An Inquiry into Health Systems Governance: the Case of Tanzania

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Summary

Over the last decade, the global movement towards universal health coverage (UHC) gradually shifted its focus. For many low- and middle-income countries (LMICs), the late 1990s and early 2000s have been characterized by strong and long-lasting efforts to eradicate infectious diseases and improve maternal and child health, expanding access to effective healthcare services. Over the following decade, global health institutions started to emphasize the role of health systems governance and the need to address high quality of care across local health systems. Governance has been identified as a building block of all health systems and deemed as conducive of improved social health protection, equity in health and increased quality of healthcare provision. Despite its importance, international institutions and researchers failed to provide a unanimous definition of health systems governance.

This dissertation aims to contribute to the debate about health systems governance in LMICs, reflecting on the case of a large sub-Saharan country: Tanzania. The broad goal of this thesis is to distil some operational governance dimensions and assess their role in health services provision in Tanzania. The introductory chapter provides an overview of the role of health systems governance in LMICs, offering a working definition of governance that is used throughout the manuscript. Part I also presents the specific research objectives, outlining the methods applied in the subsequent parts of the dissertation. Part II introduces the reader to the health system and the health policy context in Tanzania, focusing on the governance challenges that characterize this large East African country. Part III looks at the role of incentives to health workers and supervision for the provision of high-quality healthcare. The study is based on a multilevel regression analysis of secondary data on a large sample of Tanzanian public health facilities from the Service Provision Assessment (SPA) survey conducted in 2014/2015. In part IV, the focus switches on the impact evaluation of social accountability initiatives on healthcare provision. The analysis builds on the implementation of a social accountability monitoring program - by the local NGO Sikika - in the Tanzanian region of Dodoma. Using a difference-in-differences approach, the research aims at identifying the effect of the program on two specific outcomes targeted by Sikika: availability of essential medicines and infrastructure maintenance in government-managed health facilities. Part V addresses the design, management and regulation of patient referral systems in settings characterized by strong focus on primary healthcare. The study is based on primary data collected in the two rural districts of Kilolo (Iringa region, Southern Highlands zone) and Msalala (Shinyanga region, Lake zone). The analytical approach builds on previous work in the field of social network analysis, mapping the available data to networks with health facilities representing nodes and patient referrals representing directed edges. The discussion in part VI summarizes the previous results putting them into perspective, outlining a framework where interrelated governance dimensions contribute to UHC goals. The section concludes touching upon the limitations of the proposed approaches and discussing the implications for health policy.

The findings can be grouped in four main areas, reflecting the operational governance aspects explored empirically across the manuscript. The first area relates to top-down monitoring and supervision arrangements. The Tanzanian case highlights the ineffectiveness of initiatives meant to monitor the activity of local public healthcare providers spread across vast rural areas. Quality of care at point of service shows no association with the intensity of supervision at facility and individual level. Although measurement errors could prevent effective effect identification, the results cast doubts on the imple-

mentation of such arrangements. The second area addresses the role of incentive policies to push health workers towards the provision of high-quality healthcare. Financial and non-financial incentives offered to health workers show positive associations with the two measures of quality of care analysed, namely compliance with guidelines for treatment of sick children and patient satisfaction. Salary top-ups improve the otherwise poor salary conditions faced by health workers in public health facilities across the country. The analysis reveals positive effects on both indicators of quality. Among the non-financial incentives included in the analysis, subsidized housing offered to health workers appears to be positively associated to patient satisfaction. The study suggests an interpretation relating increased satisfaction to closeness between communities of health workers living in the health facility compound. The third area is related to bottom-up supervision and social accountability mechanisms. On the one hand, frequency of meetings between health facility staff and local communities is associated with increased patient satisfaction. The result reinforces the finding on subsidized housing, supporting the idea that closeness between providers and communities improves patient satisfaction. A potential pathway for this influence is the increased accessibility of providers (for example in case of emergencies) and improved ability to address the needs of the community. On the other hand, the social accountability monitoring program implemented in the Dodoma region reveals potentially positive effects on availability of essential medicines. Besides favouring effectiveness and appropriateness of treatments, the reduction of stock-outs in essential medicines contributes to improved patient satisfaction and in turn to positive healthcare seeking behaviour. The study does not detect any impact of social accountability monitoring on infrastructure maintenance, possibly suggesting different impact mechanisms related to the need of district level budgeting and resource allocation. Finally, the fourth area discusses the implications of design and regulation of patient referral systems. The results emphasize the importance of appropriate investments in infrastructure, especially in secondary level facilities (i.e. health centres). The study reveals that in Kilolo district most patient are referred directly to the regional referral hospital in Iringa Town, mainly as a result of geographic closeness and infrastructure availability. Health centres have a little role in terms of mediating referrals between primary and tertiary level facilities. A failure in the gatekeeping system may result in negative consequences in terms of increased financial burden for households required to travel to the crowded hospital words in Iringa Town. The analysis also suggests that a strategic orientation towards quality of care at district level may positively influence the functioning of patient referral systems. In Msalala district, besides higher rates of referrals to health centres, the results are consistent with a virtuous cycle of referrals directed towards smaller and more specialized facilities. Although the study is not designed to detect causal effects, these positive results may be associated to the implementation of a system-wide project aimed at strengthening different components of the health systems.

Overall, the dissertation sheds light on the complex interaction between the different health systems governance dimensions analysed. What emerges is a set of mutually connected dimensions that contribute together to the three main goals of UHC: coverage and access, financial protection and the delivery of quality health services. The conclusion offers a number of suggestions to policy makers in relation to the potential outcomes associated to the implementation of different governance tools. On a more general note, the results are consistent with the ongoing efforts to promote systems thinking in health systems research. This dissertation supports the message that health system governance is better addressed with a comprehensive approach rather than with partial policies, unleashing a multiplicative effect of self-reinforcing interactions between different governance functions and tools.

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List of Abbreviations

ANC	antenatal care
BRN	Big Results Now
CHF	Community Health Fund
CHMT	Council Health Management Team
CRSE(s)	cluster-robust standard error(s)
CSO	Civil Society Organization(s)
DHS	Demographic and Health Surveys Programme
DID	difference-in-differences
ERGM(s)	exponential random graph model(s)
FBO	faith-based organization
GDP	gross national product
HBF	Health Basket Fund
HFGC	Health Facility Governing Committee
HFS	health financing strategy
HPSS	Health Promotion and System Strengthening Project
HRH	human resources for health
HSSP	health sector strategic plan
ILS	integrated logistic system
IMCI	integrated management of childhood illness
IMTC	Inter-Ministerial Technical Committee
ITN(s)	insecticide-treated bed net(s)
LGA	local government authority
LMIC(s)	low- and middle-income country(ies)
MDG(s)	Millennium Development Goal(s)
MoH	Ministry of Health
MSD	Medical Stores Department
NBS	National Bureau of Statistics
NCD(s)	non-communicable disease(s)
NGO	non-governmental organization
NHIF	National Health Insurance Fund
NKRA	national key results area
OLS	ordinary least squares
OOP(s)	out-of-pocket payment(s)
PHC	primary health care
PPP	purchasing power parity
P4P	pay for performance
RBF	results-based financing
RCH	reproductive and child health
RCT	randomized controlled trial
SAM	social accountability monitoring
SDG(s)	Sustainable Development Goal(s)
SNA	social network analysis
SNHI	single national health insurance
SPA	Service Provision Assessment survey
SWAP	sector-wide approach
TASAF	Tanzania Social Action Fund
TB	tuberculosis
TWG	technical working group
UHC	universal health coverage
UN	United Nations
WHO	World Health Organization

Preamble

The research featured in this dissertation was motivated by a broader project titled "Health systems governance for an inclusive and sustainable social health protection in Ghana and Tanzania". The project is funded by the Swiss Programme for Research on Global Issues for Development (r4d), a joint initiative of the Swiss National Science Foundation (SNF) and the Swiss Agency for Development and Cooperation (SDC). The research consortium includes five institutions in three different countries. The leading institution is the Swiss Tropical and Public Health Institute (Swiss TPH) in Basel, one of the three Swiss partners together with the Center for Development and Cooperation (NADEL) at ETH in Zurich and the University of Applied Sciences and Arts of Southern Switzerland (SUPSI) in Lugano. The research partner in Ghana is the School of Public Health at the University of Ghana in Accra. The Tanzanian partner is the Ifakara Health Institute based in Dar es Salaam.

In the era of Sustainable Development Goals, achieving health for all emerges as a key target for all low- and middle-income countries (LMICs). The project sought to provide evidence on the role of health system governance as a tool to promote access to quality care, to strengthen accountability and to improve management of health services in the two target countries.
Within the broader project, the stream of research presented here explores a series of empirical applications. The overarching goals guiding this work are (1) to distil operational conceptualizations of health system governance and (2) study their implications for healthcare provision in Tanzania.

Part I

Introduction

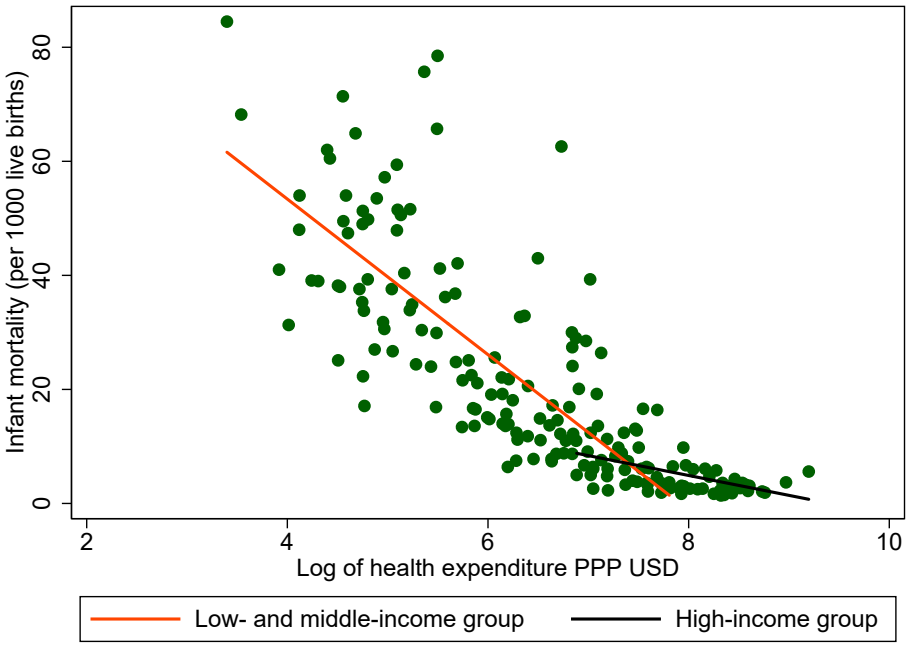
1 The case for analysing health systems governance

1.1 Health, healthcare and health systems

Despite substantial improvements in health outcomes over the last 50 years, challenges persist in relation to the strong inequality in health both across and within countries. Starting from worst initial conditions, low-income countries experienced the sharpest improvements with over 20 years in life expectancy gained between 1967 and 2017. Nevertheless, the gap in life expectancy between low and high-income countries remains close to 15 years to date. Interestingly, similar levels of inequality can be observed within the same country, even in high-income areas (Marmot, 2020). This gap in health status can be attributed to differences in a few determinants of health, above all environment, social determinants of health and access to healthcare (Commission on Social Determinants of Health, 2008; Frenk and Moon, 2013). In relation to socioeconomic status, Samuel H. Preston first described an empirical association between life expectancy and income (Preston, 1975). Although the mechanism linking health and income is still debated (Deaton, 2003; Marmot, 2002), the world income and health distributions show a similar level of cross-country inequality to this day. With regards to income, the World Bank reports a twentyfold difference in income per capita between low- (2'006 USD PPP) and high-income (44'830 USD PPP)

country groups for year 2018 [1]. Related to this difference, there is a strong gradient in the amount of economic resources allocated to health. Health expenditure measures the amount of resources injected into the health system, which interacts with social and other determinants to generate population health (Commission on Social Determinants of Health, 2008). The World Health Organization defines health systems as the mix of "all the activities whose primary purpose is to promote, restore or maintain health" (World Health Organization, 2000). The correlation between health expenditure and health is illustrated in figure 1, plotting infant mortality and log health expenditures. The steeper slope for countries with lower income per capita suggests that return on investment in healthcare may be higher in low-income settings (Deaton, 2006; Ochalek et al., 2018).

Figure 1: Relationship between country health expenditure and infant mortality for 184 countries in year 2016.



Notes: Health expenditures are converted to US dollar in purchasing power parity (PPP). PPP expresses the real purchasing power between currencies considering the different levels of prices across countries. The countries are separated into income groups based on the World Bank classification for year 2016. Source: author's elaboration on World Bank data (2017).

To fill the gap in resource availability, many LMICs relied extensively on development aid over the last decades, with some countries reporting up to 50% of health expenditure from external sources. The results of aid in terms of health outcomes are mixed and the broader topic of the effect of foreign aid on development of the recipient countries has been at the centre of a lively academic debate (Miller, 2012). Some support the idea that external investment naturally translates to development (Sachs, 2006). Others are more sceptical, arguing that (exogenous) development aid disrupts endogenous mechanism preventing growth (Easterly, 2006, 2008). On a more general note with no value judgment attached, the strategy casts some concerns about long-term sustainability of relying on foreign aid to fund essential government functions.

[1] Data referred to 2018 gross domestic product (GDP) per capita in purchasing power parity terms (constant 2011 international US dollars). For further details see `https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.KD`.

Irrespective of resource availability, advances in medical and clinical research developed a wide range of healthcare procedures that proved to be cost-effective in ideal conditions. The extent to which these interventions work in different settings is related - among other factors - to the complex mix of elements composing health systems. In spite of their great importance and partially associated to their complexity, the amount of evidence about the contribution to health associated to key components of health systems remains limited (De Savigny and Adam, 2009). Consistently, the focus of the global health community gradually shifted from technical approaches to disease eradication to a broader health systems strengthening perspective (Hafner and Shiffman, 2013) and more recently to the importance for health systems to address high quality of care (Kruk et al., 2018).

1.2 Governance and health systems

In the debate about development and effectiveness of government endeavours and development efforts, governance is a pervasive concept. Good governance and strong institutions are recognized as root-causes of social and economic development (Acemoglu et al., 2001). This importance is also reflected in the Sustainable Development Goals (SDGs) promoted by the United Nations, which highlight the need for "building effective, accountable institutions at all levels" (SDG 16). Broadly speaking, governance encompasses all political, administrative and democratic instances that oil the wheels of institutional mechanisms, making things work in public service provision and linking policies to the needs of the stakeholders involved. Governance deals with the societal mechanisms to make and implement decisions (Fryatt et al., 2017) at different levels (Ostrom, 2010; Abimbola et al., 2014). In the domain of health systems research, these concepts have been translated to a multifaceted notion encompassing a wide range of topics. Governance is thus associated with citizen representation, interplay between citizens and government, accountability mechanisms, institutional design, distribution of responsibilities, ownership, political stability, policy formulation, priority setting, strategic guidance and leadership (Mikkelsen-Lopez et al., 2011; Lewis, 2006a; Loewenson, 2008; World Health Organization, 2007).

Despite its centrality, it is not until the last decade that health systems governance gained prominence in the agenda of international organizations such as the World Health Organization (WHO) and was identified as a neglected area of research in LMICs (Gilson et al., 2017) and beyond (Smith et al., 2012). Governance progressively entered the health policy debate being recognized as a fundamental building block of all health systems (De Savigny and Adam, 2009; World Health Organization, 2010). More recently, the centrality of governance in healthcare delivery across LMICs was reaffirmed by the Lancet Global Health Commission on High Quality Health Systems in the SDG Era (Kruk et al., 2018).

Most low- and middle-income countries share a common set of challenges in regard to the governance of health systems (Brinkerhoff and Bossert, 2014). Examples of typical failures are delayed payments to providers, inadequate levels of fees for healthcare services, low transparency in exemption policies, lack of citizens involvement in regard to the implementation of new policies and poor coordination of initiatives promoted by different development partners (Lewis, 2006a). In the specific case of Tanzania, which is explored in-depth in part II, governance challenges emerged in relation to the adoption of a new health financing strategy. The Tanzanian government is mainly faced with poor quality of healthcare provision and frequent stock-outs in essential medicines, weak design and management of community-based insurance schemes, lack of coordination of waiver and exemption policies, poor resource allocation at local level and notably delayed release of government funds to health facilities. Challenges in health

systems governance are also common across high-income settings. A few such examples are the fragmented regulatory panorama of the European Union (Mossialos, 2010), the strong impact of values and politics on the implementation of health policies (Fattore and Tediosi, 2013), fiscal cutbacks after the global recession (Ongaro et al., 2015) or the Swiss case where strong democratic rights can potentially change policies (De Pietro and Crivelli, 2015).

In general, undesired outcomes for the population result from the consequences of poor governance rather than from poor governance itself. A major plague affecting health systems as a result of poor governance is corruption[2]. Looking specifically at LMICs, corruption in the health sector can take many different forms: petty corruption, bribes, absenteeism, kickbacks from referral to private facilities or dispensaries, inappropriate provision of services, under-the-table payments, leakages or private use of public resources (Vian, 2008). These illicit activities derive from various forms of rent-seeking behaviour by different actors in the health system. The main governance factors favouring illicit behaviour seem to be lack of accountability and supervision, poor resource allocation, inefficient flow of funds, lack of coordination as well as deficient management and decision making mechanisms (Savedoff and Hussman, 2006). At system level, rent-seeking behaviour undermines the effectiveness, quality and equity of health service provision. It causes severe waste of public funds in resource constrained countries, impoverishment of the population (especially living in rural areas), disruption of trust in the authorities and low economic growth (Gee and Button, 2014; Rose-Ackerman, 2006).

Poor health systems governance is also directly linked to individual performance of providers and facilities. Direct negative consequences of illicit rent-seeking behaviour range from limited access to care (due to excessive fees) associated to higher child mortality (Gaitonde et al., 2016), poor availability of medicines and consequent ineffective pharmaceutical treatment (Vian, 2008). Despite some challenges in disentangling the effect of governance from lack of management skills (Michaud et al., 2015), the lack of adequate incentives and supervision arrangements seem to favour a slack working environment that fails to target good quality of care (Dieleman et al., 2011; Barbazza et al., 2015). Some documented pitfalls on provider performance are low health worker motivation, increased mistreatment of patients, wrong subscriptions and inadequate clinical treatment (Vian, 2008; Sheikh et al., 2014; Barbazza et al., 2015).

2 Health systems governance in low- and middle-income countries

2.1 Governance and universal health coverage

Two key factors that contributed to put governance and institutions at the centre of the health policy debate in low- and middle-income countries are the movement towards primary health care (PHC) and more recently towards universal health coverage (UHC). In 1978, the Alma-Ata declaration set the stage for the subsequent rise of primary care in health policy agendas across the global South, including Africa. The declaration outlined a strategy to attain the goal of health for all, initially by year 2000. It advocated for reshaping health systems around the concept of primary care, as a tool for cheap and cost-effective delivery of healthcare. The implementation of primary care strategies and their evaluation - especially towards the goal of health for all - turned out to be rather complex (Hone et al., 2018; Rifkin, 2018).

[2]Transparency International describes corruption as "the abuse of entrusted power for private gain". For further details see here: `http://www.transparency.org/what-is-corruption/`. Last accessed on October 30th, 2019.

Nevertheless, the concept of primary healthcare successfully shaped health policies and health systems in many LMICs over the last decades. Below we reproduce point XII of the declaration:

> "XII. Primary health care:
>
> 1. reflects and evolves from the economic conditions and sociocultural and political characteristics of the country and its communities and is based on the application of the relevant results of social, biomedical and health services research and public health experience;
> 2. addresses the main health problems in the community, providing promotive, preventive, curative and rehabilitative services accordingly;
> 3. includes at least: education concerning prevailing health problems and the methods of preventing and controlling them; promotion of food supply and proper nutrition; an adequate supply of safe water and basic sanitation; maternal and child health care, including family planning; immunization against the major infectious diseases; prevention and control of locally endemic diseases; appropriate treatment of common diseases and injuries; and provision of essential drugs;
> 4. involves, in addition to the health sector, all related sectors and aspects of national and community development, in particular agriculture, animal husbandry, food, industry, education, housing, public works, communications and other sectors; and demands the coordinated efforts of all those sectors;
> 5. requires and promotes maximum community and individual self-reliance and participation in the planning, organization, operation and control of primary health care, making fullest use of local, national and other available resources; and to this end develops through appropriate education the ability of communities to participate;
> 6. should be sustained by integrated, functional and mutually supportive referral systems, leading to the progressive improvement of comprehensive health care for all, and giving priority to those most in need;
> 7. relies, at local and referral levels, on health workers, including physicians, nurses, midwives, auxiliaries and community workers as applicable, as well as traditional practitioners as needed, suitably trained socially and technically to work as a health team and to respond to the expressed health needs of the community."
>
> Source:
> Declaration of Alma-Ata
> International Conference on Primary Health Care, Alma-Ata (USSR), September 1978

The conception of PHC promoted by the Alma-Ata declaration puts strong emphasis on local ownership. Local ownership is important for primary care initiatives for two main reasons. On the one hand, it allows effective prioritization of local needs. On the other hand, decentralized management and provision of healthcare can be economically efficient, especially in primarily rural countries with poor geographic accessibility (Chan, 2008).

The functioning of health systems that rely on the involvement of local communities rests crucially on a strong cooperation between citizens, public healthcare providers and government authorities. This relationship is underpinned by accountability, transparency and participation mechanisms (Cleary et al., 2013), as opposed to market forces that regulate private providers. The design of health systems based on primary health care in LMICs is also peculiar. A common trait of such systems is a pyramidal structure with large share of primary facilities, some secondary facilities and few tertiary specialized hospitals. Primary facilities are meant to treat common and uncomplicated conditions, whilst referring to secondary or tertiary facilities for complicated cases. Lower level facilities have a gatekeeper role with regards to higher levels of care, which is useful for two main reasons. On the one hand, it ensures to cover a larger share of the population with cost-effective healthcare, avoiding the transaction costs associated to traveling to hospitals located far from home (Abimbola et al., 2015b). On the other hand, it allows to contain costs associated to hospital care and reduces waiting times in hospital wards (Hort et al., 2019).

At the level of healthcare provision, the effective functioning of patient referral systems is influenced by many factors including infrastructure availability, strong policy guidance, regulation, system design and supervision.

The universal delivery of primary healthcare in LMICs has been typically addressed by the public sector rather than relying on private providers and market mechanisms (Peters et al., 2008; Das, 2011). Whilst pitfalls in healthcare delivery by the public sector favoured an increasing role of private providers (Palmer et al., 2003; Mackintosh et al., 2016), the former appears better suited to achieve social and financial health protection for poor and marginalized population across LMICs (Wagner et al., 2011). Accordingly, health systems governance is a key component of strategies addressing universal health coverage, which the WHO decomposes in three goals [3]:

1. Equity in access to health services - everyone who needs services should get them, not only those who can pay for them;
2. The quality of health services should be good enough to improve the health of those receiving services; and
3. People should be protected against financial-risk, ensuring that the cost of using services does not put people at risk of financial harm

Achieving universal health coverage requires inclusive social health protection arrangements as well as efficient health systems able to adapt to changing population needs. To this end, health systems governance appears to be among the main contextual factors, together with the broader societal and political environment (Greer and Méndez, 2015).

2.2 A working definition inspired by the WHO

Whilst the relevance of governance is undisputed, the last decades saw a number of research and policy work producing different definitions and frameworks of health systems governance. However, research has not proposed a unanimous characterization of health system governance yet (Pyone et al., 2017). Most definitions are rather general, pointing at a mix of roles, rules and processes characterizing the interactions between politics, government bodies, health facilities and health professionals in their effort to provide health services to the population in a given country (World Health Organization, 2014). A larger consensus exists on the dimensions embedded in the abstract concept of governance. Table 1 summarizes the results of a review by Barbazza and Tello (2014), offering an overview of the common dimensions of health systems governance. In this latter case, the dimensions in the table are ordered based on the count of the occurrences in the 18 different health systems governance frameworks reviewed in the studies. Accountability emerges as a key feature of health systems governance in many different domains (financial, performance, political, social). The result is consistent with a later review of 16 governance frameworks (Pyone et al., 2017).

The authors also reveal that most policy-oriented contributions focus on pragmatic characterizations of health systems governance, which are not underpinned by broader theoretical concepts. Examples include Islam (2007); Siddiqi et al. (2009); Mikkelsen-Lopez et al. (2011); Berlan and Shiffman (2012).

[3] See here `https://www.who.int/health_financing/universal_coverage_definition/en/`, last visited October 30th, 2019.

Table 1: Governance functions emerging from 18 different frameworks (1997-2013).

Governance dimension	Occurrences
Accountability	17
Formulating policy and strategic direction	15
Generating information and intelligence	11
Participation and consensus	11
Transparency	10
Regulation	8
Organizational adequacy and system design	7
Partnership	6

Source: author's elaboration of results from Barbazza and Tello (2014).

Another group of frameworks in the literature has agency as underlying theory (Saltman and Ferroussier-Davis, 2000; Baez-Camargo and Jacobs, 2011; Brinkerhoff and Bossert, 2014; Cleary et al., 2013). Finally, Abimbola et al. (2014) propose an intriguing framework based on the institutional analysis and development framework (Ostrom et al., 1994). The authors extend Ostrom's theory to a multi-level governance framework to assess healthcare, comparing primary health care to a common-pool resource.

The WHO was the first important international organization to discuss governance for health systems. The famous 2000 World Health Report (World Health Organization, 2000) first introduced the idea of "stewardship". The concept was later embedded in a comprehensive framework in 2007, including governance among the fundamental building blocks of health systems. The UN agency identified six essential dimensions (or "functions") of governance (World Health Organization, 2007). In 2014, the WHO produced an action plan to support Ministries of Health in developing governance strengthening initiatives. The action plan includes a refined version of the previous six dimensions (World Health Organization, 2014). Table 2 proposes a working definition of health systems governance that blends WHO stewardship with the multi-level governance concept introduced by Abimbola et al. (2014).

This section outline the elements of the working definition of health systems governance employed throughout this dissertation. All components emerge from previous published work, blending and linking different elements in a comprehensive theory able to define and explain flexibly real-life health systems governance arrangements.
The first dimension of the working definition of governance theory relates to the perimeter of action. The WHO framework for governance (World Health Organization, 2014) defines a set of five basic functions. The descriptions below build on work by Yeoh and co-authors (Yeoh et al., 2019):

1. Policy guidance: formulate, review and implement national/regional policies and strategic plans

2. Generating intelligence: set up and maintain infrastructure to generate and analyse data to monitor health system performance, evaluate policies and the feed policy-making process. Relevant data include funding (health budgets, expenditures, donor commitments and disbursements), production inputs (infrastructure, human resources, technology, medical supplies), production outputs (out- and inpatient visits, maternal and child care indicators, ambulatory and surgical procedures, prescriptions, mortality, etc., healthcare quality indicators), population outcomes (prevalence, incidence, financial protection, social and health insurance coverage, impoverishment, etc.), and many more.

3. Putting in place levers or tools for implementing policy: identify organizational architecture for the health system. For the actors in the system, define roles, powers and responsibilities. Develop appropriate regulation including relevant incentives for the actors involved. Set relevant standards and devise a system to monitor, enforce rules and sanction misconduct.

4. Collaboration and coalition building: ensure involvement of all actors in the system in the planning and implementation of policies as well as in day-to-day activity. Important actors include public and private healthcare providers (individuals and groups or companies), civil society organizations and interests groups, professional associations and trade unions, patients, religious groups, etc.

5. Accountability: put in place mechanism of accountability that ensure correct and independent implementation of regulation and enforcement of rules. Accountability processes refer to both, healthcare providers and policy makers. A non-comprehensive list of accountability tools includes: monitoring and audit; transparent publication of policies, laws, operational and financial reports; social accountability initiatives involving civil society and communities in monitoring of healthcare provision and availability to political scrutiny.

The significance of governance functions lies in setting the boundaries of which broad activities fall underneath the umbrella of health systems governance. Two main motivations guided the choice of adopting the WHO functions as first vector of the three-dimensional governance construct developed here. Firstly, the five functions are comprehensive and cover virtually all possible governance-related activities addressed in the literature (Barbazza and Tello, 2014). Secondly, the WHO has an important global policy-guidance role and using its own language may favour a wider applicability of the theoretical framework. The categorization of a governance arrangement into a function is based on its primary scope. However, a correct assessment of governance cannot ignore the crucial network of interactions between function. A thorough review could highlight relevant positive or negative feedback loop that may in turn explain certain outcomes, as we explain in the next section. In fact, simplistic governance interventions that only address one single relationship ignoring the context can be ineffective at best and detrimental at worst. Whilst this may seem trivial, the reality of projects implemented by development agencies or other fragmented players is rich in such examples.

The second dimension embodies the actors or entities involved in the governance arrangement under scrutiny. The simple WHO framework has the major drawback of being government-centred, i.e. pointing to the government as the core actor of health systems governance. However, many authors recognized the central role of communities and civil society (on the demand side) and informal and private providers (on the supply side) in health systems across LMICs (Abimbola et al., 2017; Mackintosh et al., 2016; Shah et al., 2011). Likewise, governance arrangements decided or enacted at higher levels of government are usually very different from what is observed at the level of local governments or from operational micro-governance at service delivery level. Building on a specific approach developed by Abimbola and co-authors (Abimbola et al., 2014), the proposed governance definition incorporates three levels at which governance is practiced:

1. Constitutional level

2. Collective level

3. Operational level

Broadly, constitutional governance includes all high-level activities typically conducted by government authorities. Examples range from defining rules and regulations, sanctions, strategic directions, resource allocation, etc. Collective governance encompasses formal or informal interest groups that can exert direct or indirect power over activities within the health system. This may include civil society organizations (CSOs), advocacy groups in the healthcare sectors, patients associations, professional associations, trade unions or industry lobby groups. Operational governance includes all decisions and arrangements enacted at the service delivery level, possibly in response to pressures from patients. It includes specific organization of healthcare services, functioning of local healthcare markets and affect directly patterns of healthcare-seeking behaviour, provider behaviour and performance. The governance levels are not mutually exclusive but rather complementary and interrelated, as described in the following section. The definition of actors involved also includes the actors affected by governance arrangements.

A third and last element which one may want to consider is the nature of the institutional arrangements (Bertone and Meessen, 2013). This last dimension gives depth to the analysis, unpacking sensible attributes of the governance endeavour at the different levels and highlighting the interactions among levels. For each arrangement identified, the elements that should be considered in relation to the agents involved are:

- Agents' role and objective functions
- Information asymmetries
- Type of incentives addressing extrinsic motivation
- Interaction with intrinsic motivation
- Anticipated or observed behavioural change
- Change in organizational performance and impact on UHC goal

The elements above should allow a comprehensive description of governance mechanisms, highlighting crucial factors underpinning or undermining the attainment of a given UHC goal. The approach highlights elements akin to the broad field of contract theory (Bolton et al., 2005). The main motivation for connecting elements of health systems governance to contract theory is the recognition of the crucial role of information asymmetries. The approach favours links to a structured corpus of theory and concepts helpful to disentangle mechanisms and problems. Furthermore, when all elements can be identified, it may provide the foundations for formal modelling of specific mechanisms.

Interestingly, the proposed working definition (Table 2) is fully consistent with the prevailing governance dimensions emerging from the literature and summarized in table 1. A natural factor to explain this correspondence is the strong influence of the WHO on health policy and research, especially across LMICs. The working definition above outlines a set of activities associated with the core functions of governance, also salient in the prevailing literature (Barbazza and Tello, 2014).

2.3 Characterizing operational implications of governance functions

Building on the working definition of governance and in light of the multi-level nature of governance suggested by Abimbola et al. (2014), it is worth introducing some tools underpinning the broader governance dimensions at the operational level. This section provides an overview of the operational tools explored

Table 2: Working definition of governance

Governance function	Level		
	1	2	3
Policy guidance			X
Generating intelligence	X		X
Regulation and system design	X		X
Collaboration and coalition-building	X	X	X
Accountability	X	X	

Functions:

Policy guidance: Formulating sector strategies and also specific technical policies; defining goals, directions and spending priorities across services; identifying the roles of public, private and voluntary actors and the role of civil society.

Generating intelligence: Ensuring generation, analysis and use of intelligence on trends and differentials in inputs, service access, coverage, safety; on responsiveness, financial protection and health outcomes, especially for vulnerable groups; on the effects of policies and reforms; on the political environment and opportunities for action; and on policy options.

Regulation and system design: Putting in place levers and/or tools for implementing policy - including design of health system organizational structures and their roles, powers and responsibilities; design of regulation; standard-setting; incentives; enforcement and sanctions

Collaboration and coalition-building: Across sectors in government and with actors outside government, including civil society, to influence action on key determinants of health and access to health services.

Accountability: Ensuring accountability by putting in place: governance structures, rules and processes for health sector organizations; mechanism for independent oversight, monitoring, review and audit; transparent availability and publication of policies, regulations, plans, reports, accounts, etc; and openness to scrutiny by political representatives and civil society.

Levels:

1. *Operational governance*: individuals and providers within the local healthcare context
2. *Collective governance*: community coalitions with different size and scope
3. *Constitutional governance*: governments at different levels and other distant but influential actors

Source: author's elaboration based on Abimbola et al. (2014); World Health Organization (2007, 2014)

later in the manuscript. Nonetheless, other excluded tools - such as regulation of private markets, enforcement of sanctions, policy guidance, coordination across sectors and levels or budget allocation - are equally important and would deserve specific focus. The descriptions below are purposely limited as later parts of the thesis include detailed characterizations of each dimensions explored.

Incentives to healthcare providers

Financial and non-financial incentives represents important tools in the hands of policy makers. Health systems across LMICs are generally characterized by the prevalence of weak incentives for health workers. The absence of proper incentive policies results either from resource constraints or from poor policy guidance, regulation and system design. The mix of reimbursement systems, salary policies and other incentives undoubtedly shapes health workers' behaviour (Gauri, 2001). To this extent, low salaries and bad working conditions are associated to abuses in the health sector (Vian, 2008; Lewis, 2006b). On the other hand, well-structured provider payment mechanism, recruitment policies, education, planning and governance mechanisms can favour altruistic motivations among health workers (Lewis, 2006a). The last decades saw an increasing number of projects across LMICs addressing the issue of incentives with pay-for-performance or results-based financing schemes for providers and facilities (Miller and Babiarz, 2013). Evaluations of performance-based schemes report mixed results (Mendelson et al., 2017; Ogundeji et al.,

2016). Policies addressing broader salary and institutional incentives are typically decided at the central administrative level and implemented at lower levels. Implications remain however widely unexplored (Kaplan et al., 2013).

Supervision, auditing and quality control

Supervision and auditing activities are tools that contribute to align incentives of healthcare providers to the goals of the health system. Top-down monitoring activities have two main objectives: verify adherence to rules and regulation and control the quality of health service provision. Quality can be either verified with patients (treatment process, vignette, exit surveys, patient satisfaction) or based on measurable indicators. The amount and quality of supervision and auditing activities in health systems in LMICs varies across and within countries, with remote regions often left behind. Providers inclined to do so could potentially exploit the gaps in regulation, monitoring and supervision with illicit behaviour. The literature converges on the conclusion that auditing and supervision are associated to improvements in performance of the health system (Brinkerhoff and Bossert, 2008; Dieleman and Harnmeijer, 2006; Dieleman et al., 2009; Di Tella and Schargrodsky, 2003; Sikika, 2014). It is however important to note that supervision, auditing and monitoring have stronger effects only if coupled with enforcement of sanctions for violations and strong accountability arrangements.

Accountability and transparency mechanisms

Accountability is generally referred to the extent to which actors in the health system are liable for their actions. If not properly defined, accountability and top-down supervision mechanisms can be somewhat overlapping. To this end, accountability can be defined as a "contract-like" link between the two parts, in a way that the accountable actor needs to continuously abide by the "contract" because the overseeing actor directly observes its actions (Brinkerhoff and Bossert, 2008). On the other hand, for pure supervision- and auditing-based oversight, the room to violate the rules is amplified by the chance of not being supervised or audited. Similarly to supervision and auditing, accountability is more effective when violations are sanctioned. Accountability in health systems can have multiple operational forms. A non-complete list of examples includes market mechanisms for performance accountability, licensing/accreditation mechanisms for health professionals or local community participation and oversight over health services (ie. social accountability). Brinkerhoff and Bossert (2008) characterize different scopes for accountability, identifying three main types of accountability: (1) financial accountability; (2) performance accountability; (3) social/political accountability. The concept of social accountability is referred to the arrangements meant to hold health providers accountable bottom-up, at local service delivery level. In the decade, initiatives to address accountability involving the community became popular across LMICs (Ringold et al., 2012; Hoffmann, 2014; Kessy, 2014; Lambert-Mogiliansky, 2015; Baez Camargo and Stahl, 2016). Besides targeting improved accountability, these tools are useful to better tailor healthcare provision to local population needs. The range of interventions classified under the social accountability label is broad. A limited list includes: patients' score cards, community-based monitoring and auditing of health facilities; community involvement in the health facility management (e.g. governing committees); community information meetings and participatory approaches (Fox, 2015).

Transparency mechanisms contribute to better accountability allowing people to participate observing facts, data and processes within the health system (Labonté, 2010). Some operational tools used to improve transparency are public community scorecards, publicly show fees or reports of the activity at a

given health facility. Transparency mechanisms alone are however unlikely to produce improvements in healthcare delivery. Fox (2007) notes that without structural accountability mechanisms, the overseeing actors (often the civil society) typically would not have the means to stand up for their rights.

Governance structures and referral flows

The governments' role of policy planner and system designer encompasses the tasks of designing organizational and governance structures. These activities include the definition of hierarchical relationships, workflows, responsibilities and decision space (over budget spending for example) of different actors, accountability chains, decision making chains and centralization/decentralization of certain functions.
A major example of such policies is the wave of decentralization of responsibilities to local government authorities across LMICs in the last decades (Cobos Muñoz et al., 2017). These reforms were piloted at the national level to improve efficiency, quality as well as accountability of the health system at the local level. In the case of Tanzania, responsibility over the health system has been decentralized to districts (currently about 170) rather than regions (about 30). The reform resulted in high heterogeneity in the policies addressing human resources for health, internal budget allocation and levels of investments in healthcare infrastructure across the country (Kigume and Maluka, 2018).
Another example with crucial implications for LMICs with health systems based on primary health care is the design of patient referral systems. Despite the key role of cooperation between facilities at different levels of care, many countries are faced with dysfunctional patient referral systems. Most common problems are patients self-referring to hospitals instead of visiting closer primary facilities, low rate of institutional referrals from lower to higher health facilities and poor compliance of patients and providers with referral recommendations (Hort et al., 2019).

3 Overview of the empirical literature

The empirical literature recognizes good governance as an important factor for good population health. The evidence can be categorized in three big areas. A first stream of research addresses governance with a broad ("macro") perspective using cross-country aggregate governance indicators, such as the set of worldwide governance indicators developed by the World Bank (Menon-Johansson, 2005; Kirigia and Kirigia, 2011; Olafsdottir et al., 2011; Ciccone et al., 2014; Lin et al., 2014; Lee et al., 2016). All studies report a positive association between good governance and health outcomes. This approach is useful in advocating for better governance when tackling health-related problems but has two major drawbacks. Firstly, the specific value of cross-section analysis using aggregate governance indicators for LMICs is limited by the low levels of measured governance in the same group of countries compared to high income countries. Secondly, aggregate governance indicators are broad and do not relate to health systems and policy tools, thus lacking in relevance.

