in light of themes raised in the broader literature on globalization and health.

5.2.1 Effects of upstream forces on health

In distinguishing the types of pathways generated, one could generally conceptualize the link between upstream forces and health in two ways. First, one could focus on how upstream forces produce positive or negative impacts on proximal determinants that affect health conditions more directly. The second conceptualization considers the effects of upstream forces on local abilities to address health equity concerns.

This dissertation provided new evidence of a positive association between globalization and TB incidence in the 22 high-burden TB countries over the period of globalization's expansion (1990 to 2016) following the end of the Cold War. Specifically, it was found that an increase of 10 TB cases per 100, 0000 per year, on average, was associated with just one unit increase in the globalization index. These findings complement other studies that have investigated the effects being produced by this phenomenon of increasing global interconnectedness. For instance membership of the WTO was found to be associated with higher TB incidence in the 22 HBCs from 1990-2010 (Bozorgmehr & San Sebastian, 2014).

Fiscal policies and associated reductions in public health spending are common features or conditions of globalization. Using data from the European Union from 1991-2012, Reeves and colleagues' found that reductions in public health spending as a consequence of economic

recession resulted in declining rates of TB case detection and treatment success (Reeves et al., 2015).

Irrespective of political, socioeconomic, demographic or other confounding characteristics, IMF economic programs were also found to be associated with significantly worsened TB outcomes in post-communist Eastern European and former Soviet countries (Stuckler et al., 2008). A recent systematic review found that liberalization policies and trade agreements were associated with increased BMI and cardiovascular diseases although the link with TB was inconclusive (Barlow, McKee, Basu, & Stuckler, 2017). In this study, even though the link between liberalization policies and TB was not directly investigated or ascertained, evidence was found between globalization (which captures liberalization policies to some extent) and TB.

Findings of the presence of an association between TB and globalization as an upstream force serve to justify more precise examination of pathways that could be driving such effects, as I then pursued in chapters 3 and 4 addressing circumstances in South Africa.

The examination of macro-level drivers affecting TB in South Africa that was the focus of Chapter 3 was pursued to complement scholarship that has tended to focus on more proximal factors, and thereby risk ignoring important points for policy intervention. A further purpose of this sub-study was to gain insights relevant to the recently developed National Strategic Plan for TB and ascertain how it addresses perceived macro level priorities. Key informants cited the migrant labour systems, the mining sector, economic inequality, poor shelter, health system challenges, the HIV epidemic and socio-cultural factors as the main drivers of TB in South Africa. Again, it was noted that although key informants' perspectives of drivers or influences on TB were still more focused on the proximal factors than on the macro structural processes, the

current TB policy in South Africa nevertheless claims to commit to addressing the structural drivers. However, the projected budgetary allocations towards addressing these specific structural drivers do not reflect this level of commitment.

Chapter 4 investigated the drivers of TB infection among HCWs and further explored the barriers and actions that could enhance a system to prevent and control TB infection among this population. Key informants' knowledgeable in the area of occupationally acquired TB in the health sector saw this persistence as being driven by the lack of priority for OH manifested by poor governance of OHS-related issues, budgetary constraints and inadequate human resources dedicated to OH services, overall weak safety culture and social factors such as stigmatization. Applying the WHO health systems building blocks framework enabled greater focus on the overall system, noting areas where broader upstream forces could be having a significant impact and where appropriate interventions may be needed. Applying this approach highlighted the need for improved governance and accountability of TB related issues.

Prioritization, implementation and adherence to existing OHS policies were identified as crucial to improving TB prevention and control in health facilities. While development of practical guidelines to address health challenges such as occupational exposure to tuberculosis undeniably represent a positive expression of globalization, limited attention has been given to whether comparable upstream forces may be at play in restricting the implementation of these recommended practices. In this regard, one of the theorized effects of globalization on weakening public health system due to chronic underfunding merits consideration, particularly in light of this study's identification of resource constraints, human resource limitations and poor leadership as central concerns in explaining weak prevention and control of TB.

Thus, the overall findings from this dissertation provide evidence that health outcomes are indeed not only associated with pressures being generated by broader upstream forces but also suggests that greater attention be given to how forces such as globalization affect system capacities. This orientation has the potential to focus more direct attention on for instance, the adequacy of health resources allocation to public health in general, and programmes to protect the health of healthcare workers, in particular.

5.2.2 Reflection on the conceptualization of pathways

The approach generally followed in the literature examining effects on tuberculosis in relation to globalization is to focus on the pathways whereby such upstream forces affect determinants that are observed to be associated with TB. Scholarship applying this approach in relation to TB is quite widespread and is often framed as the social determinants of TB. Lönnroth and colleagues had explicitly suggested there be increased attention to upstream forces, which indeed was one of the rationales for this study (Lönnroth et al., 2009), while others had emphasized a need for models that could provide ways to analyze such effects (Pedrazzoli et al., 2017). Both have been accomplished in this dissertation.

In recognizing the pronounced weaknesses in the approaches being taken to address TB particularly with respect to funding, governance, priority-setting and other elements well considered by applying a systems approach that was observed in this dissertation, one is unavoidably drawn to pay particular attention to a second pathway, where *upstream forces may directly be generating impacts on capacities and approaches to addressing health issues*. Globalization from this perspective could be regarded as generating positive effects, such as by

increasing access to information or resources, or negative effects such as by limiting the resources available to address this same health equity concerns.

In examining this conceptualized pathway, one could consider the explanation that has been suggested for weak public health systems as a loss of government revenue necessary to fund the sector. Interestingly, key informants did not note this, potentially because some of these upstream factors are generally obscured from view in proximal settings. Nevertheless, scholarship on fiscal concerns notes that global integration largely benefits corporations who through tax exemptions, illicit financial flows [IFFs] (the unrecorded movement of capital out of a country in contravention of the regulations of that country and various accounting practices) do not then pay their fair share into the national purse (O’Hare, 2015). This draws attention to how global integration can in fact introduce mechanisms that weaken rather than reinforce national and local systems that may be needed to address locally manifest health concerns, such as TB incidence.

According to O’Hare (2015), multinational companies do this through profit shifting, a mechanism whereby multinational companies shift “their tax liabilities to sister companies located in low tax jurisdictions” (p.1). Multinational companies use profit shifting architecture to understate their profits and consequently reduce their levy liabilities due to the government. Consequently, potential revenue that could fund public services is lost, underfunding the public purse, by an estimated \$22 billion annually across Africa (African Union Commission/United Nations Economic Commission for Africa (AUC/ECA), 2015) with losses as high as \$100 billion in South Africa for the period 2002-2011(African Monitor, 2017). IFF has been noted as contributing to the weakening of the health systems of many African countries (O’Hare, 2015).

The study of key informants' perceptions revealed inadvertently that there was no consideration of lost revenues as a relevant upstream pathway. This suggests that awareness of IFFs and their consequences is low among experts in the TB-OHS community. This absence indicates that further examination of this matter is warranted.

5.3 Study strengths and unique contributions

A study of this nature is very opportune; at a time when there is an urgent call to move beyond proximate risk factors of health conditions and consider structural determinants more broadly. Indeed, there have been attempts to understand the impact of specific globalizing processes on health conditions including TB, a disease whose epidemiology is sensitive to upstream forces due to its strong ties with socio-economic conditions (Rasanathan, Sivasankara Kurup, Jaramillo, & Lönnroth, 2011). However, to the best of my knowledge, this work (Chapter 2 specifically) is the first to be conducted on the impact of globalizing processes on TB incidence, by operationalizing a well cited hypothesized pathway (Lönnroth et al., 2009).

Also, the innovative application of the WHO building blocks provided a systematic and simplified qualitative approach to conceptualize an otherwise complex situation. It shows how prevention and control can be pursued in recognition of forces that are nuanced and difficult to capture.

Post-apartheid South Africa has been marked by the widespread implementation of market-based reforms. The result has been an increase in economic strength (although the country is currently experiencing an economic recession) but underinvestment in the public health sector leading to gross health inequities in the country's population. As the process of globalization continues to present both challenges and opportunities for the health sector,

governments and other stakeholders need to be mindful of the consequences on the health of populations and implement strategies to mitigate the impact. It is hoped that findings from this study will inform a shift towards macroeconomic policies that are oriented towards distributive growth and sustainable interventions aimed at addressing the social determinants of health.

5.4 Limitations

While this dissertation offers significant contributions to the literature on the structural drivers of diseases, it is not without limitations.

A major limitation of the two qualitative sets of analyses (Chapters 3 & 4) is that although data saturation was reached with the sample size of eighteen (for the study in chapter 4) and twenty (study in chapter 3), these studies could have benefitted from a more diverse group of key informants who would potentially offer other perspectives. Many of the key informants were recruited through networks of public health and occupational health researchers. This might have influenced the results in the sense that it is possible to assume a disproportionate occupational health bias in the findings.

Overall, the three studies in this dissertation are focused at the macro level examining a policy and using aggregated data at the national level; while this is the appropriate scale and focus for policy changes related to the research question, readers should be aware that this research design avoids making causal inferences at the individual level.

5.5 Future research

The evidence on globalization and TB could be strengthened by replicating the analysis using different indices of globalization or even using only specific sub-scales of the KOF index of globalization. Also, future studies could perform trend analysis to look at the Apartheid era

versus post-Apartheid. As noted earlier, the snowball sampling strategy that was employed in the qualitative study must have led to a biased sample. Future studies could include other stakeholders like infection control practitioners, human resource managers, labour unions and representatives from joint health and safety committees of hospitals, as well as a more diverse array of clinical managers at various levels. Further research is needed to elucidate these other perspectives. Also, the reliance on perceptions speaks to a need and opportunity for clearer identification of constructs that could be more directly and systematically monitored.

5.6 Final Conclusions

Rapid travel and global interconnectedness have been observed to facilitate the spread, emergence or re-emergence of communicable diseases including TB (Gushulak & MacPherson, 2004). As a complement to strong commitments to strengthening diagnosis and treatment, the goals of the End TB strategy will not be met if structural interventions are not pursued. The findings from this dissertation should further prompt us to reflect on how we respond to this TB crisis amidst an inevitable process of globalization.

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Appendices

Appendix A Model selection and supplementary analyses

A.1 Model diagnostics

Steps in fitting the model

- Linear mixed effect models were fitted in R using the lmer function of the lme4 package.
- The study variables were log transformed and normality was assessed to see if transformation would be necessary. From **Figures A1.1-A1.10**, it was decided that transformations were not necessary.
- Since the Globalization variable is the variable of main interest, I first fitted the model with only Globalization as explanatory variable, and then I adjusted the model by adding confounders or covariates.

Deciding on model structure:

Random intercept only: $Incidence \sim Globalization + (1|country)$

Random intercept and random slope: $Incidence \sim Globalization + (1 + Globalization|country)$

1. Scatterplots of incidence versus globalization were used to examine which of the two structures fitted the data better: *random intercept only* or *random intercept and random slope*. Upon examination (**Figures A2 & A3**), it was observed that the slopes are quite different so the model with *random intercept and slope* should be considered.
2. AIC/BICs (See **Output 1**) were also used to perform model selection and the results confirmed (the model with lower AIC/BIC is better) the observations from the **Figures A2 & A3**, and hence, the model with *random intercept and slope* was selected. The selected model is $Incidence \sim Globalization + (1 + Globalization|country)$ and is denoted as **Model 2** or **M2**.

3. For the unadjusted associations between the outcome variable and confounding variables, step#2 was also used as the criteria to decide the model structure. For all these unadjusted associations, *random intercept and slope* were selected.

Fitting the model with confounders

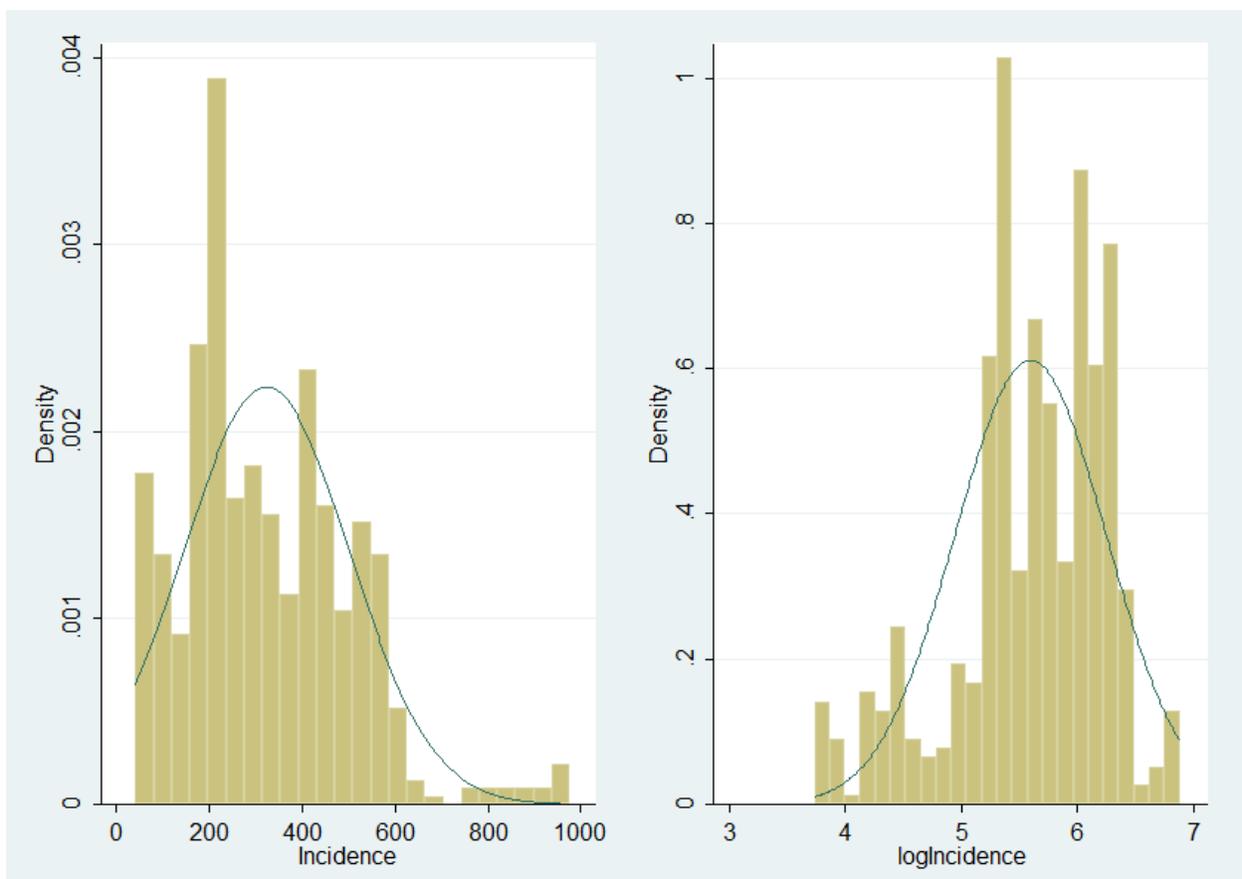
Covariates or confounders were added to the unadjusted model of choice (**Model 2**) to obtain the adjusted model (**Model 2C**). Although the inclusion of the confounders was conceptually driven, this was further confirmed statistically by comparing the AIC/BIC of the model with and without confounders, **Model 2** and **Model 2C** respectively. It was observed that including the confounders improved the model fit (**Output 2**).

Model assumptions

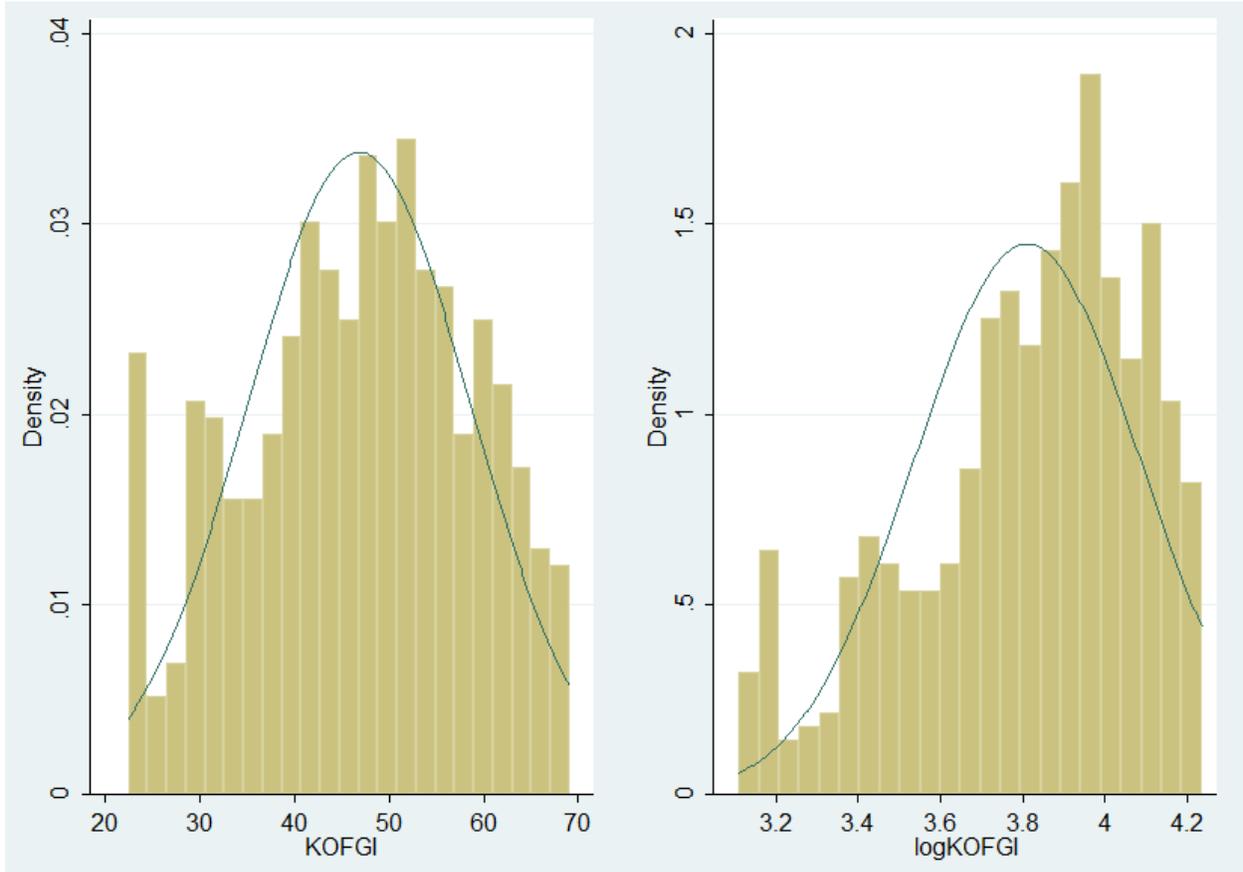
The following assumptions were verified.

1. Linearity: Scatterplots between the response and the explanatory variables were examined (**Figure A3**). In general, the relationships were assumed to be linear, although for some countries the relationship deviated from linearity.
2. Normality
 - i. Normal residuals of the model: DHARMA package in R was used to simulate the scaled residuals. Scaled residuals of the model were assumed to be normal. Per **Figure A4**, the QQ plot of the scaled residuals indicates systematic deviation from the line, but since the model is used for the hypothesis testing purposes, patterns are not so extreme to be worrisome.
 - ii. Normality of random intercept and random slope estimates: This assumption was also satisfied per **Figure A5** (most of the points are reasonably on the straight line).