The second stream of research analyses health systems issues for specific diseases, system components or geographic area using the frameworks introduced above. Examples include (but are not limited to) role of governance in mental health (Petersen et al., 2017; Hanlon et al., 2017), rural health insurance systems (Yuan et al., 2017), human resources for health and community health workers (Adeloye et al., 2017; Schneider and Nxumalo, 2017; Dieleman et al., 2011; Dieleman and Hilhorst, 2011) or more generally in health systems at the national or sub-national levels (Balabanova et al., 2013; Scott et al., 2014; Van Belle and Mayhew, 2016; Gilson et al., 2017). Pyone et al. (2017) report empirical applications

of governance frameworks to health systems in Nigeria, Zambia, Vietnam, Uganda and Pakistan. The main value of using frameworks to assess governance in specific policies or countries is the comparability across different cases within the same frameworks. The approach allows to identify common policies and practices. The evidence produced can inform policy, offering examples of ways to embed governance. The main shortcoming is the lack of adequate empirical evaluation of the outcomes (Van Belle and Mayhew, 2016). In fact, most studies stop at the level of policy analysis without linking it to qualitatively or quantitatively measurable results.

The third stream of research is concerned with the implications of governance in specific settings or countries rather than looking at cross-country data. These contributions focus on a subset of governance dimensions with sensible operational and measurable implications. It includes qualitative and quantitative evaluations (randomized and non-randomized) of development and implementation projects, analysis of secondary data as well as systematic reviews of evidence on specific topics. The governance dimension evaluated range from social accountability (Molyneux et al., 2012; Lodenstein et al., 2017; Scott et al., 2018) to strategies addressing provider performance (Rowe et al., 2018), pay for performance (Ogundeji et al., 2016; Shen et al., 2017; Soucat et al., 2017; Patel, 2018; Paul et al., 2018), health system decentralization (Cobos Muñoz et al., 2017; Abimbola et al., 2015a), supervision (Rowe et al., 2010; Gopinathan et al., 2014; Bailey et al., 2016; Schwerdtle et al., 2017; Vasan et al., 2017) or broader regulatory interventions (Kisakye et al., 2016). This type of "micro" analyses provides a fundamental evidence base to evaluate broader policies and health systems governance tools in real-life settings. A main concern about such evaluations is the lack of external validity of the results. Policies are closely related to and embedded in a specific context that does not allow generalization of the results to other settings without addressing the same contextual factors. Moreover, the volume of empirical studies addressing tools and components of health systems governance in LMICs at micro-level with sound methodologies is limited (Shukla, 2018).

The need for better evidence about "what works" in development aid has gained prominence in light of the recently awarded Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2019. The prize has been awarded to three development economists (Abhijit Banerjee, Esther Duflo and Michael Kremer) for their experimental approach to global poverty alleviation[4]. The researchers sparked a revolution that mainstreamed cluster-randomized controlled trials (RCTs) as tools to evaluate development programs and social policies. As pioneers in this field, they argue in favour of moving beyond the "macro" debate about development aid (e.g. Sachs-Easterly) to value for money and incremental cost-effectiveness (Banerjee and Duflo, 2009). Examples of experimental work on healthcare and governance in LMICs includes health subsidy policies (Ahuja et al., 2015; Dizon-Ross et al., 2015; Dupas et al., 2016), pricing policies for health services (Holla and Kremer, 2009), health worker absenteeism (Chaudhury et al., 2006), audit of primary care facilities (Das et al., 2013) and community-based monitoring (Björkman and Svensson, 2009; Björkman Nyqvist et al., 2017). Of course, the experimental approach to development has several pitfalls. A recent Lancet editorial highlights that in global health policies "one size does not fit all" and that RCTs are currently restricted in scope and unable to adapt to unforeseen changes and interactions with contextual factors (Lancet, 2019). Along the same lines, Deaton and Cartwright (2016) emphasized the need for complementing experimental evidence with a deeper qualitative and theoretical understanding of "why some things work". Although not with pure experimental approaches, the subsequent parts of the thesis contribute to this strand of literature. No-

[4]The official website is available here: `https://www.nobelprize.org/prizes/economic-sciences/2019/summary/`

tably, the papers try to evaluate the implications of governance arrangements at the local level using robust empirical analyses, proposing interpretations of working mechanisms and policy implications.

4 Objectives

Broadly, this dissertation aims at defining and evaluating selected operational dimensions of health systems governance to assess their impact on health service delivery. The relevance of the research proposed here lies in the attempt to conduct robust empirical analyses of governance-related issues. The dissertation speaks to the literature on health systems governance in LMICS, addressing some of the gaps outlined above and contributing to extend the available evidence base. These overarching goals are divided in three research objectives that focus on the sub-Saharan country of Tanzania. To this extent, part II introduces the reader to the characteristics of the Tanzanian health policies and system highlighting the related governance challenges.

Objective 1
The first research area is concerned with the role of incentives to health workers and supervision for the improvement of quality of care at service delivery level in Tanzania. The research question can be formulated as follows: *what is the association between quality of care and supervision, financial and non-financial incentives to health workers in Tanzania?*

Objective 2
The second research area aims at improving the evidence about the causal impact of social accountability mechanisms on healthcare provision, focusing on stock-outs in essential medicines. To this extent, the case of the Tanzanian region of Dodoma offers an interesting setting with relevant implications for the whole country. The research question associated to the second objective is: *do social accountability mechanisms reduce stock-outs in essential medicines at service delivery level in the Dodoma region?*

Objective 3
Finally, the third research area explores the topic of patient referrals systems. The analysis is conducted in the Tanzanian district health systems of Kilolo (Iringa region) and Msalala (Shinyanga region). The research focuses on the factors favouring the emergence of referrals related to childcare and treatment of non-communicable diseases (NCDs). The patterns of referrals are comprehensively analysed using primary data collected for the purpose of answering the following research question: *how do district and facility characteristics affect the network of patient referrals in Kilolo and Msalala districts in Tanzania?*

The objectives listed above cover all operational health systems governance functions outlined in the working definition in table 2. Table 3 maps the governance functions into the three research objectives addressed by this work. Notably, despite their importance, the "policy guidance" and "generating intelligence" functions are out of the scope of this research.

Table 3: Research objectives and governance functions

Governance functions	Objective 1	Objective 2	Objective 3
Policy guidance			
Generating intelligence			
Regulation and system design	X		X
Collaboration and coalition-building		X	X
Accountability	X	X	

5 Research strategy

5.1 Methods

This dissertation addresses the objectives presented above with a mix of empirical approaches. The manuscript incorporates - in form of papers - the research outputs of the PhD project. Each paper addresses one objective with a specific methodology. Although more demanding, a plurality of methodologies has been preferred to a unique approach in light of the multi-faceted nature of health systems governance.

Part III analyses data from a representative sample of Tanzanian government-managed health facilities, part of the 2014/15 Service Provision Assessment component of the Demographic and Health Survey (DHS). Two healthcare quality indicators were obtained from data on patient visits: compliance with Integrated Management of Childhood Illness (IMCI) guidelines and patient satisfaction. Using multilevel ordered logistic regression models, the paper estimates the associations between the outcomes and selected indicators of incentives and supervisory activity at health worker and health facility level. Part III addresses objective 1.

Part IV evaluates the impact of a social accountability monitoring (SAM) program in Tanzania. The program was implemented by a local NGO named Sikika in two out of seven districts of Tanzania's Dodoma region. The main objectives of the SAM program are the availability of medicines at health facilities and improvements of health facilities infrastructure's maintenance, resource allocation and financial management at the district level. The SAM program has been implemented since 2012, in parallel with a large health system strengthening effort (the Health Promotion and System Strengthening Project, HPSS) run in the entire Dodoma region. The study focuses only on medicines stock-outs and infrastructure maintenance. The analysis is conducted with a difference-in-differences approach to identify the additional improvements in the SAM districts over the periods 2011 and 2017. The paper addresses clustering at district level using different methods, including the wild cluster bootstrap procedure, which is superior to the standard cluster robust standard errors. This part addresses objective 2.

Finally, part V explores a quantitative application of network analysis to the study of patient referral flows in two district health systems in Tanzania. The primary data employed to address objective 3 results from fieldwork conducted in 2018 across different regions in Tanzania. The field activity was conducted by the main investigator - Igor Francetic - with support from the local research partner in Tanzania, Ifakara Health Institute. The data collection addressed patient referral flows related to child care and treatment of non-communicable diseases. The paper applies a twofold approach based on network analysis. In the first part, the study analyses the data with descriptive analysis of network

statistics and graphs, assessing network characteristics and node-level centrality indicators. Sociograms and georeferenced maps of referrals are used to visualize the data. Secondly, the study focuses on the factors associated with network and dyad formation using exponential random graph models (ERGMs). ERGMs are a sophisticated technique to analyse networks data considering the inherent dependence in the observations. ERGMs model the probability of the observed network, estimating the contributions to its likelihood of specific characteristic at network, edge or node level.

5.2 Ethical considerations

The research included in this manuscript was conducted after obtaining ethical clearance from the Institutional Review Board at the Ifakara Health Institute (IHI/IRB/ No: 20-2017) and the Tanzanian National Institute for Medical Research (NIMR/HQ/R.8a/Vol.IX/2721). Based on ethical clearance, Igor Francetic obtained the permit to conduct data collection and research activity in Tanzania from the Tanzanian Commission for Science and Technology (2018-266-NA-2018-99).

Part II

Health system reforms and challenges in Tanzania

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6 Introduction

6.1 Historical evolution of the Tanzanian health system

The United Republic of Tanzania is a mid-sized East African country, located on the Indian Ocean coast, south of the Equator. The population was about 55 million in 2016. With a land territory of about 885,800 square kilometres, Tanzania had the largest population and lowest population density in East Africa. Over two-thirds lived in rural areas.

Since its independence from Great Britain in 1961 and until the first democratic elections in 1995, Tanzania had been a one-party state. Ever since, the country experienced a remarkable degree of social and political stability. The fifth president elected in 2015, John P. Magufuli, pushed an agenda of socio-political change and anti-corruption policies. The vision of post-colonial self-reliance proposed by the first President Julius Nyerere — known as the Father of the Nation — was distilled in the Arusha Declaration of 1967. Tanzania has been one of the pioneering nations in health policy development among sub-Saharan countries. Shortly after independence, President Nyerere's ruling socialist administration announced universal and free access to primary healthcare as a tool to improve the population's health and well-being, well before the 1978 Alma Ata Declaration of the World Health Organization (WHO). It coupled specific health policies with broader social and economic development and education. The government announced a universal public health system, with budget allocations based on equity and population needs. It centralized human resources planning and training, as well as expanded investments in health infrastructure (Gilson, 1995; Semali et al., 2007). Moreover, it initially discouraged private initiative in healthcare and later banned it by law in 1977 (Kumaranayake et al., 2000).

The economic hardship of the 1970s and 1980s undermined the government's ability to sustain free universal healthcare, however. The country increasingly relied on development partners and external financing for the health sector. This resulted in large vertical programs focused on specific diseases, such as HIV/AIDS, tuberculosis, malaria and vaccination programs, but also other specific financing, often driven by donor programs rather than by national priorities (Semali et al., 2007). Over time, external donors gained more significance in healthcare financing, and between 2006 and 2012, up to 50 percent of total health expenditure came from external sources. That share declined to about one-third by 2017.
Tanzania experienced robust economic growth in the early 21st century, on average 7 percent gross domestic product (GDP) growth between 2007 and 2017. Despite the increase in income and a decline in the poverty rate (from 86 to 49.1 percent between 2000 and 2010), the absolute number of people living in poverty remained among the highest in sub-Saharan Africa (World Bank, 2017). Notably, high out-of-pocket healthcare costs pushed one out of 40 Tanzanian families below the 2012 poverty line of $1.9 PPP (World Bank, 2017). The heavy dependence on external donors caused friction. Tanzania's government felt at times overwhelmed by foreign donors who were gaining a greater say in health policy-making. For example, for many years, the World Bank and other donor agencies sponsored the community-based health insurance schemes, Community Health Fund (CHF) and TIKA, for workers in the informal sector. Those schemes aimed to increase local fundraising and improve access. The CHF and TIKA schemes were rolled out in the country despite mixed evidence about their effectiveness. It turned out to be especially hard to increase coverage in rural settings.

6.2 Healthcare and Health Financing in Tanzania in 2018

The current healthcare system and the public administration of Tanzania essentially date back to the Nyerere administration (Conyers, 1981; Frumence et al., 2013). The underlying idea was to rely on primary healthcare at the village level to provide essential services for all, targeted to local needs (especially basic curative and maternal and child healthcare), with active involvement of local communities. District and regional hospitals were to oversee the lower level structures, serving as gatekeepers for referral to secondary, tertiary and specialized care (Ministry of Health, 1990). The country's administration has 30 regions and 196 districts (National Bureau of Statistics, 2017). The majority of all health facilities in the country (about 73%) are public. Non-profit faith-based organizations and other NGOs own and manage about 12 percent of health facilities, and for-profits the remaining 15 percent. Overall, 82 percent are primary care healthcare facilities (dispensaries or health posts), 10 percent secondary level health centers, and less than 4 percent are tertiary hospitals (Ministry of Health, Community Development, Gender, Elderly and Children, 2017). After focusing on improving and expanding infrastructure, the priorities shifted in the 1980s to widening the scope of services, for example, with programs for immunization and availability of essential prescription drugs. Those programs received heavy support from external development partners and donors (Gilson, 1995; Semali et al., 2004, 2007). The Ministry of Health (MoH) presented the first comprehensive National Health Policy in 1990. That policy document incorporated principles from the 1967 Arusha Declaration by President Nyerere. The MoH presented the next update of the National Health Policy in 2007 and a third version in 2017 (Ministry of Health, 2007). In parallel, the MoH developed several specific programs and strategic plans for the health sector (Ministry of Health and Social Welfare, 2015). The earlier health policies resulted in expanded coverage and improved health outcomes in rural areas, but the economic downturns of the 1970s and 1980s created considerable pressure on the health system. Tax revenues stagnated and external development aid did not fill the gap in resources to finance free healthcare for the whole population. Severe budget cuts led to deterioration of the system (Ministry of Health, 2003). The government's answer to the economic hardship was a wave of economic liberalization in the 1990s. It lifted the ban on private health practices and recognized faith-based and private hospitals, and other health facilities as proper partners in providing healthcare services (Kumaranayake et al., 2000). It allowed faith-based hospitals to serve as district hospitals in areas where no public structures were present. The government also opened a debate about new health financing options that involved patient cost sharing, prepayment and insurance plans (Ministry of Health, 1990, 2003). The new economic directions and health policy options were clearly influenced by the Washington Consensus promoted by the International Monetary Fund (IMF) and the World Bank (Chimhutu et al., 2015). Other stakeholders, including nongovernmental organizations (NGOs) and faith-based organizations, supported that direction.

Tanzania spent about 6 percent of its GDP on health expenditures in 2015 (35% from government expenditures, 28% from private sources and 37% from external sources). External sources served to finance disease-specific vertical programs, off-budget contributions and a Health Basket Fund (HBF) administered by the government (Ministry of Health and Social Welfare, 2015; World Health Organization, 2017). The share of the public budget spending for health (7.4% of the general government expenditure in 2015) remained well below the 15 percent target set in 2001 by the African Union's Abuja Declaration (Ministry of Health and Social Welfare, 2015; World Health Organization, 2011). The allocation of the public basket, in line with the Arusha Declaration, takes into account the geographical distribution of income levels, population, burden of disease and density of health facilities across the country (Ministry

of Health, 2003). In principle, health facilities owned and managed by private companies, faith-based organizations or other NGOs do not benefit from direct government funding. Patients paid for most private healthcare directly, contributing 26.1 percent of total health expenditure or about 93 percent of private health spending in 2015 (World Bank, 2017).

To increase the availability of funds for healthcare and improve financial health protection, Tanzania decided to pursue a health insurance–based strategy in the early 1990s. With support from the World Bank, it set up the CHF to implement pilot studies in 1995 and 1996. It rolled out this scheme to about 60 districts nationwide in 2001. CHFs are district-based voluntary insurance schemes — with yearly enrolment contributions — that ultimately aimed to reach 85 percent of the (rural) population working in the informal sector. Local government authorities (LGAs) are responsible for managing and supervising the CHFs and pooling funds to co-finance primary healthcare (Joseph and Maluka, 2016). In 2009, the CHF concept expanded — with higher contribution rates reflecting higher incomes — to voluntary schemes for informal workers in both urban and suburban settings, the so-called TIKAs, acronym for the Kiswahili term Tiba kwa Kadi (Mtei and Mulligan, 2007; Kapologwe et al., 2017). Shortly after the first CHF pilot implementations, Tanzania's government introduced its national insurance scheme, targeting the formal sector under the National Health Insurance Fund (NHIF) act of 1999. The plan started with civil servants only, later opening enrolment to employees in the private sector. NHIF contributions are linked to salary, with a 3 percent worker contribution matched by the employer. Coverage from NHIF and CHFs is granted in all public facilities and to a number of accredited private, faith-based or NGO-managed health facilities (Wang and Rosemberg, 2018; National Health Insurance Fund, 2019). Despite substantial support from development partners, the insurance coverage remained poor with about 16% of the population enrolled in the CHF by 2014, and about 8% in expanded CHF and TIKA schemes (Kamuzora and Gilson, 2007; Kapologwe et al., 2017; West-Slevin et al., 2015). Besides failing to provide financial health protection to a large share of the population, the low enrolment rates undermined the capacity of insurance schemes to effectively pool risks. Furthermore, the voluntary community-based schemes suffered from a high degree of adverse selection[5](Wang and Rosemberg, 2018). There were several reasons for the low enrolment in the CHF and TIKA schemes: the regressive nature of the lump-sum annual contribution for poor households, the limited scope of services covered by CHFs (benefit package) and the low quality of healthcare services (Wang and Rosemberg, 2018).

The large segment of the population not covered by insurance was in principle exposed to out-of-pocket payments (OOPs). To reduce the risk of impoverishment related to healthcare costs, the MoH put targeted waivers and exemptions in place for vulnerable groups seeking care in public health facilities. Exemptions at point of service applied to sick children, pregnant mothers, the elderly, people with chronic conditions and the disabled. Waivers for patient fees applied to poor households based on the advice of health workers and social welfare officers in consultation with local community leaders. Despite good intentions, the waivers and exemptions led to major problems. There was a lack of clear and consistent criteria and procedures for implementation (Mubyazi, 2004; Mtei and Mulligan, 2007; Mujinja and Kida, 2014). The exemptions imposed a huge financial burden on the — already low — public health budget (Lee et al., 2018) and on health facilities that were not compensated for the forgone revenues of the patients exempted from payment (Wang and Rosemberg, 2018).

[5]Adverse selection means that people wait to pay for insurance until they know they will face costs (because they are ill). This free-rider behaviour obviously drives up the contributions for all insured and creates problems for insurance plans that accept everyone without screening.

Tanzania's healthcare faces serious challenges — shortages of financial and other resources and weak administrative and management capacity. The main problems can be summarized as follows: (1) inadequate quality of health services, lack of accountability and supervision; (2) severe shortages (up to 70%) of skilled human resources; (3) inadequate public financing and low patient contributions; (4) inefficient drug management and delivery, insufficient physical and technical infrastructures and poor health information systems; (5) ineffective targeting mechanisms of social protection schemes and insufficient coverage of health insurance schemes (Musau et al., 2011; Kwesigabo et al., 2012; Mujinja and Kida, 2014; West-Slevin et al., 2015; World Health Organization, 2016). Despite those problems, there has been progress in the overall health of the population in the last three decades. The immunization rate of infants under 2 for measles increased from 80 to 99 percent between 1990 and 2017. The percentage of births attended by skilled health staff increased from 44 to 64 percent in that same period (Afnan-Holmes et al., 2015; Masanja et al., 2008; World Bank, 2017). The infant mortality rate steadily decreased, from roughly 100 to 41 per 1'000 live births between 1990 and 2015. The prevalence of underweight children decreased from 25.1 to 13.7 percent over the same period. Total HIV prevalence was kept under control, decreasing from 4.9 to 4.5 percent of the adult population between 1990 and 2017. Along with those improvements, average life expectancy at birth went up from 50 to 63 years. Those figures suggest that the focus on primary care and the availability of healthcare services have indeed contributed to better health.

7 Two decades of health policy-making in Tanzania

7.1 The Millennium Development Goals Era, from 2000 to 2015

The MoH used its 2007 update of the National Health Policy to develop strategic health sector plans (HSSPs). These plans overlapped with earlier efforts to decentralize decision-making power and reform LGAs. They entailed the restructuring of regional and district administration. LGAs became responsible for the planning, budgeting and managing of public services like education and healthcare (Ministry of Health and Social Welfare, 2008) . The MoH further launched the Primary Healthcare Service Development Programme (PHCSDP, or Mpango wa Maendeleo ya Afya ya Msingi (MMAM) in Kiswahili), aimed to accelerate the provision of primary healthcare for all Tanzanians (Mujinja and Kida, 2014; Ministry of Health and Social Welfare, 2007, 2008). Table 4 lists the range of specific strategies towards universal health coverage under HSSP III and HSSP IV planned for the period 2009–2020. LGAs expanded their role in administering local health services. HSSP III announced additional investments to strengthen management capacity and infrastructure of District Health Services (Strategy 1). The measures included the training, specific management and monitoring guidelines for local and district staff. It also introduced performance-based incentives, such as "P4P" or results-based financing (RBF) projects sponsored by external donors, and typically focused on service delivery targets in reproductive, maternal and child care (Binyaruka and Borghi, 2017; Binyaruka et al., 2018). The government next decided to centralize the medicine supply for all public health facilities, and took steps to reduce corruption and leakages. It established a central unit, the Medical Stores Department (MSD). Strategy 3 included measures to enhance cooperation and coordination between central entities like the MoH, MSD and LGAs (Ministry of Health and Social Welfare, 2008). Since its inception, however, the MSD has faced many challenges, above all shortages of essential medicines and delays in deliveries. In reaction, the MoH allowed a growing role for the private sector as an alternative supply chain for medicine (Binyaruka and Borghi, 2017).

HSSP III focused on the health workforce and other resources. It noted that total staffing was substantially below standard in 2008. To address understaffing, Strategy 4 aimed to develop policies and regulation to improve human resources planning, utilization of available resources and training, basic professional and continuous education (Ministry of Health and Social Welfare, 2008). The government approved a Human Resource for Health (HRH) Strategic Plan for the period 2008–2013. The plan included detailed multi-sector measures to address personnel shortages, as well as specific human resources management, retention and incentive policies. With strategy 5, HSSP III addressed the crucial aspect of health financing. The main issues at the time were (and still are) the low public health budget, high OOPs, the failure of existing arrangements to protect families against the major financial risks of illness, and high dependence on external sources and vertical health programs. As mentioned earlier, external development partners have played a major role in framing Tanzania's health policy since the early 2000s. They supported projects and programs with financial resources and technical assistance. The World Bank remained a major sponsor of CHF and pilot schemes with P4P and other RBF (Binyaruka and Borghi, 2017; Chimhutu et al., 2015; Mayumana et al., 2017). These policy options are part of HSSP III, the updated National Health Policy and later strategic documents described later.

Another indication of the importance of development partners is the 1999 decision of the Tanzanian government to pursue a so-called sectorwide approach (SWAP) for health. The SWAP coordinates health reforms through sector-level committees involving all relevant stakeholders. It allows development partners to participate directly in the policy-making process. Two essential components of the SWAP are (1) the HBF and (2) the technical working groups (TWGs). The HBF is a financing mechanism supported by a set of development partners. It pools financial resources into a general fund aimed to support the implementation of strategic health sector plans and reforms. Notably, the rollout of voluntary CHF schemes across the country benefitted from a matching contribution for enrollment fees by the HBF (Wang and Rosemberg, 2018). The partners contributing to the HBF participate in the SWAP committee to periodically assess the use of funds (Development Partners Group Tanzania, 2005). The SWAP approach further includes TWGs and sub-committees working on specific components of the health sector reform. TWGs allow development partners, academics and other stakeholders to participate in the shaping of health policies down to detail (Hutton and Tanner, 2004; Ministry of Health and Social Welfare, 2015). The MoH continued to involve a wide range of stakeholders in the development of the fourth health sector plan — HSSP IV (2015–2020) — through the SWAPs and TWGs. Stakeholders included government agencies, WHO, NGOs, the private sector, the Prime Minister's Office for Regional Administration and, notably, foreign development partners.

Table 4: Strategies for the health sector in Tanzania from 2009 to 2020

HSSP III (July 2009 to June 2015)	HSSP IV (July 2015 to June 2020)
Strategy 1: district health services	Quality assurance
Strategy 2: referral hospital services	Package of intervention by levels of care
Strategy 3: central support	Health service provision by type of service
Strategy 4: human resources for health	Inter-sector collaboration for health
Strategy 5: healthcare financing	Emergency preparedness and response
Strategy 6: public private partnership	Social welfare service delivery
Strategy 7: maternal, newborn and child health	Human resources for health and social welfare
Strategy 8: disease prevention and control	Essential medicines and health products
Strategy 9: emergency preparedness	Infrastructure, transport and equipment
Strategy 10: social welfare and social protection	Monitoring and evaluation system
Strategy 11: monitoring and evaluation	ICT and e-health
Cross-cutting issues:	Health financing
quality, equity, gender sensitivity,	Financial management system
ownership and coherence in governance	Management of implementation of governance
	Gender in health
	Stepwise approach coordination and management

7.2 The Sustainable Development Goals Era: from 2015 on

One major inspirational source for HSSP IV was the idea of Sustainable Development Goals (SDGs). Another influence was Tanzania's large multi-sector development program launched in 2013, known as Big Results Now (BRN), inspired by the principle of results-based aid. BRN focused on four main principles: prioritization, coordination of implementation, methodical approaches and inter-ministerial cooperation and management systems. It aimed to accelerate the realization of the core ambition of Tanzania's Development Vision 2025 (namely becoming a middle-income nation by 2025). It sought to attract external development support in different key areas (national key results areas; NKRAs), linking financing to clear and measurable results. The cabinet designated healthcare as a specific NKRA in 2014. HSSP IV, therefore, incorporated many BRN principles (Janus and Keijzer, 2015). While the overall strategies and goals of HSSP IV (listed in table 4) are in line with HSSP III, there is more emphasis on implementation, management and multi-sector coordination (Ministry of Health and Social Welfare, 2015).

The government again took up health financing as a major issue in its 2015 HFS, a crucial component of HSSP IV. The 2015 HFS included five main elements: (1) a mandatory Single National Health Insurance (SNHI); (2) a minimum benefits package; (3) financing of public health activities; (4) mobilization of resources for health and social welfare; and (5) allocation of resources to the health sector. HSSP IV went a step further than HSSP III in presenting reliable cost estimates and framing explicit policy priorities and goals for the health sector (Ministry of Health and Social Welfare, 2015). The proposed SNHI aimed to integrate Tanzania's fragmented health insurance schemes (NHIF, CHF and TIKA) into a single financial risk pool by 2020. This would create economies of scale and allow for effective cross-subsidization across the different systems. The implementation of the SNHI faced big challenges, however: low health insurance enrolment rates, low contribution compliance, the difficulty of targeting the informal sector and the problematic task of enforcing mandatory coverage (Prabhakaran and Dutta, 2017). One important political barrier to the reforms remained the need for substantial cross-subsidization between the formal and informal sectors. The proposed financing model discriminates between the salary-based contributions for the formal sector employees and the annual CFH and TIKA contributions for unemployed, informal sector workers and the poor. The SNHI would also need to harmonize different benefit packages into one standard, minimum package. The current contributions

collected by the plans targeting the informal sector are generally too low to ensure financial sustainability. To operate, they receive heavy subsidy from development partners in the form of matching funds for the yearly contributions. At present, NHIF-insured pay a 3 percent contribution, matched by identical contributions from their employers. The merger into a unique risk pool requires the richer enrollees of the formal sector to cover part of the gap in contributions generated by the informal sector enrollees. Higher contributions, however, will likely decrease the enrolment rate — especially among informal workers — and thus further shrink the financial resources available (Prabhakaran and Dutta, 2017).

The proposed SNHI portion of the HFS marked a move away from the current waivers and exemptions for OOPs (user fees and contributions) towards an insurance-based model with wider risk pooling. Under this new model, poor and vulnerable groups would be required to enrol in the health insurance. Instead of exempting them from payments at the point of service, the government would subsidize the enrolment of targeted groups, defined as people living below the national poverty line. The latest budget analysis estimated that about 28 percent of the population (in the informal sector) is eligible for subsidized insurance (Lee et al., 2018). The HFS also sought to tackle the big issue of provider payment. As mentioned earlier, the HFS would separate the functions of providing and purchasing healthcare services. The insurance fund would mediate all payments to health providers for treatment included in the benefit package (Health Sector Working Group, 2017). The second main component of the proposal was the introduction of capitation-based payments by the CHFs, as well as improvement of the allocation formula for the public HBF (Lee et al., 2018).

Finally, the 2015 HFS aimed to increase and diversify the financial resources through new sources such as earmarked taxes. This would help decrease the high dependency on external development partners and donors (Ministry of Health and Social Welfare, 2015), especially for insurance schemes targeting the informal sector and rural populations (Lee et al., 2018). The HFS proposal underwent several rounds of reviews in the Inter- Ministerial Technical Committee (IMTC). The IMTC accepted the idea of mandatory insurance, the new public financing (except earmarked taxes) and a standardized, minimum benefits package. The cabinet rejected the SNHI in favour of reforming and harmonizing all CHF and TIKA schemes, however. The current way forward for the HFS in Tanzania — while waiting for future approval of the SNHI proposal — appears to be twofold. First, they include mandatory enrolment in the NHIF for workers in the formal sector. Second, they include efforts to improve and harmonize the CHFs and TIKAs, with effective targeting of vulnerable groups in the informal sector (Health Sector Working Group, 2017). Capacity building and training of LGAs for effective management of the system started in early 2018. The underwriting of the matching fund (financed primarily by development partners through the HBF) that currently supports the CHFs remains unclear, however (Lee et al., 2018).

8 Governance challenges in the Tanzanian health system

Although each nation has a different history, the path of the Tanzania's health system is common to a number of other countries in sub-Saharan Africa. The health policy-making process summarized in the previous sections highlights several health system governance challenges at different levels. The multi-level framework for health systems governance developed by Abimbola et al. (2014) is used in the remainder of the section to pinpoint the emerging issues.

At the higher constitutional governance level the health sector faces many different governance challenges. The economic condition of this transitioning low-income country pushing an agenda of expansion puts strong pressure on the government budget for health. The last decades revealed a lack of political commitment in increasing this budget, which is still far from the target set by the Abuja declaration in 2001. A second challenge related to the country's resource constraints is the relationship with donors. The recent history of Tanzania reveals that government decisions about health policy are not taken independently. A wide range of aid-related stakeholders have a prominent and formalized role in the policy-making process. Whilst this can be instrumental to the continuous flow of foreign aid, it also allows the same stakeholders to influence policy directions according to own preferences rather than population needs. A notable example are the market mechanisms introduced in the health sector with a clear push from donors. The political history of Tanzania - ruled for over 50 years by socialist governments - did not favour a smooth adoption of such innovations. The government and the society itself has not been able to absorb, control and direct this wave of economic liberalization in the health sector. The resulting current situation urges the need to regulate properly private healthcare providers of all sorts - pharmacies, health centres and hospitals - given their growing market shares. The insurance-based policy launched to address health financing and achieve universal health coverage poses challenges in relation to the overlap with the ongoing decentralization in the health system. The insurance strategy started with the CHFs building on local communities, in line with the decentralization of power to local government authorities. The many limitations of the CHF system pushed the government to pursue a single insurance strategy, resulting in the serious problem of harmonizing many heterogeneous CHFs managed by otherwise autonomous districts across the country. A final governance problem that emerged is related to the crisis in human resources for health. Tanzania - like many other LMICs - faces severe shortages in skilled health workers since long time. The central government showed lack of strategic direction in addressing the structural crisis of human resources for health.

At the collective or community level, three main governance issues emerge. The insurance-based strategy poses great challenges in relation to the need of substantial cross-subsidization between poor and rich. Without a collective agreement between stakeholders and social partners, higher level policies will not be successful. A related problem are the mechanisms to exempt poor and marginalized people from patient fees at point of care. The need for coordinated and standardised targeting mechanisms to identify people in need relies crucially on the involvement of the many communities. Finally, community ownership of locally implemented CHFs appears to be key for the success of a national health insurance strategy.

Operational governance is the primary focus of subsequent chapters in this thesis. At the operational level a mix of challenges affect quality of healthcare provision and ultimately undermine social health protection in Tanzania. The country literature points to poor motivation and performance of health workers related to lack of accountability, poor supervision and underpowered incentives. District health systems show inadequate infrastructure (health facilities, transportation, diagnosis) due to ineffective resource allocation and budgeting at the local level. Moreover, there is poor availability of essential medicine and other medical commodities related to inefficient stock management, supply-chains, lack of accountability, corruption and leakages. Most problems appear to be associated to the central Medical Stores Department, which supplies health facilities. New tender-based solutions to allow facilities to purchase from private providers (e.g. prime vendor system) are being implemented and scaled-up, opening new doors to corruption if governance is not properly addressed. Finally, the successful implementation of community-based insurance is limited by poor management skills, poor coordination and harmonization and lack of regulation and guidelines. Most CHFs report severe delays in the release of claims and matching funds.

Part III

Going operational with health systems governance: supervision and incentives to health workers for increased quality of care in Tanzania

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Supplement Article

Going operational with health systems governance: supervision and incentives to health workers for increased quality of care in Tanzania

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Abstract

Improving the quality of care is increasingly recognized as a priority of health systems in low- and middle-income countries. Given the labour-intensive nature of healthcare interventions, quality of care largely depends upon the number, training and management of health workers involved in service delivery. Policies available to boost the performance of health workers—and thus the quality of healthcare—include regulation, incentives and supervision—all of which are typically included in quality improvement frameworks and policies. This was the case in Tanzania, where we assessed the role of selected quality improvement policies. To do so, we analysed data from a representative sample of Tanzanian government-managed health facilities, part of the 2014/15 Service Provision Assessment component of the Demographic and Health Survey. We constructed two healthcare quality indicators from data on patient visits: (1) compliance with Integrated Management of Childhood Illness (IMCI) guidelines and (2) patient satisfaction. Using multilevel ordered logistic regression models, we estimated the associations between the outcomes and selected indicators of incentives and supervisory activity at health worker and health facility level. We did not identify any association for the different indicators of top-down supervision at facility and individual level, neither with IMCI compliance nor with patients' satisfaction. Bottom-up supervision, defined as meetings between community and health facility staff, was significantly associated with higher patient satisfaction. Financial incentives in the form of salary top-ups were positively associated with both IMCI compliance and patient satisfaction. Both housing allowances and government-subsidized housing were positively associated with our proxies of quality of care. Good healthcare quality is crucial for promoting health in Tanzania not only through direct outcomes of the process of care but also through increased care-seeking behaviour in the communities. The results of this study highlight the role of community involvement, better salary conditions and housing arrangements for health workers.

Keywords: Health systems research, multivariate analysis, incentives, quality of care, human resources, governance

Key Messages

- Current institutional arrangements for top-down supervision of health services provision in public health facilities in Tanzania do not show sensible effects on quality of care.
- Community involvement in supervision and management of the health facilities is associated with higher patient satisfaction at point of service.
- HR management policies that include financial incentives in form of salary top-ups to health workers are associated with higher clinical compliance to Integrated Management of Childhood Illness (IMCI) guidelines and higher patient satisfaction.
- Financial allowances for health workers targeted to housing are associated with improved clinical compliance to IMCI guidelines. Assigning health workers to government subsidized housing is associated with higher patient satisfaction at point of service.

Introduction

After past eras of global health focused on the efficiency of interventions, in many low- and middle-income countries (LMICs) policymakers and development partners are gradually directing efforts on improvements in quality of healthcare and equity (Hongoro and Normand, 2006; Chandler *et al.*, 2009; Songstad *et al.*, 2011; Das *et al.*, 2018; Kruk *et al.*, 2018). The reason for this shift of focus is that the effectiveness and efficiency of investments in health are related to the extent to which healthcare services reach an acceptable level of quality (Kruk and Freedman, 2008; Nair *et al.*, 2014). Moreover, quality of care is a determinant of the utilization of healthcare services, above all for public health facilities (Mariko, 2003; Sahn *et al.*, 2003; Kyei-Nimakoh *et al.*, 2017).

Quality of healthcare is typically characterized as a three-dimensional construct, the components being resources, processes and outcomes (Reerink and Sauerborn, 1996; Donabedian, 1997; Hongoro and Normand, 2006). Quality of services is closely related to providers' skills and behaviour. In a systematic review on ambulatory healthcare quality, Berendes *et al.* (2011) list several direct measures of provider performance as indicators of different quality dimensions. Such examples include compliance with guidelines, correct prescribing behaviour, length of consultation time, number of explanations given and friendliness. Likewise, DiPrete-Brown *et al.* (1992) highlight the crucial role of provider effort in achieving effective and efficient care, safety of patients, continuity of care and sound interpersonal relationship with patients among different subdimension of quality of care. The centrality of provider performance emerges also from the components of high-quality health system framework components recently proposed by Kruk *et al.* (2018).

To foster performance among health workers, policymakers have few non-exclusive options, namely: regulation, monetary and non-monetary incentives, supervisory and management activities such as quality control, auditing, supportive supervision, bottom-up supervision, community involvement, accountability mechanisms and active management practices (Rowe *et al.*, 2005, 2010; Dieleman and Harnmeijer, 2006; Lewis, 2006; Willis-Shattuck *et al.*, 2008; Dieleman *et al.*, 2009; Brinkerhoff and Bossert, 2014).

Specific policies addressing the performance of health workers necessarily need to include a mix of different levers, affecting different facets of provider performance. For some of the policy options above, the evidence in the literature points towards clear impact pathways (see below). Other approaches still lack consistent evidence about their effectiveness. Notably, little is known about the combined effect of the different policy tools. Our contribution aims at partially filling this gap, generating evidence on the effects of different policy levers for provider performance combined in different broader policies addressing human resources for health.

The available evidence shows that active human resources management policies—including a mix of financial and non-financial incentives—effectively foster motivation and performance among health workers (Hongoro and Normand, 2006; Mathauer and Imhoff, 2006; Althabe *et al.*, 2008; Lewin *et al.*, 2008; McCoy *et al.*, 2008). The evidence on the impact of policy instruments generally related to oversight is mixed. For example, supportive and external supervision (from higher-level authorities) were found to positively impact provider performance in several studies (Manongi *et al.*, 2006; Bradley *et al.*, 2013; Kiplagat *et al.*, 2014; Moran *et al.*, 2014; Bhatnagar *et al.*, 2017). Yet, different studies report overall inconclusive results (Bosch-Capblanch and Garner, 2008; Rowe *et al.*, 2010; Bosch-Capblanch *et al.*, 2011; Sipsma *et al.*, 2012; Bailey *et al.*, 2016). Likewise, for different forms of community involvement in health service delivery (such as health facility committees or social accountability monitoring) the literature reports only limited qualitative evidence, with lack of robust external validity (Kessy, 2008, 2014; Rosato *et al.*, 2008; Macha and Borghi, 2011; McCoy *et al.*, 2012; Frumence *et al.*, 2014; Kilewo and Frumence, 2015; Bhatnagar *et al.*, 2017). A large systematic review of strategies to improve provider practices in LMICs revealed that most policies mixing different strategies are more effective than strategies employed in isolation. The same study found that policies with larger effect sizes involved a simultaneous combination of community support and training for healthcare providers (Rowe *et al.*, 2018).

In Tanzania, despite the Government's effort to expand geographical access increasing the number of health facilities and aiming at primary healthcare for all, the performance of health providers in rural areas is not yet satisfactory (Leonard and Masatu, 2007; United Republic of Tanzania and Ministry of Health and Social Welfare, 2007; Musau *et al.*, 2011; Kruk *et al.*, 2017). Health policy reforms in Tanzania generally touched upon all the points above, including a wave of decentralization by devolution of decisional and managerial responsibilities towards local government authorities (LGAs; Semali *et al.*, 2005; United Republic of Tanzania and Ministry of Health and Social Welfare, 2007; Mboya *et al.*, 2016). The reform of LGAs in Tanzania strengthened the steering role of councils over the district health systems, with the goal of better addressing the needs of the population by bridging the gap between health services providers and communities (Gilson, 1995).