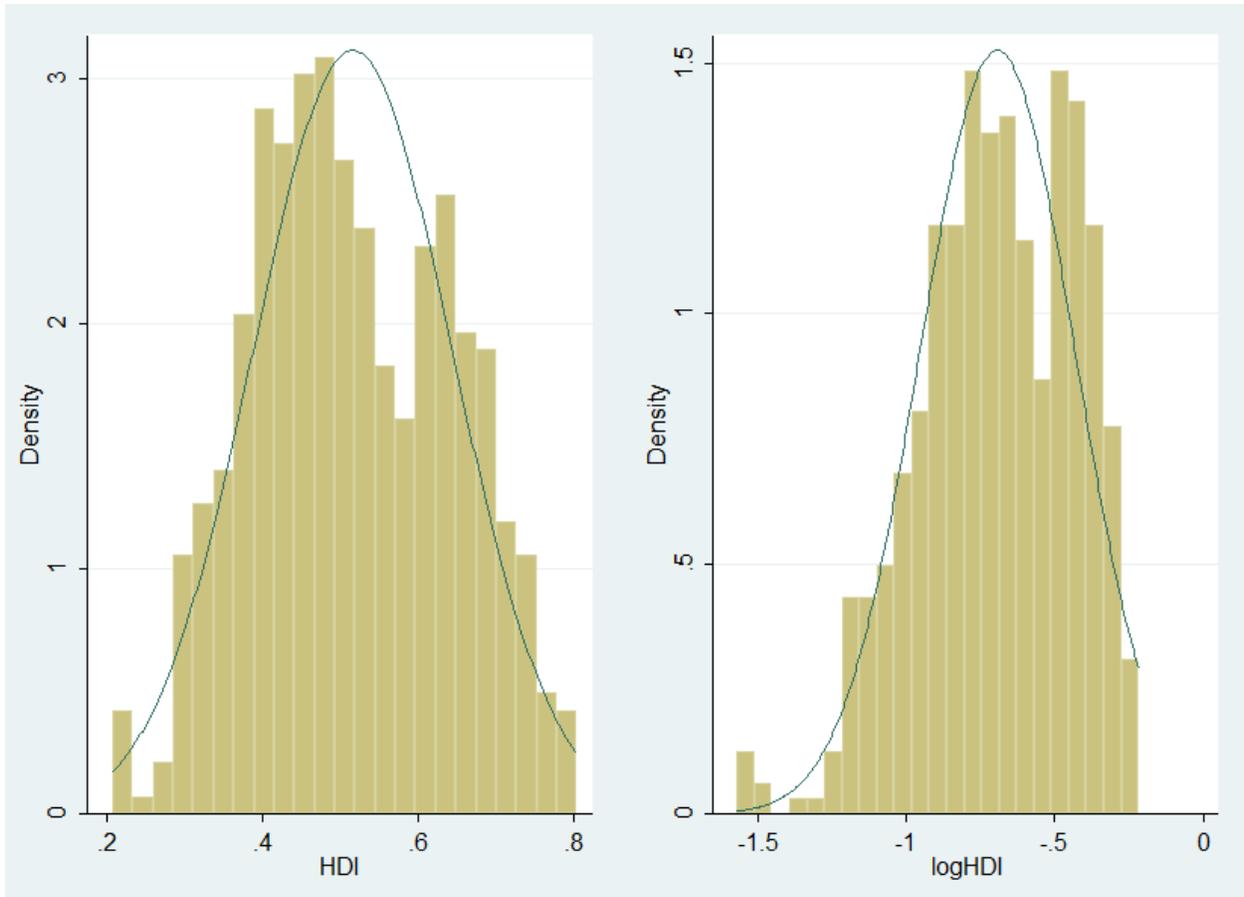
- iii. Homoscedasticity of variance: The distribution of the residuals as a function of the predicted incidence exhibit some patterns which might suggest deviation from homogeneity. However, this is not so worrisome because the model is used for hypothesis testing (Fig. A6).



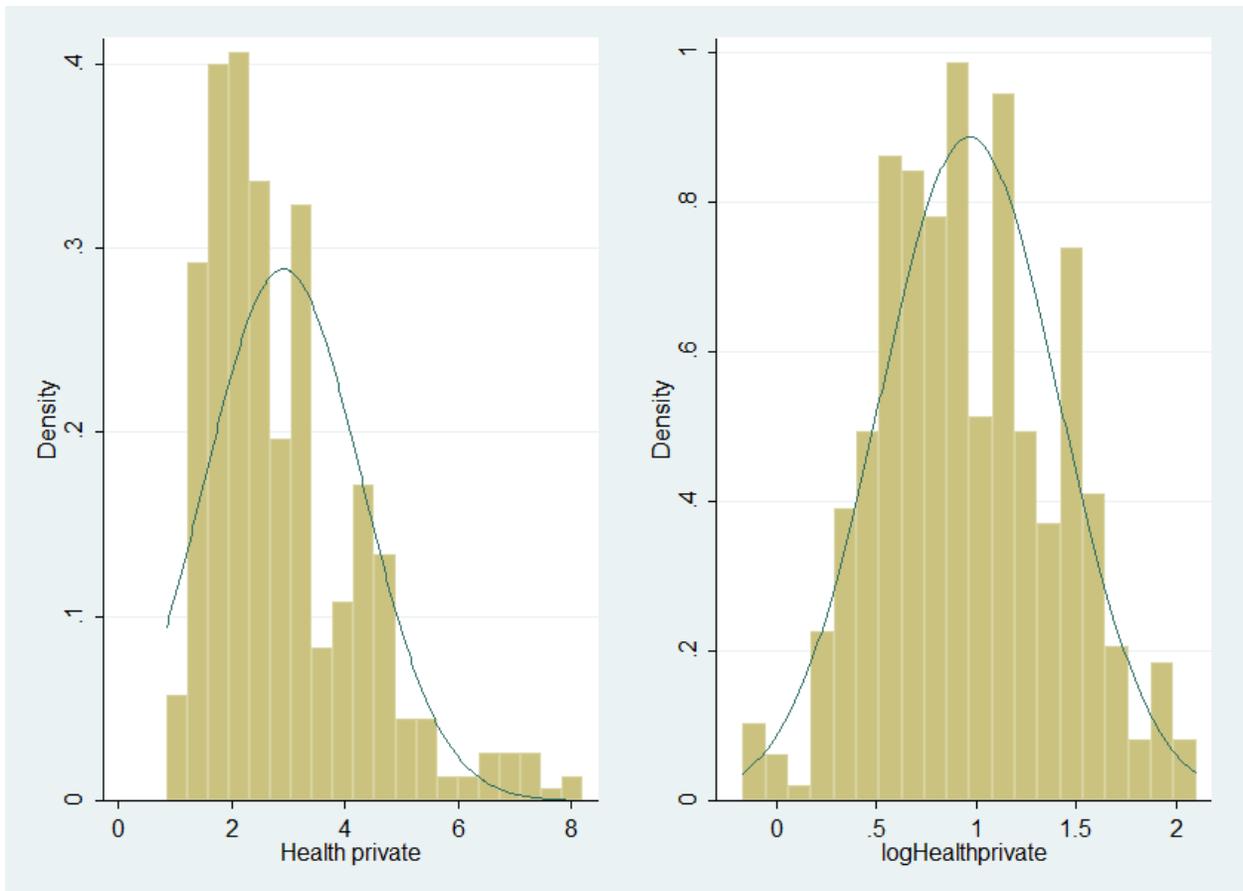
Figures A1.1: Histograms showing the distribution of Incidence and log-Incidence variables



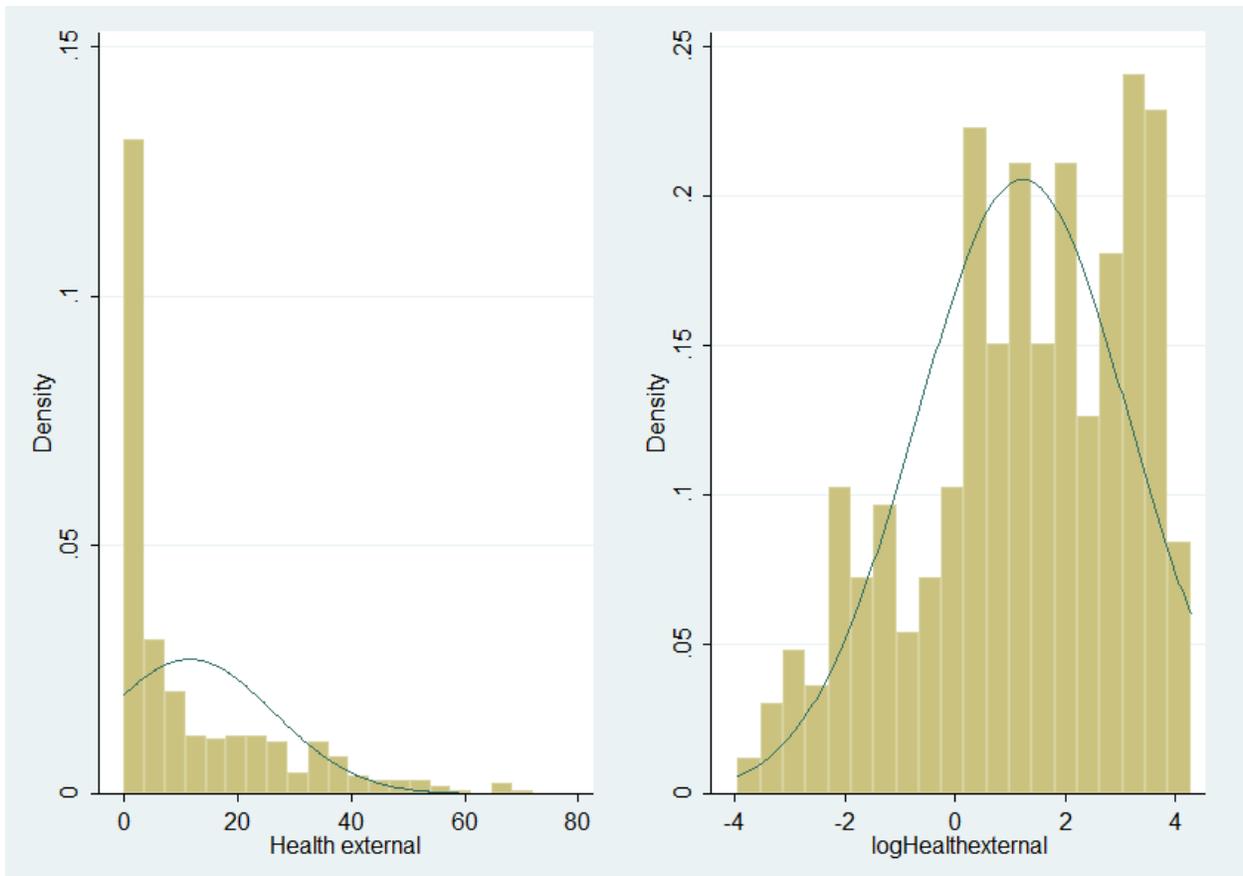
Figures A1.2: Histograms showing the distributions of the globalization and log-Globalization variables