The current structure of the Tanzanian public health system is parallel to the administrative division of government authorities in the country. The central authorities maintain control over the main basket fund for health, allocation and budget for human resources

as well as national referral and specialized hospitals. The 30 regions act as intermediary oversight bodies between central and the local authorities, represented by 173 districts (Musau *et al.*, 2011; National Bureau of Statistics and Office of Chief Government Statistician, 2013). The President's Office for Regional Administration and Local Government directly oversees and supports the districts in their steering role over the health system, together with Ministry of Health,[1] Ministry of Finance and Planning as well as Regional Authorities. Each district is directly responsible for the management, supervision and audit of public health facilities within its boundaries, including primary (dispensaries), secondary (health centres) and tertiary level (district hospitals) structures (Ministry of Health and Social Welfare/Tanzania *et al.*, 2016). Health facilities are organized in a hierarchical structure that is reflected in the referral flows (bottom-up, from primary to secondary or tertiary level structures) and in the cascade supervision arrangements (top-down). Currently, health facilities have autonomy in the use of funds, both for basket fund (through own bank accounts) and for funds generated locally through user fees and Community Health Funds (Maluka and Chitama, 2017).

In the last decade, the Government of Tanzania approved two strategic plans aimed at improving quality of care: the 'Human Resource for Health and Social Welfare Strategic Plan 2014–2019' (United Republic of Tanzania and Ministry of Health and Social Welfare, 2014) and 'The Tanzania Quality Improvement Framework in Health Care 2011–2016' (United Republic of Tanzania and Ministry of Health and Social Welfare, 2011). The implementation of bottom-up accountability mechanisms (e.g. social accountability) in the healthcare system has been coupled with a cascade supervision system for public health facilities (from tertiary level down to primary care level) as well as external administrative supervision from council authorities. In addition, specific incentive policies for the retention of health workers have been introduced with the aim of improving motivation and satisfaction of healthcare providers (Kimaro and Sahay, 2007; World Health Organization, 2013; United Republic of Tanzania and Ministry of Health and Social Welfare, 2011, 2014; Mboya *et al.*, 2016). In the last few years—with support from the World Bank—pilot projects have been implemented to test the impacts of results-based financing and pay for performance (P4P) arrangements aimed at linking healthcare providers performance to explicit financial incentives (Manongi *et al.*, 2014; Borghi *et al.*, 2015; Binyaruka and Borghi, 2017).

District councils translated the National policies above into different human resources management practices consistently with the resources available and local availability of public providers.

Rationale

Our study aims at exploiting the variation in human resources management, supervision and accountability practices across Tanzania, studying the role of different levers of health worker performance on healthcare quality. Specifically, we aim at assessing the association of a range of policy tools (financial and non-financial incentives, monitoring and supervision arrangements as well as community oversight) with two relevant quality of care indicators sensitive to provider performance: provider compliance to Integrated Management of Childhood Illness (IMCI) guidelines and patient satisfaction.

We have three main hypotheses guiding our analysis. First, other things equal, incentives to health workers increase the workers' efforts, improving performance and the resulting quality of services produced. Second, higher frequency of supervision visits and active management meetings reduce opportunities for negligence, increase accountability (top-down) and compliance with current regulations whilst also helping health facilities and health workers to address weaknesses. All the above mechanisms lead—in principle—to increased quality of healthcare provision at point of service. Third, higher frequency of meetings between health facility staff and community representatives increases accountability (bottom-up) and bonds between providers and patients, leading to greater effort, improved performance and thus higher quality of care.

Methods

Data

Our analysis relies on a nationally representative sample of public health facilities in Tanzania surveyed by the Demographic and Health Surveys (DHS) programme and selected for the Service Provision Assessment (SPA) survey between 2014 and 2015 (Ministry of Health and Social Welfare/Tanzania *et al.*, 2016). The SPA survey is a health facility assessment that provides a comprehensive overview of a country's health service delivery. It collects information on the overall availability of different facility-based health services in a country and their readiness to provide those services. The data collected range from infrastructure, resources and management through health facility inventory interviews, provider characteristics (from health workers interviews) and process of care through patient visit observations. The latter set of information has proved to be effective in measuring several dimensions of quality of care (Leonard and Masatu, 2005).

We analyse data from government-managed health facilities only, as private ones are not subject to most Government policies on human resources for health, monitoring or supervision. A descriptive overview of the health facilities included in the analysis is provided in Table 1.

The majority of health facilities interviews is in dispensaries (~45%) and in health centres (~39%), located primarily in rural areas (74%). Compared with the actual distribution of government-owned health facilities in Tanzania, our data oversample health centres and hospitals, accounting for ~9.5% and 2.5% of facilities, respectively (Ministry of Health and Social Welfare/Tanzania *et al.*, 2016). The distribution of health facilities is similar across the two samples.

Table 2 describes the sample of health workers included in our analyses. The analysis on IMCI compliance includes ~40% of female health workers. Notably, the share of female health workers doubles to ~80% in the sample employed for the analysis on patient satisfaction. The difference in sample composition is related to the nature of patient visits included in the patient satisfaction sample, which pools visits to sick children and antenatal care (ANC) visits. The latter is typically performed by female nurse midwifes. This is also reflected in the distribution of health worker cadres across the two samples, with 65% of medical officers and 21% of nurses in the IMCI compliance sample, whereas the patient satisfaction sample is characterized by 10% medical officers and 70% nurses (including nurses midwifes).

Empirical strategy

Our empirical strategy takes the specific administrative structure of the Tanzanian health system into account, allowing a multilevel structure in the data. Figure 1 describes the data structure of the sample used in our analysis. The units of analysis are unique patients; given the cross-sectional nature of the survey, no patient

Table 1 Descriptive statistics for sample of health facilities

	Sample IMCI compliance				Sample patient satisfaction			
Variable	*N*	%	Avg. (SD)	Median	*N*	%	Avg. (SD)	Median
Dispensary	250	44.96			303	45.09		
Health centre	218	39.21			260	38.69		
Hospital	88	15.83			109	16.22		
Total	556	100.00			672	100.00		
Rural area	415	74.64			497	73.96		
Results-based financing	40	7.19			37	5.51		
Any client feedback mechanism	256	46.04			333	49.55		
OPD visits last month: <201	124	22.30			156	23.21		
OPD visits last month: 200–400	173	31.12			197	29.32		
OPD visits last month: 400–600	85	15.29			104	15.48		
OPD visits last month: 600–800	39	7.01			48	7.14		
OPD visits last month: >800	135	24.28			167	24.85		
Total staff	556	100.00	42.15 (132.35)	8.00	672	100.00	45.98 (157.10)	8.00
Health Services Index	556	100.00	18.00 (3.66)	18.00	672	100.00	17.91 (3.78)	18.00

Note: The Health Services Index is a proxy measure of breadth of service offered at a specific health facility. The index represents the simple sum of the services provided by the facility, as listed in the health facility inventory interview from the SPA 2014/15.

Source: Author's own elaboration on DHS SPA 2014/15 data.

Table 2 Descriptive statistics for sample of health workers

	Sample IMCI compliance				Sample patient satisfaction			
Variable	*N*	%	Avg. (SD)	Median	*N*	%	Avg. (SD)	Median
Total	682	100.00			867	100.00		
Female	278	40.76			698	80.51		
Managing position	389	57.04			366	42.21		
Qualification								
Medical doctor	26	3.81			11	1.27		
Medical/clinical officer	446	65.40			92	10.61		
Nurse	144	21.11			607	70.01		
Assistant	66	9.68			157	18.11		
Any salary supplement	572	83.87			600	69.20		
Any non-monetary incentive	405	59.38			433	49.94		
Monetary incentives to provider								
Salary top-up	203	29.77			264	30.45		
Per diem when training	190	27.86			250	28.84		
Duty allowance	218	31.96			286	32.99		
Payment for extra activities	66	9.68			107	12.34		
On-call allowance	228	33.43			168	19.38		
Housing allowance	21	3.08			21	2.42		
Non-monetary incentives to provider								
Uniform/caps/backpack	214	31.38			281	32.41		
Training	107	15.69			140	16.15		
Subsidized housing	166	24.34			148	17.07		
Time off/holidays	68	9.97			81	9.34		
Years of tenure at facility	682	100.00	5.22 (7.26)	2	867	100.00	7.16 (9.04)	3
Education years	682	100.00	14.53 (2.43)	15	867	100.00	13.50 (2.53)	13
Days with supportive supervision over last 6 months	682	100.00	2.50 (2.49)	2	867	100.00	3.19 (2.29)	3

Note: The table shows the number of health workers in the two samples that reported benefitting from the different incentives. Each health worker can benefit from one or more incentives at once, depending on the policy in place.

Source: Author's own elaboration on DHS SPA 2014/15 data.

experienced multiple visits. Patients are treated by providers (clustering level 3), working in a given health facilities (clustering level 2) in a given region (clustering level 1). Statistical tests that support the use of a multilevel model are provided in Supplementary Table SM1. We employ regions as highest level in the data structure in order to maintain the highest level of representativeness in the results, although the administrative units effectively steering the health systems in Tanzania are LGAs represented by District Councils. Unfortunately, the survey sampling design did not allow the use of the latter. The data analysis was carried out with the statistical software STATA 14. For the analysis of the two main dependent variables, both coded as ordered scales, we estimated multilevel

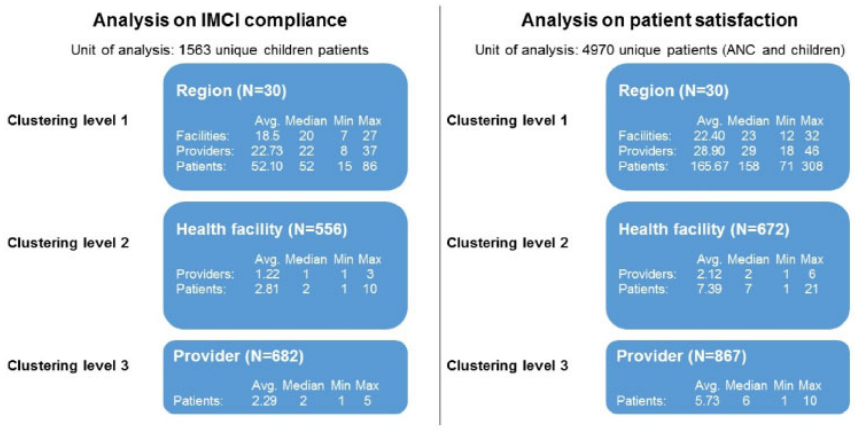

Figure 1 Data structure and clustering levels for the two samples considered in the analyses. *Source*: Author's own elaboration.

ordered logistic models with three clustering levels. To check the robustness of our results, we estimated the same specifications with multilevel models with two clustering levels as well as with standard logistic models with clustered errors.

Outcomes

The two quality of care measures selected as dependent variables are (1) compliance with IMCI guidelines and (2) patient satisfaction. Both outcome measures are referred to our two samples of patient visits. The characteristics of patients in the two samples are described in Table 3.

Compliance with recommended treatment or assessment guidelines represents a process indicator for quality of care (Donabedian, 1997; Boller *et al.*, 2003; Rowe *et al.*, 2005; Berendes *et al.*, 2011; Das *et al.*, 2016; Kruk *et al.*, 2018). Among the health issues with higher prevalence in LMICs, child mortality is arguably the most prioritized in global health. The Millennium Development Goals (MDGs) explicitly addressed this issue and the Sustainable Development Goals continue to focus on child mortality outcomes, together with maternal health and the disease control (Travis *et al.*, 2004; Liu *et al.*, 2016). A global initiative that emerged from the MDGs to tackle child mortality is the IMCIs strategy, fostered by the World Health Organization and the United Nations Children's Fund. IMCI guidelines have been implemented in several LMICs (Osterholt *et al.*, 2009; Chakkalakal *et al.*, 2013; Rakha *et al.*, 2013). In Tanzania guidelines were implemented since 1996 with positive impacts on child survival (Armstrong *et al.*, 2004; Rakha *et al.*, 2013; Gera *et al.*, 2016). In spite of the focus on primary healthcare embedded in the IMCI guidelines, the country extended the implementation to outpatient departments (OPDs) of secondary and tertiary level facilities like district hospitals (MoHSW *et al.*, 2016; Muhe *et al.*, 2018). We obtained the indicator for compliance with IMCI guidelines directly from patient visits observations for sick children. Patient visit observations include information on processes and activities carried out by the healthcare provider during the visit. The index of compliance with recommended assessment and treatment guidelines is referred to the IMCI chart booklet (World Health Organization, 2014) and counts the share of activities executed by the provider out of all the activities recommended by IMCI for any specific health condition. We computed the IMCI compliance index only for a subset of health conditions that allowed a clean isolation of the care process in the data, namely: respiratory problems, conditions affecting the digestive system, malaria, fever and ear infections. We coded the resulting index to a five points ordinal scale representing 20% incremental steps in the percentage of recommended activities executed by the health provider. In spite of comparable results in terms of sign and statistical significance obtained with linear regression analysis on the crude IMCI compliance index, the choice of generating a five points ordinal scale is supported by two main arguments. First, IMCI guidelines encompass a finite limited number of activities. Although treating the IMCI compliance index as a continuous variable is feasible, the index remains a variable 'whose range is restricted in some important way' (Wooldridge, 2010). Hence, we preferred to treat it accordingly and avoided using standard linear regression analysis. Second, the use of an ordinal scale analysed with ordinal logistic regression that produces odds ratios (ORs) allows direct comparability of coefficients with our second outcome of interest, described below and measured on a three points Likert scale. Table 3 shows that IMCI compliance is higher than 40% for less than half of the sick children observed.

Patient satisfaction is another important measure related to the quality of care (Hongoro and Normand, 2006; Kruk and Freedman, 2008; Glick, 2009). Patient satisfaction indicators were readily available in the SPA survey data for all patient visit observations. The opinions collected at the end of a visit measure a quality dimension directly related to the experience with health service provision. The SPA patient exit interview includes patient satisfaction coded to a three points Likert scale (i.e. 'Not satisfied', 'Somewhat satisfied' and 'Very satisfied'). Table 3 shows the distribution of patient satisfactions in our study sample. For the analysis on patient satisfaction, we gathered data of sick children visits and ANC visits. In case of sick children (under five), the satisfaction rating was collected from the caretaker who brought the child to the health facility (mother, father, sibling or other family member). The sample of visits to sick children used in our analysis of patient satisfaction includes all observations from the IMCI compliance analysis sample. The additional sick children included in the patient satisfaction sample (2671 compared with 1563 in the IMCI compliance sample) represent the visits for which we were not able to compute our IMCI compliance index. Patient satisfaction is generally high, with 79% of patients/caretakers reporting being 'Very satisfied' and only 3.9% reporting being 'Not satisfied'. Interestingly, looking at the restricted sample of sick children included in the IMCI compliance analysis, satisfaction is sensibly lower with 8% of caretakers

Table 3 Descriptive statistics for sample of patients

	Sample IMCI compliance				Sample patient satisfaction			
Variable	*N*	%	Avg. (SD)	Median	*N*	%	Avg. (SD)	Median
Total	1563	100.00			4970	100.00		
Type of patient: sick child	1563	100.00			2671	53.74		
Female (sick children only)	794	50.79			1151	50.07		
Age for sick children (years)	1563	100.00	1.59 (1.21)	1.25	2299	46.76	1.70 (1.24)	1.33
Age for ANC patients (years)					2671	53.74	26.42 (9.55)	25
Age of adult caretaker (years)	1543	98.72	27.97 (8.35)	27	2299	46.76	29.44 (12.12)	27
Relationship between patient and caretaker (if any)								
Mother	1431	91.55			2093	42.11		
Father	56	3.58			94	1.89		
Sibling	22	1.41			31	0.63		
Other	54	3.45			81	1.63		
Literacy level of patient/caretaker								
Cannot read or write	379	24.25			1227	24.68		
Read only	38	2.43			109	2.19		
Read and write	1146	73.32			3634	73.12		
Diagnosis related to								
Respiratory problem	1177	75.30						
Digestive system	178	11.39						
Malaria	478	30.58						
Fever	251	16.06						
Ear infection	38	2.43						
Insurance coverage (any)	258	16.51			745	14.99		
Treatment with drug prescription	1523	97.44			4601	92.57		
Client waiting time								
No waiting time					315	6.34		
Up to 30 min					1360	27.36		
31–60 min					880	17.71		
61–90 min					169	3.40		
1.5–2 h					827	16.64		
2–3 h					644	12.96		
3–4 h					346	6.96		
More than 4 h					429	8.63		
Compliance with IMCI guidelines								
0–20% of activities	264	16.89						
21–40% of activities	566	36.21						
41–60% of activities	582	37.24						
61–80% of activities	129	8.25						
81–100% of activities	22	1.41						
Satisfaction of patient/caretaker								
Very satisfied	1113	71.21			3963	79.72		
Somewhat satisfied	325	20.79			813	16.35		
Not satisfied	125	8.00			195	3.92		

Notes: (1) All observations from the IMCI compliance sample are included in the sample used for the patient satisfaction analysis. The sample employed for the analysis on patient satisfaction includes a higher number of sick children compared with the IMCI compliance sample because the outcome variable in the latter analysis was computed on a subset of IMCI compatible health conditions. (2) We reported the share of female patients only for sick children because all antenatal care patients are female, by definition. The percentage is computed accordingly on the total number of sick children included in the sample.

Source: Author's own elaboration on DHS SPA 2014/15 data.

reporting being 'Not satisfied'. To account for the difference in characteristics of the two groups of patients, we also ran the analysis on the two separated sub-samples (sick children and ANC patients only).

Covariates

The variables of interest in our analysis are indicators representing supervision and incentive policies for health workers.

Monitoring and supervision are the only options available to central administrators to directly oversee and support the activity of decentralized health service providers. Despite mixed results in terms of effectiveness (Leonard *et al.*, 2007; Bosch-Capblanch and Garner, 2008; Bosch-Capblanch *et al.*, 2011; Bradley *et al.*, 2013; Bailey *et al.*, 2016; Bhatnagar *et al.*, 2017; Snowdon *et al.*, 2017; Vasan *et al.*, 2017; Renggli *et al.*, 2018), supportive, external and managerial supervision remain an important lever of health system governance.

To measure the extent of supervision, we computed proxy indicators for the intensity of supportive, cascade, managerial and community supervision (see Box 1). The proxy indicator for supportive supervision to health workers corresponds to the count of work supervision visits in the 6 months prior to the interview. For managerial and community supervision, the proxy indicators were coded as three points ordinal scales indicating whether the facility

Box 1 Overview of supervision and management activity at health facility and health worker level in Tanzania and relevant frequency indicators from SPA 2014/15

Type of activity

Management meetings in the last 6 months

Health facilities (in particular health centres and dispensaries, as hospitals naturally have a different management system) are required to organize regular staff meetings to review progress in implementing yearly plans, identify performance problems and develop actions to improve performance.

We coded a three-level variable indicating whether the facility held none, one or more than one management meetings in the 6 months prior to the day of the interview.

Meetings with the community in the last 6 months

Health facilities are required to conduct statutory quarterly meetings as well as ad hoc meetings with the Health Facility Governing Committee (HFGC). The HFGC is a governance body—that contributes to the management of the health facility—composed by community representatives. HFGCs are the strongest form of community participation in health service delivery in Tanzania.

We coded a three-level variable indicating whether the facility held none, one or more than one meeting with community representatives (HFGC) in the 6 months prior to the day of the interview.

Cascade supervision visit in the last 6 months

Higher-level authorities are responsible for the supervision the activity of lower level health facilities, down in the administrative hierarchy (from district, regional, zonal or national offices, depending on the type of health facility).

We coded a three-level variable indicating whether the facility experienced a cascade supervision visit within the 6 months prior to the day of the interview, more than 6 months before the interview or not at all.

Work-related supportive supervision to staff

Health facility managers are required to provide health providers employed in their facilities with continuous supportive supervision of work. The goal of supportive supervision is to ensure positive feedback and quality improvement of healthcare provision.

We used the SPA 2014/2015 variable stating the number of work supervisions for the interviewed health professional in the 6 months prior to the day of the interview.

had none, one or more supervisory visits in the 6 months prior to the interview. Likewise, we coded intensity of cascade supervision from higher-level authorities as an ordinal scale indicating whether the facility experienced any supervision (within the last 6 months or less often).

Table 4 offers an overview of the distribution and variability of our proxy indicators for supervision intensity at the health facility level, for our two samples and for different types of health facilities. The two samples show comparable frequencies for all supervision indicators considered.

Financial and non-financial incentives are powerful tools available to policymakers to trigger extrinsic motivation of healthcare providers. Despite some evidence of crowding-out effect on intrinsic motivation (Leonard and Masatu, 2010), financial incentives remain an important health system governance tool (Mathauer and Imhoff, 2006; Leonard *et al.*, 2007; Lewis, 2007; Althabe *et al.*, 2008; Das *et al.*, 2008; Lewin *et al.*, 2008; McCoy *et al.*, 2008; Chandler *et al.*, 2009; Chimhutu *et al.*, 2015, 2014). The current Tanzanian strategic plan incorporates 'a mix of monetary and non-monetary incentives for high performers' implemented through LGAs (Ministry of Health and Social Welfare, 2015). Nevertheless, at sub-national level, no detailed guidelines or specific data on financial incentives are available. The Health Sector Strategic Plan IV also envisages good working conditions for staff employed in all health facilities, specifying housing and other non-monetary incentives as important elements on the path to better quality healthcare provision (United Republic of Tanzania and Ministry of Health and Social Welfare, 2007; 2014; Ministry of Health and Social Welfare, 2015). Again—apart from generic strategic statements—no specific implementation plan is provided from central authorities to LGAs. Local authorities maintain great discretion in the allocation of funds to human resources for health and thus present great variability in the type of non-monetary incentives and working conditions offered to health workers. Variability is exacerbated by two factors, namely (1) lack of coordination among different development partners working across the country (Rubin, 2012) and (2) high prevalence of informal payments and corruption (Stringhini *et al.*, 2009), both highly detrimental for the quality of healthcare provision. In our analysis, the specific incentive policy in place in the health facility was modelled as a series of dummy variables (generated from health worker self-reported answers) indicating whether the health worker benefits from a given incentive. Both monetary and non-monetary incentives are included in our analysis although, for monetary incentives, specific amounts are not available. Table 5 below offers an overview of the distribution and variability for the incentive categories considered in our analysis across different health workers cadres. Box 2 includes a description of the different incentives.

Several control variables were included in the analysis to account for observed heterogeneity in patients, providers and health facilities that may concur to affect the selected dependent variables. Table 3 includes summary statistics for the available controls at patient level.

Results

Below we report results for our preferred model with three clustering levels (region, health facility and provider). Two comparison models (multilevel ordered logistic with two clustering levels and standard ordered logistic regression with clustered errors) are reported in Supplementary Tables SM2 and SM3. We report all results in form of ORs with 95% confidence intervals to facilitate interpretation.

Compliance with IMCI guidelines

Concerning our analysis on compliance to IMCI guidelines, the final sample includes 1563 different children aged 5 years or less treated in the surveyed facilities. Table 6 shows the results.

Our analysis shows no statistically significant association between compliance with IMCI and supervision, of any kind. The rate

Table 4 Distribution of supervision indicators across health facility types

Variable	Total	Dispensary	Health centre	Hospital
	(Column percentages in parentheses)			
Sample for IMCI compliance analysis				
Frequency of management meetings in the last 6 months				
Never	89 (16.01)	70 (28.00)	17 (7.80)	2 (2.27)
Once	25 (4.50)	15 (6.00)	10 (4.59)	0 (0)
More than once	442 (79.50)	165 (66.00)	191 (87.61)	86 (97.73)
Total	556 (100)	250	218	88
Frequency of meetings with the community in the last 6 months				
Never	176 (31.65)	80 (32.00)	59 (27.06)	37 (42.05)
Once	50 (8.99)	22 (8.80)	21 (9.63)	7 (7.95)
More than once	330 (59.35)	148 (59.20)	138 (63.30)	44 (50.00)
Total	556 (100)	250	218	88
Last cascade supervision visit in the last 6 months				
Never	3 (0.54)	3 (1.20)	0 (0)	0 (0)
Within past 6 months	540 (97.12)	241 (96.40)	212 (97.25)	87 (98.86)
More than 6 months ago	13 (2.34)	6 (2.40)	6 (2.75)	1 (1.14)
Total	556 (100)	250	218	88
Sample for patient satisfaction analysis				
Frequency of management meetings in the last 6 months				
Never	108 (16.07)	86 (28.38)	20 (7.69)	2 (1.83)
Once	28 (4.17)	16 (5.28)	12 (4.62)	0 (0)
More than once	536 (79.76)	201 (66.34)	228 (87.69)	107 (98.17)
Total	672 (100)	303	260	109
Frequency of meetings with the community in the last 6 months				
Never	219 (32.59)	105 (34.65)	69 (26.54)	45 (41.28)
Once	56 (8.33)	25 (8.25)	24 (9.23)	7 (6.42)
More than once	397 (59.08)	173 (57.10)	167 (64.23)	57 (52.29)
Total	672 (100)	303	260	109
Last cascade supervision visit in the last 6 months				
Never	7 (1.04)	5 (1.65)	1 (0.38)	1 (0.92)
Within past 6 months	639 (95.09)	283 (93.40)	249 (95.77)	107 (98.17)
More than 6 months ago	26 (3.87)	15 (4.95)	10 (3.85)	1 (0.92)
Total	672 (100)	303	260	109

Source: Author's own elaboration on DHS SPA 2014/15 data.

of compliance with IMCI guidelines seems to be unaffected by the intensity of supportive supervision to health workers, cascade supervision from higher-level authorities, internal managerial activity or community supervision through meetings with community representatives.

On the other hand, our preferred three levels ordered logistic model shows a strong significant association between monetary housing allowances to health workers and higher compliance with IMCI. Health workers provided with housing allowance, other things equal, are four times more likely to show higher compliance with IMCI. Salary top-ups are also positively and significantly associated to IMCI compliance (OR 1.640). All other specific incentives show no significant association with IMCI treatment compliance.

The compliance to IMCI was higher for diagnoses related to malaria and digestive system problems, as opposed to acute ear infections (our reference category). The result is not surprising given the focus of national and international campaigns on reducing malaria morbidity and mortality. On the other hand, children with a respiratory diagnosis and/or later in childhood are less likely to be treated in compliance with IMCI. The compliance with IMCI guidelines was lower for clinical assistants compared with Medical Doctors (reference category) and for younger children. Other control variables do not show significant association with our measure of compliance with IMCI guidelines.

Patient satisfaction

The final pooled sample for our analysis of patient satisfaction includes 4970 patient visits, including ANC visits and treatment of sick children in the surveyed facilities. The results are provided in Table 7 for the full sample and the sub-samples of sick children and ANC patients separately.

Higher intensity of community supervision (in form of meetings with the community) is significantly associated with higher patient satisfaction in the analysis on the full sample and the sub-sample of ANC patients, but not in the sub-sample of sick children. Our analysis shows that, when community meetings were held more than once within the 6 months prior to the survey, patients were consistently more satisfied with health service provision (point estimate for OR is 1.316 for full sample and 1.727 for ANC patients).

Among the different incentive categories, two were significantly associated with higher patient satisfaction in the full sample: salary top-ups and subsidized housing for health workers. In both cases, providers benefiting from these incentives are about 1.3 times more likely to leave their patients satisfied. The analysis on the sub-sample of sick children shows a positive and significant association between patient satisfaction and salary top-ups (OR 1.456), payment for extra activities (OR 1.784) and subsidized housing (OR 1.593). The sub-sample of ANC patients does not show any significant positive association with the incentive categories considered

Table 5 Distribution of incentives across health worker cadres

Variable	Managing position	Medical doctor	Medical/clinical officer	Nurse	Assistant
Sample for IMCI compliance analysis					
Total staff in cadre	934 (59.76)	38 (2.43)	1038 (66.41)	349 (22.33)	138 (8.83)
Monetary incentives to provider					
Salary top-up	277 (29.66)	16 (42.11)	298 (28.71)	101 (28.94)	54 (39.13)
Per diem when training	310 (33.19)	7 (18.42)	282 (27.17)	134 (38.40)	28 (20.29)
Duty allowance	320 (34.26)	2 (5.26)	352 (33.91)	106 (30.37)	45 (32.61)
Payment for extra activities	128 (13.70)	1 (2.63)	122 (11.75)	40 (11.46)	3 (2.17)
On-call allowance	326 (34.90)	27 (71.05)	388 (37.38)	64 (18.34)	42 (30.43)
Housing allowance	29 (3.10)	8 (21.05)	23 (2.22)	5 (1.43)	0 (0)
Non-monetary incentives to provider					
Uniform/caps/backpack	293 (31.37)	14 (36.84)	313 (30.15)	95 (27.22)	58 (42.03)
Training	196 (20.99)	1 (2.63)	175 (16.86)	75 (21.49)	15 (10.87)
Subsidized housing	296 (31.69)	3 (7.89)	251 (24.18)	102 (29.23)	31 (22.46)
Time off/holidays	79 (8.46)	0 (0)	109 (10.50)	33 (9.46)	14 (10.14)
Sample for patient satisfaction analysis					
Total staff in cadre	2379 (47.87)	96 (1.93)	1622 (32.64)	2570 (51.71)	682 (13.72)
Monetary incentives to provider					
Salary top-up	693 (29.13)	32 (33.33)	436 (26.88)	789 (30.70)	186 (27.27)
Per diem when training	743 (31.23)	9 (9.38)	414 (25.52)	765 (29.77)	177 (25.95)
Duty allowance	941 (39.55)	8 (8.33)	570 (35.14)	928 (36.11)	240 (35.19)
Payment for extra activities	366 (15.38)	11 (11.46)	201 (12.39)	326 (12.68)	85 (12.46)
On-call allowance	772 (32.45)	61 (63.54)	616 (37.98)	493 (19.18)	161 (23.61)
Housing allowance	91 (3.83)	14 (14.58)	41 (2.53)	68 (2.65)	16 (2.35)
Non-monetary incentives to provider					
Uniform/caps/backpack	830 (34.89)	31 (32.29)	464 (28.61)	896 (34.86)	269 (39.44)
Training	446 (18.75)	4 (4.17)	246 (15.17)	436 (16.96)	87 (12.76)
Subsidized housing	618 (25.98)	19 (19.79)	399 (24.60)	418 (16.26)	122 (17.89)
Time off/holidays	269 (11.31)	0 (0)	189 (11.65)	255 (9.92)	77 (11.29)

Source: Author's own elaboration on DHS SPA 2014/15 data.

Box 2 Overview of monetary incentives to health workers in Tanzania and relevant frequency indicators from SPA 2014/15

Type of incentive

Salary top-ups

Long-term permanent monetary payments that top-up the basic government salary payable to medical cadres for permanent additional activities, responsibilities, within the facility or with external partners (e.g. project funded by donors that involves activity of health facility staff).

Per diem when training

Lump sum monetary subsistence allowance payable to medical cadres spending days/nights away on training within the country or abroad.

Duty allowance

Lump sum monetary allowance payable to a number of medical cadres for duties such as nightshifts.

Payment for extra activities

Lump sum monetary payment payable to a number of medical cadres if he/she personally worked beyond normal working hours for exceptional reasons and but cannot compensate taking time off during normal working hours.

On-call allowance

Lump sum monetary allowance payable to a number of medical cadres who after a nightshift (or similar) cannot be granted a day off.

Housing allowance

Lump sum monetary allowance meant to facilitate payment of the rent (or part of it) payable to medical cadres entitled to free or subsidized housing for which Government housing (usually within the health facility compound) is not available.

Uniform/caps/backpack

Equipment and clothing offered to health workers in excess to what is strictly necessary to perform their activities.

Training

Opportunities to attend additional training, specialization, diplomas and degrees.

Free or subsidized housing in government housing (usually within the health facility compound).

Subsidized housing

Time off/holidays

Compensation offered for extra time spent at work or reward in form of time off during normal working hours.

Table 6 Regression results for IMCI compliance

Three levels ordered logit	Sick children OR (95% CI)
Rural area	1.182 (0.647–2.160)
Results-based financing	1.429 (0.326–6.265)
Health Services Index	1.024 (0.930–1.127)
Any patient feedback mechanism	1.045 (0.683–1.599)
Caretaker literacy (reference: neither read nor write)	
Read only	0.592 (0.264–1.326)
Read and write	0.980 (0.730–1.314)
Caretaker relationship with patient (reference: mother)	
Father	0.846 (0.430–1.663)
Sibling	1.710 (0.624–4.687)
Other	0.958 (0.488–1.880)
Patient gender: female	0.900 (0.706–1.148)
Patient age	0.823*** (0.740–0.915)
Health insurance coverage	0.976 (0.678–1.403)
Diagnosis (reference: ear problem)	
Respiratory problem	0.230*** (0.155–0.340)
Digestive system	1.681** (1.141–2.476)
Malaria	2.009*** (1.393–2.897)
Fever	0.927 (0.619–1.388)
Patient charged for visit	0.727 (0.376–1.406)
Provider gender: female	1.075 (0.715–1.615)
Provider tenure at facility	1.025 (0.997–1.053)
Provider qualification (reference: medical doctor)	
Medical/clinical officer	0.484 (0.153–1.530)
Nurse	0.301 (0.0830–1.088)
Assistant	0.199* (0.0464–0.851)
Provider manager or in-charge of unit	1.126 (0.722–1.756)
Facility has IMCI guidelines	1.507 (0.973–2.334)
Number of OPD visits during the last month (reference: 0–200 visits)	
200–400 visits	1.290 (0.738–2.255)
400–600 visits	0.881 (0.456–1.704)
600–800 visits	0.715 (0.299–1.712)
More than 800 visits	0.705 (0.354–1.403)
Type of health facility (reference: dispensary)	
Hospital (any level)	1.311 (0.484–3.551)
Health centre	0.799 (0.426–1.498)
Frequency of management meetings at the health facility in the last 6 months (reference: never)	
Once	0.586 (0.217–1.586)
More than once	1.073 (0.607–1.897)
Frequency of meetings with the community at the health facility in the last 6 months (reference: never)	
Once	1.240 (0.604–2.546)
More than once	1.230 (0.804–1.880)
Last external supervision at the health facility (reference: never)	
More than 6 months ago	0.247 (0.0153–4.012)
Within past 6 months	0.300 (0.0238–3.777)
Days of work supervision to the provider	1.073 (0.988–1.165)
Monetary incentives to provider	
Salary top-up	1.640* (1.035–2.599)
Per diem when training	0.891 (0.568–1.398)
Duty allowance	1.068 (0.705–1.620)
Payment for extra activities	1.024 (0.545–1.927)
On-call allowance	1.079 (0.703–1.658)
Housing allowance	3.988* (1.229–12.94)
Non-monetary incentives to provider	
Uniform/caps/backpack	1.134 (0.743–1.732)
Training	1.096 (0.607–1.980)
Subsidized housing	1.460 (0.918–2.324)
Time off/ holidays	1.129 (0.573–2.227)
N	1563
Log-likelihood	−1717.1
LR chi^2	175.3
Prob > chi^2	1.13e−16
Number of iterations	6

Exponentiated coefficients; 95% confidence intervals in brackets.
$^*P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$.,
OPD, outpatient department; LR, likelihood-ratio test.

in the analysis. In contrast, non-monetary incentives to health workers in the form of additional holidays are associated with lower patient satisfaction for the full sample and the sub-sample of ANC patients. Other forms of supervision and incentive categories are not significantly associated with patient satisfaction in our estimated models.

Among the control variables, we found that patients that obtained a prescription for medicines during the visit are about 1.5 more likely to report higher satisfaction (1.9 times for the sub-sample of sick children). Second, patients waiting >90 min for the visit at the health facility are increasingly less satisfied. These findings are consistent with the existing literature as well as with the anecdotal evidence about patient satisfaction in rural settings in LMICs. Third, the literacy level of patients (or caretakers, for sick children) has a negative influence on satisfaction. Fourth, consistently with descriptive statistics in Table 3, patient satisfaction is significantly lower for visits of sick children (as opposed to ANC visits) and in health centres (secondary level of care) as opposed to dispensaries (primary level of care). Last, in the sub-sample of sick children, being charged for the visit results in sensibly lower patients' satisfaction (OR 0.552). This latter result is consistent with the policy in place in Tanzania on free healthcare for children under five.

Robustness checks

We conducted several types of robustness checks to verify the consistency of our results. From the technical point of view, we ran the preferred three levels ordered logistic regression with different numbers of integration (quadrature) points, namely 8, 12 and 16 as opposed to the standard of 7. The results—perfectly equivalent to the standard specification—are not reported.

Second, we estimated our main models using a multilevel regression with two clustering levels (provider and health facility) as well as a standard ordered logistic model with clustered errors. The results are reported in Supplementary Tables SM2 and SM3.

The SPA survey data employed for our analysis oversample the number of hospitals and health centres. We accounted for this characteristic of the dataset controlling for the type of facility in our analysis within the analysis. To further check the robustness and stability of our results, we ran the analyses omitting patients treated in hospitals. Supplementary Tables SM4 and SM5 show that the estimates do not differ significantly.

Finally, the set of independent incentives proposed in our analysis (Box 2) may hinder some degree of interaction or multicollinearity. Supplementary Table SM6 shows the cross-correlation matrix (Spearman's rho) for our 10 incentive variables. The higher

Table 7 Regression results for patient satisfaction

Three levels ordered logit	Full sample OR (95% CI)	Sick children only OR (95% CI)	ANC only OR (95% CI)
Rural area	1.207 (0.859–1.698)	1.094 (0.709–1.689)	1.203 (0.703–2.060)
Results-based financing	0.618 (0.241–1.583)	0.653 (0.241–1.768)	0.619 (0.196–1.952)
Health Services Index	1.021 (0.965–1.080)	0.986 (0.920–1.057)	1.094 (0.995–1.204)
Any patient feedback mechanism	0.858 (0.671–1.098)	1.108 (0.814–1.507)	0.541** (0.359–0.815)
Patient or caretaker literacy (reference: neither read nor write)			
Read only	0.567* (0.334–0.962)	0.579 (0.298–1.126)	0.508 (0.212–1.214)
Read and write	0.940 (0.767–1.152)	0.805 (0.624–1.039)	1.218 (0.870–1.705)
Patient or caretaker age	0.987* (0.975–0.999)	1.061 (0.975–1.156)	0.986* (0.974–0.998)
Health insurance coverage	0.982 (0.853–1.130)	1.157 (0.847–1.580)	0.950 (0.815–1.107)
Drug prescription during visit	1.511* (1.076–2.122)	1.974* (1.002–3.888)	1.410 (0.943–2.107)
Waiting time (reference: no waiting time)			
Up to 30 min	0.833 (0.553–1.254	0.926 0.580–1.481	0.591 (0.247–1.416
30–60 min	0.769 (0.501–1.179	0.884 0.540–1.448	0.562 (0.230–1.375
60–90 min	0.587 (0.329–1.046)	0.765 (0.378–1.548)	0.334* (0.114–0.975)
90–120 min	0.588* (0.383–0.903)	0.605* (0.368–0.994)	0.500 (0.205–1.218)
120–180 min	0.516** (0.331–0.806)	0.669 (0.390–1.146)	0.338* (0.139–0.821)
180–240 min	0.358*** (0.220–0.581)	0.454* (0.244–0.845)	0.237** (0.0947–0.592)
More than 240 min	0.390*** (0.245–0.623)	0.457** (0.254–0.821)	0.279** (0.113–0.687)
Patient type: sick child	0.190*** (0.123–0.293)		
Patient charged for visit	0.699 (0.489–1.000)	0.552* (0.350–0.870)	0.829 (0.461–1.491)
Provider gender: female	1.145 (0.892–1.469)	1.322 (0.992–1.762)	0.719 (0.416–1.241)
Provider tenure at facility	1.001 (0.987–1.015)	1.010 (0.991–1.030)	0.993 (0.973–1.012)
Provider qualification (reference: medical doctor)			
Medical/clinical officer	1.519 (0.774–2.981)	1.178 (0.548–2.533)	3.819 (0.728–20.03)
Nurse	1.990 (0.958–4.135)	1.329 (0.553–3.195)	5.469* (1.097–27.25)
Assistant	1.709 (0.758–3.852)	0.947 (0.354–2.529)	6.380* (1.169–34.81)
Provider manager or in-charge of unit	0.991 (0.780–1.259)	0.878 (0.638–1.206)	1.062 (0.735–1.534)
Number of OPD visits last month at the health facility (reference: 0–200 visits)			
200–400 visits	1.134 (0.818–1.572)	0.961 (0.637–1.450)	1.245 (0.724–2.140)
400–600 visits	1.195 (0.821–1.739)	1.168 (0.723–1.888)	1.057 (0.574–1.948)
600–800 visits	0.962 (0.589–1.572)	0.787 (0.431–1.437)	1.191 (0.507–2.799)
More than 800 visits	1.119 (0.766–1.635)	1.078 0.667–1.742	0.931 (0.499–1.739)
Type of health facility (reference: dispensary)			
Hospital (any level)	0.722 (0.409–1.274)	0.526 (0.258–1.073)	0.852 (0.339–2.144)
Health centre	0.684* (0.474–0.988)	0.762 (0.482–1.205)	0.554 (0.301–1.023)
Frequency of management meetings at the health facility in the last 6 months (reference: never)			
Once	0.869 (0.482–1.565)	0.848 (0.428–1.681)	0.991 (0.322–3.048)
More than once	0.951 (0.676–1.340)	0.918 (0.606–1.388)	1.030 (0.570–1.860)
Frequency of meetings with the community at the health facility in the last 6 months (reference: never)			
Once	1.177 (0.788–1.756)	1.104 (0.667–1.828)	1.582 (0.803–3.119)
More than once	1.316* (1.029–1.685)	1.210 (0.892–1.640)	1.727** (1.146–2.605)
Last external supervision at the health facility (reference: never)			
More than 6 months ago	1.169 (0.293–4.664)	1.606 (0.264–9.763)	0.621 (0.0720–5.348)
Within past 6 months	1.243 (0.368–4.198)	1.328 (0.269–6.555)	0.950 (0.141–6.420)
Days of work supervision to the provider	0.997 (0.951–1.046)	0.975 (0.919–1.033)	1.018 (0.941–1.101)
Monetary incentives to provider			
Salary top-up	1.343* (1.030–1.752)	1.456* (1.040–2.039)	0.621 (0.0720–5.348)
Per diem when training	0.824 (0.642–1.058)	1.051 (0.755–1.462)	0.950 (0.141–6.420)
Duty allowance	1.001 (0.794–1.262)	1.033 (0.769–1.388)	1.018 (0.941–1.101)
Payment for extra activities	1.261 (0.898–1.771)	1.784* (1.117–2.850)	0.621 (0.0720–5.348)
On-call allowance	1.043 (0.815–1.335)	1.056 (0.781–1.427)	0.950 (0.141–6.420)
Housing allowance	1.538 (0.788–3.004)	2.042 (0.864–4.828)	1.018 (0.941–1.101)
Non-monetary incentives to provider			
Uniform/caps/backpack	1.003 (0.795–1.265)	1.069 (0.788–1.451)	0.840 (0.590–1.196)
Training	1.124 (0.804–1.572)	1.036 (0.679–1.582)	1.320 (0.778–2.238)
Subsidized housing	1.386* (1.046–1.836)	1.593** (1.129–2.247)	1.109 (0.693–1.776)
Time off/ holidays	0.674* (0.465–0.977)	0.873 (0.534–1.428)	0.534* (0.306–0.931)
N	4970	2299	2671
Log-likelihood	−2679.1	−1655.3	−984.7
LR chi^2	256.3	87.85	75.97
Prob > chi^2	1.32e−30	0.000199	0.00355
Number of iterations	6	6	55

Exponentiated coefficients; 95% confidence intervals in parentheses.
$^*P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$.,
LR, likelihood-ratio test.

value for a pairwise correlation is about 0.3, between per diem allowances for training and non-monetary incentives in the form of additional training. This value does not seem excessive and reflects the obvious connection between the two types of incentives. Further, a stepwise approach in including our independent variable did not show sensible changes in the estimated coefficients indicating no relevant confounders and absence of multi-collinearity (results not provided in tables). A full modelling of all interaction terms between incentive indicators would result in model overfitting.

Discussion

The empirical approach employed here represents a novel attempt to simultaneously assess the effect of supervision and incentives on selected measures of quality of care. We considered a broad range of quantitative proxy variables that map the extent of supervision and the incentive policy in place in the surveyed health facilities.

Our analysis revealed a positive and significant association between the frequency of meetings with the community and patient satisfaction for the full sample and the sub-sample of ANC patients only. First, the results suggest a difference in the patients' experiences between ANC patients and adult caretakers assisting sick children during visits to health facilities. This may be related to the interaction of both demand and supply-side factors. With higher frequency of meetings with the community, healthcare providers may be more aware of the needs of the community and, therefore, able to address them better. Consistently, this seems to be more prominent in the domain of ANC visits as opposed to acute health issues affecting children. In the full sample (pooling sick children and ANC patients), depending on the type, between 25% and 40% of health facilities reported that they did not have meetings with the community within the 6 months prior to the survey date (see Table 4). The IMCI compliance sample alone shows comparable percentages across all types of supervision indicators included in the analyses, supporting the hypothesis that the difference is driven by patients' perceptions and experiences rather than structural differences in the health facilities. The result contributes to the weak evidence base showing that—all other things equal—a closer interaction between health service providers and community improves patient satisfaction (Nair *et al.*, 2014; Dansereau *et al.*, 2015). Our interpretation of the mechanism is that community participation influences access to healthcare—and thus social health protection outcomes—through multiple channels. On the one hand, there is an indirect impact through increased patient satisfaction, favouring health-seeking behaviour in the served community (Rutherford *et al.*, 2010). The quality of every patient experience is crucial in determining future patient behaviours towards healthcare services and access to care in general (Andaleeb, 2001; Andaleeb *et al.*, 2007; Glick, 2009; Alrubaiee and Alkaa'ida, 2011). On the other hand, community participation can have a direct impact on access to care as a result of health promotion activities within the communities (Fotso *et al.*, 2009). The self-reinforcing loop described above is also consistent with the high-quality health system framework proposed by Kruk *et al.* (2018). In the race for universal health coverage, there is a need for further research to shed light on this 2-fold relationship.

Another interesting finding in our analysis relates to the effects of financial and non-financial incentives for health workers. This result is particularly valuable in light of the distribution of incentives across cadres reported in Table 5. In fact, salary top-ups appear to be evenly distributed across health worker qualifications, supporting the hypothesis that the positive association results from true individual incentive effect rather than capturing the role of one or two incentivized categories. The overall positive effects of incentive policies on quality—especially in terms of financial incentives such as salary top-ups—are in line with the available evidence (Chaudhury *et al.*, 2006; Dieleman and Harnmeijer, 2006; Hongoro and Normand, 2006; Mathauer and Imhoff, 2006; Dambisya, 2007; Henderson and Tulloch, 2008; Chandler *et al.*, 2009; Munga *et al.*, 2014). Nevertheless, our contribution provides additional evidence based on a robust analytical strategy, high-quality data and a wide range of controls of contextual factors. This result has implications for Tanzanian policymakers, e.g. in case of implementation of new policies and improvement of existing arrangements. Based on our results, we believe that pilot projects across the country should expand the role of better housing and general salary conditions for health workers in government-managed health facilities, instead of focusing on performance-related incentives such as P4P projects.

The differential effect of financial and non-financial housing incentives on the different quality of care measures is a puzzling yet interesting result. It is indeed reasonable to assume that certain classes of incentives may affect some quality dimensions more than others. Specifically, salary supplements for housing are positively associated with IMCI compliance, whereas non-financial incentives in the form of subsidized housing showed a positive association with patient satisfaction. Our interpretation is that subsidized housing—namely the chance of living in houses usually built by the government in the compound of the health facility—affects only the outcome dimension of quality of care related to the patients' experiences. In the authors' own experience, the opportunity of knocking on the door of the health facility in-charge just metres away from the closed health facility leaves a sense of great availability and proximity to the patient. There is no such direct link between actual living arrangements and the process dimension of quality, which may be the reason why we did not find the same association with the measure of compliance with IMCI. The salary supplement, despite being targeted to housing, increases the monthly budget of health providers. As such is closer to any other form of salary supplement and does not show the direct link with the proximity effect of subsidized housing described above. To this extent, the difference in the results on patient satisfaction across patients groups is informative. In fact, subsidized housing shows a significant association for the sub-sample of sick children but not for ANC patients. This can be interpreted in light of the difference in timing of visits for the two groups of patients: planned and scheduled for ANC visits—with no clear advantage of having providers living close-by—vs potentially unplanned and urgent needs for sick children.

The distribution of housing incentives, presented in Table 5, is generally consistent with the above interpretation. In the patient satisfaction full sample, subsidized housing is evenly distributed across health worker qualifications and roles. This rules out the hypothesis of the effect capturing the role of specific cadres. On the other hand, in the IMCI compliance sample, financial housing allowances are disbursed disproportionately to Medical Doctors (compared with other qualifications). The IMCI compliance sample includes health conditions affecting sick children for which the process of care dimension is more relevant. As Medical Doctors are likely to be more competent than other professionals in handling the process of care, the effect in our results may reflect an higher responsiveness of the process of care to financial incentives for this professional category.

Another curious result is the negative association between patient satisfaction and additional holidays. Although additional holidays should make health workers happy and motivated, additional time off and related abuses (i.e. absenteeism) may lead to

suboptimal organization of shifts in the health facilities and excessive workload for health workers on duty. Our finding supports the argument that overloaded providers tend structurally to produce queues and longer waiting times, besides healthcare of lower quality (Kisakye *et al.*, 2016). Another finding that supports the latter statement is the negative effect of per diem allowances for training, consistently across type of quality of care measure. The effect is statistically significant only in the analysis on patient satisfaction that excludes hospitals from the sample. Yet, the result is consistent with some literature pointing to the negative effects of per diems—and the associated travelling away from work—on provider performance (Ridde, 2010; Vian *et al.*, 2012). Nonetheless, our interpretation of latter nuances in the results related to incentive policies is far from being conclusive and would greatly benefit from further research focused on the decision-making process of health workers.

The last major result of our analysis is the lack of any association between quality of care and frequency of external, supportive or managerial supervision. Besides problems related to effective coverage of supervision in remote areas (Manzi *et al.*, 2012) and nature of supervision activity (Snowdon *et al.*, 2017; Vasan *et al.*, 2017), the result fits well with the literature suggesting that supervision alone is not effective in generating improvements in provider performance and quality of care (Kok *et al.*, 2018; Kruk *et al.*, 2018). On the one hand, our interpretation is that the quality of feedback from supervision matters as much (if not more) as the frequency of supervision itself. The importance of feedback for the effectiveness of supervision is not new to the literature (Manongi *et al.*, 2006; Moran *et al.*, 2014; Kok *et al.*, 2018; Renggli *et al.*, 2018). In fact, health providers may turn out to feel judged and not supported with constructive feedback, no matter if positive or negative. As a result, they may lack the necessary motivation to put more effort into work, resulting in suboptimal quality of healthcare provision. On the other hand, the combination of supervision, training and community involvement in multifaceted quality improvement initiatives proved to be largely more effective than isolated policies (Kruk *et al.*, 2018). These broad approaches to quality improvement are likely to enhance the characteristics and perception of supervision among healthcare workers (Rowe *et al.*, 2010). Although our results are based on a survey and employ a statistical technique that is not meant to detect all real-life human interactions between supervisors and health workers, they may also reveal problems in the implementation of these activities in Tanzania. Further research should focus on thorough evaluation of the effectiveness of supervisory practices within public health facilities, in Tanzania and elsewhere.

Finally, among the control variables included in our analysis on patient satisfaction, two main results arise and confirm the existing evidence. First, high-waiting times are detrimental for patient satisfaction with health services provided. Second, drug prescription during treatment is associated to higher patient satisfaction.

One major limitation of our analysis is that we look at a proxy of the outcome—quality of care—that results from an intermediate process related to the effort put in the work by different health providers, with varying levels of expertise and skills. In particular, our analysis overlooks the direct impact pathway of incentives and supervision on healthcare quality through provider motivation and effort. Future research in this field should try to disentangle the process and outputs of measured quality of care.

The accuracy of quality measurement also has room for improvement. Routine monitoring and evaluation programmes should collect objective measures of quality of care, such as appropriateness of prescribing behaviour and diagnosis accuracy. Further, integration between healthcare quality data and patient cohort studies could help to capture long-term impacts on health status.

The sample of health facilities included in our analysis is limited to public (government managed) health facilities, intentionally excluding relevant factors such as faith-based, non-profit and private healthcare providers. The sampling strategy employed to collect the data ensures the statistical validity of the sub-sample but does not elude the fact that we portray only part of the full healthcare provision panorama. Still, we believe that—in low-income settings—public health facilities maintain a major role in granting access to affordable healthcare for the poor and thus reducing social inequalities.

In conclusion, we acknowledge the explorative nature of our study, which is based on cross-sectional data and includes simultaneously a large set of control variables. Although the large number of controls is essential to reduce omitted-variable bias, it also reduces the power to detect significant associations. As suggested by Kruk *et al.* (2018), future research should produce better multi-year evidence on the impact of quality improvement initiatives, including supervision and incentives.

Conclusion

High quality of care is a key for promoting health in Tanzania not only through direct positive outcomes of the process of care but also through increased care-seeking behaviour in the communities. Our results confirm that better salary conditions for health workers are beneficial for both our quality of care indicators, namely compliance with IMCI and patients' satisfaction. Consistently with its labour-intensive nature, the effort put in by adequately incentivized health workers influences the quality of healthcare produced.

Housing arrangements for health workers—especially in rural settings—are associated with higher patient satisfaction. Based on our analysis, health facility compounds should include living spaces for health workers that are likely to create a sense of closeness with community and ultimately patients. Along the same lines, higher frequency of meetings between community and health facility representatives improves patients' satisfaction with health services provided. In turn, increased patient satisfaction will most likely favour a positive attitude of patients towards health service provision—in our case for government-owned health facilities—and increased health-seeking behaviour.

The policy tools described above are all subject to direct control of LGAs and central authorities. Besides testing new interventions with pilot projects funded by development partners, policymakers in Tanzania and in other LMICs should take into serious account the available body of evidence to shape effective health policies ensuring good quality healthcare for all.

Note

1. As of 2018, the full name is Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC).

Supplementary data

Supplementary data are available at *Health Policy and Planning* online.

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Conflict of interest statement. None declared.

Ethical approval. The specific study did not require any ethical clearance. Nevertheless, the researchers involved in the project obtained ethical clearance to conduct research in Tanzania from the Institutional Review Board at Ifakara Health Institute (IHI, Dar es Salaam, Tanzania) and from the National Institute for Medical Research (NIMR, Dar es Salaam, Tanzania).

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Part IV

Impact of social accountability monitoring on health facility performance: Evidence from Tanzania

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Impact of social accountability monitoring on health facility performance: Evidence from Tanzania

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Abstract

Social accountability programs are increasingly used to improve the performance of public service providers in low-income settings. Despite their growing popularity, evidence on the effectiveness of social accountability programs remains mixed. In this manuscript, we assess the impact of a social accountability intervention on health facility management exploring quasiexperimental variation in program exposure in Tanzania. We find that the social accountability intervention resulted in a 1.8 SD reduction in drug stockouts relative to the control group, but did not improve facility infrastructure maintenance. The results of this study suggest that social accountability programs may be effective in areas of health service provision that are responsive to changes in provider behavior but may not work in settings where improvements in outcomes are conditional on larger health systems features.

KEYWORDS
community monitoring, essential medicines, health infrastructure, social accountability, Tanzania

1 | INTRODUCTION

Social accountability programs are an increasingly popular tool for improving the performance of health systems in low- and middle-income countries (LMICs). By allowing patients and citizens to directly provide feedback to health workers, social accountability essentially empowers communities to exert social pressure on responsible health workers, increasing their incentives to meet local expectations. Social accountability programs come in many different forms in practice, and range from citizen monitoring and oversight of public sector performance to citizen participation in resource allocation and decision making, public disclosure of data through scorecards, community scorecards, and formal community-based

health facility committees (Fox, 2015; Joshi, 2017; Joshi & Houtzager, 2012; Molina, Carella, Pacheco, Cruces, & Gasparini, 2017; Ogbuabor & Onwujekwe, 2018). Several earlier studies have linked accountability mechanisms to a wide array of positive outcomes at the health systems level, including increased service accessibility, better quality of care, increased patient satisfaction and provider performance, lower corruption, and ultimately better health outcomes (Greer, Matthias, Josep, & European Observatory on Health Systems and Policies, 2016; Kalolo, Radermacher, Stoermer, Meshack, & De Allegri, 2015; Lewis, 2006; Lewis & Pettersson, 2009). Fueled by successful programs like Uganda's community-based monitoring (Björkman & Svensson, 2009), social accountability projects have been launched in many low-income healthcare settings in recent years (Molina et al., 2017).

Yet, the evidence on the effectiveness of social accountability programs remains mixed. Some further positive evidence on reduced corruption and increased service quality in Uganda (Fiala & Premand, 2018) as well as on improved access to maternal health services in India (Hamal, Tjard de Cock, De Brouwere, Bardají, & Dieleman, 2018) is contrasted by several studies finding no impact associated with social accountability initiatives (Gaventa & McGee, 2013; Lodenstein et al. 2017, 2018), including an attempt to replicate the original "power to the people" project results in Uganda (Björkman Nyqvist, de Walque, and Svensson 2017).

In this study, we assess the impact of a social accountability monitoring (SAM) program recently implemented in selected areas of Tanzania. Starting in 2011, a large *Health Promotion and System Strengthening* (HPSS) *Project* was launched in all seven districts of Dodoma region, Tanzania. Two out of seven districts in the region were selected for an additional SAM program. These SAM districts were similar to the five other (control) districts in the region in terms of demographic and socioeconomic characteristics, as well as with respect to their health systems characteristics at the beginning of the project. The main objectives of the SAM program implemented from 2012 were to increase the availability of medicines, to improve health facilities infrastructure maintenance, and to improve resource allocation as well as financial management at the district level. Using a difference-in-differences (DID) approach to identify the changes in the two SAM districts relative to the five districts not receiving the program over the periods 2011 and 2017, we find that the SAM intervention on average reduced the number of drug stockout days, but did not change facility infrastructure maintenance efforts. Our results suggest that stockouts across all drugs considered were reduced by 266 days over a 3-month period, a 1.8 standard deviation reduction relative to the stockout levels observed at baseline. Most of these reductions seem to be linked to stockouts in antibiotics and other essential drugs. We implemented an extensive series of robustness checks to address potential threats to our primary identification strategy. First, we address potential selection into treatment based on initial differences in study outcomes using a lagged dependent variable (LDV) approach. Second, we use drug availability from national surveys to estimate alternative models with matched control districts outside of the region. Thirdly, we estimate our main model selectively excluding treatment and control districts. Finally, we run placebo regressions, analyzing a set of alternative outcomes which should not have been affected by the policy. All of these tests substantially confirm our main results.

In the last part of the paper, we discuss potential mechanisms that may explain the incremental effect of the SAM project. Building also on qualitative data collected across a purposely sampled group of facilities in Dodoma region, we argue that the most plausible mechanism for the improved drug stocking outcomes seems to be a perceived increase in pressure on providers, who reacted to this increase in social pressure by intensifying efforts in domains under their direct influence, such as forecasting needs of medicines and filing timely and complete drugs orders. Other domains of health facility performance—where change potentially requires coordinated efforts with higher level authorities, substantial funding and planning—were likely harder to control for local staff and thus less likely to respond to social accountability.

The results presented in this study are consistent with the idea that increased transparency and social accountability can improve outcomes in settings where marginal changes in provider efforts can affect observable outcomes (Fiala & Premand, 2018; Fox, 2007, 2015; Joshi, 2017; Joshi & Houtzager, 2012; O'Meally, 2013). The main enabling factor highlighted in the literature that is supported by our analysis is the ability to accommodate context specific factors into the program (Danhoundo, Nasiri, and Wiktorowicz 2018; Gaventa & McGee, 2013; Martin Hilber et al., 2016). In the specific case analyzed here, the non-governmental Organization (NGO, Sikika) was able to embed the accountability process into existing social and institutional mechanisms. Several authors have also highlighted the importance of feedback cycles between community and government authorities (Fox, 2015; Ringold, Holla, Koziol, & Srinivasan, 2012).

The remainder of the paper is structured as follows: Section 2 introduces the study setting and the social accountability intervention, Section 3 discusses data and methods. We present our main results in Section 4 and our discussion in Section 5.

2 | STUDY SETTING AND SOCIAL ACCOUNTABILITY INTERVENTION

2.1 | Study setting

Our study was conducted in Tanzania. The country has an estimated population of 56 million and is administratively organized in 31 regions, further divided into about 170 districts councils. The Tanzanian health system is highly decentralized with many health system responsibilities delegated to local government authorities and health districts (Kigume and Maluka 2018b). Regional authorities maintain an overseeing role over districts and act as intermediaries with respect to the central government, which assigns the core budget based on broad population characteristics (Kigume and Maluka 2018b). Health care is organized with a pyramidal structure, with a large number of dispensaries (about 80% of all health facilities) offering primary care, local health centers offering secondary care (about 15%) and supervision to dispensaries, and individual (public, private or faith-based) district hospitals (about 4%) providing highest level care in each district (Musau et al., 2011).

The SAM program analyzed was implemented in the region of Dodoma. Figure 1 shows a map of the region with districts borders. As of 2012, Dodoma had a population of about 2.1 million people spread across 41′311 square km; 16% of the population lived in urban areas. The under-five mortality rate was 76.4 per 1000 live births in 2012, slightly above the national average of 66 (National Bureau of Statistics and Office of Chief Government Statistician 2013).

Starting in 2012, a *HPSS* program was implemented across all districts of Dodoma region (University Consultancy Bureau 2018). Supported by the Swiss Agency for Development and Cooperation, the HPSS program includes five main components: Health Promotion, Health Financing, Medicine Management, Health Technology and Maintenance and crosscutting issues such as gender, social inclusion and HIV/AIDS.[1]

Stockouts of essential medicines have been a central problem in Tanzania for many years. Appendix A1 offers an overview over medical supplies in Tanzania as well as specific national policies implemented to increase access to essential medicines in the last decade. In short, when drugs are not available at point of care, households typically buy them in drug stores, pharmacies or accredited dispensing outlets. These shops are abundant in urban areas but less accessible in most rural areas, with little difference across our study sites (Wiedenmayer et al., 2019). Larger pharmacies and wholesale drug stores are also rare across rural districts, which complicates the procurement process for health facilities experiencing shortages, as we discuss in length in Appendix A1. To address the problem, the HPSS Medicine Management component had a specific sub-component addressing health workers' training, accountability, rational use of medicines and notably the medicines supply-chain (Wiedenmayer et al., 2019). This latter element was explicitly meant to address stockouts, inefficiencies and shortages in medicines deliveries attributable to the centralized government central Medical Store Department (MSD). The medical supply chain tool was a complementary supply of medicines through an innovative public-private partnership initiative known as "Jazia Prime Vendor" (PVS) system (Wiedenmayer, 2017). Under the PVS, district authorities were allowed to purchase medicines from a single private provider when the centralized MSD experienced shortages; in these cases, district authorities consolidate the orders placed by health facilities for the Prime Vendor, which then executes them. The single private supplier—the Prime Vendor—had to be tendered and contracted for the whole region based on price and quality attributes. District authorities were then responsible for the distribution of supplies purchased through the PVS to facilities. This system replaced the previous uncoordinated and inefficient procurement from local private providers to complement unmet needs related to MSD central stockouts. The Jazia PVS did not take off until the end of year 2014, with a pilot project implemented from September 2014 to July 2018 in all districts in the Dodoma Region simultaneously.

Besides the availability of medicines, HPSS also addressed maintenance of health facility infrastructure. The state of infrastructure and equipment in public health facilities across LMICs—together with the availability of trained staff, drugs, and health commodities—is a crucial prerequisite for the provision of quality healthcare (Penfold et al., 2013; van Pelt et al., 2020). Despite the importance of infrastructure and equipment, and in spite of large investments to extend geographical access to care, the level of investments in maintenance across Tanzanian health facilities remains inadequate (Scholz, Ngoli, & Flessa, 2015) especially for lower tier facilities (Boex, Fuller, & Malik, 2015).

No regional plans or guidelines for the maintenance of health technology and infrastructure were available in Dodoma region as of 2012. Planning and execution of infrastructure maintenance was generally delegated to health facilities, either with own funds or with funds obtained by district authorities through specific applications (Stoermer, Werlein, & Molesworth, 2011). The lack of personnel trained in infrastructure maintenance—as well as the high burden of care-related activities—severely impaired the ability of facilities to conduct proper maintenance. Starting from 2013, the HPSS program issued standard operating procedures, conducted inventories, gradually trained personnel on maintenance or hired specialized staff such as technicians and engineers (Stoermer et al., 2011).

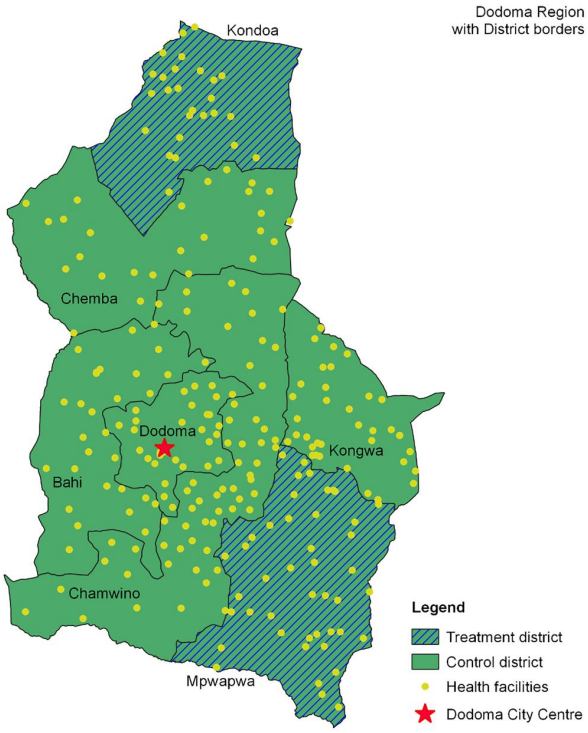

FIGURE 1 Districts in Dodoma Region and location of surveyed health facilities. Geographic Information System (GIS) layers with district boundaries are NBS (2017). GIS position for surveyed health facilities was recorded by the Health Promotion and System Strengthening project

2.2 | The intervention: SAM

The social accountability intervention evaluated in our study was implemented by a local NGO called Sikika. Sikika's stated mission is "to enhance health and public finance systems through Social Accountability and advocacy at all government levels"[2]. With funding from several development partners, Sikika launched a SAM program targeting health service delivery in 2012. Sikika's SAM project was centered on an articulated accountability process that involved several steps: formation and training of community based supervision teams, district stakeholders meetings, field visits for data collection, analysis, reporting to district authorities, feedback to stakeholders and continuous monitoring. Based on available funding and existing links to these districts, Sikika decided to implement the SAM program in two out of the seven districts in Dodoma: Kondoa and Mpwapwa. As illustrated in Figure 1, the two districts lie at the Northern and Southern ends of the region, with the five other districts located in between these two areas providing some obvious reference or benchmark.
The outcomes explicitly targeted by the SAM program in the Dodoma region were the following:

- Reduction of stockouts in essential medicine
- Improvement of infrastructure maintenance
- Improvement of the allocation, disbursement and utilization of funds received from government basket fund, Community Health Fund (CHF), and National Health Insurance Fund (NHIF)
- Improvement of existing local governance and accountability arrangements (e.g., Health Facility Governing Committees [HFGCs])

The intermediary effects expected from the SAM project were increased community sensitization, engagement and empowerment, improved accountability of health workers and district representatives as well as increased transparency, that is, effective disclosure and access to public district budget documents and plans for SAM teams and more

generally all interested citizens. Sikika also developed and implemented a multichannel media strategy aimed at facilitating the achievement of the above objectives (Sikika 2013).

Before starting the implementation of the SAM process in a new district, Sikika met with local government authorities and other stakeholders to introduce the SAM process and principles of the project. After this preliminary stage, community meetings were held to select democratically citizens that would join the district SAM team; each district SAM team was composed of 15–20 members, including citizens, representatives from district authorities (Council Health Management Team, Council Management Team), HFGCs, religious groups, local NGOs or other grass-roots level CSOs. Each SAM team was responsible for the implementation of the SAM process, covering all government managed health facilities within the district boundaries (in our case 20–50 depending on the district). Once the formation of SAM teams was complete, members followed a two weeks training on various topics, including principles of SAM, human resources for health, professional integrity, planning, and resource allocation, expenditure management, performance management and oversight bodies. The full SAM process encompasses the following steps for each round, taking about one and a half years each. Full details are reported in Appendix A2.

As illustrated in Table 1, the SAM program was launched in 2012, simultaneously to the launch of HPSS project activities (that were implemented in all seven districts). Up to September 2014, the HPSS program implemented only inventory and training activities related to the health technology and infrastructure component. From September 2014 to May 2017, Sikika's SAM also overlapped with the HPSS component addressing the medicines supply-chains, namely the Jazia PVS. Given that these HPSS programs were run in all districts of Dodoma, our estimated impact of the SAM program should be interpreted as incremental benefits of the SAM intervention in the context of larger health system reform efforts.

Sikika's SAM initiative was supposed to yield increased health workers' effort in forecasting needs and filing timely orders at the level of health facilities. At the level of districts, the SAM program was meant to help highlighting and demanding improvements on the failing elements in the procurement and delivery chain, as well as to increase efforts to promote facility maintenance and investment through mobilization of district level funds.

Table 2 compares control and treatment areas at baseline with respect to population, health system and health facilities characteristics. Overall, treatment and control areas seem very similar at baseline—none of observed differences at baseline appear to be statistically significant. The only variable where substantial (even if not statistically significant) differences were observed for health insurance enrollment. The higher baseline health insurance coverage in the treatment group appears to be driven by Kondoa district, where district authorities actively promoted enrollment in the community health insurance scheme for all individuals covered by the national poverty alleviation scheme (Tanzania Social Action Fund [TASAF]; Sikika 2016b). Higher insurance coverage is also reflected in a higher amount of funds disbursed by the health insurance schemes across treatment districts, which could in turn improve local availability of funds and infrastructure maintenance. As described in further detail in Section 3.2, we control for per capita CHF funds disbursed to facilities at the district level in our analysis to reduce potential confounding or omitted variable concerns.

3 | DATA AND METHODS

3.1 | Data

The main data sources for our analysis are two health facility surveys conducted as part of the HPSS project activities.

HPSS surveyed randomly selected households and health facilities in Dodoma region 2011 (baseline) and in 2017 (endline). Both health facilities surveys covered only government-managed health facilities; private and faith-based facilities were neither included in the HPSS project nor targeted by the SAM program. As of 2012, the Dodoma region had 267 government-managed health facilities. The number rose to about 286 in 2017 (Ministry of Health, Community Development, Gender, Elderly and Children 2019; Ministry of Health and Social Welfare 2011). The 2011 baseline HPSS survey included all government-managed health facilities in the region. For the 2017 survey, HPSS sampled randomly about half of the health facilities in the region, stratifying by district and health facility type (Kuwawenaruwa, Wyss, Wiedenmayer, Metta, & Tediosi, 2020; University Consultancy Bureau 2018). The full samples resulting from preliminary data cleaning procedures include 112 health facilities at endline, 91 of which were observed at both time points forming the balanced panel on which we focus in our main analysis. We did not detect systematic characteristics in the facilities excluded at data cleaning stage which could generate bias in the results, including the facilities lost due to attrition. Table 3 shows the composition of our main sample, while Appendix A3 reports specific compositions of the two cross-sectional samples (baseline and endline).

TABLE 1 Timeline of interventions in Dodoma region

Year	Month	Actor	Event
2011	Aug–Sep	Health Promotion and System Strengthening (HPSS)	Baseline survey in Dodoma region
2012	Oct	Sikika	First SAM round starts in Kondoa and Mpwapwa districts
2013	Jan	HPSS	First training and inventory activities for health technology and infrastructure
2014	Feb	Sikika	Second social accountability monitoring (SAM) round starts in Kondoa and Mpwapwa districts
2014	Sep	HPSS	Jazia Prime vendor (PV) system starts operations to address stock outs
2015	Jan–Dec	Sikika	Follow up and monitoring activities in Mpwapwa
2016	Jan–Dec	Sikika	Follow up and monitoring activities in Mpwapwa
2016	Aug	Sikika	Third SAM round starts in Kondoa
2017	Jan–Jun	Sikika	Follow up and monitoring activities in Kondoa and Mpwapwa
2017	May–Jun	HPSS	Endline survey in Dodoma region

Sources: Stoermer et al. (2011); Sikika (2013, 2014, 2015, 2016a); Wiedenmayer (2017).

Our first outcome of interest was drug stockout days. The HPSS survey collected detailed data on a number of essential medicines (University Consultancy Bureau 2018). After data cleaning and subsequent cross-validation with HPSS staff, we included 13 medicines in our analysis and computed total stockout days as the (cumulative) sum of days these medicines were out of stock (duration) during the 3 months prior to the survey. The 90 days reference period should offer a good proxy indicator of average stocking behavior at the surveyed facilities, and can also be viewed as a measure of the effective treatment days lost as a result of lack of appropriate medicines. Appendix A4 shows the main drug groups included in our analysis, which include four antibiotics, two antimalarials, four drugs specifically used in reproductive health and three other essential drugs and vaccines.

Our second outcome of interest was infrastructure maintenance. To assess infrastructure, we extracted data on drug storage infrastructure availability from a wider check-list of infrastructure maintenance practices. These questions were asked by independent surveyors to health facility staff as part of the HPSS health facility surveys. Among the 16 questions listed in Appendix A4, we focused on the items that seemed most closely linked to the program's goals, that is, (1) functioning equipment to maintain cold storage for vaccines and medicines, and (2) adequate furniture and equipment to store properly medicines. The SAM program also targeted financial management and governance. These outcomes were however not as clearly defined and thus not included in our analysis.

We complemented the HPSS survey data with multiple additional sources, listed in Appendix A6. We included several contextual factors—at health facility and district level—that may affect availability of drugs in our model. At health facility level, we included the type of health facility, the existence of a functioning HFGC, location in urban versus rural area, distance to the city center of Dodoma as proxy for the distance from the central zonal MSD store and average yearly rainfall (Wagenaar et al., 2014). In this context, the inclusion of average rainfall as covariate is motivated by three factors: (1) reduced ease of access to health facilities for households during rainy season may exogenously curb demand, (2) traveling during rainy season in areas with few tarmac roads can affect negatively the ability of MSD to deliver drugs, and (3) areas with higher yearly rainfall are characterized by higher malaria prevalence, which exogenously increases demand of antimalarials and other generic drugs to treat children (Adhvaryu & Nyshadham, 2015; Moïsi et al., 2010). To control for the pace of implementation of the HPSS program and the possible influence on our outcome variable, in our analysis we also added a dummy variable indicating facilities reporting at least one HPSS supportive supervision on medicine supply in the previous quarter. At the district level, we used Annual Health Statistics developed by the Tanzanian Ministry of Health and Social Welfare (MoHSW) and National Bureau of Statistics (NBS) to obtain data on population, density of health facilities and outpatient visits. To account for household trends in wealth, we also constructed district wealth index quintiles using data made available by the local NGO Twaweza. Since 2009, with support of the British, Danish and Swedish development agencies, Twaweza implemented an educational program (Uwezo) and contextually collected district-representative households surveys from 2009 to 2017 (Sumra, Ruto, and Rajani 2015). Finally, in the Tanzanian decentralized health system, both the availability of essential medicines and infrastructure maintenance depend—with varying degrees—upon the availability of locally generated

TABLE 2 Differences between control and treatment group at baseline (2011)

Variable[a]	Control group		Treatment group		Difference[c]	
	Obs.	Avg./Perc.	Obs.	Avg./Perc.	(C–T)	*p*-value
Delivery at health facility (perc.)	217	37.79	91	36.26	1.53	0.872
Children birth weight (g)	94	3215.43	37	3213.51	1.91	0.987
Children received Tuberculosis vaccine (perc.)	206	94.17	89	93.26	−0.91	0.793
Children received first vaccine for diphtheria, pertussis and tetanus (perc.)	206	92.23	89	93.26	−1.02	0.483
Children received first polio vaccine (perc.)	206	90.78	89	93.26	−2.48	0.267
Children received measles vaccine (perc.)	205	71.22	88	67.05	−4.17	0.400
District population (number)	147	311704	58	301258	10,446	0.727
District pop. in poorest wealth quintile (perc.)	147	24.88	58	31.33	−6.46	0.400
District pop. in richest wealth quintile (perc.)	147	15.24	58	11.07	4.17	0.466
District health insurance coverage (perc.)	147	0.13	58	0.27	−0.14	0.308
Districts funds disbursed by Community Health Fund per capita (TZS)[b]	147	158.78	58	209.39	−50.62	0.592
District health facility density (per 100′000)	147	16.07	58	15.70	0.36	0.779
District outpatient department (OPD) visits per 100′000 pop.	147	4389.03	58	4527.37	−138.34	0.868
Active health facility committee (perc.)	147	0.92	58	0.88	0.04	0.707
Urban area (perc.)	147	0.03	58	0.05	−0.02	0.233
Average yearly rainfall (mm per year)	147	560.36	58	630.88	−70.53	0.185
Share of exempted patients (perc.)	141	3.35	58	3.05	0.30	0.422
Facilities quarterly supervised on medicine supply (perc.)	146	0.66	58	0.71	−0.05	0.844
Facilities with staff trained on maint. (perc.)	141	0.55	58	0.64	−0.09	0.534
Antibiotics (days out of stock)	147	62.37	58	91.10	−28.74	0.387
Antimalarials (days out of stock)	147	51.32	58	47.38	3.94	0.701
Drugs used in reproductive health (days out of stock)	147	44.33	58	58.19	−13.86	0.133
Other essential drugs and vaccines (days out of stock)	147	34.82	58	43.15	−8.33	0.378
All drugs (days out of stock)	147	192.84	58	239.83	−46.99	0.263
Cold storage (e.g., fridge) is available	147	0.62	58	0.81	−0.19	0.086
Adequate furniture and equipment is available	147	0.39	58	0.26	0.13	0.517

[a]Detailed data sources are listed in Appendix A6.

[b]The exchange rate as of end of 2018 was 1 USD = 2298 Tanzanian Shillings (TZS).

[c]Slight inaccuracies in the reported differences (C–T) are due to rounding. Test for differences in means or proportions with robust errors clustered by district. We reported the *p*-values in the last column.

funds (Kuwawenaruwa et al., 2020). In the case of Dodoma, these result either from user fees or from funds collected and disbursed by the local community health insurance scheme, known as the CHF. Heterogeneity in local availability of these funds might cast doubts about our identification strategy. Therefore, we obtained data on the amount of funds (per capita) disbursed by the CHF to health facilities across the district.