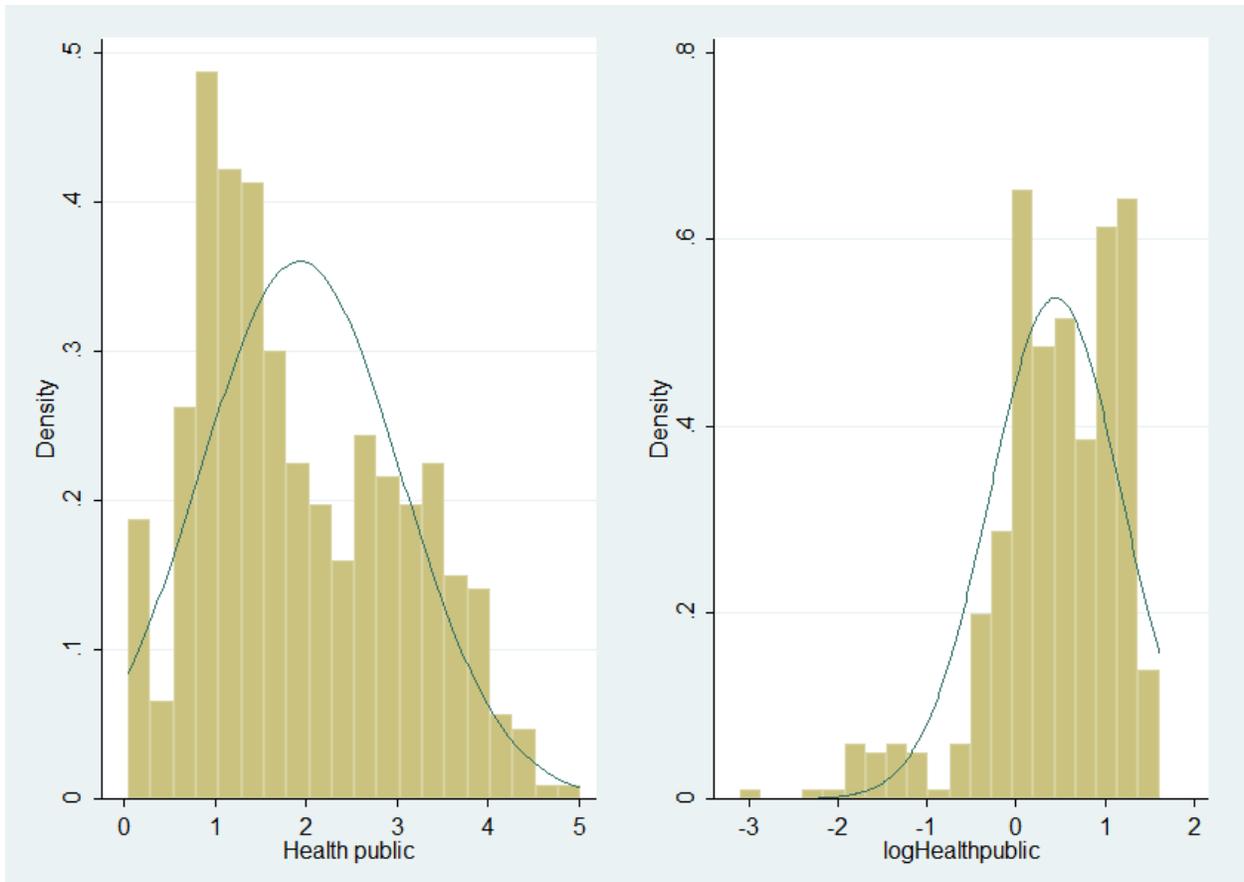
Figures A1.3: Histograms showing the distributions of HDI and log-HDI variables



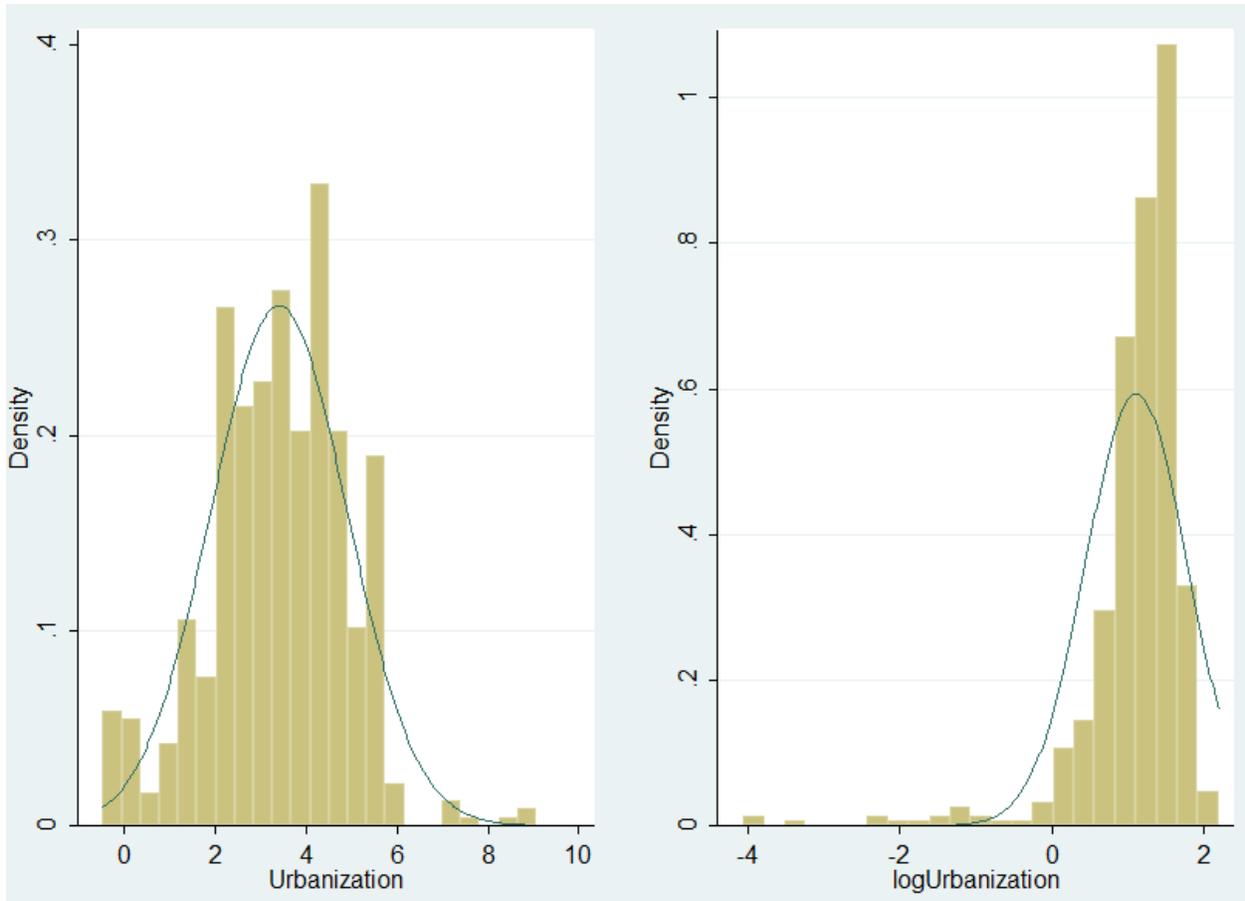
Figures A1.4: Histograms showing the distributions of the Private health expenditure and log-Private health expenditure variables



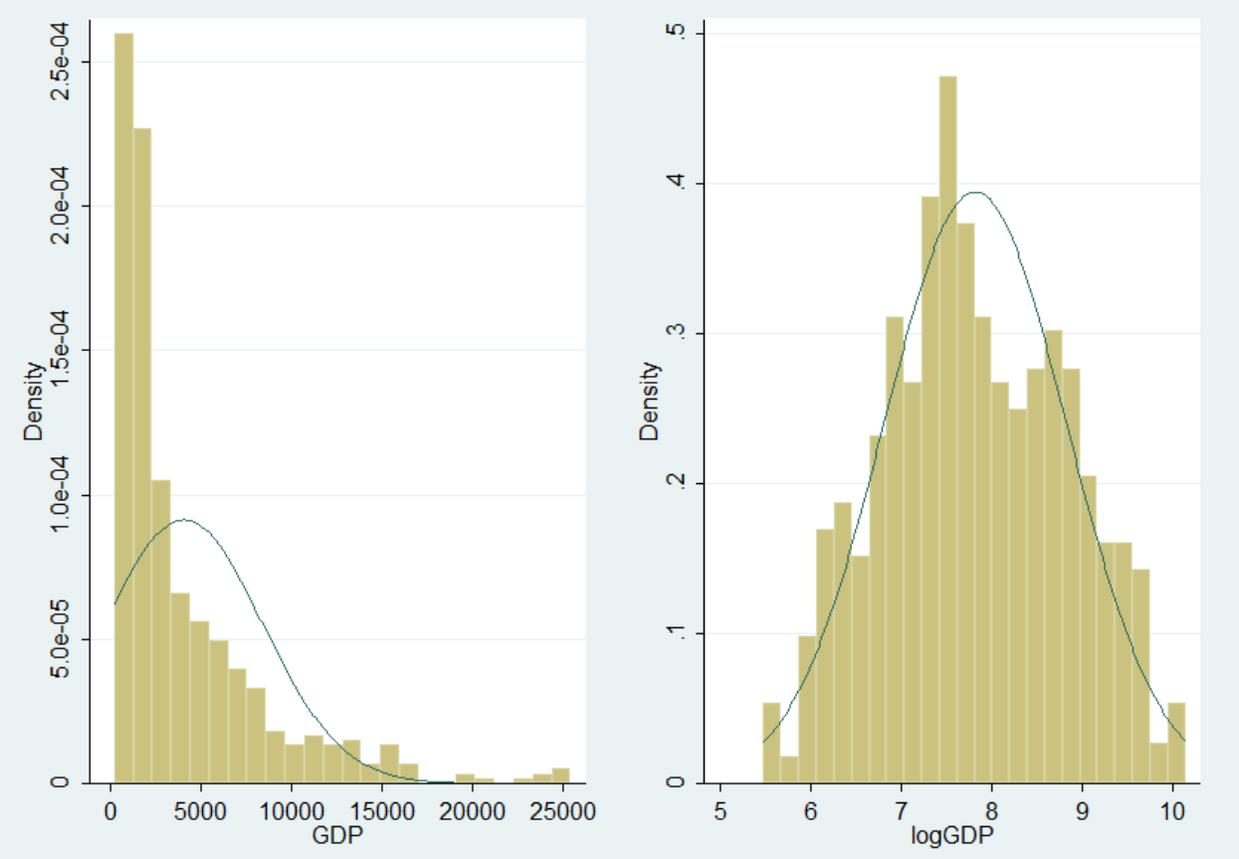
Figures A1.5: Histograms showing the distributions of External resources for health and log-External resources for health variables