3.2 | Empirical approach

Our study aims at assessing the impact of SAM on health facility performance, measured as duration of stockout for 13 essential medicines and two indexes representing maintenance of infrastructure (drug storage and dispensing areas). Our main DID approach explores differences between treatment and control areas over time. Our treatment group

TABLE 3 Composition of main sample (balanced panel) at baseline and endline

	Dispensary *N* (%)	Health center *N* (%)	District hospital *N* (%)	Total *N* (%)
Baseline (pre)	56 (84.9)	8 (12.1)	2 (3.0)	66 (100.0)
Control				
Treatment	20 (80.0)	11 (12.0)	2 (8.0)	25 (100.0)
Endline (post)	57[a] (86.4)	7[a] (10.6)	2 (3.0)	66 (100.0)
Control				
Treatment	20 (80.0)	11 (12.0)	2 (8.0)	25 (100.0)

[a]One facility classified as health center at baseline was re-classified as (downgraded to) dispensary at endline—we treated this facility the same in both survey rounds.

includes 25 facilities in the districts of Kondoa and Mpwapwa, where the Sikika program was rolled out. In our main specification, the control group includes 66 facilities located in the other five districts in Dodoma region (Figure 1). The full model is given by:

$$Y_{i,d,t} = \alpha_i + \beta_0 + \beta_1\, Post_t + \beta_2\, \text{Treatment}_d + \delta\, \text{Post}_t \times \text{Treatment}_d + \beta_3\, X_{i,t} + \beta_4\, \Omega_{d,t} + \in_{i,d,t}$$

where, $Y_{i,d,t}$ is the outcome of interest for health facility i in district $d \in D$ for period $t \in (2011,\ 2017)$. *Post* is a binary indicator for the time period (either 0 for the pretreatment 2011 baseline or 1 for the post-treatment 2017 endline). *Treatment* is an indicator variable that equals 1 for health facilities in the treatment districts and zero for those included in the control group. $X_{i,t}$ is a matrix of observable health facility control variables, while $\Omega_{d,t}$ is a matrix of district level control variables. β_3 and β_4 are the vectors of coefficients for the control variables and α_i is a vector of time-invariant health facility fixed characteristics (facility-specific intercepts). Finally, $\epsilon_{i,d,t}$ is the idiosyncratic error. Our coefficient of interest—capturing the additional effect of the SAM program—is represented by δ.

To ensure that our results are not affected by differences at the health facility level, we exploit the longitudinal dimension of our data and estimate our main model using a fixed effects (FE) within-estimator, averaging out any time-invariant observed and unobserved facility characteristics to remove this potential source of bias. The primary identifying assumption in our main model is thus of independence of the SAM treatment conditional on unobserved time-invariant facility effect as well as on time-variant observable facility and district characteristics.

From an inference perspective, the small number of groups (seven districts) in our analysis poses an additional challenge (Wooldridge, 2010). To deal with the small number of clusters, we first perform significance tests using a t distribution with $G-1$ degrees of freedom (where, G is the number of clusters, in our case $G = 7$) following (Donald and Lang 2007). We also explore inference tests based on the permutation-based wild clustered bootstrap (Cameron, Gelbach, & Miller, 2008) with a 6-point weight distribution (Rokicki, Cohen, Fink, Salomon, & Beth Landrum, 2018; Webb, 2013) and the sub-cluster wild bootstrapping approach recommended by (MacKinnon & Webb, 2018).

The overlap between HPSS and Sikika's activity casts doubts about the potential confounding effect of HPSS on our results. To address this issue, we report our analyses with and without process variables capturing the extent of HPSS activities. If these activities were the true drivers of changes observed, then estimated treatment effects should shrink or disappear when these efforts are controlled for empirically. All data management and analysis was conducted using the statistical package Stata, version 14.

3.3 | Addressing threats to causal inference

The proposed identification strategy in our primary DID rests on the key assumption of parallel trends in treatment and control groups in absence of the treatment (Dimick & Ryan, 2014), which is hard to verify even if pretrend data was available. Differences in trends may arise due to different long-term trajectories, but also due to differential governmental or NGO efforts in treatment or control areas. Given that we cannot formally test the common trends assumption, we test whether our main results are robust to alternative model specifications that do not rely on common trends as central assumption (Angrist & Pischke, 2009). In light of these limitations—although we rely on the FE DID as

main estimator due to its intuitive interpretation in our setting—the results should be interpreted jointly with the following alternative specifications.

3.3.1 | Controlling for pretreatment differences with a LDV approach

Although the DID identification strategy technically does not require baseline balance between outcomes in treatment and control groups, the initial differences in medicines availability highlighted in Table 2 raise concerns regarding potential convergence effects. Even in the absence of additional interventions it seems possible that poorly performing health facilities in treatment areas could have experienced faster improvements compared to facilities in control areas due to convergence or mean reversion patterns in the data. To address this concern, we estimate LDV (or analysis of covariance) models that explicitly control for the initial levels of stockout days and only assume independence conditional on past outcomes and covariates (O'Neill, Kreif, Grieve, Sutton, Jasjeet, & Sekhon, 2016). Besides having less restrictive identifying assumptions and controlling for potential baseline differences, this approach can achieve greater power compared to DID, which is interesting provided our limited sample size (Raza, Van de Poel, and Van Ourti 2018). Additionally, FE and LDV estimates can be used for bracketing likely ranges, providing plausible lower (LDV) and upper (FE) bounds to the casual effects of interest (Angrist & Pischke, 2009; Ding and Li 2019).

3.3.2 | Matching control districts outside Dodoma based on past outcomes and covariates

Besides imbalances in baseline characteristics, which we try to address with the LDV approach, it seems possible that the two districts chosen for the treatment were somewhat special with respect to their basic infrastructure and supply chains. We thus pursue an alternative matched control approach to support our main results, broadly following previous work by O'Neill at al. (2016). Both the 2012 Service Availability and Readiness Assessment (SARA) and the 2014 Service Provision Assessment survey (SPA) collected nationally representative data on the availability of essential medicines on the day of the survey, including the 13 drugs described in Appendix A4. Using these data sets, we constructed availability indicators (i.e. the number of medicines available on the survey date, out of the 13 considered) for all health facilities included in our original data as well as for additional facilities in other regions and districts across Tanzania. The resulting dataset features repeated cross-sections from several surveys which we could not link longitudinally: 2011 HPSS baseline survey, 2011/2012 SARA, 2014 SPA and 2017 HPSS endline survey. The primary drug availability index is different from the one used in the main model because it only covers drug availability on the day of the interview (rather than availability over 90 days). Conceptually, this measure may be less prone to recall biases, but is more likely to be affected by random within-period variation in stocking, and thus likely does not capture average stock availability as well as the measure available in the HPSS survey data.

In order to make this approach fully complementary to our main approach (and to rule out local spillover effects), we excluded original control districts, as well as districts where Sikika implemented similar SAM activities after 2012 as well as two regions with other HPSS program (Morogoro and Shinyanga) from this matching exercise. This allows additionally to assess the program impact over a time span when the main HPSS medicine management component was not in place yet. We then computed district level Malahanobis distance between potential controls and the two treatment districts at baseline (Kantor, 2012). Multidimensional distance was computed over a vector of baseline district characteristics, including: the outcome of interest, share of facilities within the district located in urban areas, district population, district malaria prevalence, as well as share of population in lowest and highest wealth index quintiles. Further details are reported in Appendix A7. Based on the resulting Mahalanobis scores, we selected the 10 most similar control districts. Figure 2 shows the location of our original treatment and new matched control districts. Baseline average availability for our set of essential medicines was 9.20 (st. dev. 0.24) for control and 8.74 (st. dev. 0.49) for treatment districts.

3.3.3 | Alternative treatment and control groups

To rule out effects driven by the specific composition of treatment and control groups, we estimated our main model using alternative treatment and control group specifications for the main pooled drug stockout days outcome. It seems possible, for example that the intervention districts in the South (Mpwapwa) or North (Kondoa) could have

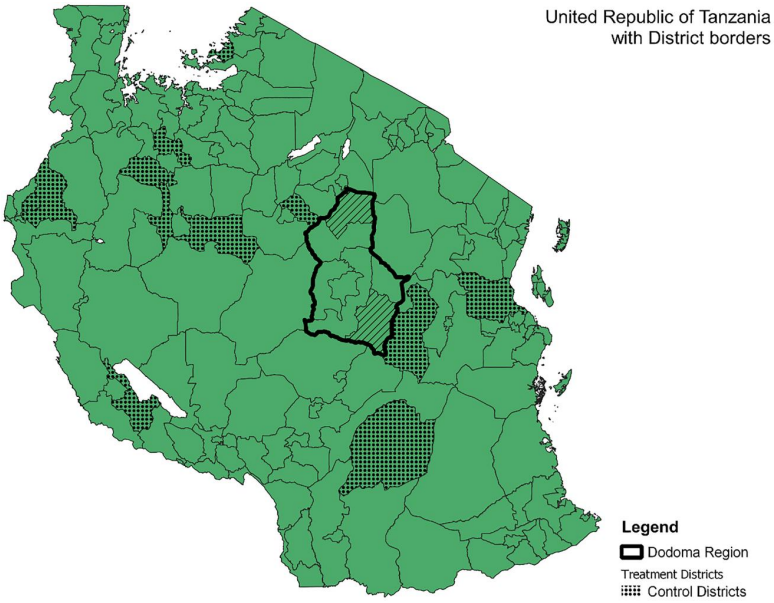

FIGURE 2 Location of treated and matched control districts. GIS layers with district boundaries are National Bureau of Statistics (2017)

differentially been affected by health insurance coverage (see Table 2) or that control areas in City of Dodoma—as capital city of the United Republic of Tanzania—have been affected by other governmental or political efforts.

3.3.4 | Additional approaches to assess the reliability of our main specification

To further attenuate concerns regarding other unobserved factors affecting the treatment districts, we propose a falsification test based on placebo regressions (Athey & Imbens, 2017; Egedesø, Hansen, and Jensen 2020). In absence of pre- or post-treatment data which allow directly testing for differential trends, we analyze two variables that should not show any response to the SAM program over the study period unless there were other policy initiatives or local changes affecting the health system. Finding an intervention effect on these placebo outcomes would thus suggest other programs or factors driving differences between districts, other than the changes introduced by the SAM program. First, we look at the share of people exempted from user fees at the surveyed facilities. This variable captures both local poverty levels and general health system financing efforts by the government that could create differential demand across districts, and potentially explain our main results. Second, we look at the share of households reporting children under five sleeping under insecticide-treated bed nets, which we consider both a proxy for (vertical) program-specific efforts by the government, but could of course also predict the demand for antimalarials (where we see large effects) at facilities.

One may still be concerned that the observed impact on drug availability may be related to a differential efficiency of the governmental medicine supplier (MSD) in the first place. While higher MSD order fulfillment would certainly decrease stockouts, the centralized structure of MSD makes the local SAM very unlikely to affect this indicator. We therefore looked at the treatment effect on a dummy variable indicating whether the last MSD order (previous to the survey) was completely fulfilled across the facilities included in our main analysis.

As mentioned above, we do not have data on facility stocking or infrastructure prior to 2012 that would allow us to directly analyze pretrends. In Appendix A13 we include an attempt to assess parallel pretrends using two indicators that should reflect health system efforts as well as general disease ecology.

3.4 | Simulated power calculation

Given that our analysis is based on data which was not collected for the primary purpose of evaluating the impact of Sikika's SAM program, ex ante power calculations are not available. To provide some sense of required effect

sizes with the data set at hand and error corrections applied, we simulate power for our main outcomes in Appendix A8. Starting from the original baseline values for our core sample of health facilities, we simulate endline values using an AR (1) data generating process calibrated to approximate endline control group average values. We then empirically assessed the likelihood of obtaining *p*-values below the 0.05 threshold for a range of plausible effect sizes. The results of these simulations suggest that our main FE specification with 91 facilities should have allowed us to detect effect sizes of 0.5 standard deviations with probability 0.8, and effect sizes of 0.65 standard deviations with power 0.9.

4 | RESULTS

4.1 | Main results

Table 4 presents the results of our main FE DID specification. We estimate that the Sikika SAM program reduced antibiotic stockout days by 118 days (out of a potential maximum of 360), reproductive health stockout days by 70 (potential maximum 360), and other essential drug stockout days by 76. Overall stockout days were reduced by 266 days over a 3-month period, which means approximately three additional medicines available on each of the 90 days considered. Relative to baseline, this corresponds to a 1.6 SD improvement in antibiotics availability, a 1.1 SD improvement in reproductive health supplies and a 1.8 SD improvement in the availability of other essential drugs and for overall drugs. The inclusion of HPSS implementation controls in the bottom panel of Table 4 affected the estimated effects only marginally, suggesting that HPSS activities do not substantially interfere in the identification of the SAM impact.

Table 4 also reports bootstrapped *p*-values based on the wild cluster bootstrap procedure in addition to the cluster-robust standard errors (CRSEs) used in our main model. In Appendix A10 we report *p*-values under a range of alternative approaches that have been proposed in the literature for settings like ours with a small number of clusters: a *t* distribution with six degrees of freedom, wild clustered bootstrap and wild bootstrap at sub-cluster level. Under CRSEs, estimated impacts are statistically significant at $p < 0.05$ for pooled stockout days, antibiotics, drugs used for reproductive health as well as other essential drugs or vaccines. Without HPSS controls, and using a cutoff value of 5%, the policy effect is significant under alternative *t* test approach for all drug groups except antimalarials. The *p*-values under wild cluster bootstrap were considerably larger than standard CRSE, yielding *p*-values < 0.05 only for antibiotics and all drugs pooled. Overall, significance for subgroups of medicines varied quite a bit with the approach chosen, while the estimated impact on total stockout days, antibiotics and other essential drugs or vaccines were so large in magnitude that they remained significant independent of the correction procedure applied.

In Table 4, we also included results of FE estimates for the indicators related to drug storage infrastructure availability. We do not find any impact of SAM on drug storage infrastructure relative to facilities in control districts, which suggests a stark difference in the impact of SAM across areas of health facility performance. The alternative coefficient testing procedures listed above also point to null results. We discuss these differences between the drug availability and infrastructure results in further detail below.

4.2 | Robustness checks

4.2.1 | LDV approach

Table 5 shows the regression results for our same sample of 91 facilities for pooled drug stockout days and the two infrastructure variables. Given that this analysis focuses on changes in the outcome as a function of initial levels, we have only one observation per facility. The LDV estimates suggest a 200-day decline in overall stockout days, which is marginally smaller than our primary DID estimate, but not statistically different in terms of magnitude. Similar to our main results, no impact was found for infrastructure indicators. For both classes of dependent variables, the lagged coefficient is not significant, suggesting that mean reversion only plays a limited role in this setting. The high degree of similarity between our FE and LDV estimates suggest that the true causal effect should be relatively close to the 1.8 standard deviation effect reported in our main specification.

TABLE 4 Change in drug stockout days and drug storage infrastructure 2011–2017 in core health facilities—main model with facility fixed effects

	(1) Antibiotics[a]	(2) Antimalarials[a]	(3) Other essential drugs and vaccines[a]	(4) Reproductive health[a]	(5) All drugs[a]	(6) Cold storage (e.g., fridge) is available[b]	(7) Adequate furniture and equipment is available[b]
Models without Health Promotion and System Strengthening (HPSS) control[c]							
Post X treatment[h]	−118.1*** (30.40)	−1.371 (29.34)	−76.31*** (15.74)	−70.36** (25.18)	−266.2** (80.25)	−0.393 (0.290)	−0.0813 (0.0620)
Bootstrapped *p*-value [d]	0.02**	0.97	0.02**	0.09*	0.05**	0.87	0.27
Adjusted R2	0.199	0.403	0.179	0.166	0.198	0.479	0.207
Akaike Information Criterion (AIC)	1863.3	1720.4	1708.9	1812.0	2126.9	−6.036	61.01
Bayesian Information Criterion (BIC)	1882.5	1739.6	1728.2	1831.2	2146.1	13.19	80.23
Observations[e]	182	182	182	182	182	182	182
Health facility controls[f]	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District controls[f]	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HPSS controls[c]	No	No	No	No	No	No	No
Models including HPSS control[b]							
Post X treatment[h]	−118.0** (33.14)	1.849 (25.49)	−73.87*** (18.45)	−60.79 (28.48)	−250.9** (88.54)	−0.384 (0.295)	−0.0360 (0.0650)
Bootstrapped *p*-value[d]	0.04**	0.96	0.04**	0.14	0.09	0.90	0.49
Adjusted R2	0.206	0.391	0.174	0.198	0.214	0.473	0.218
AIC	1831.6	1693.8	1680.8	1766.5	2086.9	−6.480	54.49
BIC	1850.7	1712.9	1699.9	1785.7	2106.0	12.64	73.61
Observations[e]	179	179	179	179	179	179	179
Health facility controls[f]	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District controls[f]	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HPSS controls[c]	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Baseline average[g]	75.15	53.77	32.65	53.47	215.04	0.68	0.36
Baseline standard dev.[g]	72.89	50.36	40.88	63.35	146.76	0.46	0.48

[a]Stockout days were computed over the 3 months (90 days) prior to the survey dates (September 2011 for baseline and May 2017 for endline). Composition of drug groups in Appendix A4.

[b]The variables represent binary responses to a check-list related to facility infrastructure availability, status and maintenance. The full check-list is available in Appendix A5.

[c]The HPSS implementation control variable is a dummy indicating facilities with supportive supervision for medicine management at least quarterly.

[d]Bootstrapped *p*-values referred to the wild cluster procedure.

[e]Sample includes all health facilities observed in both baseline (2011) and endline (2017) surveys.

[f]Control variables included: active health facility committee, average yearly rainfall, share of people in poorest wealth index quintiles, density of health facilities in district, number of OPD visits in district, district per capita Community Health Fund funds disbursed to health facilities.

[g]Baseline average and standard deviation referred to the dependent variable for the sample of facilities for year 2011.

[h]Estimates based on fixed effects (within) estimator. Full results including coefficients for covariates included in Appendix A9.

Cluster robust standard errors in parentheses: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

TABLE 5 Robustness check, lagged dependent variable estimation

	(1) Stockout days across all drugs[a]	(2) Cold storage (e.g., fridge) is available[b]	(3) Adequate furniture and equipment is available[b]
Post X treatment[g]	−200.3*** (50.17)	0.390* (0.172)	0.180 (0.238)
Bootstrapped *p*-value[c]	0.041**	0.36	0.68
Adjusted R^2	0.291	0.444	0.021
AIC	1064.5	20.64	131.2
BIC	1079.6	35.71	146.3
Observations[d]	91	91	91
Health facility controls[e]	Yes	Yes	Yes
District controls[e]	Yes	Yes	Yes
Health Promotion and System Strengthening controls	No	No	No
Baseline average[f]	215.04	0.68	0.36
Baseline standard dev.[f]	146.76	0.46	0.48

[a]Stockout days were computed over the 3 months (90 days) prior to the survey dates (September 2011 for baseline and May 2017 for endline) across all 13 drugs considered and listed in Appendix A4.

[b] The variables represent binary responses to a check-list related to facility infrastructure availability, status and maintenance. The full check-list is available in Appendix A5.

[c]Bootstrapped *p*-values are based on the wild cluster bootstrapping.

[d]Sample includes all health facilities observed in both baseline (2011) and endline (2017) surveys.

[e]Control variables included: active health facility committee, urban/rural area, facility type, distance to Medical Stores Department (MSD) warehouse, share of people in poorest wealth index quintiles, density of health facilities in district, number of OPD visits in district, district per capita CHF funds disbursed to health facilities.

[f]Baseline average and standard deviation referred to the dependent variable for the sample of facilities for year 2011.

[g]Estimates based on ordinary least squares (OLS) estimator. Full results including coefficients for covariates included in Appendix A12.

Cluster robust standard errors in parentheses: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

4.2.2 | Matched control approach

Table 6 shows the results of a DID model estimated using a multilevel specification with random intercepts (districts and regions) to account for the nested structure of the data. We ran the analysis over two time frames. Firstly, we restricted the study period to years 2011–2014, that is, the period before the alternative supply chain program in Dodoma (JPV) started. Secondly, we ran the same analysis for the full 2011–2017 period. The results are substantially aligned with our main analysis, suggesting increased availability of medicines in treatment districts. Interestingly, as anticipated, the effect appears higher for the analysis that includes the HPSS endline 2017 data. On average, we find that the SAM program increased the short-term availability of drugs by 1.5 drugs for the period 2011–2014, which corresponds to 0.82 standard deviations. For the full period 2011–2017 the effect increases to about 2 drugs, or 1.1 SD. While similar in relative magnitude, the effects estimated in Table 6 are not directly comparable to our main results in Table 4 because the SPA only measures availability on the day of the survey rather than stockout days over a 90 day period; both larger and smaller treatment effects over a longer reporting period definitely seem possible in principle.

4.2.3 | Alternative treatment and control groups

Appendix A12.4 reports full results for our analyses on drug stockouts with (1) treatment facilities only from Mpwapwa district, (2) treatment facilities only from Kondoa district, and (3) a control group excluding facilities in Dodoma Urban district. Using only Mpwapwa as treatment district we identify a 0.96 SD effect size; using only Kondoa as treatment district the effect is 1.15 SD. The estimated effect on the sample excluding the predominantly urban district of Dodoma 1.02 SD; none of the estimated coefficients is statistically different from our main estimates in Table 4.

TABLE 6 Robustness check, changes in drug availability 2011–2014 and 2011–2017 with matched outside-of-region control district approach

	(1) Pre-Jazia PVS period 2011–2014[a,b]	(2) Full period 2011–2017[a,b]
Post X treatment group[f]	1.541** (0.607)	1.940*** (0.594)
AIC	1679.8	1784.6
BIC	1712.1	1817.5
Observations[c]	421	450
Health facility controls[d]	Yes	Yes
District controls[d]	Yes	Yes
Baseline average[e]	9.13	9.13
Baseline standard dev.[e]	1.88	1.88

[a]The dependent variable represents the number of drugs available on the day of the interview computed across the 13 drugs considered in Appendix A4, based on identical questions included in the different surveys. During the period 2011–2014, the Health Promotion and System Strengthening (HPSS) medicine management component (Jazia PVS) has not been rolled out. The full period 2011–2017 includes 3 years (2015, 2016 and 2017) with overlap of potentially beneficial effects from Jazia PVS and our intervention of interest (SAM).

[b]Matching of control districts outside of the Dodoma region based on smallest Mahalanobis distance computed on the following baseline district characteristics: outcome variable, share of facilities in urban areas, district population, malaria prevalence and share of people in lowest and highest wealth index quintile. The procedure is described in Appendix A7. The location of the 10 matched control districts is highlighted in Figure 2.

[c]Analysis based on pooled observations from HPSS (2011 and 2017), SARA 2012 and SPA 2014 surveys. See Appendix A6 for further details about data sources.

[d]Control variables included: facility type, health facility density, district population, urban/rural area, share of population in poorest and richest wealth index quintile.

[e]Baseline average and standard deviation referred to the dependent variable for the full sample of facilities for year 2011.

[f]Estimates based on multilevel model with random intercept (districts and regions), estimated using Maximum Likelihood with Expectation-Maximization algorithm. Complete results including coefficients for covariates and results of pooled OLS models with district fixed effects included in Appendix A12.

Heteroscedasticity-robust standard errors in parentheses; $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

4.2.4 | Additional robustness checks

The tables in Appendix A12 also report full results for our additional robustness checks introduced in Section 3.3.4. In our placebo regressions (A12.5) we did not detect any meaningful differences between treatment and control areas. Similarly, the results reported in A12.6 reveal no association between SAM and MSD order fulfilment.

5 | DISCUSSION

In this study, we evaluated the effect of a SAM program in two mostly rural districts of Tanzania. Overall, our results suggest that SAM had a positive and significant impact on drug availability—with particularly large effects on antibiotics and few other essential medicines. Interestingly, we found no program impact on antimalarials, which are in high demand in this area. One possible explanation for this is that malaria drugs are often managed outside government channels by large multilateral initiatives and vertical programs. All other categories of drugs—including antibiotics and other essential medicines/vaccines—are instead procured and distributed to government-managed health facilities through the regular supply-chain, which can potentially be influenced more easily by forecasting and order filing behavior of facility staff.

Our analysis did not find effects for other dimensions of health facility performance addressed by the SAM program. The analysis conducted on the indicators of drug storage infrastructure showed null effects with both the FE and LDV approaches. Unfortunately, we did not have reliable quantitative data for financial management, utilization of funds at

local level and functioning of health facility committees. We also did not have very detailed measures of infrastructure and efforts to maintain infrastructure—efforts in particular are rather hard to capture in routine facilities surveys. This clearly limits the scope of the measured impact of Sikika's program and the general conclusions to be drawn on the ability of the SAM program to improve health systems performance more broadly.

In addition to its limited ability to directly measure all four dimensions targeted, our study has some relevant limitations. Firstly, it is based only on two time points, that is, baseline and endline. The analysis would have benefited from the availability of preintervention time points, and would also have benefited from more intermediate outcomes to assess the quality of implementation of both the HPSS and the Sikika SAM programs. Secondly, our analysis represents a post-hoc analysis of a project implemented independently with nonexperimental treatment assignment and without a preanalysis plan. This limited our study in several ways, mainly restricting our ability to control for all possible confounders and producing analyses with inherently limited statistical power. We are aware that some factors excluded from our analysis may exert an influence either on our outcomes of interest or on the social accountability mechanism that we are evaluating. Our main assumption is that these factors did not change in ways systematically correlated with the program assignments. Future research would benefit from an earlier involvement between researcher and implementation projects such as HPSS. This would allow the planning of a solid strategy to collect quantitative and qualitative data with relevant control variables and adequate pretreatment and intermediate outcomes (Boydell, McMullen, Cordero, Steyn, & James, 2019; Leatherdale, 2019). Lastly, similarly to other existing studies assessing impact of social accountability (e.g., McCoy, Hall, & Ridge, 2012; Molina et al., 2017; O'Meally, 2013), the results of our study, that is focused on a single region in Tanzania which is undergoing broader health reforms, may have somewhat limited external validity.

Despite these limitations, the results presented in this paper support the idea that SAM approaches might be effective in improving health systems performance fostering provider efforts. The magnitudes observed in our study are similar to those found in (Björkman & Svensson, 2009) as well as the results from a more recent pay for performance scheme in Tanzania (Binyaruka & Borghi, 2017).

One likely important contextual element is the positive and receptive administrative environment created by the region-wide implementation of the HPSS project, which likely facilitated systematic change in facility operations. Locally, Sikika is a well-known "watchdog" organization that was able to connect relatively easily with district authorities through the SAM process itself. The multiple rounds of discussion between the SAM teams and district authorities as well as the feedback to communities likely contributed to the positive outcomes for essential medicines as well as the generally positive attitudes toward the program seen in focus group discussions and interviews with facility staff. The SAM process introduced a structured bottom-up and top-down feedback loop, training local community members on the monitoring tools needed and thus empowering them (Björkman Nyqvist, de Walque, and Svensson 2017). Furthermore, as reflected by the political turmoil around the SAM in Kondoa and other evidence (Mamdani et al., 2018), Sikika's reputation of publicly exposing wrongdoing among public officials likely triggered improved responsiveness among district authorities. Our interpretation is also consistent with stream of literature suggesting that the ability to maintain independence from formal government mechanisms is critical for SAM programs (Feruglio & Nisbett, 2018). This seems to be particularly relevant when monitoring programs are embedded in formal government structures or when citizens are recruited for monitoring policies without proper training. These findings are supported by qualitative data purposely collected in the two treatment districts of Kondoa and Mpwapwa (see Appendix 14 for further details). Overall, focus group discussions and interviews suggest that both health facility workers and citizens appreciated the SAM program. The regular meetings appear to have resulted in increased feedback to facilities, and also may have increased both the direct social pressure from the community to perform well and indirect pressure through exchanges with the district office.

Even though the SAM program studied achieved only some of its objectives, we believe the program did have a meaningful impact on a crucial element for the functioning of health systems. Access to essential medicines is among the top global health priorities, as reflected by the United Nations Sustainable Development Goals (goal 8E, specifically). Despite major efforts in the past decades, making essential medicines available in a consistent and reliable fashion was and remains a major challenge in many countries due to several and frequently concurrent inefficiencies in healthcare delivery. Stockouts of essential medicines have been linked to gaps in immunization coverage (Favin, Robert SteinglassFields, Banerjee, & Sawhney, 2012), poor control of noncommunicable diseases (Attaei et al., 2017), ineffective antiretroviral therapy (Berheto, Haile, and Mohammed 2014), incomplete detection and treatment of malaria (Layer et al., 2014), and increased maternal and child mortality (Githinji et al., 2013). Stockouts of essential medicines at public health facilities also have been shown to increase out-of-pocket payments by forcing patients to

purchase required drugs from private providers (Mikkelsen-Lopez, Shango, Jim BarringtonZiegler, Smith, & Don, 2014; Wagenaar et al., 2014; Wales, Tobias, Malangalila, Godfrey, & Wild, 2014), to generate dissatisfaction with services and to inhibit health seeking behavior (Ikoh, Udo, Charles, & Charles, 2009; Kruk, Rockers, Godfrey, Paczkowski, & Galea, 2010; Muhamadi et al., 2010; Tefera, Tesfaye, Abeba BekeleElias, Waltensperger, & Marsh, 2014). Lastly, low availability of essential medicines has been associated with low enrollment in social or community-based health insurance schemes (Fadlallah et al., 2018; Kalolo et al., 2015; Kamuzora & Gilson, 2007; Renggli et al., 2019).

Our study has important implications for LMICs planning to introduce social accountability mechanisms as tools to improve bottom-up governance in the health system. The lack of effect on outcomes related to infrastructure and the differential results across drug classes suggests that the objectives and targets of SAM programs should be carefully reviewed and locally adapted. These results indicate that SAM programs are effective in boosting the performance of health facilities where functioning local health systems are in place. This implies that social accountability alone may not produce the expected results in settings where broader structural health systems failures hinder the performance of health facilities. Furthermore, social accountability seems more likely to yield the desired results in settings where changes in provider efforts yield tangible results. Areas of health care characterized by binding institutional constraints (e.g., drug delivered through vertical programs, investments in infrastructure requiring long application for additional funds, etc.) are unlikely to respond to increased provider efforts. Targeting outcomes in areas that cannot easily be controlled by health workers thus seems somewhat unlikely to yield positive results and should be avoided in the design of future SAM programs. Finally, the results of this study are consistent with those from previous literature, suggesting that social accountability initiatives should go beyond simple information sharing and include a strong monitoring component. This entails promoting feedback loops between community, service providers and authorities, opening channels for the government to better react to citizens' "voice" (Fox, 2015; Ringold et al., 2012), as well as building capacity, providing tools and training citizens' involved, enabling them to fulfill their roles (Lopez Franco & Shankland 2018).

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CONFLICT OF INTEREST STATEMENT

The authors report no conflicts of interest.

ETHICAL APPROVAL

Ethical clearance for this study was obtained from the Ifakara Health Institute (IHI) Institutional Review Board (IHI/IRB/No: 20-2017) and the Tanzanian National Institute for Medical Research (NIMR/HQ/R.8a/Vol.IX/2721).

AUTHORS CONTRIBUTION

Igor Francetic developed the analytical framework, prepared the data, performed the data analysis and took the lead in writing the manuscript. Günther Fink and Fabrizio Tediosi provided critical feedback and helped shape the research, analysis and manuscript. All authors approved the final version of the manuscript.

DATA AVAILABILITY STATEMENT

Data available on request from the authors.

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ENDNOTES

[1] See http://www.hpss.or.tz/ and https://www.jaziaprimevendor.or.tz/ for further details.

[2] See http://www.sikika.or.tz/ for further details.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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Part V

A network analysis of patient referrals in two district health systems in Tanzania

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Original Article

A network analysis of patient referrals in two district health systems in Tanzania

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Abstract

Patient referral systems are fragile and overlooked components of the health system in Tanzania. Our study aims at exploring patient referral networks in two rural districts in Tanzania, Kilolo and Msalala. Firstly, we ask whether secondary-level facilities act as gatekeepers, mediating referrals from primary- to tertiary-level facilities. Secondly, we explore the facility and network-level determinants of patient referrals focusing on treatment of childhood illnesses and non-communicable diseases. We use data collected across all public health facilities in the districts in 2018. To study gatekeeping, we employ descriptive network analysis tools. To explore the determinants of referrals, we use exponential random graph models. In Kilolo, we find a disproportionate share of patients referred directly to the largest hospital due to geographical proximity. In Msalala, small and specialized secondary-level facilities seem to attract more patients. Overall, the results call for policies to increase referrals to secondary facilities avoiding expensive referrals to hospitals, improving timeliness of care and reducing travel-related financial burden for households.

Keywords: Referral system, networks, child health, non-communicable disease, primary health care

Introduction

Patient referral systems are crucial, yet weak components of health systems across low- and middle-income countries (LMICs) (Kruk *et al.*, 2018). Such systems rely on a pyramidal structure with local primary facilities covering remote rural communities and disadvantaged urban areas that host the largest share of the population. Primary-level facilities provide simple preventive and treatment procedures with little equipment and human resources capacity, and rely on secondary- and tertiary-level facilities for the treatment and diagnosis of more complicated cases. The referral system should promote the delivery of appropriate healthcare to rural and urban population and contain costs (Hort *et al.*, 2019).

Across sub-Saharan African countries, the effectiveness of the patient referral system is influenced by the transportation infrastructure (Atuoye *et al.*, 2015; Nkurunziza *et al.*, 2016). To this extent, the meagre public budgets available to maintain appropriate roads and means of transportation (e.g. ambulances) undermine the operational efficacy of patient referral arrangements (Hsia *et al.*, 2012). Additionally, the high financial burden associated to private transportation remains a major barrier for successful referral among low-income households (Pembe *et al.*, 2008; Porter *et al.*, 2013; Boex *et al.*, 2015). The referral system in Tanzania faces several challenges including the lack of adequate resources and means to transfer patients (Simba *et al.*, 2008), lack of solid referral criteria and compliance at higher level (Jahn *et al.*, 1998; Jahn and De Brouwere, 2001), poor households' decision-making process especially for maternal health (Maluka *et al.*, 2020), frequent delays (Schmitz *et al.*, 2019), frequent self-referrals to hospitals related to the perceived poor quality of care at primary-level facilities (Manzi

KEY MESSAGES

- We study referrals for treatment of childhood illnesses and non-communicable diseases in two rural districts in Tanzania, Kilolo (Iringa region) and Msalala (Shinyanga region).
- In Kilolo, most patients are referred to hospitals due to geographical closeness. There is little role for secondary-level facilities.
- In Msalala, small and specialized secondary facilities receive many referrals. The effect is partially explained by longer travel distance to the closest hospital, compared with Kilolo.
- Referrals to secondary facilities could improve timeliness of care and reduce costs for the health system. Travel-related financial burden for households could also be reduced.

et al., 2012; Yahya and Mohamed, 2018). Yet, to the best of our knowledge, little is known about referral flows, whether dispensaries and health centres effectively act as gatekeepers of the system and which health facility characteristics are associated with the occurrence of referrals between facilities. This study aims to start filling this gap by analysing patient referrals in the two Tanzanian rural districts: Msalala and Kilolo.

Network analysis and patient referrals

Patient referrals in a given geographical area can be interpreted as networks where each referral represents a directional tie between a pair of health facilities. Network analysis (or social network analysis) is an analytical approach to quantitatively study networks of relations between individuals or organizations, with a broad range of applications in the social sciences (Borgatti *et al.*, 2009). Network analysis should be preferred over other regression techniques to study relational data in light of its ability to deal with interdependent observations, i.e. to account for the existence of ties changing the likelihood of ties to or from adjacent nodes (Pomare *et al.*, 2019). In the last decade, network analysis emerged as a versatile approach to study relationships and networks between healthcare providers (Luke and Harris, 2007; Blanchet and James, 2012). Yet, most published studies addressing connections between healthcare providers are only descriptive (Chambers *et al.*, 2012; Bae *et al.*, 2015) whilst studies addressing the collaboration between healthcare facilities in LMICs remain rare (Sabot *et al.*, 2017).

Studies at the individual level typically analyse complex healthcare situations, mostly in high-income countries. Examples include interpersonal communications during emergency care (Patterson *et al.*, 2013; Hertzberg *et al.*, 2017), collaboration during cardiac implants (Moen *et al.*, 2016), influenza vaccination in teams (Llupià *et al.*, 2016) and medicine prescription process (Boyer *et al.*, 2010; Creswick and Westbrook, 2010; Chan *et al.*, 2017). The studies analysing networks between organizations focus on programme managers implementing development aid projects (Blanchet and James, 2013; Kawonga *et al.*, 2015), healthcare provision organization (Ssengooba *et al.*, 2017; Prusaczyk *et al.*, 2019) and policy-making processes (Shearer *et al.*, 2016, 2014). This latter strand of literature shows a remarkably higher share of studies focusing on LMICs. However, they mostly feature descriptive analyses about observed networks. To the best of our knowledge, there are no published studies in LMICs specifically addressing patient referral systems with network analysis tools. Few authors explored patterns of patient referrals between healthcare organizations in high-income settings, with interesting results (Pallotti *et al.*, 2013; Lomi *et al.*, 2014; Kitts *et al.*, 2017). In light of the above, addressing patient referrals in LMICs from a network analysis angle shall not be interpreted as a methodological musing. Instead, the approach can potentially provide novel insights into the underexplored challenge of strengthening referral systems for primary care.

Referral system for treatment of childhood illnesses and non-communicable diseases in Tanzania

In this study, we focus on patient referrals related to treatment of childhood illnesses and of some non-communicable diseases (NCDs) in Tanzania. The role of referrals in obstetric and childcare is crucial for the effectiveness of antenatal and postnatal care (Pembe *et al.*, 2010; Hanson *et al.*, 2017). A number of studies report a high risk of child and maternal mortality directly associated to inefficiencies in the referral system (Atuoye *et al.*, 2015; Bohn *et al.*, 2016; Slusher *et al.*, 2018). On the other hand, the increasing burden of NCDs in LMICs, including Tanzania (Kavishe *et al.*, 2015; Kane *et al.*, 2017), is proving taxing on systems designed to deliver primarily maternal and childcare and treatment for infectious diseases (Byass *et al.*, 2014; Kengne and Mayosi, 2014; Mwangome *et al.*, 2017). On the supply side, the treatment of NCDs requires a radical shift to prevention and continuous support for people affected by chronic diseases. To this end, despite policies requiring dispensaries and health centres to be equipped for preventive care and treatment of non-complicated cases related to NCDs, Tanzanian health facilities at primary and secondary level showed poor preparedness (Peck *et al.*, 2014). On the demand side, there is growing evidence of households incurring in catastrophic health expenditures in relation to long-term treatment of chronic and other NCDs, such as cardiovascular diseases and hypertension (Murphy *et al.*, 2020). In response to studies raising such warnings (Peck *et al.*, 2014; Metta *et al.*, 2015; Bintabara and Mpondo, 2018), the Government of Tanzania recently adopted a prevention plan for NCDs (Ministry of Health, Community Development, Gender, Elderly and Children, 2016). The Tanzanian strategy is aligned to WHO guidelines and relies heavily on primary care and prevention as cost-effective tools to curb the growth in health expenditures associated to NCDs (Walley *et al.*, 2012). Notably, access to health services for sick children and NCDs is free of charge in all Tanzanian public health facilities (Mwangome *et al.*, 2017).

The Tanzanian health system is highly decentralized, with districts responsible for budgeting, organization and management of public health facilities (Kigume and Maluka, 2018a). Primary care in Tanzania is delivered mostly through dispensaries, which are evenly spread across the whole country with catchment areas of around 6000 to 10 000 people (Maluka *et al.*, 2018). Secondary care is offered by health centres, facilities that typically have larger catchment areas of about 50 000 people. Health centres are supposed to provide minor surgical care, preventive medicine, some inpatient services and laboratory diagnostics (Hanson *et al.*, 2013). Primary- and secondary-level facilities are mandated to offer

preventive care and basic treatment of NCDs. Tertiary care is provided by fully equipped district and regional referral hospitals, and a few national specialized hospitals (Baker *et al.*, 2013). The distribution of facilities across levels of care should reflect the healthcare needs of the population, with the majority of cases treated at the primary level by dispensaries. Slightly more severe cases should be referred to health centres whilst complex cases should be referred to hospitals, generally by health centres and less often by dispensaries, e.g. for emergency conditions (Hanson *et al.*, 2017). To this extent, district hospitals show sign of structural weakness such as underfunding, understaffing and an excessive burden associated to their oversight role over the district healthcare system (McCord *et al.*, 2015). Supplementary Appendix SA1 shows additional details with regard to roles and responsibilities at different healthcare levels within the system. The most recent nation-wide governmental programme for primary health services and referral systems (MMAM) was implemented between 2007and 2017 (Ramsey *et al.*, 2013). With respect to referral systems, the MMAM plan dated 2006 tackled the many known weaknesses, namely a high share of self-referrals to hospitals favoured by understaffing and lack of resources of primary and secondary level, lack of transportation infrastructure and lack of communication facilities to support referrals operations.