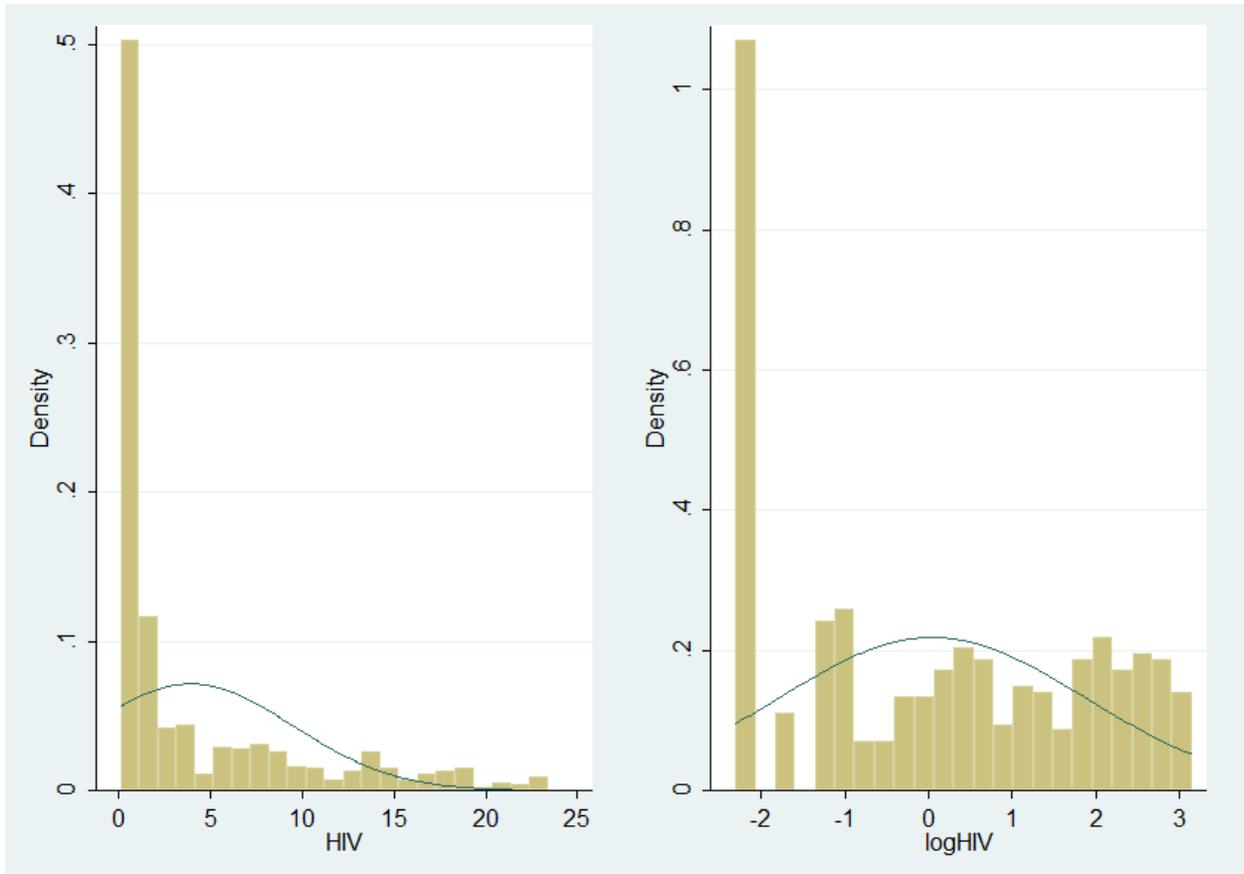
Figures A1.6: Histograms showing the distributions of the Public health expenditure and log-Public health expenditure variables



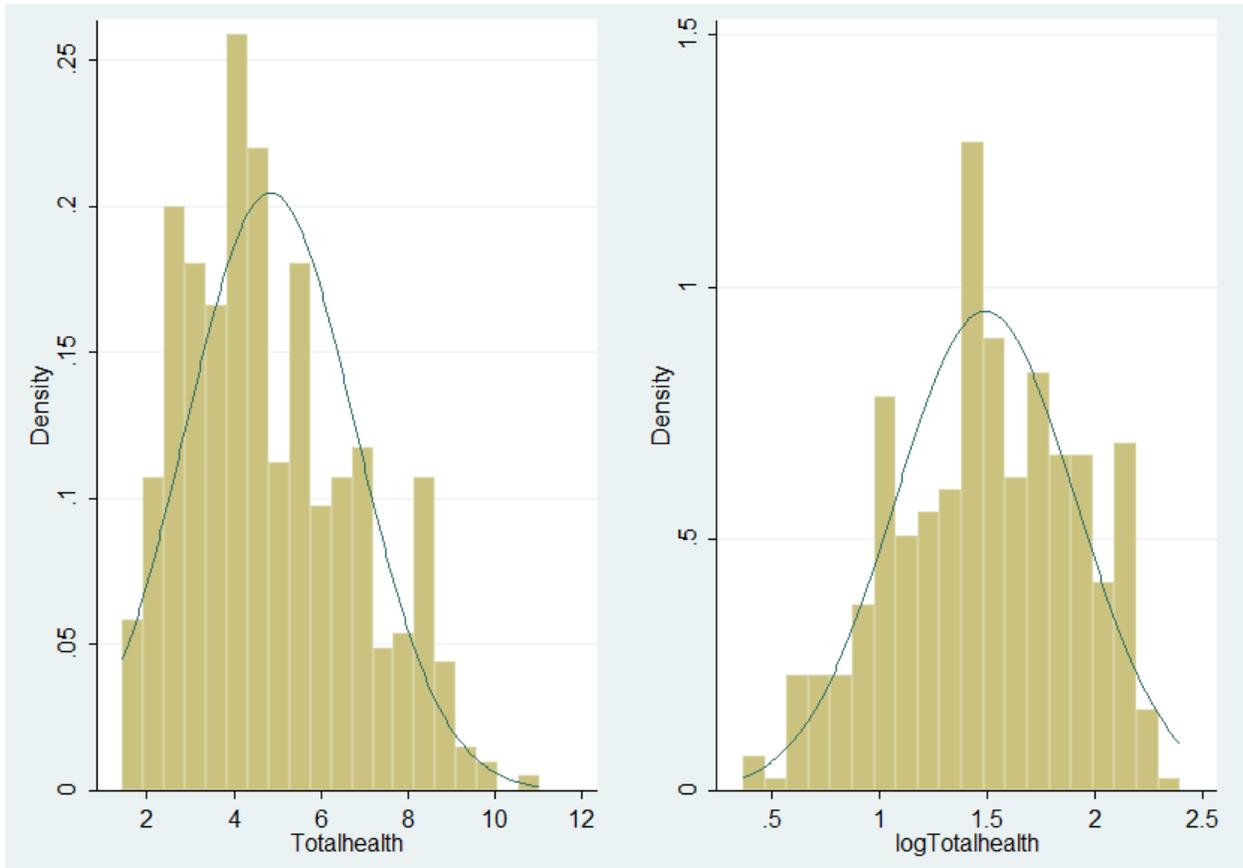
Figures A1.7: Histograms showing the distributions of Urbanization and log-Urbanization variables



Figures A1.8: Histograms showing the distributions of the GDP and log-GDP variable



Figures A1.9: Histograms showing the distributions of the HIV and log-HIV variable



Figures A1.10: Histograms showing the distributions of the Total health expenditure and log-Total health expenditure variable

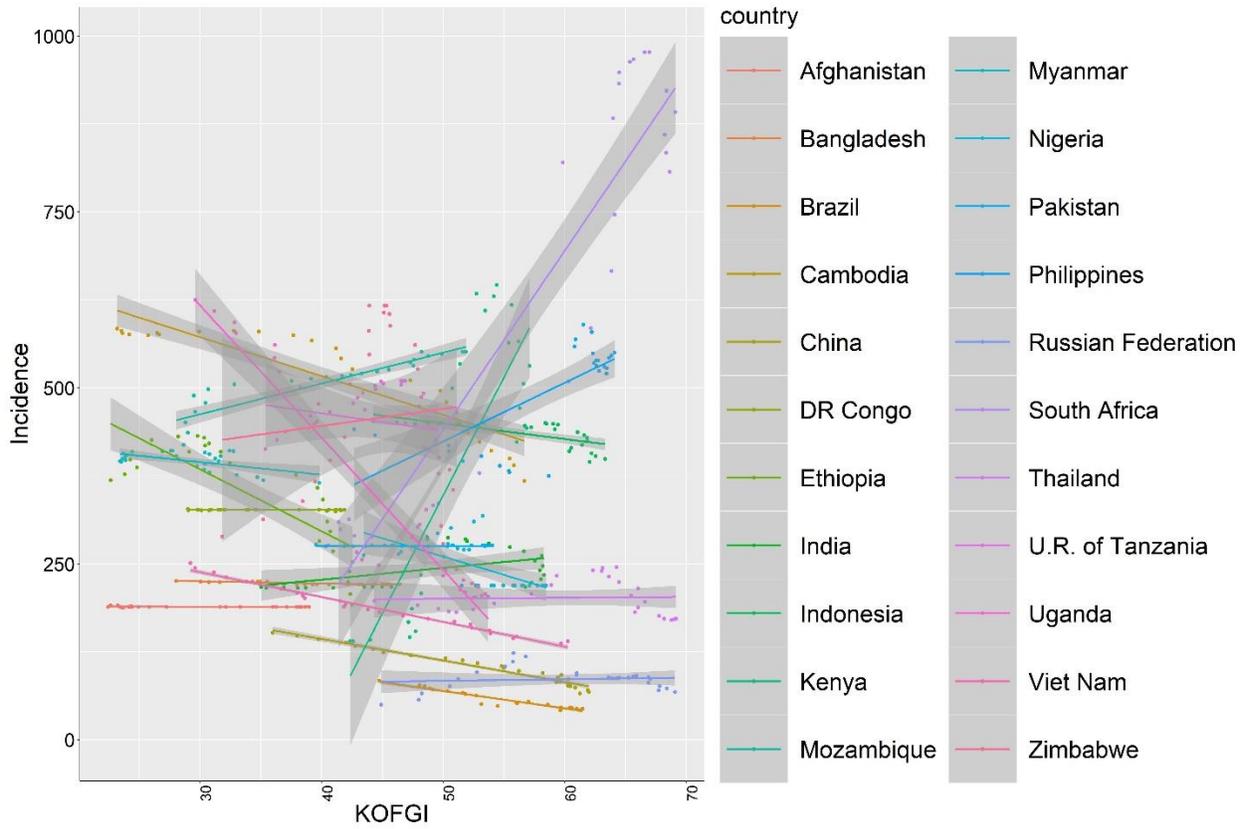


Figure A2: Plot of incidence versus globalization displaying different slopes per country

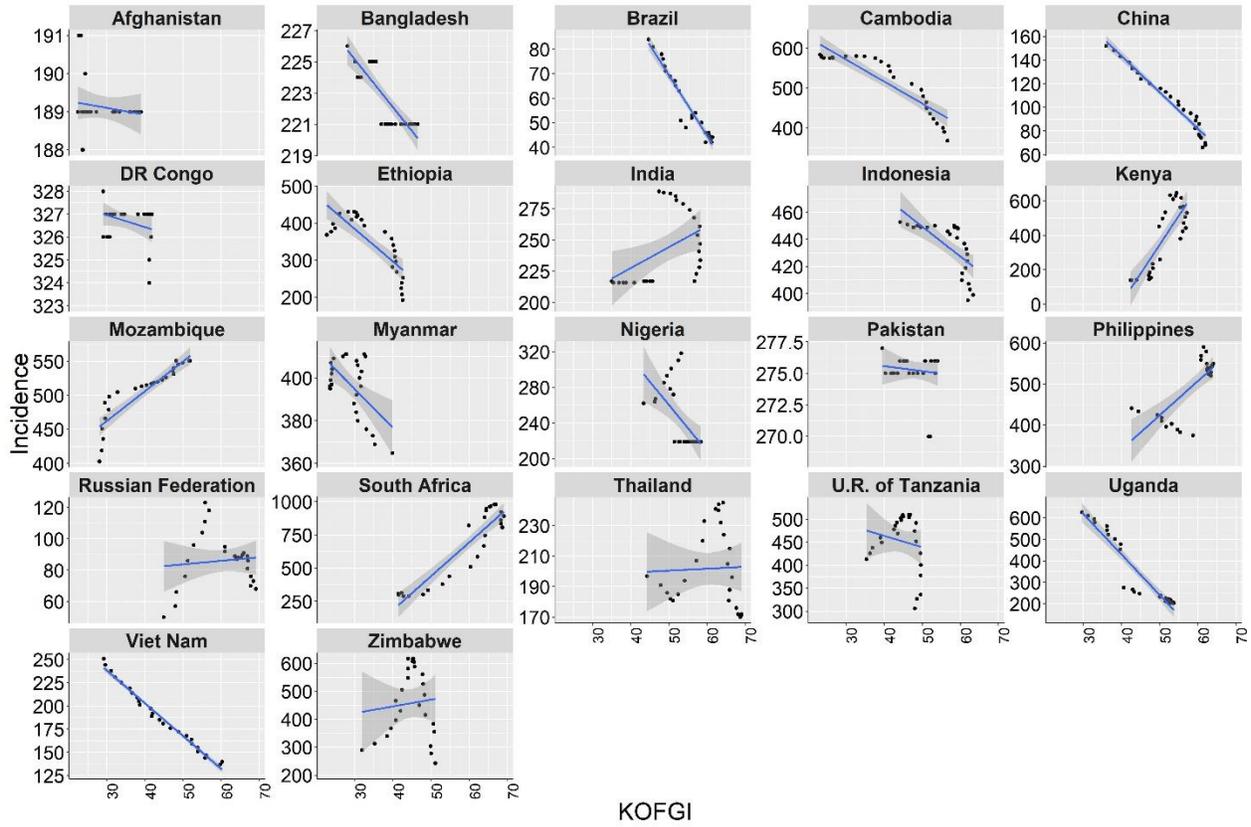


Figure A3: Scatterplots of Incidence versus Globalization per country

QQ plot of scaled residuals

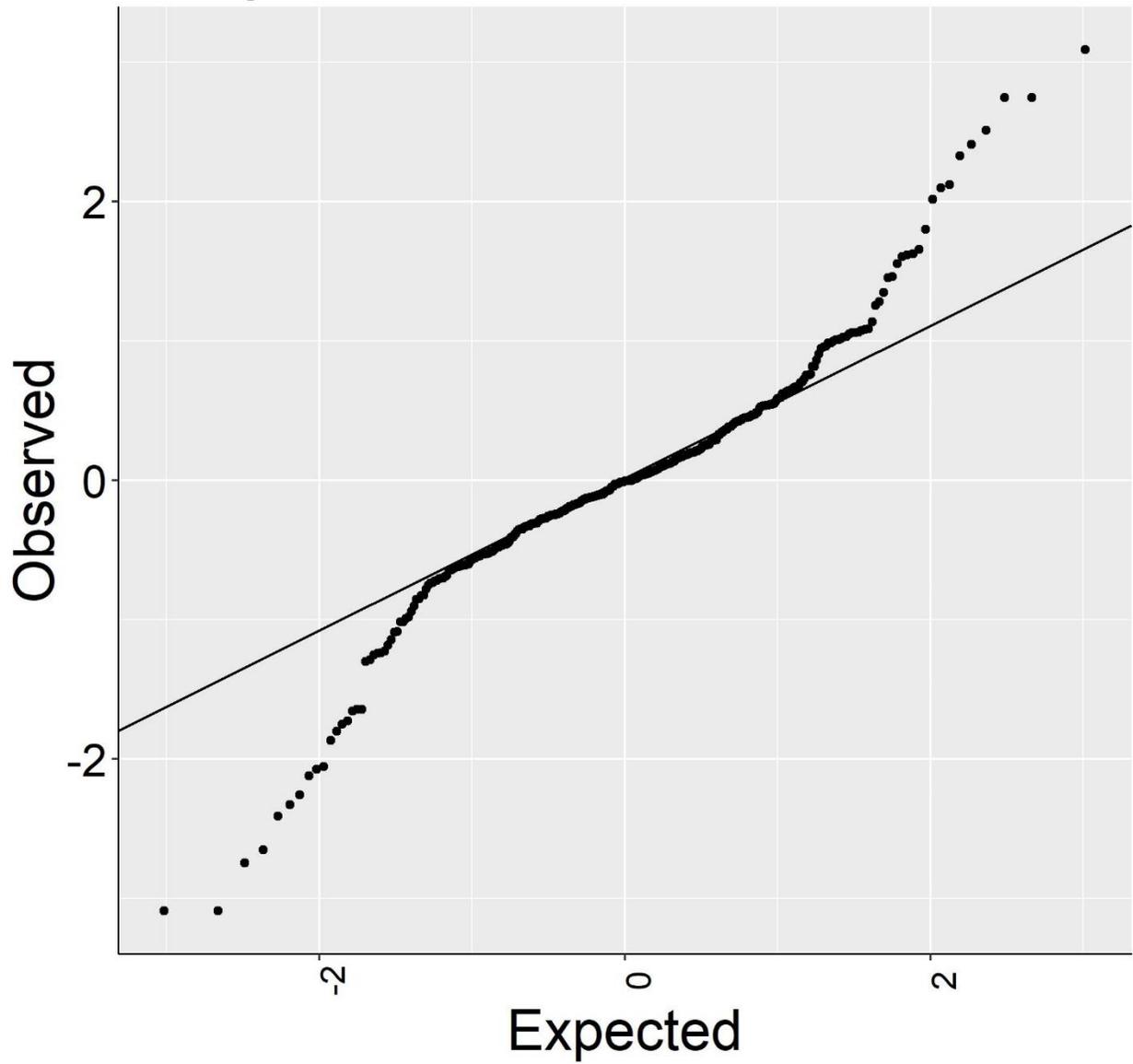


Figure A4: QQ plot of scaled residuals of the model

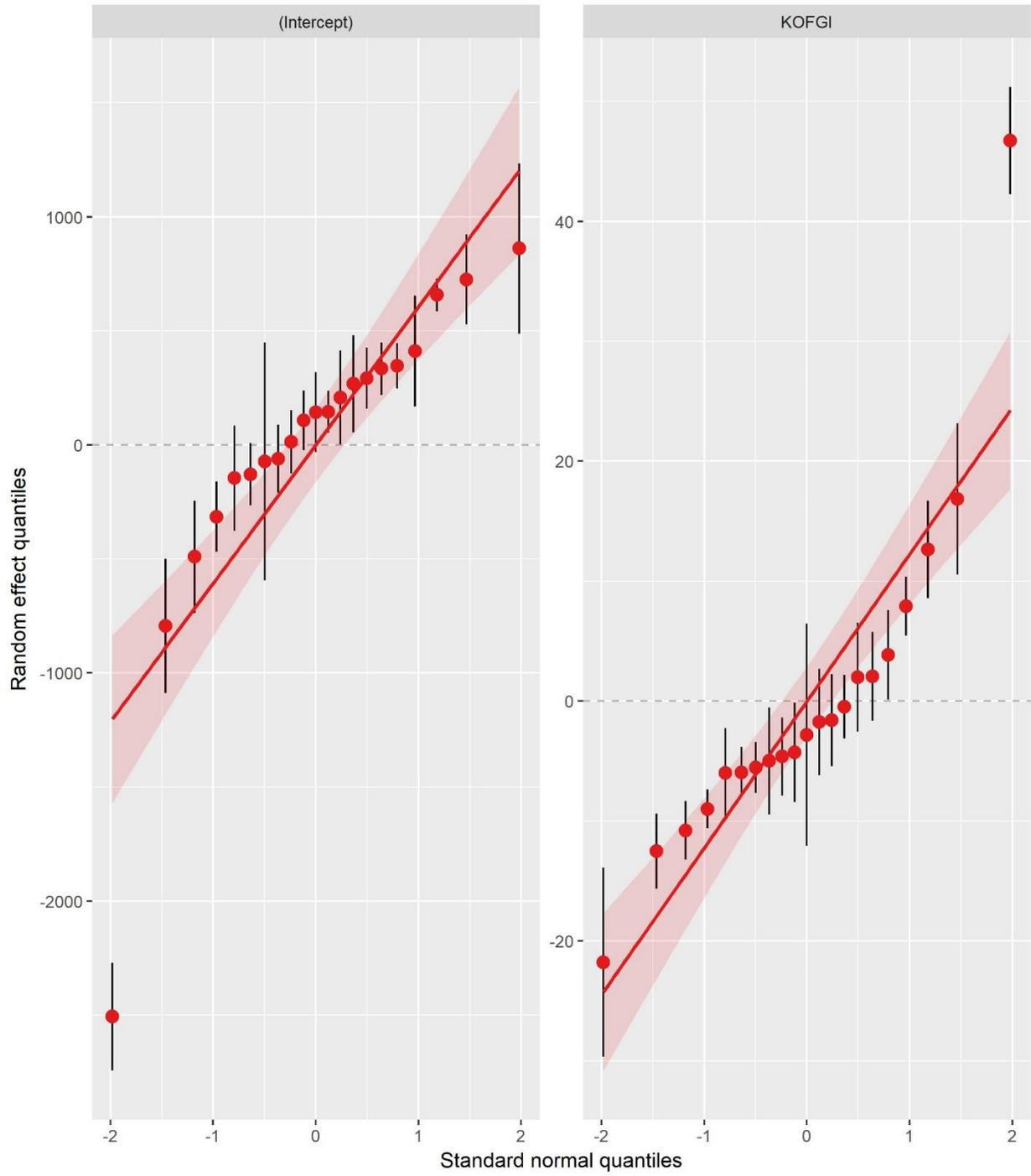


Figure A5: Normality of random intercept and random slope estimates

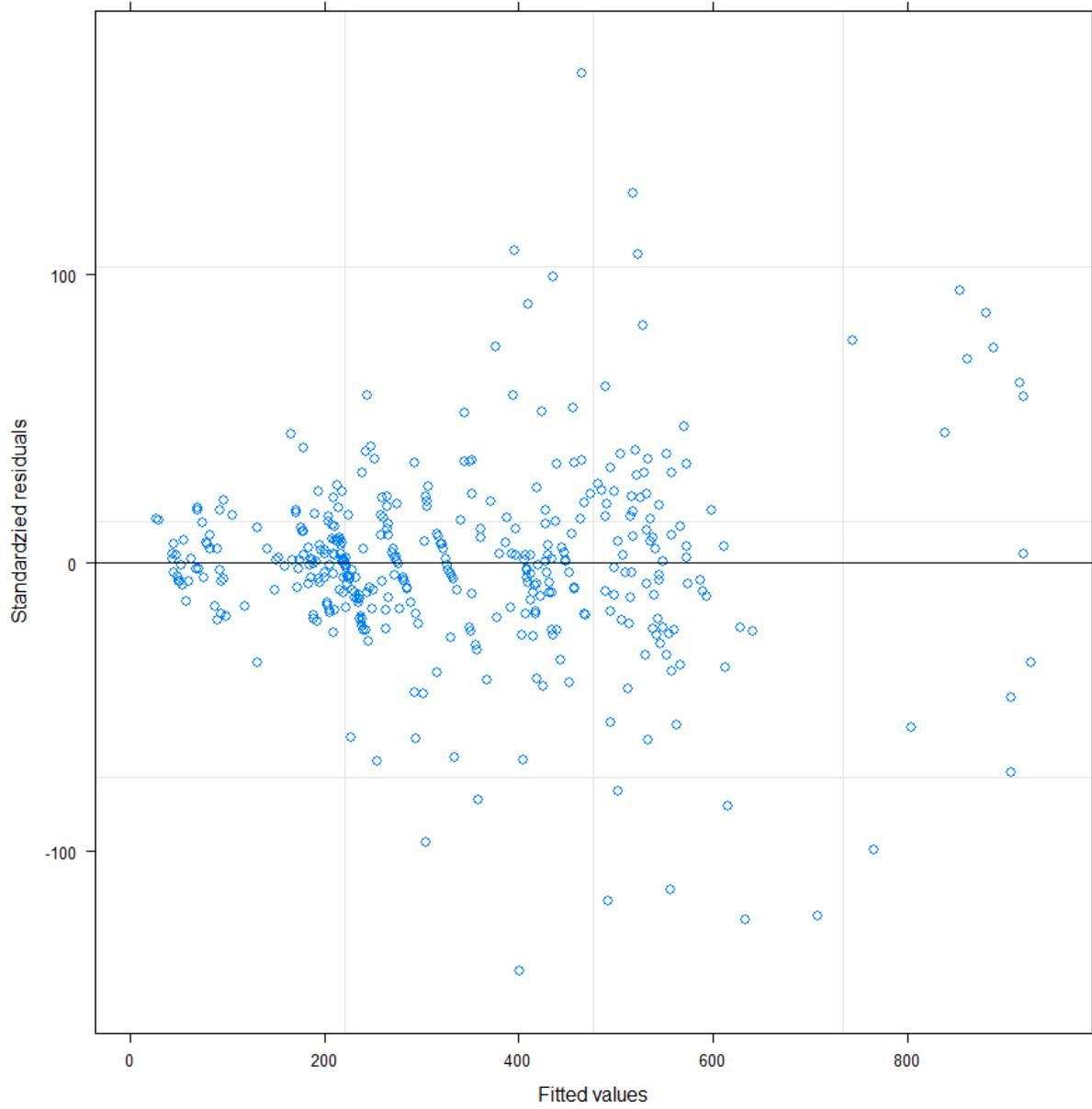


Figure A6: homogeneity of the variance

Model 1: Random intercept only

 	Estimate	Std. Error	df	t value	Pr(> t)
** (Intercept) **	296.4	42.29	49.16	7.008	6.335e-09
KOFGI	0.6066	0.5407	567.1	1.122	0.2624

Model 1C: Random intercept only with confounders:

 	Estimate	Std. Error	df	t value	Pr(> t)
** (Intercept) **	495	62.52	183.4	7.917	2.252e-13
KOFGI	6.988	1.331	379	5.248	2.563e-07
HDI	-1042	165.5	374	-6.295	8.601e-10
Totalhealth	-12.7	4.933	369.5	-2.575	0.01041
Urbanization	3.219	6.242	382.5	0.5157	0.6063
GDP	0.003592	0.001803	378.1	1.992	0.04714
HIV	21.04	2.618	333.8	8.037	1.609e-14

Model 2: Random intercept and random slope

 	Estimate	Std. Error	df	t value	Pr(> t)