To shed light on some of the issues above, this study assessed firstly whether health centres act as effective gatekeepers, mediating referrals from dispensaries to hospitals in two rural districts of Tanzania. Secondly, it explored the health facility characteristics associated with the occurrence of patient referrals.

Methods

Data

The data for our analysis were collected in the Tanzanian regions of Iringa and Shinyanga. Although repeated observations over a longer time period would have added value and depth to our study, budget constraints limited our data collection to one round between May and July 2018. Table 1 describes the two regions selected for the study.

Iringa and Shinyanga are located in different parts of the country and are distant enough to constitute separate referral networks, with no shared referral flow. The data were collected through a survey conducted across all public health facilities and the private facilities officially designated as referral centres across two rural districts: the first, Kilolo in Iringa region, and the second Msalala in Shinyanga region. As of 2019, Kilolo had an estimated population of 262 431; the district is characterized by a mountainous surface, low population density (26 people per square kilometre) and health outcomes well below average. On the other hand, Msalala is slightly more densely populated (population 323 587 and density of 81 people per square kilometre), with a flat highland territory and slightly better health outcomes, although still below national averages. We deliberately focused on patient referral patterns in rural rather than urban districts. Our choice rests on two main arguments: (1) about two thirds of Tanzanians live in rural settlements and; (2) geographical access to care, referral and self-referral is practically much easier in urban areas with higher density of health facilities. The study districts were purposely selected based on an ongoing collaboration with the Health Promotion and System Strengthening (HPSS) project. Since 2015, with the supported of the Swiss agency for Development and Cooperation, HPSS has implemented several activities aimed at strengthening the local health system in the Shinyanga region, hence the selection of Msalala district. Based on contextual knowledge and good connections with neighbouring authorities, HPSS officials recommended the selection of Kilolo district and facilitated the procedures to obtain the required authorizations to conduct research in the area.

The survey focused on the occurrence of patient referral and advice-seeking events related to treatment of childhood illnesses and NCDs in the 3 months prior to the interview. Despite the limited amount of referrals expected over such a short time span, our choice was informed by dialogues with stakeholders and essentially aimed at ensuring higher data quality. Specifically, focusing on patient referrals over the 3 months prior to the interview, we aimed to limit probability of missing data and reduce responder recall bias. We identified respondents within the management team or senior staff of the health facility at the time of the visit. The first part of the questionnaire focused on health facility infrastructure and staffing. In the second part, the respondents were asked to retrieve information concerning the referrals for different conditions from official ledger books at the health facility. For conditions with one or more referrals, respondents were asked additional questions in relation to the referral history of the most recent patient listed in the ledger book. The data collection was carried out using tablet technology based on Open Data Kit (Brunette *et al.*, 2013). Table 2 shows characteristics of the surveyed health facilities and respondents within the facilities. In Kilolo, we collected data from 40 dispensaries, 1 health centre and 1 hospital. In Msalala, we visited 24 dispensaries and 3 health centres. Most of the respondents were in-charge of the health facilities (38.1% and 29.6% in Kilolo and Msalala, respectively) and nurses (45.2% and 55.6%).

The survey collected information regarding several childhood conditions or services identified from the IMCI chart booklet (World Health Organization, 2014), WHO priority areas for childcare (World Health Organization, 2012) and the most prevalent NCDs in Tanzania (Institute for Health Metrics and Evaluation, 2018). Supplementary Appendix SA2 lists and describes the referral conditions addressed by the survey whilst the full questionnaire is available in Supplementary Appendix SA3.

The data cleaning and preparation procedure involved coding the data to binary non-weighted networks. In other words, we imputed an existing referral between a pair of health facilities (i.e. a dyadic tie) for all dyads with an existing referral in one or more categories above. Supplementary Appendix SA4 shows the density of referrals across the categories of care considered.

In spite of 69 health facilities surveyed (42 in Kilolo and 27 in Iringa, see Table 2), the resulting networks of referral flows included a total of 77 network nodes (46 in Kilolo and 31 in Msalala). All referral facilities that are either private or outside of our study districts were not directly surveyed due to budget constraints. However, we were able to obtain a limited amount of contextual data for the full set of facilities in our referral networks (i.e. surveyed referring facilities and non-surveyed referral facilities out of study scope), which we in turn used in the exponential random graph model (ERGM) analyses below. Whilst this limited our inferential analysis—as the set of covariates included in our survey instrument was much richer—we were able to obtain a number of key indicators. These are summarized in Table 3, which describes the distribution of facilities in the referral networks. Facilities managed by private or faith-based organizations do not appear to be important referral points for the surveyed government-managed health facilities. In Kilolo, our network includes only 3 faith-based facilities out of 17 active in the district, as reported in the official health facility registry maintained by the Ministry of Health (see Table 1). In Msalala, one private and one faith-based facility received referrals out of four and two operating in the district, respectively.

Table 1 Descriptive statistics about districts

	Kilolo DC	Msalala DC
Region	Iringa region	Shinyanga region
Country zone	Southern highlands	Lake, Northwest
District population (2019)	262 431	323 587
Region population estimate (2019)	1 149 481	1 993 589
Region population density (pers./km^2)	26	81
Life expectancy at birth (region, years)	44	55
Malaria mortality (region, per 100 000)	21.38	28.67
Under five mortality rate (region, per 1000)	145.1	104.3
Facility deliveries (% of total, 2019)	55.8	78.1
Share of children with reported birth weight below 2.5 kg (2019)	6.5	5.9
Share of caesarean section deliveries (2019)	14.1	2.0
Share of children with pentavalent vaccine at 1 year	89.2	88.6
Full availability of 10 tracer medicines (% of facilities)	96.0	96.5
Health workers density (per 10 000, 2018)	6.3	3.9
Dispensaries		
Public	40	24
Faith-based	15	2
Private	5	3
Health centres		
Public	1	3
Faith-based	1	
Private		1
Hospitals		
Public		
Faith-based	1 (district designated)	
Private		
HPSS project	No	Yes, since 2015

Notes: (1) Data from National Bureau of Statistics (2013), MoHCDGEC, NBS, OCGS and ICF International (2016), Malaria Atlas Project (2017) and MOHCDGEC (2020); (2) The list of 10 tracer medicines considered includes: disposable syringe and needles, oral rehydration salts, albendazole/mebendazole oral, amoxycillin/cotrimoxazole, artemether/lumefantrine oral, depo provera, supplies for malaria microscopy, saline solution/dextrose, pentavalent vaccine and oxytocin/ergometrine/misoprostol; (3) Health workers density related to public facilities for the following cadres: nurse, clinical assistant, clinical officer, medical officer, pharmacist and nursing officer; and (4) Msalala district has no public district hospital. The closest district referral hospital is in the neighbouring district of Kahama.

Table 2 Characteristics of the surveyed sample of facilities and respondents

	Kilolo DC	Msalala DC
Facilities, *N* (%)		
Dispensary	40 (95.2)	24 (88.9)
Health centre	1 (2.4)	3 (11.1)
Hospital	1 (2.4)	0 (0.0)
Total staff assigned (mean, median, range)	5.97, 3, 1–109	6.52, 5, 1–28
Respondent qualification, *N* (%)		
Health facility in-charge (MD, clinician, nurse)	16 (38.1)	8 (29.6)
Clinician or clinical assistant (not in-charge)	3 (7.1)	3 (11.1)
Nurse (not in-charge)	19 (45.2)	15 (55.6)
Midwife (not in-charge)	4 (9.5)	1 (3.7)
Years of tenure (mean, median, range)	5.21, 3.37, 0.3–30	3.20, 3, 0.5–10

Consistently with the large proportion of dispensaries in the sample, the median health facility is rather small and similar in both districts. The average facility infrastructure looks fairly similar in the two districts with about three to four rooms, two or three beds, one delivery bed, no ICU beds and no vehicle. In the analysis, we used the number of facility deliveries based on two considerations. First, a successful facility delivery is likely to increase the chance of subsequent childcare visits to the same health facility (Larson *et al.*, 2014; Kujawski *et al.*, 2015). Second, the number of facility deliveries can be interpreted as an indirect proxy of perceived quality of Reproductive and Child Health (RCH) services at facility level. This latter assumption builds on compelling evidence suggesting a relationship between perceived quality of care and decision to give birth at a specific health facility (Exavery *et al.*, 2014; Tafere *et al.*, 2018).

Analytical strategy

Our analytical approach is twofold. Firstly, we explored the data with descriptive analysis of network statistics and graphs. Secondly, we analysed factors associated with network and dyad formation using ERGMs.

Table 3 Descriptive statistics for health facilities in the networks

	Kilolo DC (mean, median, range)	Msalala DC (mean, median, range)
Total (*N*)	46	31
Dispensary	40	25
Health centre	3	4
Hospital	3	2
Private health facilities (*N*)	0	1
Faith-based facilities (*N*)	3	1
Population served	29 111, 3321, 1200–950 000	64 471, 10 995, 610–1 535 000
Rooms in the building/compound	5.17, 4, 1–36	4.61, 3, 1–26
Patient beds	21.72, 3, 0–366	24.35, 2, 0–300
Delivery beds	2.022, 1, 0–17	1.64, 1, 0–8
Intensive Care Unit (ICU) beds	0, 0, 0	0, 0, 0
No. of ambulance vehicles	0.26, 0, 0–5	0.35, 0, 0–3
No. of motorcycles	0.26, 0, 0–2	0.26, 0, 0–2
Facility deliveries in the 3 months prior to the survey	65.98, 8.5, 1–1159	125.2, 19, 5–1892
Facility deliveries (per 1000 people served)	9.82, 3.02, 0.40–272.97	7.35, 2.73, 0.32–52.00

Source: MOHCDGEC (2020) and Sawe *et al.* (2014).

The descriptive analysis of the observed referral networks concerns structural characteristics of the networks and node-level centrality measures. We used sociograms and maps to visualize data about patient referrals. We then analysed basic structural characteristics of the network, such as the number of nodes (i.e. facilities), edges (referrals) and density. Network density is defined as the number of existing ties out of all possible ties, given the number of nodes in the network (Jackson, 2010). To link our network indicators to volume of healthcare provision, we also report the rate of referrals per 1000 outpatient and RCH cases at referring facilities. At the node level, we analysed the distribution of two specific measures of centrality: in-degree and betweenness. In the network analysis literature, centrality measures are node-level statistics that represent different types of power or popularity in the network (Jackson, 2010). In-degree represents the sum of incoming referrals for each health facility and indicates the extent to which a health facility attracts referrals from other facilities. Technically, betweenness centrality represents the proportion of shortest paths between two nodes that pass through the node of interest (Borgatti *et al.*, 2009). In the context of district health systems, this translates to the proportion of referral paths that link three or more health facilities on which each facility lies on, without being at the extreme ends of the chain. For example, given a dispensary referring a patient to a health centre and the same health centre referring a patient to a hospital, the latter is considered central from the betweenness perspective. Betweenness is the closest centrality concept associated to the gatekeeper role as conceived in the referral system from primary to tertiary care. To assess the extent to which health centres fulfil their gatekeepers' role, we employed the centrality measures in two alternative ways. First, we visually present the two networks with nodes size proportionate to node-level betweenness. Second, we rank health facilities based on both in-degree and betweenness scores, comparing the resulting ordering.

Visualization and ranking of centrality measures provide a valuable description of the networks and the relative positions of health facilities. To assess the determinants of referrals underpinning the emerging network structure, we employ a set of ERGMs (Robins *et al.*, 2007). ERGMs (also known as p-star models) represent a higher-order analysis of networks that try to model the observed network as a whole. The models measure the contribution of specific characteristic—at network, edge or node level—to the emergence of the specific network observed in the data. The estimation procedure relies on Monte Carlo Markov chains (MCMCs) to approximate a maximum pseudolikelihood estimate for the coefficients contributing to the likelihood of observing the given network, modelled as an exponential probability distribution. The procedure involves comparing the observed network to a large sample of possible random networks (given the number of nodes considered) in order to obtain a maximum-likelihood estimator for the vector of parameters (Van Der Pol, 2019). The main motivation for the development of ERGMs is the inherent inability of regression models to deal with data that exhibit structural dependence, such as ties in a network of collaborating nodes. Similarly to regression models, ERGMs allow testing hypotheses about the role of influence of specific characteristics (at node and edge level) on the formation of ties in the observed network (Byshkin *et al.*, 2018).

Our estimated models include three types of coefficients:

1. Endogenous network structure: edges propensity, isolates propensity, geometrically weighted in-degree distribution.
2. Edge: road distance between the facilities.
3. Facility covariates: type of facility, number of delivery beds, number of patient beds, number of rooms, number of motorcycles, number of ambulances, catchment population and number of facility deliveries (for networks related to treatment of childhood illnesses).

Structural coefficients capture inherent characteristics of the network. The correct parametrization of structural coefficients ensures the convergence of MCMCs. In our case, the most prominent characteristics are low density of the network, high share of isolate nodes (i.e. facilities that do not send or receive referrals) and skewness in the in-degree distribution. Edge and facility covariate try to capture the effect of different covariates on the formation of incoming and outgoing ties, ultimately contributing to the likelihood of the observed network. As discussed above, our selection of covariates was limited to variables that we could obtain for both surveyed and non-surveyed referral facilities (either private or outside of our study districts).

With regard to the analysis of referrals for treatment of childhood illnesses, we applied a stepwise approach. First, we estimated a simple model with only endogenous network and health facility characteristics as explanatory variables (model 1). Second, we added the (log) number of deliveries in the 3 months prior to the survey, which might be a proxy of the level of quality of services (model 2).

The rationale for this approach is to assess whether the estimated coefficients change with the inclusion of an output covariate that might be related to quality of service at facility level. For networks of referrals related to treatment of NCDs, we only estimated one model for each district including all endogenous network features and health facility characteristics. Results for all models are reported separately for networks of referrals related to treatment of childhood illnesses and NCDs. The coefficients associated to the explanatory variables represent conditional contributions to log-odds of any given tie. Given a vector of significant model coefficients and the associated vector of change statistics, including the characteristics of a pair of nodes (i, j), an inverse-logit transformation returns the probability of observing a tie between nodes i and j. The intuition can be best understood in the simplest case of a (directed or undirected) network modelled just as a function of the number of edges observed. In this case, an inverse-logit transformation of the ERGM coefficient associated to edges propensity would simply return the observed network density. Put it another way, the probability of a tie between any pair of nodes would depend only upon the total number of edges observed in the network and the number of nodes. Supplementary Appendix SA6 provides a numerical example.

All computations, analyses and sociograms (Figure 3) were obtained using the open-source statistical software R. Maps (Figures 1 and 2) were generated using the open-source GIS software QGIS.

Results

Descriptive analysis of referral networks

Table 4 reports basic statistics about the networks of referrals. Most outgoing referrals are from dispensaries towards higher-level facilities. Notably, some referrals are directed from surveyed government health facilities to private facilities. In other cases, referrals are directed from surveyed facilities in the selected districts to public facilities in neighbouring district councils. The referral networks in our analysis show a low density in both districts. The survey confirmed that referrals are rare compared with the overall volume of patient visits. In our sample and over our 3 months study period, 14–24 children were referred to another facility every 1000 RCH clinic visits. Focusing on the treatment of NCDs, only five to seven patients per 10 000 OPD visits were referred.

Figures 1 and 2 present the georeferenced maps of referral networks for Kilolo and Msalala districts, respectively. The maps show the entire regions of Iringa and Shinyanga, with district borders highlighted in bold black.

Besides larger extension and a higher number of health facilities in the Kilolo district, the most prominent difference between the two settings is the closeness to the regional capital city. Kilolo district shares border with the Iringa urban district, the extended Iringa town that hosts the regional referral hospital. On the other hand, Msalala is far from Shinyanga town, with parts of the district located >100 km apart from the regional referral hospital in Shinyanga. This difference in geography may explain the fact that—compared with Msalala—Kilolo shows a larger number of cases directed towards the regional referral hospital. In the case of Msalala district, the closest district referral hospital is located in the neighbouring Kahama urban district.

Figure 3 shows the different referral networks in the two districts, with nodes size proportional to betweenness score. Edges represent the existence of at least one referral between two facilities. In both districts, the networks related to treatment of childhood illnesses have slightly higher density. The structural patterns observed in the networks of childcare referrals do not differ compared with those for treatment of NCDs. In Kilolo, two facilities polarize most incoming referrals: the regional referral hospital (Iringa Town) and the Ililula district designated hospital. Concerning referrals for treatment of childhood illnesses, health centres appear moderately connected. For referrals related to treatment of NCDs, health centres are marginal in the network. In Msalala, although the Kahama hospital is very central in both networks, the referrals are more uniformly distributed. Health centres are well connected in the referrals network, receiving referrals from dispensaries and sending referrals to Kahama hospital. Interestingly, the Lunguya health centre has a relevant gatekeeping role for childcare which is not observed for treatment of NCDs. The opposite is true for Chela health centre, which attracts several patient referrals in the domain of NCDs but much less among sick children. These changes are consistent with a recognized proficiency at Lunguya and Chela in treating sick children and patients affected by NCDs, respectively.

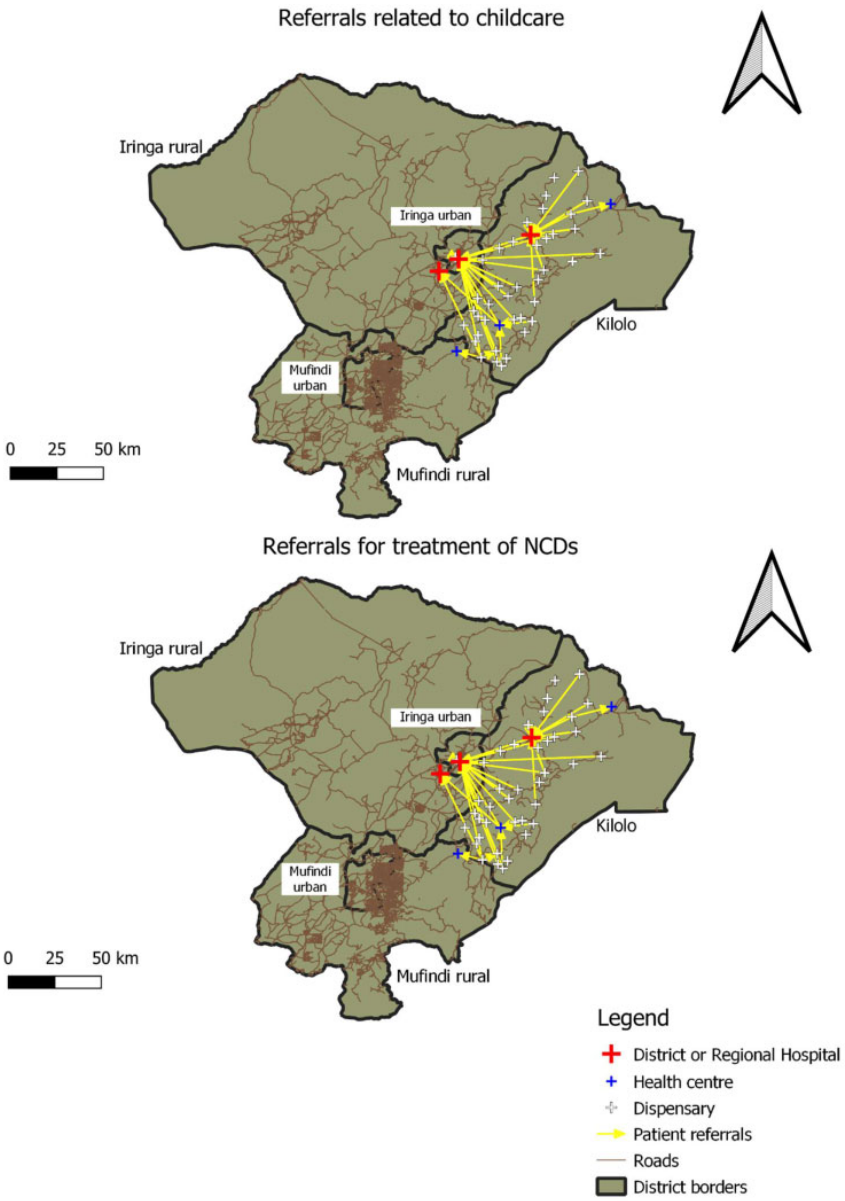
Table 5 reports ranking of in-degree and betweenness score for treatment of childhood illnesses and NCDs. In Kilolo, the regional referral hospital in Iringa Town attracts most of referrals, followed by a district designated hospital (Ililula, FBO) and a health centre (Kidabaga). The health facility that emerges with highest betweenness score is the Ililula district designated hospital. Whilst from these figures, we cannot infer the reasons for the observed patterns of referrals, we can state that the referral flows show a marginal role of health centres in Kilolo. Most prominently, the regional referral hospital in Iringa town plays a key role. The large number of referrals towards hospitals is likely to contribute to an increased burden of hospital wards at regional and district hospitals.

In Msalala, the Kahama district hospital has the highest number of incoming referrals, followed by two health centres (Lunguya and Chela). Health centres also have high betweenness score. This indicates that the network position of health centres in Msalala is consistent with the role of gatekeepers for tertiary specialized care provided in hospitals. As suggested above, the large number of referrals reaching the Kahama hospital should not surprise, provided that it is the closest district hospital.

Analysis of referral network determinants

All the estimated ERGMs show no signs of degeneracy and perform well in all standard goodness-of-fit tests. Detailed diagnostics are included in Supplementary Appendix. Table 6 reports results for models fitted on the networks of referrals related to treatment of childhood illnesses in the two districts. In Kilolo, distance among facilities decreases the conditional likelihood of tie formation, for both model specifications. Consistently with the networks represented in figures above, hospitals appear to be more likely than health centres to have incoming referrals. The number of beds at facility level does not appear to influence network formation. On the other hand, the coefficient for the number of rooms in model 2 suggests that—conditionally on other characteristics—the size of the facility increases slightly the log-odds of a tie. Furthermore, our models do not detect any influence of availability of transportation means on network formation. The number of facility deliveries is also not associated to probability of tie formation in our model.

In Shinyanga, distance between facilities is associated to lower odds of referral. Conditionally on all variables included in the models, incoming referrals are more likely in facilities with larger labour wards. The inclusion of the number of facility deliveries in model 2 changes the estimate associated with the type of facility. In model 1,



Note: District names reported outside of district borders.

Figure 1 Maps of patient referrals for Kilolo district, Iringa Region.

Note: District names reported outside of district borders.

the coefficient associated to health centres is large and positive whilst hospitals show no significant association. In model 2, consistently with the figures, hospitals are more likely than health centres to have incoming referrals. Compared with model 1, model 2 also shows a negative coefficient associated to number of rooms for incoming ties. This suggests that smaller facilities are more likely to attract referrals. Finally, the coefficient associated to facility deliveries is fairly large and significant.

To put these results into perspective, let us consider a referral originating from a dispensary with 4 rooms and 1 delivery bed and 19 deliveries in the previous 3 months (our median facility). Moreover, let us consider a potential referral to a health centre 5 km away with 4 delivery beds, 40 rooms and 90 deliveries in the previous 3 months. For Kilolo, our model suggests that the health centre would experience a 35% increase in the probability of incoming referral expanding its infrastructure from 40 to 45 rooms. In Msalala, for an analogous pair of facilities, the health centre would experience a 16% increase in the probability of an incoming referral with 150 instead of 100 deliveries in the previous 3 months. It is worth noting that the intensity of the effect depends on the initial

Table 4 Descriptive statistics for networks of referrals related to treatment of childhood illnesses and NCDs

	Kilolo DC	Msalala MC
Treatment of childhood illnesses		
Number of referrals	33	32
Referrals to private or faith-based facilities	9	1
Referrals outside of district boundaries	21	19
Referrals		
Between dispensaries		3
From dispensaries to health centres	5	10
From dispensaries to hospitals	22	16
From health centres to dispensaries	1	
Between health centres		1
From health centres to hospitals	2	2
From district hospital to regional hospital	3	
Network density	0.016	0.034
Referrals per 10 000 outpatient visits	7.34	8.25
Referrals per 1000 RCH visits	24.00	13.69
Treatment of NCDs		
Number of referrals	33	19
Referrals to private or faith-based facilities	15	1
Referrals outside of district boundaries	17	12
Referrals		
Between dispensaries	0	2
From dispensaries to health centres	2	6
From dispensaries to hospitals	25	8
Between health centre		
From health centres to hospitals	1	3
From district hospital to regional hospital	5	
Network density	0.016	0.020
Referrals per 10 000 outpatient visits	7.34	4.89

Note: Ratio of inpatient, outpatient and RCH visits based on reported number of visits at the surveyed (referring) health facilities in the 3 months prior to the survey date.

conditions (i.e. change statistics) representing the edge and the characteristics of the pair of facilities evaluated.

Table 7 reports the results of ERGMs fitted on the networks of referrals related to treatment of NCDs. Overall, the ERGMs results are consistent with the geographical distribution of health facilities and patient referrals for treatment of NCDs represented in Figures 1 and 2. Similarly to referrals for treatment of childhood illnesses, both districts are characterized by higher tendency of referrals between facilities that are geographically close to each other. Furthermore, hospitals are more likely to receive referrals compared with health centres. For Kilolo, outgoing referrals seem to be slightly less likely for facilities with more beds and smaller catchment areas. The number of rooms is associated with higher likelihood of a tie, although we could not separate effects for senders and receivers.

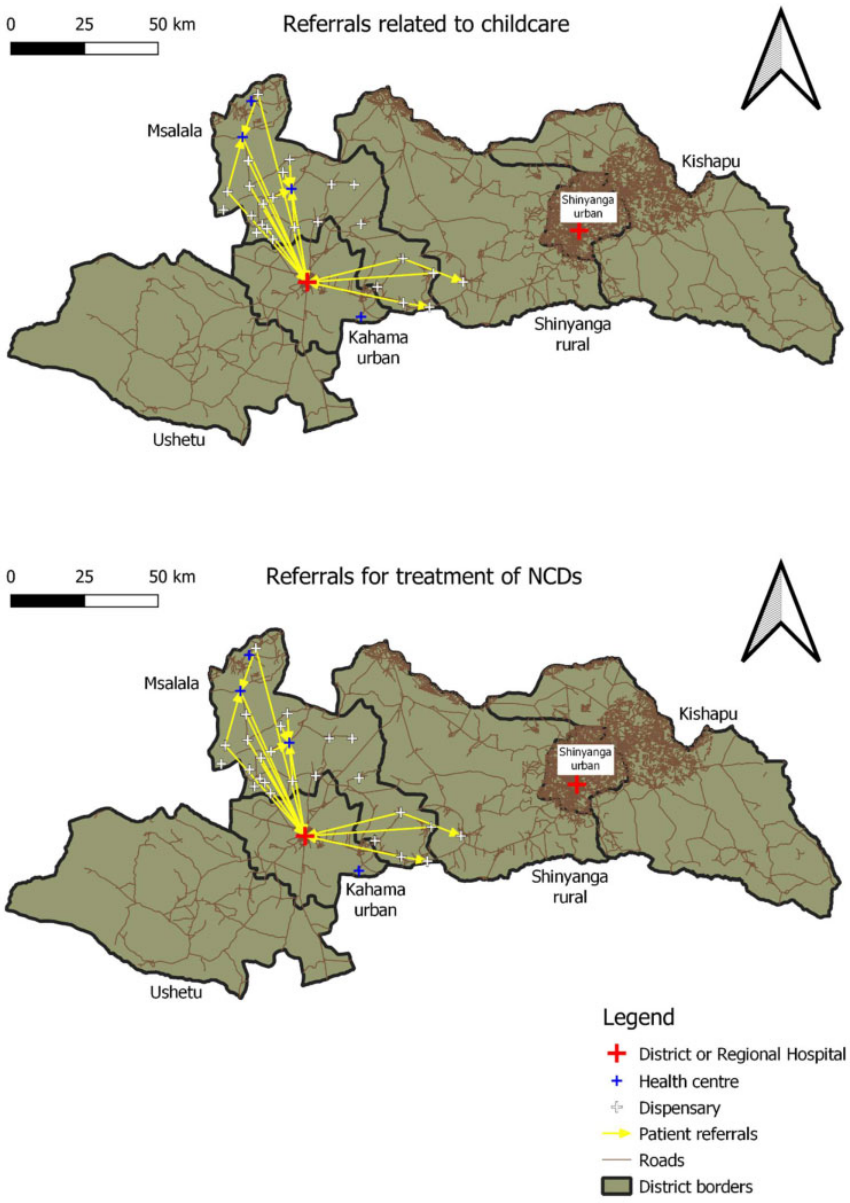
Discussion

The results show two contrasting situations. In Kilolo, the majority of patient referrals are directed towards the regional and district referral hospitals. Health centres play a minor role, with few incoming referrals and limited gatekeeping activity as measured by the betweenness indicator. The latter deviations from standard district referral flows can arise for multiple reasons, including: geographical closeness, better quality of care, community preferences or pre-existing ties between individual providers. The geographic distribution of facilities suggests that the disproportionate share of referrals directed towards the regional referral hospital in Iringa Town might be related to geographical proximity. The analysis of the determinants of patient referrals network supports this interpretation. Notably, ERGMs results also reveal that the only facility characteristic, among those investigated, associated with the emergence of childcare referrals is the number of rooms. For patient referrals related to treatment of NCDs, a higher number of inpatient beds are associated to lower odds of referring patients whilst a higher number of rooms are generally associated with increased probability of a tie. Our analysis suggests that the local health system in Kilolo relies heavily on tertiary hospital care and not much on secondary care provided by hospitals. Whilst this may be clinically appropriate, it could be expensive and cause financial hardship for the households required to move to the referral facility.

In Msalala, we observe a concentration of referrals directed towards the closer district hospital in Kahama district, as Msalala does not have a tertiary-level facility. However, the referral networks indicate an important role for health centres, which attract referrals from dispensaries acting effectively as gatekeepers. This is especially true for the network of referrals related to treatment of childhood illnesses. Compared with Kilolo, the travel distance from many dispensaries to the closest hospitals is larger. Conditionally on the other relevant factors, this likely contributes to the higher rate of referrals directed to health centres, compared with Kilolo. The ERGM analysis of referrals for treatment of childhood illnesses in Msalala suggests smaller facilities with higher number of deliveries seem to be more likely to receive a patient referral. A possible interpretation for this result is that of a virtuous cycle; specialization may be recognized as proxy of quality and thus trigger more incoming referrals to closer and smaller facilities. With regards to patient referrals related to NCDs, the number of motorcycles available in the facilities seems to be weakly associated to the likelihood of a patient referral between two facilities. This supports the idea that transportation infrastructure facilitates patient referrals. We are, however, careful in over interpreting the result as the absence of a similar association for Kilolo is likely related to different geographic characteristics. The mountainous territory in Kilolo is impervious compared with the lowland in Msalala.

Our analysis points to the importance of adequate investments in infrastructure for intermediate secondary-level referral facilities (Mwangome *et al.*, 2017). For instance, there is compelling evidence the rural and mountainous Kilolo district saw few funds allocated to construction and maintenance of secondary and tertiary facilities, to means of transportation (Kigume and Maluka, 2018b) and staffing (Maluka *et al.*, 2020). Consequently, an FBO-managed hospital is designated as district referral hospital, which may discourage attendance of poor households imposing user fees, contrary to public facilities (Saksena *et al.*, 2010). Furthermore, many patients in need of referral are directly sent to the regional referral in Iringa Town, whilst health centres do not appear to receive referrals from nearby dispensaries. These well-known disruptions in the intended referral flows may further discourage access to care due to high travel expenses (Saksena *et al.*, 2010) and specific cultural policies, e.g. spouse accompany (Maluka *et al.*, 2020). Lastly, health facilities located close to district borders—or in districts that do not have a tertiary-level facility—naturally refer patients to other facilities located in neighbouring district not included in our analysis.

Finally, households required to travel to a district or regional hospital face a high financial and organizational burden. Therefore, the interpretation of referrals from dispensaries to hospitals being driven by explicit patient request appears unlikely. Additionally, the

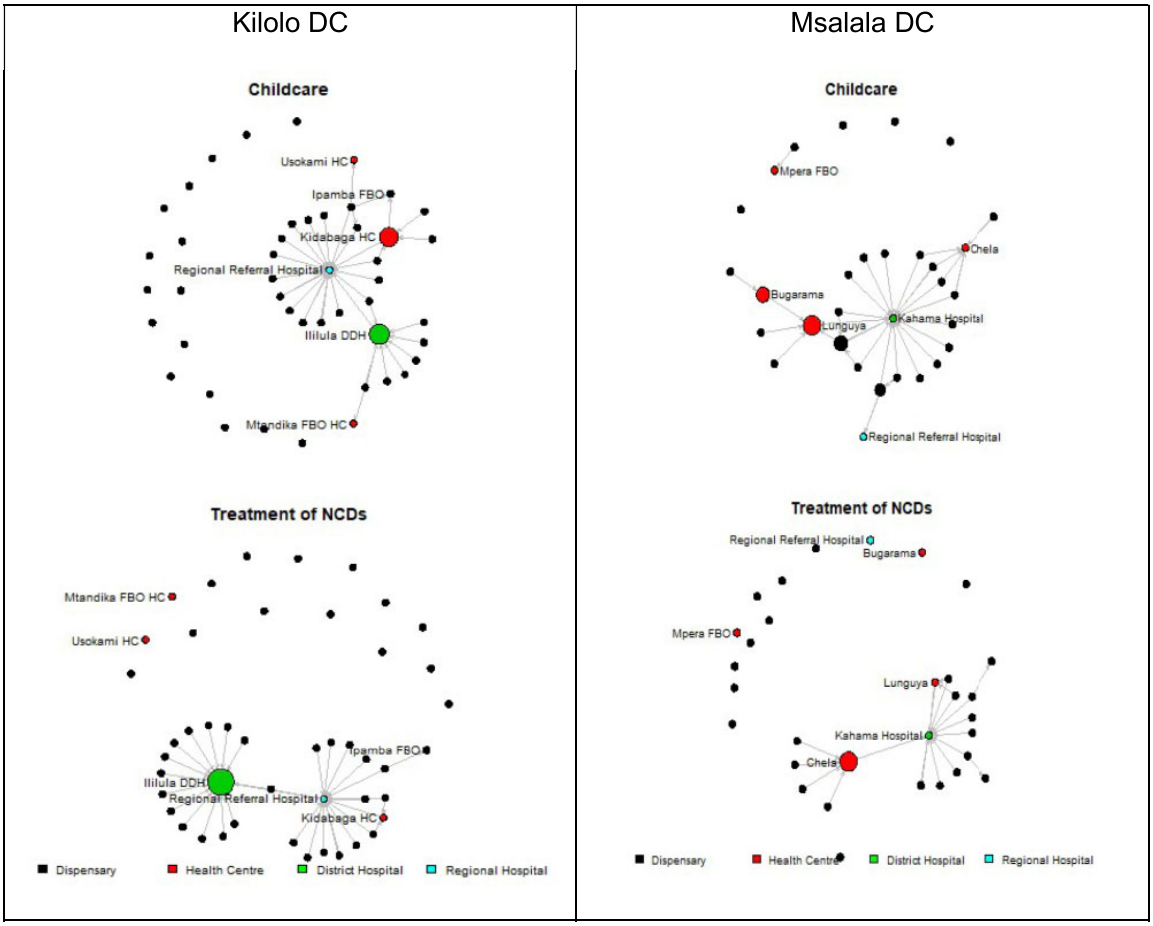


Note: District names reported outside of district borders.

Figure 2 Maps of patient referrals for Msalala district, Shinyanga Region.

current regulation of public healthcare provision exempts childcare and NCDs care from payments across all public facilities and does not attach specific financial incentives to patient referrals. Accordingly, the hypothesis of distorted incentives at the level of dispensaries and towards referring patients to hospitals rather than health centres seems likewise implausible.

Nevertheless, the study has several limitations. First of all, we analysed primary data from a survey conducted on public facilities only. Private healthcare providers are embedded in health systems and treat a substantial share of patients across Tanzania, including Kilolo and Msalala districts. A better representation of patient referrals should include all providers. Specifically, whilst we captured some referrals towards private providers, it is important to also report on referrals from private providers towards other facilities. Secondly, data were collected from the sending health facilities, without details about the clinical and organizational appropriateness, success and outcomes of patient referrals. A complete assessment of the effectiveness of referral systems cannot be conducted



Note: Dots represent facilities, arrows indicate referrals. Names of the facilities are reported for health centres and hospitals only.

Figure 3 Sociograms for referral networks in Kilolo DC and Msalala DC with nodes size.

Note: Dots represent facilities and arrows indicate referrals. Names of the facilities are reported for health centres and hospitals only proportional to betweenness score.

Table 5 Facilities with highest In-degree and betweenness scores for referrals in Kilolo and Msalala districts

Treatment of childhood illnesses				*Treatment of NCDs*			
In-degree	*Value*	*Betweenness*	*Value*	*In-degree*	*Value*	*Betweenness*	*Value*
Kilolo DC							
Regional Hospital	18	Ililula hospital	6	Regional hospital	16	Ililula hospital	13
Ililula Hospital	7	Kibadaga health centre	5	Ililula hospital	14		
Kidabaga health centre	2			Kidabaga health centre	2		
Msalala DC							
Kahama hospital	17	Lunguya health centre	4	Kahama hospital	11	Chela health centre	4
Chela health centre	5	Segese dispensary	2	Chela health centre	4		
Lunguya health centre	4	Bugarama health centre	2	Lunguya health centre	2		

without properly considering its relevance and the associated patient outcomes. Regarding the last remarks, constant improvements in health information systems and routine data collection across LMICs provide interesting opportunities for future research (Harries *et al.*, 2013; Wagenaar *et al.*, 2016). Third, the ERGMs employed to study determinants can potentially reveal mechanisms that are hard

Table 6 ERGMs for referral networks related to treatment of childhood illnesses

	Kilolo DC		Msalala MC	
	Model 1	Model 2	Model 1	Model 2
Edges	−11.62*	−10.70*	−3.78	−24.06***
	(4.69)	(4.16)	(2.66)	(7.20)
Isolates	−0.06	−0.11	−0.83	−0.67
	(0.61)	(0.61)	(0.77)	(0.77)
Geometrically weighted in-degree distribution (GWIDEG)	4.61	3.82	−0.58	10.54**
	(3.23)	(2.67)	(1.61)	(3.89)
Edge covariate: road distance (KM)	−1.78**	−1.86**	−3.74***	−3.57***
	(0.64)	(0.65)	(0.72)	(0.72)
Incoming ties, node factor: health centre	6.52**	5.70**	4.05*	11.86**
	(2.22)	(1.93)	(1.90)	(2.78)
Incoming ties, node factor: hospital	10.46**	9.62**	−2.02	19.78***
	(3.66)	(3.41)	(9.81)	(3.64)
Incoming ties, node covariate: delivery beds	−0.24	−0.39	1.19**	2.21*
	(0.56)	(0.54)	(0.45)	(0.92)
Outgoing ties, node covariate: delivery beds	0.27	0.19	0.39	0.68
	(0.28)	(0.30)	(0.64)	(0.66)
Incoming ties, node covariate: patient beds	−0.01	−0.01	0.04	0.10
	(0.02)	(0.01)	(0.04)	(0.07)
Outgoing ties, node covariate: patient beds	−0.04	−0.04	−0.05	
	(0.02)	(0.02)	(0.04)	
Incoming ties, node covariate: no. of rooms			−0.15	−2.90***
			(0.29)	(1.03)
Outgoing ties, node covariate: no. of rooms			−0.20	−0.35
			(0.25)	(0.20)
Combined node covariate: no. of rooms	0.30	0.32*		
	(0.16)	(0.16)		
Node covariate: no. of motorcycles	−0.31	−0.41	0.07	−0.43
	(0.56)	(0.56)	(0.62)	(0.66)
Node covariate: number of ambulances	0.13	0.12	0.34	−0.01
	(0.66)	(0.63)	(0.73)	(0.80)
Node covariate: log of catchment population	−0.14	−0.25	−0.01	−0.07
	(0.36)	(0.38)	(0.27)	(0.26)
Incoming ties, log number of facility deliveries		0.22		4.46***
		(0.27)		(1.38)
GWIDEG decay parameter	0.7	0.7	0.5	1.2
Akaike Information Criterion	186.67	188.03	145.18	132.97
Bayesian Information Criterion	265.56	272.56	2217.70	205.50
Log-likelihood	−79.33	−79.01	−57.59	−51.48

Notes: Coefficients represent contributions to log-odds. Standard errors are in parentheses.
$^{***}P < 0.001$, $^{**}P < 0.01$, $^{*}P < 0.05$.