** (Intercept) **	362.4	182.7	19.14	1.983	0.06185
KOFGI	-1.417	3.645	19.15	-0.3889	0.7016

Model 2C: Random intercept and slope with confounders

 	Estimate	Std. Error	df	t value	Pr(> t)
** (Intercept) **	380.6	163.7	22.61	2.325	0.02941
KOFGI	9.79	3.208	22.99	3.052	0.005654
HDI	-1131	131.8	367.3	-8.577	2.765e-16
Totalhealth	-14.5	3.408	375.4	-4.254	2.652e-05
Urbanization	4.782	4.902	377.9	0.9755	0.3299
GDP	0.006256	0.001845	376.7	3.391	0.0007709
HIV	22.28	3.47	175.3	6.419	1.239e-09

Output 1: Comparing the two unadjusted models (random intercept only model, Model 1 versus random intercept and random slope model, Model 2).

```
M1: Incidence ~ Globalization + (1 | country)
M2: Incidence ~ Globalization + (1 + Globalization | country)
  Df   AIC   BIC logLik deviance  Chisq Chi Df Pr(>Chisq)
M1  4 6878.7 6896.1 -3435.4  6870.7
M2  6 6305.3 6331.3 -3146.6  6293.3 577.46      2 < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Output 2: Confirmation that model with covariates (Model 2C) is better than model without covariates (Model 2), using AIC and BIC