Table 7 ERGMs for networks of referrals related to treatment of NCDs

	Kilolo DC	Msalala MC
Edges	34.97***	−0.68
	(9.47)	(1.89)
Isolates	−1.69*	0.07
	(0.76)	(0.60)
Geometrically weighted in-degree distribution (GWIDEG)	9.83	−3.19***
	(4.19)	(0.85)
Edge covariate: geographic distance (KM)	−2.33***	−1.74*
	(0.76)	(0.74)
Incoming ties, node factor: health centre		2.31**
		(0.85)
Incoming ties, node factor: hospital		6.07***
		(0.31)
Combined node covariate: health centre	3.84**	
	(1.40)	
Combined node covariate: hospital	15.71***	
	(4.04)	
Incoming ties, node covariate: patient beds	−0.07***	0.01
	(0.02)	(0.02)
Outgoing ties, node covariate: patient beds	−0.25***	
	(0.06)	
Incoming ties, node covariate: no. of rooms		−0.27
		(0.18)
Outgoing ties, node covariate: no. of rooms		−0.13
		(0.14)
Combined node covariate: no. of rooms	0.65**	
	(0.22)	
Incoming ties, node covariate: no. of motorcycles		0.96*
		(0.40)
Outgoing ties, node covariate: no. of motorcycles	0.21	−0.04
	(0.69)	(0.61)
Node covariate: no. of ambulances	1.02	0.07
	(0.94)	(0.71)
Outgoing ties, node covariate: log of catchment population	1.54**	−0.04
	(0.60)	(0.22)
GWIDEG decay parameter	2.25	0.9
Akaike Information Criterion	141.24	133.58
Bayesian Information Criterion	208.87	196.44
Log-likelihood	−58.62	−53.79

Notes: Coefficients represent contributions to log-odds. Standard errors are in parentheses.
$^{***}P < 0.001$, $^{**}P < 0.01$, $^{*}P < 0.05$.

to identify with a qualitative approach due to intrinsic limits on the number of factors that a researcher can consider (Kim *et al.*, 2016). However, standard ERGMs present many limitations (Desmarais and Cranmer, 2012), including risk of degeneracy associated to MCMC estimation and inability to deal with missing data. For example, the latter limitation restricted our analysis on a subset of facility characteristics that were available for all network nodes. Fourth, the representation of the estimated effects could be improved by the use of graphs showing marginal probabilities across a range of values of the covariates of interest. This visual tool was out of the explorative scope of this analysis but could be included in network analyses focused on the effect of specific characteristics. To this extent, it is important to stress that marginal probability depends upon the change statistics associated to the type of edge and the pair of nodes of interest. In general, the quantification of network-wide average effects is only meaningful for intrinsic network characteristics, such as edge propensity. Finally, our study has limited external validity: we only analysed two district health systems that do not represent the full spectrum of district health systems in Tanzania.

Conclusion

This study showed the potential of using network analysis to assess patient referrals. The results of the study highlight the need for Tanzanian authorities to tackle the central issue of patient referrals from dispensaries. Viable policies might include strengthening physical and transport infrastructures at health centres, improving staffing, training and procedures in secondary-level facilities and possibly setting up a new system of financial and non-financial incentives rewarding successful

patient referrals. Improved referral to secondary-level facilities could avoid unnecessary referrals to hospitals, reducing the travel-related burden for households and expensive hospital care.

Supplementary data

Supplementary data are available at *Health Policy and Planning* online.

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Authorship statement

IF developed the analytical framework, prepared the data collection tools, coordinated and contributed to the data collection, prepared the data, performed the data analysis and took the lead in writing the manuscript. FT provided critical feedback and helped shape the research, analysis and manuscript. AK contributed to coordinate of data collection tools and data collection, provided critical feedback and helped to shaped the research, analysis and manuscript.

Conflict of interest statement. None declared.

Ethical approval. Ethical clearance for this study was obtained from the Ifakara Health Institute (IHI) Institutional Review Board (IHI/IRB/No: 20-2017) and the Tanzanian National Institute for Medical Research (NIMR/HQ/R.8a/Vol.IX/2721).

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Part VI

Discussion

9 Summary and interpretation of the results

9.1 Overview of the governance tools explored

With a focus on the United Republic of Tanzania, the broad goal of the research presented here was to evaluate the impact of a subset of operational health systems governance dimensions on outcomes related to health service delivery. Building on a rather heterogeneous body of theoretical and policy-oriented contributions, part I proposes a working definition of governance. The definition - summarized in table 2 - distinguishes between governance functions and levels. The Tanzanian health system and policy-making in the race towards universal health coverage (UHC) is presented in part II, which also outlines the main governance challenges affecting the country's health system. The papers in parts III, IV and V proposed three attempts to explore the implications of different operational governance levers on health service provision outcomes associated to UHC. In doing so, the manuscript sheds light on some of the mechanisms underpinning effectiveness of governance interventions as well as policy implications. This section summarizes the empirical results in relation to the operational governance aspects: top-down supervision, incentives to health workers, social accountability, system design and regulation.

Top-down monitoring and supervision

The role of monitoring and supervision can be crucial for two main purposes. On the one hand, monitoring contributes to align the incentives of health workers to the goals of the health system. If not characterized by strong intrinsic motivation, providers working in isolation may be tempted to pursue different goals or fail to target high quality of care. On the other hand, different types of supervision contribute to improve performance and quality of care, supporting health workers and providing feedback on procedures and management practices. In the Tanzanian public health system, a number of different monitoring and supervision arrangements have been implemented at different times and levels. The pyramidal structure of the health system prescribes top-down supervision flows from hospitals to health centres and from health centres to dispensaries (and inverse referral flows). District and regional authorities provide supportive supervision to hospitals and other health facilities. Quality and financial audits are conducted at regional and district level. Managers in administrative bodies and health facilities are trained and offered tools to conduct periodic monitoring and evaluation of service provision.
The results in part III revealed that intensity of external audits, supportive supervision at health facility level and individual supervision to health workers are not associated with two measures of healthcare quality: compliance to IMCI guidelines and patient satisfaction. The analysis was conducted using 2014/2015 data on a large sample of Tanzanian public health facilities, representative per region. For facility level supervision, intensity was measured using ordinary scales of frequency over the 6 months prior to the survey date (i.e. never, once, more than once). For individual work-related supervision, intensity was measured as the number of days with supervision in the month prior to the survey. Using multilevel regression models that account for clustering in the data and including a large set of control variables, neither of these indicators showed a significant association with the two quality of care outcomes above.

In the case of Tanzania, the result is unlikely to be related to a high level of service delivery with little room for benefits from supervision and monitoring. Although measurement errors and imperfect control for confounders are possible, the analysis points to ineffectiveness or poor implementation of monitoring and supervision activities at all levels.

Financial and non-financial incentives

Targeted or non-targeted incentives are common levers to trigger extrinsic motivation in health workers. Moreover, deteriorating salary and working conditions can be detrimental also for intrinsic motivation in public service. The overall budget for salaries for public healthcare providers in Tanzania is set by the central government, which disburses funds allocated to regions based on population needs. The central government also allocates skilled staff to different regions and districts. In light of their crucial role for the quality of healthcare delivery, different policies have been put in place to complement the basic government salary for health workers. Pay for performance (p4p) schemes at both individual and health facility level emerged as means to push providers towards higher performance and quality of care. Whilst piloting p4p but failing to scale-up the scheme nationally, the Tanzanian government included performance bonuses in its latest health sectors strategic plan. Furthermore, decentralization allows district authorities to implement different health worker incentive policies at local level. Financial and non-financial incentives can target different aspects of provider motivation and performance. The good mix of both type of policies is crucial to complement the otherwise poor salary conditions faced by most low cadres deployed in rural areas and primary or secondary level facilities across the country.
Part III explored the association between incentives to health workers and quality of care indicators. The results suggest that financial incentives - especially salary top-ups to health workers - may be conducive of higher quality of care, both in terms of process (compliance to IMCI) and outcome (patient satisfaction). The opportunity to complement low baseline salaries with additional earnings seems to be an important aspect for health workers in their daily activity with patients. The results are even more interesting with regards to non-financial incentives. Whilst they do not appear to trigger increased compliance to clinical guidelines, the analysis showed a positive association between subsidized housing and patient satisfaction. In rural settings, subsidized housing is typically offered to health workers in the compound of the health facility, bringing providers close to the point of service and the target community. This can thus be interpreted as a positive impact of subsidized housing on patient satisfaction, mediated by closeness to the community and consequent better ability to address the needs of the community itself.

Bottom-up supervision and social accountability

Likewise many other LMICs, Tanzania is characterized by a strongly decentralized health system, which helps to target health services to the needs of the community. Public health facilities are spread across vast rural territories. Primary and secondary health facilities are geographically located far from district and regional authorities, with the resulting challenges in the implementation of strong top-down supervision and auditing. Both aspects contribute to a generalized lack of accountability in the health system, as a result of greater freedom for healthcare provider and less control. A powerful governance tool that emerged to address these pitfalls is what is generally referred to as social accountability. According to Lodenstein et al. (2017), social accountability can be defined as a situation where "political and governmental actors, including public service providers, are held to account for their actions and decisions by citizens. Public providers are thereby expected to actively respond to citizens' demands, requiring

a behavioural change towards more openness towards discussing poor performance and willingness to improve the power of service users and accountability, and eventually to adapt service delivery practices". In operational terms, social accountability encompasses a wide palette of interventions including light forms of transparency, scorecards, community monitoring and institutionalized government committees with members elected by the community. Many of these interventions have been implemented in Tanzania, some at local level (e.g. pilot projects of social accountability monitoring or community score cards) and others scaled up at national level (e.g. health facility governing committees).

This dissertation addresses two specific social accountability tools. Part III focuses on the frequency of meetings with the community at health facility level across the whole country. The results of the multilevel regression introduced above suggested a positive association between frequency of meetings with the community and patient satisfaction. The analyses did not detect any association with the process dimension of quality, namely compliance with IMCI. The proposed interpretation intertwines with the result for subsidized housing offered to health workers. Higher frequency of meetings with the community reduces the distance between healthcare providers and communities. This results in better understanding of the healthcare and social needs of the community and in turn increased trust and patient satisfaction. On the other hand, higher frequency of meetings with the community shows no association with clinical compliance of health workers. This last result can be explained primarily by to the strong information asymmetry between patients and providers.

Part IV offers an impact evaluation of a comprehensive social accountability monitoring pilot intervention in the region of Dodoma. The program has been implemented by the Tanzanian NGO Sikika, a watchdog organization focused on corruption, quality of care and public finances management. The Dodoma region, located in central Tanzania and hosting the country's capital city, is predominantly rural. Since 2012, the health system in Dodoma has been characterized by the implementation of a health system strengthening effort (HPSS, health promotion and system strengthening project) funded by the Swiss Agency for Development and Cooperation. The HPSS project overlapped with the social accountability monitoring program implemented since 2012 by Sikika in two out of the seven districts in the region. The analysis focused on two outcomes (days of stock-out for a set of essential medicines and indexes of infrastructure maintenance) and used health facility level data from two surveys in 2011 and 2017. The diff-in-diff analysis identified a reduction in stock-out days for antibiotics. The hypothesized impact pathway involves a strengthened link between district authorities (responsible for delivery of drug stocks to health facilities) and health facility governing committees (HFGCs). HFGCs are responsible for micromanaging the facility and representing the community health needs with members elected directly by and from the community. The models did not find effects of social accountability monitoring neither on other drug categories (e.g. antimalarials, drugs for maternal and child health) nor on infrastructure maintenance. The limited scope of the program on drug stock-outs (only for antibiotics) can be interpreted in light of the parallel supply chain - managed by vertical programs or central governments - which characterizes antimalarials and child health medicines, among others. The lack of measured impact on infrastructure maintenance is in strong contrast with the anecdotal evidence promoted by organizations involved in social accountability. Changes in infrastructure management and investments may require longer periods and depend on the availability of funds, either at local level or approved and disbursed by regional/central authorities. Overall, the results indicate a positive effect of social accountability on resource availability at health facility level, although limited to availability of essential medicines.

Design and support of patient referral systems

The design of strong patient referral systems is crucial for the effectiveness and efficiency of district health systems in Tanzania. Firstly, referring patients from primary to secondary or tertiary health facilities is a fundamental need for all systems that rely on a large base of primary healthcare facilities. The latter are purposely not equipped to treat complicated cases which should be addressed by higher level facilities. Secondly, having health centres as secondary level facilities favours an improved gatekeeping system that prevents undue hospitalization, ultimately reducing healthcare costs. Effective patient referral systems require a mix of organizational and physical infrastructure. Referral flows need to be clearly defined and embedded in standard operating procedures, including adequate diagnostic criteria and guidelines for case management. The successful transfer of patients depends on the availability of space, technology and staff in the receiving facility. Moreover, road infrastructure, proper means of transportation and financial protection for patients in relation to travel expenses emerged as key success factors.

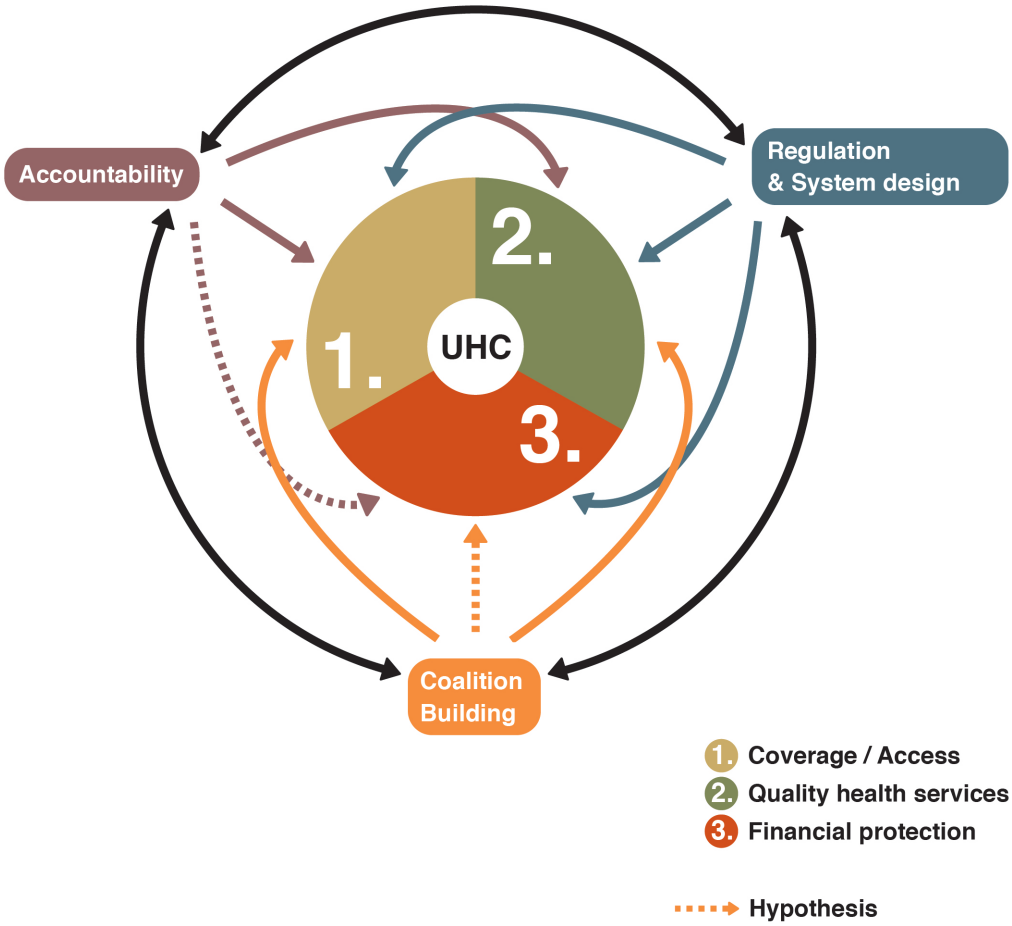
The analysis in part V addressed the topic of patient referral flows with a network analysis approach. The study used a novel dataset on two Tanzanian districts Kilolo (Iringa region) and Msalala (Shinyanga region). With support from local partners, the first author coordinated the primary data collection in mid 2018 focusing on referral flows originating from public health facilities in the two districts. The questionnaire focused on patient referrals related to childcare and treatment of NCDs in the 3 months prior to the survey date. The resulting list of patient referrals was mapped to a referral network for each district. Descriptive centrality statistics and network visualization highlighted a marked difference between the two rural districts. Specifically, facilities in Kilolo appeared to refer a disproportionate amount of patients to the regional referral hospital in Iringa city instead of the available health centres. The negative consequences of this setting are increased costs generated by high rate of hospitalizations, financial burden for patients involved and increased waiting times in hospital wards. On the other hand, in Msalala district the distribution of patient referrals appeared more balanced. Although the closest district hospital showed the higher number of incoming patients, health centres had a relevant role.

The study also explored the determinants of referral flows using a statistical approach known as Exponential Random Graph Models (ERGMs). ERGMs model a random network formation probability with parameters at structural (network), node (facility) and edge (patient referral) levels. The resulting estimates represent different contributions to the log-odds of ties. For Kilolo, the analysis revealed that main determinants of referrals are road distance and availability of space. Interestingly, the level of output or specialization did not appear to play a significant role. For Msalala the situation appeared again different. Focusing on childcare referrals, referrals emerged to be associated to higher specialization (more beds for child care and health facility deliveries) and smaller facilities. The results give rise to a dual interpretation. In Kilolo, resource constraints and geographic closeness to the regional capital city Iringa generate the undesired effect of a high proportion of patients transferred to the regional referral hospital. In Msalala, the analysis is consistent with a virtuous cycle of specialization, with patients referrals directed towards the nearby facilities most experienced to treat the specific condition.

9.2 Results in perspective

As introduced in section 2.1, health systems governance favours the attainment of universal health coverage. To this end, figure 2 represents the interactions between governance and UHC supported by the empirical analyses in the previous parts of this manuscript. In relation to the operational governance dimensions analysed, what emerges is a set of interrelated dimensions all contributing to the three core aspects of UHC: coverage, financial protection and quality healthcare services. The influence relationships represented in figure 2 are commented below. Further research could complete the diagram with empirical support in relation to the two governance functions not explicitly targeted in this dissertation: policy guidance and generating intelligence.

Figure 2: Linking empirical results to role of governance in the race to UHC



Source: author's own elaboration.

Interactions between the governance dimensions explored in the thesis

Regulation and system design ↔ *Accountability*: Appropriate regulation can be conducive to increased accountability. A notable example are health facility governing committees across all public health facilities in Tanzania. Furthermore, incentive policies contribute to increased accountability putting health workers in a better position to report and cooperate with local communities. For example, the analyses summarized above suggests that non-financial incentives to health workers in form of subsidized housing in the health facility compounds improve closeness to the community. On the other hand, accountability favours a feedback of precious information to regulators. Different accountability arrangements - for example social accountability monitoring - help to better identify needs of the served communities, producing useful data which LGAs could use to improve systems design.

Coalition building ↔ *Accountability*: As extensively discussed in part IV, most accountability arrangements in LMICs with health systems based on primary health care build on community involvement. To this extent, social accountability and coalition building go hand in hand. Without the successful involvement of civil society representatives (village leaders, religious leaders, local CSOs or NGOs) social accountability initiatives are bound to fail. Higher interaction and cooperation between social partners, public and private providers naturally favours accountability, stimulating information flows and contract-based market arrangements (e.g. public tenders).

Regulation and system design ↔ *Coalition building*: Good system design favours cooperation between actors within the health system, for example outlining clear decision/support/referral flows or improving acceptability of policies among the civil society. Regulators shall also acknowledge the growing role of private providers in healthcare delivery and act accordingly. Private healthcare provision in LMICs is both a threat and an opportunity. To prevent the harmful consequences of providers uniquely oriented to profit and not concerned with patient welfare, there is a need for improved regulation and sanctions enforcement. On the other hand, private or faith-based providers constituted a strong network of facilities with skilled workforce across LMICs. Regulators should seize this opportunity designing inclusive policies that allow private/faith-based provider to fill the gaps that public facilities cannot cover, possibly with public funding when necessary.

How governance supports UHC

Accountability → *UHC*: The results discussed in the previous sections - and especially in parts III and IV - support the idea that accountability has a positive impact on all dimensions of UHC. With regards to quality healthcare services, the studies identified two positive contributions. Firstly, increased interaction with the community at facility level is associated with higher quality of care (patient satisfaction). Secondly, social accountability monitoring is associated with increased availability of essential medicines. In relation to coverage and access, accountability has direct and indirect benefits. The direct way is represented by the increased awareness and acceptability of accountable healthcare services. Indirectly, accountability exerts a positive influence on coverage through the mediating effect of increased patient satisfaction, which stimulates healthcare seeking behaviour among patients. Finally, the above studies did not directly explore the relationship between accountability and financial protection. However, a hypothesized second-order effect - closely associated to the increased access - is represented by potential decreased out-of-pocket payments. Availability of drugs and higher patient satisfaction attract patients to public facilities which - unlike private providers - exempt vulnerable people from payments.

Regulation and system design → UHC: Regulation and system design contribute to the goals of universal health coverage in a number different ways. Part III confirmed that incentive strategies are relevant for quality of care. Financial incentives are associated with both clinical compliance and patient satisfaction. On the other hand, subsidized housing is associated only with increase patient satisfaction. The studies also stress the importance of patient satisfaction for increased access. On the same note, part V suggests the that design of patient referral systems and investments in the infrastructures can have sensible implications on the way people seek care in complicated situations. Unequipped and understaffed referral health facilities can drive patients to long travel times towards the closest hospital, which may in turn discourage them from seeking care or generate detrimental financial consequences. This latter case highlights an instance where system design can have an influence on the third goal of UHC, financial protection. Although not discussed in the empirical research presented here, an additional logic pathway to impact on financial protection is the range of policies related to fees, exemptions/waivers and health insurance implemented at national or local level.

Coalition building → UHC: The analyses in parts IV and V partially address the governance function of coalition building within and involvement of the civil society in the health sector. An influence pathway of coalition building on quality of care is the mediated effect of social accountability initiatives, that build crucially on the involvement of the civil society, in form of CSOs, local NGOs or community/village representatives in HFGCs. The UHC goal of coverage and access can benefit from spillover effects of strong cooperation with the private sector, in that the population can benefit of an extended network of health facilities. A typical example is the appointment of designated FBO/private facilities in areas where public infrastructure is lacking. More broadly, coalition building facilitates the acceptability of healthcare reforms, favouring an early involvement of the communities and promoting solution targeted to their needs. The dissertation did not address directly the association between coalition building and financial protection, which is nevertheless hypothesized and highlighted with a dashed line in figure 2 and is up for further explorations.

10 Policy implications

Tanzania is an ambitious country seeking to improve the welfare of its citizens and raise from low- to middle-income country by year 2025. A substantial part of these efforts is aimed at improving health, approaching universal health coverage and strengthening governance across all sectors (Sirili et al., 2013). This dissertation looked at the intersection between these domains. The results summarized above have direct relevance for health policy in Tanzania at all levels, from central government to LGAs.

For policy makers at central government level, a first general takeaway relates to public finances. The findings suggest the need for stronger commitment to increased health budget allocation, towards the Abuja target and beyond the basket fund supported by development partners. Higher availability of funds could allow LGAs to invest in better infrastructures and human resources for health. In relation to health systems governance, central authorities should further institutionalize, promote and strengthen extant social accountability arrangements whilst avoiding excessive bureaucratization. The introduction of health facility governing committees and council health management teams at district level about 20 years ago has been a positive step on the road to accountable healthcare (Kessy, 2014). Many factors seem however to hinder their effectiveness, calling for new and better mechanisms to mobilize the communities and activate virtuous accountability loops. Furthermore, government and law-makers should

set a strong legal basis to allow contracting and collaboration with private or faith-based healthcare providers whenever needed to fill gaps in public healthcare provision. Finally, the lack of bite of supervision and auditing arrangements may be partially associated to flaws in the enforcement of rules and laws. Sanctions for wrongdoing do not seem to act as binding constraints for healthcare providers at local level. Central government authorities should thus support LGAs with appropriate legal support for effective sanctions. However, the topics discussed in this dissertation are mostly relevant for local - region and district - government authorities. LGAs bear the responsibility of steering health systems and managing public health facilities, excluding the very few specialized national hospitals. To this extent, policy implications span over four areas.

1. Investments in infrastructure: better infrastructure at primary and secondary level could limit unnecessary patient referrals to hospitals. The results above suggest that geographic closeness and infrastructure availability are relevant factors associated to patient referrals. Avoiding long travel to hospitals could protect patients from financial hardship. Moreover, increased availability and quality of government housing for health workers within health facility compounds could favour the positive quality-improvement loop fuelled by closeness to the community.

2. Human resources for health and incentives: first of all, LGAs should increase hiring to reduce the huge shortage in skilled personnel, especially at primary and secondary level. The staffs' skill-mix should include both specific clinical and managerial training. Secondly, LGAs should implement comprehensive incentive strategies to complement low salaries of public health workers. Salary top-ups and other allowances - if regulated and harmonized to avoid inequalities across providers - appear to have scope for improvement and could benefit quality of care. Furthermore, subsidized housing to health workers should be extended in coverage to virtually all primary care facilities and possibly also to secondary facilities.

3. Supervision and monitoring arrangements: in the last decade, different supervision arrangements have been included in government policies and guidelines for the public health sector. Their implementation seems however to be flawed. Besides training supervisors, LGAs should reassess their procedures. Given the ample room for improvements in quality of care and efficiency of healthcare delivery, it is highly unlikely that supervision and monitoring do not have scope in Tanzania. Other factors that are likely to hinder the effectiveness of these arrangements are the lack of effective enforcement of sanctions, poor availability of monitoring and evaluation data as well as the lack of transparency in the supervision process. Only addressing all these factors, supervision arrangements can play a relevant role in the improvement of healthcare quality.

4. Social accountability: as mentioned above, social accountability arrangements have been included in the national health strategies. Health facility governing committees for primary and secondary facilities and council health management teams at district level have been instituted about 20 years ago, with mixed results to date. The evidence above point to a positive influence of social accountability on patient satisfaction and availability of essential medicines. The studies suggest the need for the implementation of well-designed (social) accountability mechanisms to link health facilities and district authorities. LGAs should thus invest in strengthening the relationships with the facility committees, effectively enabling positive information feedback loops and identification of local needs. In fact, without the budget and decision power of the district authorities, health facilities are left with few locally generated funds that give little room for action and fail to support the trusted accountability link with communities.

11 Limitations

The analyses proposed here represent an ambitious attempt to systematically and empirically address operational health systems governance in Tanzania. The approach has some relevant limitations - mostly related to data and measurement - which are listed in this section.

Part III focused on two proxy indicators for quality of care using cross-sectional survey data on supervision and incentives at facility and health worker levels. Data availability limited the study in a few relevant ways. Firstly, the analysis did not address health worker motivation, which is likely to mediate the effect of supervision and incentives on quality of care. Secondly, both dependent and independent variables in the analysis - constructed based on the available survey data - have room for improvements in terms of measurement accuracy. In the specific case of frequency indicators for supervision and monitoring, the simple likert scales could be enriched with more accurate information on the content and quality of supervision itself. Finally, the proposed analysis focused only on the 2014/2015 wave of the SPA survey. A longitudinal study - when possible in the future - could provide far more insights into the interplay between governances tools and health service provision outcomes.

The analysis presented in part IV evaluated the impact of a social accountability monitoring program on availability of essential medicines and infrastructure maintenance using a quasi-experimental approach. Once again, challenges with the available data limited the scope of the analysis in three main ways. The start of the research well after the implementation of both HPSS and Sikika projects did not allow to influence the data collection process. Therefore, the study was conducted using the available data gathered with two surveys (baseline in 2011 and endline in 2017) by HPSS. The robustness of the results would have greatly benefited from either pre-intervention data or intermediate outcomes. A second weakness is the lack of strong support for the identifying assumption of parallel trends in absence of the social accountability monitoring intervention implemented by Sikika. An important concern is that HPSS may have contributed to improve outcomes in the two treatment districts, thus interacting with the very effect that the analysis sought to estimate. To this extent, the study had to deal with the lack of additional data points (base- and endline) outside of the HPSS intervention area. Thirdly, unlike the more general country-wide scope of part III, the results in part IV have a lower level external validity outside of the specific implementation context.

With part V the dissertation offers an innovative network-based perspective on patient referral flows related to childcare and treatment of NCDs in two Tanzanian districts. The study was conducted using primary data collected by the authors during fieldwork in 2018. In relation to the data collection, budget and time constraints limited the sampling to the referrals originating only from public health facilities. As a result, the lack of data about referrals originated by private and faith-based health facilities limits the scope of the overall assessment of full health system panorama in the two districts. Another weakness in the data is represented by the lack of proper control - beyond a satisfaction rating - for the success rate of patient referrals reported. Furthermore, the study did not (and was not meant to) consider the clinical appropriateness of the patient referrals included in the data, as it focused on the organizational and system design implications. Finally, as with any network analysis, the study models interrelations in a specific setting and shall be extended with caution to different contexts.

12 Concluding remarks

The research agenda on health systems governance in LMICs is both challenging and rich in opportunities. Healthcare governance issues such as providers' payment and regulation of health insurance captured the attention of health economists and other researchers since long time in high income countries, mostly to explore virtues of market arrangements (Arrow, 1963; Hsiao, 1995). However, the lessons drawn from rich industrialized economies with strong institutions typically do not apply to low-income settings with weakly developed institutions. This dissertation contributes to a relatively new and unpopulated strand of literature which explores the empirical implications of health systems governance in low-income settings.

After an initial push by the WHO, the number of theories and frameworks to identify governance in health systems surged in the last decade. Unfortunately, the quantity of sound empirical evidence remained and still is limited, leaving governments across LMICs mostly unaware of the best options available. Many resource constrained governments rely on development aid to fund healthcare expenditure. With such an unclear menu of options to tackle governance in health systems, the policies adopted are often heavily influenced by foreign donors. This influence can be either in form of wide pilot projects or with a direct involvement in the health policy process, for example in the Tanzanian case of the Health Basket Fund. Foreign aid in health and the related policy directions undoubtedly brought positive changes to health systems across LMICs. However, health systems governance interventions are profoundly different from clinical interventions in terms of efficacy in real-world situations. In many instances, exogenous solutions are pushed on the basis of groundless assumptions or ideological positions. In the latter cases, failure is a likely outcome which however tends to emerge only after many years and many resources are spent to set up the relevant infrastructure and shape the health system. A similar recent example in Tanzania is the implementation of community-based health insurance (CHBI) systems. CHBI schemes have been heavily supported by the World Bank (Basaza et al., 2009; Fenny et al., 2018) despite early evidence showing poor performance in terms of coverage and low impact on financial health protection.

The evolution of health systems across the world - in LMICs as much as in high-income settings - is very much context specific and dependent upon historical paths. In Europe, two exemplary cases are the NHS in the United Kingdom and the German social health insurance system inspired by the reforms of Chancellor Otto von Bismarck in the XIX century. Likewise, Tanzanian's pioneering focus on primary care dates back to President Nyerere's policies in the 1960's. Within all health systems, governance arrangements are even more rooted in local contexts, reflecting balances of power and negotiations. To this extent, health systems researchers appreciate that there is not such thing as a "one size fits all" fix to issues affecting health systems in LMICs. Solutions should always be developed by policy makers at the local level, involving relevant stakeholders and integrating all relevant contextual factors that ultimately shape the populations' approach towards health services. Nevertheless, robust and generalizable evidence on the effect of specific policies is an essential starting point. With a very narrow focus on few specific operational governance tools, this dissertation tries to satisfy this latter need. Future research shall continue on the road of generating sound evidence, focusing on which policies addressing health systems governance work in the race towards UHC and why. Researchers should try to build on existing definitions and frameworks to favour comparability. Finally, valuable contributions shall both unpack policies into smaller parts or tools and evaluate complex interventions accounting for contextual factors.

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Appendices

A Appendix to part III

Table SM1: Statistical tests for model selection. Source: author's own elaboration on DHS SPA 2014/2015 data.

IMCI analysis	
Test multilevel ordered logit against ordered logit	
Log-likelihood multilevel model with 3 levels:	-1717.5
Log-likelihood ordered logit model	-1863.0
LR test score chi2(3)	291.0
P-value	0.000
Test three-levels ordered logit against two-levels ordered logit	
Model with 3 clustering levels	
Log-likelihood	-1717.12
Akaike information criterion	3542.233
Bayesian information criterion	3831.369
Model with 2 clustering levels	
Log-likelihood	-1735.64
Akaike information criterion	3577.291
Bayesian information criterion	3861.072
LR test score chi2(1)	37.06
P-value	0.000
Conclusion: model with 3 clustering levels preferred.	

Patient satisfaction analysis	
Test multilevel ordered logit against ordered logit	
Log-likelihood multilevel model with 3 levels:	-2679.15
Log-likelihood ordered logit model	-2793.64
LR test score chi2(3)	229.0
P-value	0.000
Test three-levels ordered logit against two-levels ordered logit	
Model with 3 clustering levels	
Log-likelihood	-2679.15
Akaike information criterion	5462.292
Bayesian information criterion	5800.873
Model with 2 clustering levels	
Log-likelihood multilevel model with 2 levels:	-2709.98
Akaike information criterion	5521.956
Bayesina information criterion	5854.026
LR test score chi2(1)	61.66
P-value	0.000
Conclusion: model with 3 clustering levels preferred.	

Table SM2: Robustness checks for regressions on IMCI compliance.

	Two levels ordered logit		*Ordered logit with clustered errors*	
	OR	95% CI	OR	95% CI
Rural area	1.163	[0.626,2.161]	0.957	[0.673,1.359]
Results-based financing	1.451	[0.635,3.314]	1.422	[0.637,3.174]
Health Services Index	1.025	[0.932,1.127]	1.017	[0.962,1.076]
Any patient feedback mechanism	0.946	[0.613,1.459]	0.939	[0.691,1.278]
Caretaker literacy (reference: Neither read nor write)				
Read only	0.601	[0.267,1.356]	0.601	[0.267,1.356]
Read and write	0.993	[0.740,1.334]	0.993	[0.740,1.334]
Caretaker relationship with patient (reference: Mother)				
Father	0.861	[0.437,1.700]	0.816	[0.473,1.407]
Sibling	1.663	[0.606,4.569]	1.507	[0.803,2.830]
Other	0.987	[0.502,1.940]	0.870	[0.479,1.580]
Patient gender: Female	0.897	[0.703,1.146]	0.865	[0.716,1.044]
Patient age	0.821***	[0.738,0.913]	0.863***	[0.797,0.936]
Health insurance coverage	1.004	[0.698,1.445]	1.069	[0.807,1.414]
Diagnosis (reference: Ear problem)				
Respiratory problem	0.218***	[0.147,0.324]	0.234***	[0.166,0.330]
Digestive system	1.743**	[1.182,2.570]	1.871***	[1.396,2.507]
Malaria	1.896***	[1.323,2.719]	1.421*	[1.058,1.909]
Fever	0.871	[0.581,1.307]	0.833	[0.598,1.161]
Patient charged for visit	0.689	[0.355,1.336]	0.847	[0.500,1.434]
Provider gender: female	1.041	[0.689,1.574]	0.864	[0.655,1.141]
Provider tenure at facility	1.026	[0.998,1.055]	1.015	[0.998,1.032]
Provider qualification (reference: Medical Doctor)				
Medical/Clinical officer	0.471	[0.146,1.519]	0.529	[0.229,1.225]
Nurse	0.287	[0.0779,1.059]	0.427	[0.168,1.085]
Assistant	0.189*	[0.0429,0.833]	0.297*	[0.0894,0.990]
Provider manager or in-charge of unit	1.163	[0.737,1.836]	0.996	[0.706,1.406]
Facility has IMCI guidelines	1.857**	[1.195,2.884]	1.530**	[1.146,2.042]
Number of OPD visits during the last month (reference: 0-200 visits)				
200 – 400 visits	1.341	[0.753,2.388]	1.244	[0.832,1.859]
400 – 600 visits	1.118	[0.571,2.189]	1.293	[0.795,2.103]
600 – 800 visits	0.937	[0.381,2.306]	1.041	[0.607,1.784]
More than 800 visits	0.679	[0.335,1.378]	0.817	[0.493,1.357]
Type of health facility (reference: Dispensary)				
Hospital (any level)	1.433	[0.525,3.912]	1.079	[0.623,1.870]
Health center	0.836	[0.441,1.585]	0.803	[0.561,1.150]
Frequency of management meetings at the health facility in the last 6 months (reference: Never)				
Once	0.532	[0.187,1.514]	0.708	[0.291,1.722]
More than once	1.204	[0.666,2.176]	1.135	[0.771,1.669]
Frequency of meetings with the community at the health facility in the last 6 months (reference: Never)				
Once	1.156	[0.545,2.448]	1.095	[0.659,1.818]
More than once	1.370	[0.882,2.130]	1.318	[0.948,1.831]
Last external supervision at the health facility (reference: Never)				
More than 6 months ago	0.179	[0.00991,3.251]	0.348	[0.114,1.059]
Within past 6 months	0.302	[0.0215,4.249]	0.474	[0.196,1.148]
Days of work supervision to the provider	1.054	[0.970,1.145]	1.040	[0.988,1.095]
Monetary incentives to provider				
Salary top-up	1.490	[0.959,2.316]	1.330	[0.990,1.786]
Per diem when training	0.867	[0.546,1.375]	0.975	[0.700,1.358]
Duty allowance	1.093	[0.719,1.660]	1.152	[0.867,1.531]
Payment for extra activities	0.990	[0.521,1.881]	1.120	[0.715,1.755]
On-call allowance	1.157	[0.750,1.783]	1.112	[0.828,1.494]
Housing allowance	3.800*	[1.128,12.80]	2.092	[0.944,4.634]
Non-monetary incentives to provider	1.274	[0.834,1.944]	1.150	[0.865,1.527]
Uniform/caps/backpack	0.941	[0.533,1.661]	0.934	[0.626,1.396]
Training	1.679*	[1.048,2.689]	1.281	[0.911,1.801]
Subsidized housing	1.352	[0.701,2.609]	1.073	[0.715,1.610]
Time off/ holidays	1.490	[0.959,2.316]	1.330	[0.990,1.786]
N	1563		1563	
Log-likelihood	-1735.6		-1862.8	
LR chi2	191.8		266.4	
Prob > chi2	2.14e-19		2.01e-32	
Number of iterations	4		4	

Exponentiated coefficients; 95% confidence intervals in brackets; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table SM3: Robustness checks for regressions on patient satisfaction (full sample).