```
> AIC(M2C, M2)
  df   AIC
M2C 11 4122.297
M2   6 4286.347
> BIC(M2C, M2)
  df   BIC
M2C 11 4166.064
M2   6 4310.220
```

A.2 Model with different sources of healthcare funding

Model 2CH: Random intercept and random slope with confounders (using different sources of healthcare funding)

 	Estimate	Std. Error	df	t value	Pr(> t)
** (Intercept) **	384.6	165.8	21.32	2.319	0.0304
KOFGI	10.33	3.098	21.5	3.336	0.003061
HDI	-1274	162.3	338	-7.849	5.586e-14
PublicH	-10.64	5.055	344.7	-2.104	0.03606
PrivateH	-16.22	5.348	352.4	-3.032	0.002609
ExternalH	0.559	0.39	332.5	1.434	0.1527
Urbanization	10.12	5.578	353.9	1.815	0.07042
GDP	0.01144	0.00312	355.6	3.667	0.000283
HIV	21.13	4.042	135.8	5.229	6.3e-07

A.3 Fitting a model that excludes data from South Africa

M2wSA: Model that excludes data from South Africa, no covariate

 	Estimate	Std. Error	df	t value	Pr(> t)
** (Intercept) **	302.8	98.36	19.53	3.079	0.006036
** globalization **	-0.2424	2.028	19.71	-0.1196	0.906

M2CwSA: Model that excludes data from South Africa, with covariate

 	Estimate	Std. Error	df	t value	Pr(> t)
** (Intercept) **	473.9	160.9	21.47	2.945	0.007619
** KOFGI **	7.67	3.225	21.55	2.378	0.02671
** HDI **	-1053	118.9	344.4	-8.859	4.376e-17
** Totalhealth **	-11.34	3.061	355.5	-3.706	0.0002443
** Urbanization **	2.393	4.362	354.1	0.5486	0.5836
** GDP **	0.003836	0.001666	356.4	2.302	0.02191
** HIV **	11.19	3.314	113.1	3.375	0.001011

Appendix B **Initial Contact Letter for Participant Recruitment**

Unravelling upstream forces as determinants of health: Tuberculosis among healthcare workers in South Africa

Principal Investigator:

Co-Investigators:

Sponsor: This research is supported by a grant from the Canadian Institutes of Health Research.

Date:

Subject: Request for academic interview

Dear [NAME],

I am a graduate student at the University of British Columbia, Canada. I received your name from [NAME]. I am currently conducting a research project to study evidence of perceptions of macro/upstream factors that affect the effectiveness of actions to control and prevent Tuberculosis among health sector workers. The principal investigator for this study is Prof. Jerry Spiegel, a professor at University of British Columbia. Co-investigators include: As part of this study, I am interviewing hospital CEOs, managers, worker organizations; ministry of health and labour and compensation (social security); occupational health and safety professionals; researchers with interest in OHS, public policy and globalization

The research project examines the central question, *“In what ways have integration into the global economy helped South Africa to address or instead exacerbate occupationally acquired TB among healthcare workers, and what policies could lead to improvements?”*.

By focusing on how upstream forces affect TB incidence among healthcare workers in South Africa, I believe such an inquiry on one hand can provide insights into how upstream factors affect health equity so that they can be more appropriately pursued. On the other hand, this provides an opportunity to identify policies and processes that can contribute to addressing a continuing health challenge in South Africa, in a way relevant to other countries reliant on a healthy health worker workforce.

The result of this study will benefit both the South African and global community by identifying pathways through which upstream forces impact occupational health. The research focus and methodological approach will be of interest to researchers and policy makers in this area looking at how macro level policies impact health as well as how to analyze the consequences of those in place or being considered.

I will be in Johannesburg from [Date]. If you are willing and available, I would very much like

to meet with you to interview you regarding your organization's activities and any involvement you have had with the aforementioned research question

If you agree to be interviewed, you may choose to either have your name and organization mentioned in publications that result from the study, or to have your name and/or organization remain anonymous in connection with any statements you make during the interview. The duration of the interview will be approximately 60 minutes and I can schedule it for a time that is convenient for you.

The results of this study will be published eventually as part of my Ph.D. dissertation at the University of British Columbia.

If you are able to make time for an interview, kindly contact me at [Email]. I will contact your office shortly to set up an appointment.

Thank you for your time, and please feel free to contact me if you have questions about the study or the interview.

Yours faithfully,

Prince A. Adu, MPH
Ph.D. Candidate, School of Population and Public Health
Faculty of Medicine, University of British Columbia, 2206 East Mall,
Vancouver, BC, Canada, V6T 1Z3
Telephone:

Appendix C **Consent Form**

Unravelling upstream forces as determinants of health:
Tuberculosis among healthcare workers in South Africa

Co-Investigators

Prince A. Adu, MPH, Ph.D. Candidate
School of Population and Public Health, University of British Columbia (UBC)
2206 East Mall, Vancouver, BC V6T 1Z3
E-mail:

Michael Law, PhD, Associate Professor, UBC
E-mail:

Annalee Yassi, MD, Professor, UBC
E-mail:

Principal Investigator
Jerry Spiegel, PhD, Professor, UBC
E-mail:

Informed Consent: Expert Interview

Please read all sections of this form carefully. In order for your responses to be included in the analysis phase of this research project you will need to sign this form at the beginning of this interview.

Consent to Participate

This project is called Unravelling upstream forces as determinants of health: Tuberculosis among healthcare workers in South Africa.

This study is being carried out by health researcher Prince Adu, Doctoral Candidate, from the School of Population and Public Health, Faculty of Medicine, UBC.

Information garnered may eventually be used in published papers. You understand that your participation is voluntary and any identifiable data collected from you will remain strictly confidential and will not be attributed to you without your permission.

What does consent mean?

Your consent means that you understand what participation in the study will involve and agree to

participate in the study of your own free will. In-depth semi-structured interviews will be conducted, and interviews will utilize a number of open-ended questions.

The information may be used as support in a variety of accounts the researchers may present. You understand that the interviews will be audio recorded and the material will be managed to ensure appropriate confidentiality of sources. The information provided to the interviewer is considered confidential. Interviews will be approximately one hour in length.

What is the study about?

The study basically looks at the evidence surrounding the impact of globalization (upstream forces) and health; evidence is being sought at the population level and also among healthcare workers (HCW). Essentially evidence is being sought to support the hypothesis that the failure to adequately implement measures to protect HCW such as through allocating adequate health resources to public health in general and occupational health in particular is itself rooted in identifiable upstream forces that are capable of being addressed. The central research question is: In what ways has integration into the global economy helped South Africa to address or instead exacerbate occupationally acquired TB among healthcare workers, and what policies could lead to improvements?

Sponsor

This research is supported by a grant from the Canadian Institutes of Health Research.

Why is your participation important?

Globalization is having a profound and far reaching impact on public health. Through greater appreciation of the often neglected circumstances of HCW, alongside consideration of opportunities for policies more integrated with upstream forces, this study will provide an innovative contribution for practical ways to conceive of pathways for greater health equity. As an expert interviewee you are in a position to provide a factual account of an event, a procedure, a process, a historical account, and so forth.

What will happen in the interview?

In the interview you will be asked to provide your expert knowledge on the evidence of macro/upstream factors that affect the effectiveness of actions to control and prevent tuberculosis among health sector workers. The interview will be informal with open-ended questions and may last up to one hour. The discussion will be recorded. Information about you will not be associated with the data, and you will be asked to help construct how any references to you or this interview may be described. Once the interview is completed, the information you provide will be analyzed, compared and supported by information received in other interviews. Information provided will not be attributed to you unless requested. The information will then be presented in a doctoral thesis and publications in scholarly journals.

Who will get to see the information and what will they get to see?

Audio tapes and interview transcripts will be contained in a locked filing cabinet at the School of Population and Public Health at UBC. All audio recordings and original data will be destroyed after five years.

Who can you contact for more information?

If you have any concerns or complaints about your rights as a research participant and/or your experiences while participating in this study, contact the Research Participant Complaint Line in the UBC Office of Research Ethics at 604-822-8598 or if long distance e-mail RSIL@ors.ubc.ca or call toll free 1-877-822-8598.

I understand that my participation in this expert interview is voluntary and any information I provide will be considered confidential. That means my name will not be associated in any way with the results of this research without my consent.

Please attribute comments to myself in publications that use information from this interview.

Initial – Yes

Initial - No

By signing below, I agree to participate in the expert interview.

Printed Name

Signature of Participant

Date

You will be given a copy of this consent form for your records. Please retain that copy and refer to the contact information if you have further question.

Appendix D Interview Script

Unravelling upstream forces as determinants of health: Tuberculosis among healthcare workers in South Africa

In-depth, semi-structured interviews will be conducted. This script will guide the discussion of the impact of macro level determinants of tuberculosis infection among healthcare workers.

The interview will be conducted with key informants from three identified stakeholder groups:

- Government/including Provincial & National Health Department
- Hospital Level Personnel
- Academic Experts

A number of thematic categories of inquiry have been identified that the research seeks to address. Information will be collected and analyzed on the following themes as guided by the research questions and study objectives. The interview questions have been divided into these thematic categories.

Introduction

Thank you for agreeing to talk with me, and for your participation in this research project. I anticipate the interview will last about an hour, and appreciate any information you can provide to help me learn more how factors characterized as “upstream” or “macro” can influence the presence of tuberculosis among health worker – a workforce that has been observed to have rates of infection that are 3 to 5 times greater than the general population. By “upstream” or “macro” I mean the policies, conditions and processes that are not within the control of individuals – which I refer to as “micro level” or their immediate workplace or organization – which I refer to as the “meso level”.

I am interested in both your individual perspective as well as the perspective of your organization, if this is relevant.

I am currently recording this conversation and would also like to record the interview. As a standard procedure before the interview, I will read a short paragraph concerning the protection of privacy.

If you agree to have your interview recorded, the recording, as well as transcripts of the interview, will be kept in a protected file for a period of at least 5 years. The recording will be used as backup to the notes that I will be taking during the interview. Only the principal investigator (who is my supervisor), the co-investigators and staff will have access to the recorded interview and my notes. I will not share the detailed comments from your interview with any other party. The recording and any detailed notes will be considered personal information and, as such, will be protected in accordance with the Access to Information and Privacy Acts. Your acceptance or refusal will be recorded on tape for proof of acceptance or

refusal as well as documented in writing. Do you accept that we record your interview?

Thank you for accepting. (If refusal: Do you object to me taking notes during the interview?)

Do you have any questions before we begin?

About the Participant

Tell me about how in *your* role you might consider the effects of upstream or macro factors that can have consequences for health concerns, such as tuberculosis. This could include direct or indirect influences on its spread - or on programs that could or do exist to control and prevent its spread and effects.

Tuberculosis in SOUTH AFRICA

1. In your opinion, why does SOUTH AFRICA have such a high presence of tuberculosis?
2. In your opinion, how serious a health concern is tuberculosis? Are circumstances getting better or worse?
3. What factors (at different scales: micro, meso, macro) do you think are influencing the growth of MDR and XDR TB.

Part A: Macro level challenges/barriers to implementation of effective occupational health and infection control program

4. In your opinion, what are the macro level barriers to implementation of effective occupational health and infection control programs?
5. Are you aware of any organizational or cultural barriers (or promoters) to implementing effective TB prevention programs at the workplace?
6. Are there barriers to accessing treatment? What are they?
7. Do you think effective occupational health and infection control in your facility is influenced by broader forces such as politics and economics? How? Any specific instance where this was evident.
8. How much impact do you think education or awareness of TB program at the workplace has on occupationally acquired TB?
9. Do you think that the mining sector plays a role in perpetuating and addressing the high TB burden in the country; If so, elaborate please.
10. Is there anything else that you want to add?

Part B: Policies that could enhance the capacities to prevent and control TB infection among health workers

11. Are you aware of any policy in place on how to prevent TB transmission at the workplace? What about treatment? Is it implemented? If not, why?
12. Please describe the landscape of resource allocation for occupational health. From your

perspective, has public funding for health especially for occupational health increased post-apartheid?

13. What is the nature of governance on TB in the workplace? Is there a feedback mechanism? What is the decision-making structure and what kind of influence do healthcare workers have in that?

Closing

14. Is there anything else that you want to add? Is there anything you would like to ask me?
15. Is there anyone else I should speak to within your organization about TB control?
16. Are there any other policy documents produced by your organization or others that I should review?
17. Would you like to receive your draft transcript for review? (yes/no)
18. Would you like to receive a summary of the findings? (yes/no)
19. If the results are published, can I send you the link? (yes/no)

Thank you for your time.

End of Interview