	Two levels ordered logit		*Ordered logit with clustered errors*	
	OR	95% CI	OR	95% CI
Rural area	1.159	[0.833,1.614]	1.174	[0.882,1.562]
Results-based financing	0.738	[0.463,1.177]	0.769	[0.517,1.145]
Health Services Index	1.034	[0.981,1.090]	1.029	[0.985,1.075]
Any patient feedback mechanism	0.804	[0.631,1.023]	0.848	[0.683,1.054]
Patient or caretaker literacy (reference: Neither read nor write)				
Read only	0.588	[0.345,1.001]	0.651	[0.400,1.061]
Read and write	0.964	[0.787,1.181]	0.975	[0.807,1.179]
Patient or caretaker age	0.987*	[0.975,0.998]	0.985**	[0.975,0.996]
Health insurance coverage	0.986	[0.856,1.135]	0.948	[0.824,1.091]
Drug prescription during visit	1.520*	[1.082,2.137]	1.480*	[1.081,2.027]
Waiting time (reference: No waiting time)				
Up to 30 min	0.855	[0.571,1.280]	0.831	[0.571,1.210]
30-60 min	0.791	[0.518,1.207]	0.829	[0.562,1.224]
60-90 min	0.585	[0.329,1.041]	0.596*	[0.356,0.998]
90-120 min	0.599*	[0.392,0.915]	0.651*	[0.438,0.967]
120-180 min	0.523**	[0.337,0.813]	0.587*	[0.390,0.882]
180-240 min	0.376***	[0.233,0.607]	0.442***	[0.280,0.697]
More than 240 min	0.377***	[0.237,0.599]	0.372***	[0.241,0.574]
Patient type: sick child	0.192***	[0.125,0.295]	0.234***	[0.160,0.343]
Patient charged for visit	0.661*	[0.465,0.939]	0.745	[0.544,1.020]
Provider gender: female	1.113	[0.863,1.434]	1.087	[0.889,1.331]
Provider tenure at facility	1.002	[0.988,1.016]	1.001	[0.988,1.014]
Provider qualification (reference: Medical Doctor)				
Medical/Clinical officer	1.814	[0.940,3.501]	1.594*	[1.083,2.346]
Nurse	2.487*	[1.224,5.054]	2.155***	[1.368,3.397]
Assistant	2.238*	[1.014,4.941]	1.968*	[1.132,3.420]
Provider manager or in-charge of unit	1.048	[0.822,1.335]	1.030	[0.842,1.259]
Number of OPD visits last month at the health facility (reference: 0-200 visits)				
200 – 400 visits	1.107	[0.799,1.532]	1.109	[0.813,1.512]
400 – 600 visits	1.178	[0.813,1.709]	1.150	[0.817,1.619]
600 – 800 visits	0.926	[0.569,1.508]	1.003	[0.643,1.565]
More than 800 visits	1.130	[0.775,1.649]	1.163	[0.812,1.665]
Type of health facility (reference: Dispensary)				
Hospital (any level)	0.697	[0.404,1.201]	0.714	[0.451,1.132]
Health center	0.658*	[0.462,0.937]	0.713*	[0.525,0.970]
Frequency of management meetings at the health facility in the last 6 months (reference: Never)				
Once	1.047	[0.579,1.893]	0.941	[0.532,1.664]
More than once	1.038	[0.738,1.459]	1.011	[0.762,1.342]
Frequency of meetings with the community at the health facility in the last 6 months (reference: Never)				
Once	1.023	[0.689,1.519]	1.050	[0.755,1.461]
More than once	1.344*	[1.054,1.714]	1.250	[0.991,1.577]
Last external supervision at the health facility (reference: Never)				
More than 6 months ago	1.469	[0.363,5.951]	1.651	[0.682,3.998]
Within past 6 months	1.179	[0.343,4.057]	1.112	[0.507,2.439]
Days of work supervision to the provider	0.990	[0.945,1.038]	0.991	[0.952,1.033]
Monetary incentives to provider				
Salary top-up	1.159	[0.909,1.479]	1.158	[0.916,1.462]
Per diem when training	0.827	[0.643,1.065]	0.862	[0.689,1.077]
Duty allowance	1.013	[0.808,1.270]	1.016	[0.834,1.238]
Payment for extra activities	1.299	[0.925,1.822]	1.244	[0.884,1.753]
On-call allowance	0.979	[0.767,1.248]	1.038	[0.838,1.285]
Housing allowance	1.592	[0.828,3.059]	1.357	[0.736,2.502]
Non-monetary incentives to provider				
Uniform/caps/backpack	0.988	[0.787,1.241]	0.988	[0.813,1.202]
Training	1.020	[0.745,1.397]	1.090	[0.822,1.447]
Subsidized housing	1.418*	[1.071,1.879]	1.395*	[1.049,1.854]
Time off/ holidays	0.705	[0.495,1.005]	0.796	[0.555,1.141]
N	4970		4970	
Log-likelihood	-2710.0		-2793.6	
LR chi2	278.8		259.1	
Prob > chi2	1.11e-34		4.14e-31	
Number of iterations	5		4	

Exponentiated coefficients; *t* statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table SM4: Regression on IMCI compliance for sample without hospitals.

Three levels ordered logit	*Sample without hospitals*	
	OR	95% CI
Rural area	1.267	[0.633,2.539]
Results-based financing	0.877	[0.165,4.649]
Health Services Index	1.044	[0.934,1.166]
Any patient feedback mechanism	1.071	[0.672,1.707]
Caretaker literacy (reference: Neither read nor write)		
Read only	0.544	[0.232,1.277]
Read and write	0.883	[0.640,1.218]
Caretaker relationship with patient (reference: Mother)		
Father	1.018	[0.461,2.249]
Sibling	2.298	[0.771,6.852]
Other	1.124	[0.553,2.286]
Patient gender: Female	0.885	[0.673,1.163]
Patient age	0.840**	[0.746,0.945]
Health insurance coverage	0.923	[0.622,1.370]
Diagnosis (reference: Ear problem)		
Respiratory problem	0.229***	[0.146,0.358]
Digestive system	1.584*	[1.018,2.464]
Malaria	2.284***	[1.508,3.458]
Fever	0.949	[0.604,1.492]
Patient charged for visit	0.607	[0.287,1.286]
Provider gender: female	1.131	[0.708,1.809]
Provider tenure at facility	1.016	[0.981,1.052]
Provider qualification (reference: Medical Doctor)		
Medical/Clinical officer	0.514	[0.0549,4.814]
Nurse	0.278	[0.0280,2.765]
Assistant	0.241	[0.0217,2.682]
Provider manager or in-charge of unit	1.228	[0.741,2.033]
Facility has IMCI guidelines	1.602	[0.947,2.709]
Number of OPD visits during the last month (reference: 0-200 visits)		
200 – 400 visits	1.441	[0.797,2.605]
400 – 600 visits	0.985	[0.486,1.996]
600 – 800 visits	0.925	[0.361,2.367]
More than 800 visits	0.912	[0.401,2.074]
Type of health facility (reference: Dispensary)		
Health center	0.699	[0.354,1.383]
Frequency of management meetings		
at the health facility in the last 6 months (reference: Never)		
Once	0.634	[0.224,1.792]
More than once	1.225	[0.673,2.228]
Frequency of meetings with the community		
at the health facility in the last 6 months (reference: Never)		
Once	1.328	[0.579,3.042]
More than once	1.144	[0.697,1.876]
Last external supervision at the health facility (reference: Never)		
More than 6 months ago	0.187	[0.0104,3.376]
Within past 6 months	0.290	[0.0221,3.811]
Days of work supervision to the provider	1.058	[0.968,1.157]
Monetary incentives to provider		
Salary top-up	1.869*	[1.104,3.165]
Per diem when training	0.985	[0.596,1.628]
Duty allowance	1.044	[0.649,1.677]
Payment for extra activities	1.403	[0.688,2.862]
On-call allowance	1.141	[0.687,1.893]
Housing allowance	3.219	[0.860,12.05]
Non-monetary incentives to provider		
Uniform/caps/backpack	1.227	[0.756,1.993]
Training	1.072	[0.554,2.074]
Subsidized housing	1.337	[0.821,2.180]
Time off / holidays	1.102	[0.501,2.424]
N	1255	
Log-likelihood	-1359.6	
LR chi2	145.4	
Prob > chi2	3.00e-12	
Number of iterations	6	

Exponentiated coefficients; *t* statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table SM5: Regression on patient satisfaction for sample without hospitals.

Three levels ordered logit	*Sample without hospitals*	
	OR	95% CI
Rural area	1.187	[0.802,1.757]
Results-based financing	0.403	[0.150,1.078]
Health Services Index	1.042	[0.977,1.111]
Any patient feedback mechanism	0.834	[0.635,1.096]
Patient or caretaker literacy		
(reference: Neither read nor write)		
Read only	0.533*	[0.304,0.936]
Read and write	0.922	[0.737,1.154]
Patient or caretaker age	0.991	[0.978,1.004]
Health insurance coverage	0.997	[0.860,1.157]
Drug prescription during visit	1.780**	[1.179,2.689]
Waiting time (reference: No waiting time)		
Up to 30 min	1.084	[0.690,1.702]
30-60 min	0.983	[0.612,1.578]
60-90 min	0.614	[0.317,1.190]
90-120 min	0.642	[0.400,1.029]
120-180 min	0.560*	[0.341,0.919]
180-240 min	0.432**	[0.246,0.757]
More than 240 min	0.467**	[0.278,0.783]
Patient type: sick child	0.224***	[0.139,0.361]
Patient charged for visit	0.658	[0.432,1.003]
Provider gender: female	1.120	[0.836,1.500]
Provider tenure at facility	1.011	[0.993,1.030]
Provider qualification (reference: Medical Doctor)		
Medical/Clinical officer	1.919	[0.454,8.118]
Nurse	2.279	[0.518,10.02]
Assistant	1.871	[0.405,8.639]
Provider manager or in-charge of unit	0.905	[0.686,1.192]
Number of OPD visits last month at the health facility		
(reference: 0-200 visits)		
200 – 400 visits	1.065	[0.753,1.506]
400 – 600 visits	1.192	[0.797,1.782]
600 – 800 visits	0.970	[0.569,1.653]
More than 800 visits	1.258	[0.800,1.978]
Type of health facility (reference: Dispensary)		
Health center	0.578**	[0.389,0.859]
Frequency of management meetings at the health facility		
in the last 6 months (reference: Never)		
Once	0.871	[0.472,1.607]
More than once	0.918	[0.640,1.317]
Frequency of meetings with the community at the health facility		
in the last 6 months (reference: Never)		
Once	1.157	[0.730,1.832]
More than once	1.302	[0.971,1.746]
Last external supervision at the health facility (reference: Never)		
More than 6 months ago	1.289	[0.283,5.880]
Within past 6 months	1.246	[0.327,4.746]
Days of work supervision to the provider	1.006	[0.953,1.061]
Monetary incentives to provider		
Salary top-up	1.601**	[1.169,2.193]
Per diem when training	0.702*	[0.528,0.933]
Duty allowance	1.034	[0.791,1.353]
Payment for extra activities	1.220	[0.825,1.804]
On-call allowance	0.939	[0.700,1.261]
Housing allowance	1.813	[0.864,3.801]
Non-monetary incentives to provider		
Uniform/caps/backpack	1.008	[0.766,1.328]
Training	1.232	[0.836,1.814]
Subsidized housing	1.603**	[1.181,2.175]
Time off/ holidays	0.561**	[0.366,0.861]
N	3846	
Log-likelihood	-2027.6	
LR chi2	185.3	
Prob > chi2	1.24e-18	
Number of iterations	5	
N	3846	

Exponentiated coefficients; *t* statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table SM6: Cross-correlation table (Spearman's rho) for incentive indicators in the samples used in the analysis. Source: author's own elaboration on DHS SPA 2014/2015 data.

IMCI analysis

Variable N = 1'583	Salary top-up	Per diem when training	Duty allow.	Payment for extra activities	On-call allow.	Housing allow.	Uniform/ caps/…	Training	Subsid. housing	Time off/ holidays
Salary top-up	1									
Per diem when training	0.0231	1								
Duty allowance	-0.1266*	0.0072	1							
Payment for extra activities	-0.1273*	0.0363	-0.0299	1						
On-call allowance	-0.02	-0.0302	0.0388	-0.1200*	1					
Housing allowance	-0.0357	0.0248	0.0036	0.0028	0.0363	1				
Uniform/caps/backpack	0.0475	-0.0513*	0.0618*	-0.0819*	0.2185*	0.1095*	1			
Training	0.0700*	0.3487*	0.0527*	-0.0469	0.0283	-0.0018	0.035	1		
Subsidized housing	0.0317	0.002	0.0722*	0.0513*	0.1184*	-0.0579*	0.0467	0.0041	1	
Time off/ holidays	0.0473	0.0726*	0.0051	0.0477	0.0998*	-0.0513*	0.1108*	0.1578*	0.0641*	1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Patient satisfaction analysis

Variable N = 4'970	Salary top-up	Per diem when training	Duty allow.	Payment for extra activities	On-call allow.	Housing allow.	Uniform/ caps/…	Training	Subsid. housing	Time off/ holidays
Salary top-up	1									
Per diem when training	0.0076	1								
Duty allowance	-0.1030*	-0.0024	1							
Payment for extra activities	-0.1404*	0.0407*	-0.0291*	1						
On-call allowance	-0.0535*	0.0005	0.0404*	-0.0766*	1					
Housing allowance	0.0098	0.0132	0.0516*	0.0169	0.0573*	1				
Uniform/caps/backpack	-0.0159	0.0173	0.1142*	0.0128	0.0881*	0.0662*	1			
Training	0.0631*	0.3305*	0.0726*	-0.0535*	0.0564*	-0.0223	0.0398*	1		
Subsidized housing	0.0156	-0.007	0.0464*	0.0322*	0.1330*	-0.0117	0.0238	-0.0113	1	
Time off/ holidays	0.0300*	0.1205*	-0.0179	0.0331*	0.0719*	0.0017	0.0961*	0.1540*	0.0626*	1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

B Appendix to part IV

Online appendix

to the paper “Impact of social accountability monitoring on health facility performance: Evidence from Tanzania”

Version 03/12/2020

A.1 Availability of essential medicines in Tanzania: evidence and health reforms over the period 2008-2020

A health facility survey conducted at the national scale in 2006 found that two thirds of government managed health facilities could not abide to the treatment protocol for malaria as a result of shortage of medicines (Ministry of Health, 2007). More recent surveys conducted in 2012 and 2014/2015 essentially confirmed the earlier figures, revealing full availability in less than half public health facilities (Ministry of Health and Social Welfare and Ifakara Health Institute 2013; Ministry of Health and Social Welfare [MoHSW] and National Bureau of Statistics [NBS], 2015). Specific data for the Tanzanian Region of Dodoma revealed that in 2011 the availability of 24 tracer medicines in public health facilities was as low as 53% (Wiedenmayer et al. 2019). A major driver of stockouts at health facilities in Tanzania appears to be the main public supply-chain managed by the central Medical Store Department (MSD). The MSD is responsible for pooling orders, procuring medicines through public tender procedures and delivering drugs to districts through a central warehouse and several zonal stores, including one in Dodoma city for the entire region (White et al. 2013). The ordering procedure for medicines required facility staff to forecast needs and file drug orders to MSD. Besides inherent inefficiencies and poor management, MSD suffers severe underfunding and complex interactions with vertical programs for the delivery of different classes of drugs, including antiretroviral drugs, reproductive health drugs and commodities, antimalarials and vaccines (White et al. 2013). In the case of MSD shortages, each district authority could purchase complementary medicine supplies from different private providers without specific public tender procedures. The resulting system was bureaucratic, expensive and more exposed to corruption (Wiedenmayer et al. 2019). Furthermore, rural districts showed a very limited availability of wholesale drug stores (Wiedenmayer et al. 2019). The system also added a considerable burden on already overwhelmed clinicians at health facilities, often resulting in order procedures being severely delayed or incomplete (White et al. 2013; Wiedenmayer 2017; Wiedenmayer et al. 2019). Below we discuss a series of specific reforms adopted by the Government of Tanzania over the last decades to increase the availability of essential medicines (Mujinja and Kida 2014).

Health reforms implemented since 2008

1. a shift from a “push” delivery system of predetermined kits to a “pull” system based on local needs through an Integrated Logistic System (ILS) managed by the Ministry of Health; (2) greater coordination across institutions through a sector-wide approach with technical working groups involving stakeholders;
2. increased monitoring and data collection;
3. improved budgeting and procurement processes;
4. improved prescription practices and rational use of essential medicines;
5. decentralization of management to local government authorities for increased ownership and better prioritization of local needs.
6. Accredited Drug Dispensing Outlets (ADDOs) were piloted since 2003 and gradually rolled out across the country since 2008. Building on the high share of self-medication across the population, the policy primarily aimed at extending direct access to drugs through accredited shops supposed to attain given quality standards (Rutta et al., 2015). These stores are neither meant nor prepared to complement stocks of drugs for health facilities in case of stockouts. Instead, the latter appear to refer patients to ADDOs when out of stock for given classes of medicines. Unfortunately, despite good intentions in the policy, ADDOs rarely refer patients to health facilities for complicated conditions, possibly with negative consequences for patients' health and households' financial situation (Embrey et al., 2016).
7. another notable option are complementary supply-chains to fill the capacity gap of the public system, such as the Prime Vendor system described below (Musau et al., 2011; Wales et al., 2014; White et al., 2013; Wiedenmayer et al., 2019).

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A.2 Detailed steps of the Sikika SAM process

1. Identification of salient issues and analysis of relevant documents to prepare site visits at Health Facilities. Documents analysed include district strategic plans, comprehensive council health plans that include budget allocations (for infrastructure, medicines, human resources, etc.), implementation plans in the domain of health and healthcare as well as internal audit reports;
2. Based on the issues identified, SAM teams visit a sample of health facilities across the district to assess the situation, in terms of infrastructure investments and maintenance, disbursement and utilization of funds, availability of medicines, human resources, management capacity and functioning of HFGC;
3. After site visits, analysis and reporting to Council Health Management Team (CHMT) with preliminary results and questions (feedback typically due within 1 week);
4. Internal SAM team meetings to discuss questions and answers emerging from the reporting. The SAM team discusses issues and evidence collected across the district, looking for an agreement on improvements needed;
5. Meeting with district stakeholders to discuss results of SAM;
6. Community meetings to discuss results of SAM, presenting issues identified and responses received from district authorities to citizens, community representatives and health workers, looking for a consensus about the issues;
7. Definition of a monitoring strategy for the next years. Citizens and monitors are engaged, taking into account their respective capacity. CHMT updated on the progress;
8. Meetings between monitors and SAM teams on a monthly basis. Regular updates to the community about progress;
9. Participation in planning and budget allocation with district authorities.

A.3 Composition of control and treatment groups across districts over time

Baseline (Pre)				
	Dispensary	Health centre	District hospital	Total
	(*count and %*)	(*count and %*)	(*count and %*)	(*count and %*)
Control	124	19	3	146
	84.93	13.01	2.05	100.00
Treatment	54	3	2	59
	91.53	5.08	3.39	100.00
Total	178	22	5	205
	86.83	10.73	2.44	100.00

Endline (Post)				
	Dispensary	Health centre	District hospital	Total
	(*count and %*)	(*count and %*)	(*count and %*)	(*count and %*)
Control	72	8	3	83
	86.75	9.64	3.61	100.00
Treatment	24	3	2	29
	82.76	10.34	6.90	100.00
Total	96	11	5	112
	85.71	9.82	4.46	100.00

A.4 Overview of drugs considered in the analysis and composition of sub-groups

Drug type	**Main indication**	**Sub-group**			
		Antimalarials	Antibiotics	Reproductive health	Other essential drugs and vaccines
Artemether/lumefantrine	Antimalarial	Yes	-	-	-
Quinine	Antimalarial	Yes	-	-	-
Amoxicillin 250mg caps	Antibiotic	-	Yes	-	-
Amoxicillin syrup	Antibiotic	-	Yes	-	-
Benzyl Penicilling 5MU inj.	Antibiotic	-	Yes	-	-
Metronidazole tabs	Antibiotic	-	Yes	-	-
Medroxyprogesterone inj.	Contraceptive	-	-	Yes	-
Oxytocin	Contraceptive	-	-	Yes	-
Iron and folic acid	Anemia	-	-	Yes	-
Condoms	Contraceptive	-	-	Yes	-
ORS sachet	Diarrhea	-	-	-	Yes
Paracetamol 500mg tabs	Fever and pain	-	-	-	Yes
Vaccines	Immunization	-	-	-	Yes
Maximum days of stockout	1170	180	360	360	270
Number of items	13	2	4	4	3

A.5 Infrastructure maintenance of medicines storage and dispensing areas

The following questions were asked as part of all facility assessments for infrastructure maintenance (storage room and the dispensing area) conducted at baseline and endline. The range of allowed answers was limited to “Yes” or “No”. Source: University Consultancy Bureau (2018).

1. There is a method in place to control temperature (e.g. roof and ceiling with space between them, air conditioners, fans etc)
2. There are windows that can be opened or there are air vents
3. Direct sunlight cannot enter the area (e.g. window panes are painted or there are curtains/blinds to protect against the sun)
4. Area is free of moisture (e.g. leaking ceiling, roof, drains, taps etc)
5. There is a cold storage in the facility
6. There is a regularly filled temperature chart for the cold storage
7. Medicines are not stored directly on the floor
8. Medicines are stored in a systematic way (e.g. alphabetical, pharmacological etc)
9. Medicines are stored first-expiry-first-out (FEFO)
10. There is no evidence of pest in the area
11. Tablet/capsules are not manipulated by naked hand
12. There are security measures to avoid burglary
13. Ledgers are up to date and complete
14. Storage equipment is adequate (shelves, pellets, etc)
15. Adequate storage space is available for drugs and medical supplies
16. Dispensing bags for medicines are available

A.6 Data sources for control variables

Variable	Level	Source of data	Years
Active HF committee (Yes/No)	Health facility	HPSS base- and endline surveys	2011,2017
Urban area (Yes/No)	Health facility	HPSS	2011, 2017
Share of exempted patients	Health facility	HPSS	2011, 2017
Quarterly supervision on medicine management	Health facility	HPSS	2011, 2017
Fulfilment of last MSD order	Health facility	HPSS	2011, 2017
Facility with staff trained on maintenance	Health facility	HPSS	2011, 2017
Average yearly rainfall (attributed from closest cluster)	Health facility	AIS 2007 and MIS 2017 companion data	2011, 2017
Distance from MSD store (km)	Health facility	GIS Open data Esri and NBS	2011, 2017
District population (Number)	District	Annual Health Statistics, MoHSW	2011, 2017
Share of pop. wealth index Q1/Q5	District	Twaweza Uwezo Surveyss	2011, 2017
Health facility density (per 100'000)	District	Annual Health Statistics, MoHSW	2011, 2017
Nr. of OPD visits (Number)	District	Annual Health Statistics, MoHSW	2011, 2017
District funds disbursed by CHF (TZS)	District	HPSS reports	2011,2017
Health insurance coverage	Household	DHS 2010 and DHS 2011	2010, 2011
Participants reporting medical injection	Households	AIS 2007 and AIS 2011	2007, 2011
Children sleeping under bednet	Household	DHS 2010 and DHS 2011	2010, 2011
Health facility delivery	Household	DHS 2010	2010
Children birthweight	Household	DHS 2010	2010
Anemic children	Household	DHS 2010	2010
Children vaccination	Household	DHS 2010	2010

Notes: (1) Cluster characteristics are matched with health facility based on shortest distance, using QGIS software for spatial analysis. (2) Annual Health Statistics produced by National Bureau of Statistics (NBS) and Ministry of Health and Social Welfare (MoHSW) of Tanzania. As of 2019, the name changed to Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC). (3) Distance from MSD store computed using GIS Open Data produced by Esri Eastern Africa using QGIS software for spatial analysis.

A.7 Matching synthetic controls based on Mahalanobis distance

Matching procedure steps:

1. Generate availability variable for drugs in table 4 for data from SARA 2012 and SPA 2014 surveys, pool the new data with original HPSS survey data (2011 and 2017 waves). The full resulting sample includes 1'720 data points.
2. Exclude facilities located in other districts which experienced Sikika's SAM programme after 2012 (Iramba, Simanjiro, Kilolo, Kilwa, Kibaha, Singida DC, Lindi Urban, Kigoma, Temeke, Ilala, Kinondoni) and the two regions where HPSS was extended since 2015 (Morogoro and Shinyanga). The resulting data include 1'608 datapoints, 785 pre-treatment and 823 post-treatment.
3. Compute district averages across the remaining data for the control variables considered in the analysis: outcome variable, share of facilities in urban areas, district population, malaria prevalence and share of people in lowest and highest wealth index quintile
4. Compute Mahalanobis distance between all potential control districts and the two treatment districts, separately. Given the vector of district averages of n covariates for the control district i which is given by $\overline{x_i^C} = (\bar{x}_{i,1}, \bar{x}_{i,2}, \dots, \bar{x}_{i,n})$ and an analogous vector for treatment district $d \in (\mathrm{Kondoa}, \mathrm{Mpwapwa})$, that is $\overline{x_d^T} = (\bar{x}_{d,1}, \bar{x}_{d,2}, \dots, \bar{x}_{d,n})$ and a covariance matrix Ω, the Mahalanobis distance is defined as

$$M_{i,d} = \sqrt{\left(\overline{x_i^C} - \overline{x_d^T}\right)^T \Omega^{-1} \left(\overline{x_i^C} - \overline{x_d^T}\right)}$$

5. Accordingly, the Mahalanobis distance equals 0 for two identical vectors.

Based on the values obtained for $M_{i,d}$, we selected the 10 districts with smaller distance. The selected synthetic controls are: Kilosa, Bagamoyo, Kasulu Urban, Uyui, Singida, Sumbawanga, Ulanga, Musoma Rural, Kasulu and Kahama.

A.8 Simulated power calculation results

Baseline descriptive statistics for outcome variables:

	N	Mean	Std. Dev.
All drugs (days out of stock)	91	215.04	146.76

Endline descriptive statistics for outcome variables in control group:

	N	Mean	Std. Dev.
All drugs (days out of stock)	66	153.73	98.32

We simulated endline data using a simple $AR(1)$ data generating process:

$$y_{i,d,t} = y_{i,d,t-1} + \epsilon_i \sim N(\mu, \sigma)$$

where $d \in D$ is an index for the district and t indicates the period ($Pre = 0$ and $Post = 1$) for health facility i.

Summary of 1000 random draws from our simulated data generating process, in absence of treatment:

	N	Average Mean	Average Std. Dev.	Distribution parameters μ, σ
All drugs (days out of stock)	1000	153.54	98.91	149,108

Below we report the probability of detecting significant effects ($\alpha = 0.05$) in simple regressions for 1000 random draws of the DGP above, given the effect size (absolute and relative to baseline standard deviation). The estimated regression was:

$$y_{i,d,t} = \beta_0 + \beta_1 * Post + \beta_2 * Treatment + \delta * Post \times Treatment$$

where $Treatment = 1$ for facilities in Mpwapwa and Kondoa districts. Significance of the treatment coefficient was assessed using wild cluster bootstrapping to account for the small number of clusters.

Simulated power calculation:

	Effect	Effect size	Power
All drugs (days out of stock)	73	0.50	81.7%
All drugs (days out of stock)	95	0.65	91.2%

A.9 Full results for main models

A.9.1 Drug stockout days, no HPSS process variable

	(1) Antibiotics	(2) Antimalarials	(3) Other drugs & vaccines	(4) Reproductive health	(5) All drugs
Post X Treatment group	-118.1***	-1.371	-76.31***	-70.36**	-266.2**
	(30.40)	(29.34)	(15.74)	(25.18)	(80.25)
Post	33.10	-61.30***	-42.96***	12.47	-58.70
	(37.70)	(10.93)	(3.539)	(12.52)	(32.86)
Health centre	6.861	-35.56	27.74	71.32***	70.37
	(19.07)	(25.93)	(32.57)	(14.33)	(40.18)
Facility has active HF committee	-6.145	-35.98***	-12.88	-45.33	-100.3*
	(21.93)	(6.890)	(9.333)	(30.90)	(51.45)
Urban area	-18.85	-19.44*	-2.722	17.54*	-23.48
	(24.33)	(9.170)	(3.692)	(8.287)	(35.79)
Average yearly rainfall	-0.336*	0.00659	-0.100	-0.00890	-0.438
	(0.153)	(0.146)	(0.0887)	(0.123)	(0.392)
Pop. share in lowest wealth quintile	-1.863	-2.802	-7.006***	-2.805	-14.48*
	(3.410)	(1.872)	(1.120)	(2.062)	(6.599)
District health facility density	-13.47	-37.49***	-14.39**	0.454	-64.89
	(19.71)	(8.151)	(5.376)	(13.08)	(33.49)
District number of OPD visits	-0.00077	0.0037***	0.0029***	-0.0031*	0.00277
	(0.004)	(0.0009)	(0.0007)	(0.0014)	(0.005)
District p.c. CHF funds (TZS)	-0.0750	0.0427**	0.127***	-0.0249	0.0695
	(0.0874)	(0.0169)	(0.0099)	(0.0285)	(0.0876)
Adjusted R^2	0.199	0.403	0.179	0.166	0.198
AIC	1863.3	1720.4	1708.9	1812.0	2126.9
BIC	1882.5	1739.6	1728.2	1831.2	2146.1
Observations	182	182	182	182	182

Estimates based on Fixed Effects (within) estimator. Cluster robust standard errors in parentheses: * p < 0.1, ** p < 0.05, *** p < 0.01

A.9.2 Drug stockout days, with HPSS process variables

	(1) Antibiotics	(2) Antimalarials	(3) Other drugs & vaccines	(4) Reproductive health	(5) All drugs
Post X Treatment group	-118.0**	1.849	-73.87***	-60.79*	-250.9**
	(33.14)	(25.49)	(18.45)	(28.48)	(88.54)
Post	39.88	-60.19***	-38.15***	25.49	-32.98
	(38.03)	(14.46)	(2.930)	(14.12)	(35.34)
Health centre	10.14	-36.74	27.97	71.37***	72.74
	(20.93)	(26.43)	(31.79)	(14.32)	(38.92)
Facility has active HF committee	-9.698	-35.27***	-13.37	-46.73	-105.1*
	(19.66)	(6.994)	(8.361)	(29.28)	(44.72)
Urban area	-21.05	-17.32	0.0380	24.41*	-13.92
	(26.85)	(10.45)	(3.535)	(11.80)	(46.03)
Average yearly rainfall	-0.307	0.00334	-0.0959	0.00869	-0.391
	(0.163)	(0.129)	(0.0982)	(0.138)	(0.421)
Quarterly supervision on medicine supply	-17.31	-0.222	-7.738	-21.70**	-46.98*
	(9.287)	(13.23)	(8.006)	(7.323)	(23.78)
Pop. share in lowest wealth quintile	-2.069	-2.533	-6.769***	-2.065	-13.43
	(3.586)	(1.780)	(1.137)	(2.212)	(7.184)
District health facility density	-20.60	-36.09**	-15.47***	-2.543	-74.70
	(18.62)	(12.18)	(3.843)	(15.57)	(39.51)
District number of OPD visits	0.0000830	0.00373*	0.00310***	-0.00235	0.00456
	(0.00455)	(0.00161)	(0.000528)	(0.00167)	(0.00620)
District p.c. CHF funds (TZS)	-0.0829	0.0395*	0.119***	-0.0468	0.0289
	(0.0833)	(0.0180)	(0.0111)	(0.0274)	(0.0766)
Adjusted R^2	0.206	0.391	0.174	0.198	0.214
AIC	1831.6	1693.8	1680.8	1766.5	2086.9
BIC	1850.7	1712.9	1699.9	1785.7	2106.0
Observations	179	179	179	179	179

Estimates based on Fixed Effects (within) estimator. Cluster robust standard errors in parentheses: * p < 0.1, ** p < 0.05, *** p < 0.01

A.9.3 Infrastructure maintenance, no HPSS process variables

	(1) Cold storage (eg. fridge) is available [a)]	(2) Adequate furniture and equipment is available [a)]
Post X Treatment group	-0.393	-0.0813
	(0.290)	(0.0620)
Post	-0.533*	0.190*
	(0.221)	(0.0899)
Facility has active HF committee	0.214	-0.276
	(0.270)	(0.256)
Urban area	-0.319*	-0.173
	(0.131)	(0.145)
Health centre	-0.120	-0.0806
	(0.309)	(0.245)
Pop. share in lower wealth quintile	-0.0478	-0.0552***
	(0.0272)	(0.00574)
District health facility density	-0.172	-0.544***
	(0.141)	(0.0544)
District number of OPD visits	0.000113**	0.0000496***
	(0.0000309)	(0.00000623)
District p.c. CHF funds (TZS)	0.00337***	-0.000486*
	(0.000599)	(0.000215)
Adjusted R^2	0.479	0.207
AIC	-6.036	61.01
BIC	13.19	80.23
Observations	182	182

Estimates based on Fixed Effects (within) estimator. Cluster robust standard errors in parentheses: * p < 0.1, ** p < 0.05, *** p < 0.01

A.9.4 Infrastructure maintenance, with HPSS process variables

	(1) Cold storage (eg. fridge) is available [a)]	(2) Adequate furniture and equipment is available [a)]
Post X Treatment group	-0.384	-0.0360
	(0.295)	(0.0650)
Post	-0.567*	0.247**
	(0.256)	(0.0926)
Facility has active HF committee	0.240	-0.295
	(0.281)	(0.250)
Urban area	-0.281*	-0.185
	(0.126)	(0.143)
Health centre	-0.136	-0.0796
	(0.314)	(0.239)
Quarterly supervision on medicine supply	0.0951	-0.118
	(0.172)	(0.133)
Pop. share in lower wealth quintile	-0.0440	-0.0551***
	(0.0249)	(0.00492)
District health facility density	-0.116	-0.587***
	(0.102)	(0.0541)
District number of OPD visits	0.000103**	0.0000609***
	(0.0000286)	(0.00000576)
District p.c. CHF funds (TZS)	0.00338***	-0.000557**
	(0.000624)	(0.000187)
Adjusted R^2	0.473	0.218
AIC	-6.480	54.49
BIC	12.64	73.61
Observations	179	179

Estimates based on Fixed Effects (within) estimator. Cluster robust standard errors in parentheses: * p < 0.1, ** p < 0.05, *** p < 0.01

A.10 Tests on policy coefficient δ for analysis on drugs stockout days with alternative inference strategies

A.10.1 Without HPSS process variables

	DoF	*t* Statistic	P-value	P-value Inflation factor
Antibiotics Alternative t test	6.00	3.89	0.00	0.50
Antibiotics Wild cluster	6.00	2.67	0.02	1.97
Antibiotics Subcluster	90.00	1.70	0.03	3.46
Antimalarials Alternative t test	6.00	0.05	0.48	0.50
Antimalarials Wild cluster	6.00	0.03	0.97	1.00
Antimalarials Subcluster	90.00	0.03	0.97	1.01
Child care Alternative t test	6.00	4.85	0.00	0.50
Child care Wild cluster	6.00	3.34	0.02	7.35
Child care Subcluster	90.00	1.73	0.02	5.60
Reproductive health Alt t test	6.00	2.79	0.02	0.50
Reproductive health Wild cluster	6.00	1.92	0.09	2.93
Reproductive health Subcluster	90.00	1.16	0.11	3.35
All drugs Alternative t test	6.00	3.32	0.01	0.50
All drugs Wild cluster	6.00	2.28	0.05	3.74
All drugs Subcluster	90.00	1.72	0.02	1.37

Notes: (1) significance tests for estimated DID policy coefficients (δ ="Post × Treatment"). (2) Following Roodman, MacKinnon, Nielsen, and Webb (2018) – due to the strong assumption of asymptotic normality of coefficients required we do not provide the standard errors implied by the t statistics obtained under the wild clustered bootstrap approach.

A.10.2 Including HPSS process variables

	DoF	*t* Statistic	P-value	P-value Inflation factor
Antibiotics Alternative t test	6.00	3.56	0.01	0.50
Antibiotics Wild cluster	6.00	2.42	0.04	3.45
Antibiotics Subcluster	90.00	1.67	0.02	1.77
Antimalarials Alternative t test	6.00	0.07	0.47	0.50
Antimalarials Wild cluster	6.00	0.05	0.96	1.02
Antimalarials Subcluster	90.00	0.04	0.96	1.02
Child care Alternative t test	6.00	4.00	0.00	0.50
Child care Wild cluster	6.00	2.72	0.04	5.79
Child care Subcluster	90.00	1.62	0.02	3.39
Reproductive health Alt t test	6.00	2.13	0.04	0.50
Reproductive health Wild cluster	6.00	1.45	0.14	1.81
Reproductive health Subcluster	90.00	0.99	0.14	1.87
All drugs Alternative t test	6.00	2.83	0.01	0.50
All drugs Wild cluster	6.00	1.92	0.09	3.02
All drugs Subcluster	90.00	1.59	0.04	1.28

Notes: (1) significance tests for estimated DID policy coefficients (δ ="Post × Treatment"). (2) Following Roodman et al. (2018) – due to the strong assumption of asymptotic normality of coefficients required - we do not provide the standard errors implied by the t statistics obtained under the wild clustered bootstrap approach.

A.11 Tests on policy coefficient δ for analysis on infrastructure maintenance with alternative inference strategies

A.11.1 Without HPSS process variables

	DoF	*t* Statistic	P-value	P-value Inflation factor
Cold storage: Alternative t test	6.00	1.35	0.11	0.50
Cold storage:Wild cluster	6.00	0.93	0.87	3.86
Cold storage:Subcluster	90.00	1.26	0.10	0.42
Furniture/Equipment: Alt. t test	6.00	1.31	0.12	0.50
Furniture/Equipment:Wild cluster	6.00	0.91	0.27	1.12
Furniture/Equipment: Subcluster	90.00	0.23	0.72	3.01

Notes: (1) significance tests for estimated DID policy coefficients (δ ="Post × Treatment"). (2) Following Roodman et al. (2018) – due to the strong assumption of asymptotic normality of coefficients required - we do not provide the standard errors implied by the t statistics obtained under the wild clustered bootstrap approach.

A.11.2 Including HPSS process variables

	DoF	*t* Statistic	P-value	P-value Inflation factor
Cold storage: Alternative t test	6.00	1.30	0.12	0.50
Cold storage:Wild cluster	6.00	0.89	0.90	3.72
Cold storage:Subcluster	90.00	1.17	0.11	0.47
Furniture/Equipment: Alt. t test	6.00	0.55	0.30	0.50
Furniture/Equipment:Wild cluster	6.00	0.38	0.49	0.82
Furniture/Equipment: Subcluster	90.00	0.10	0.88	1.47

Notes: (1) significance tests for estimated DID policy coefficients (δ ="Post × Treatment"). (2) Following Roodman et al. (2018) – due to the strong assumption of asymptotic normality of coefficients required - we do not provide the standard errors implied by the t statistics obtained under the wild clustered bootstrap approach.

A.12 Full results for robustness checks

A.12.1 Lagged depended variable (LDV) only with facilities observed in both waves

	(1) Stockout days: All drugs	(2) Maintenance of storage area	(3) Maintenance of dispensing area
Post X Treatment group	-200.3***	0.390*	0.180
	(50.17)	(0.172)	(0.238)
Baseline stock-out days for all drugs	-0.0780	-0.0865	0.299**
	(0.0978)	(0.0935)	(0.0838)
Facility has active HF committee	-1.943	0.236	0.0532
	(19.77)	(0.124)	(0.419)
Urban area	-32.79*	-0.264*	-0.0749
	(15.78)	(0.128)	(0.162)
Average yearly rainfall	0.481*		
	(0.244)		
Health centre	-0.404	-0.0868	-0.186
	(15.92)	(0.0986)	(0.205)
District hospital	-78.80	0.156	-0.0742
	(52.58)	(0.128)	(0.320)
Distance from MSD store	109.1**		
	(36.65)		
Pop. share in lower wealth quintile	-5.602**	0.0368**	0.0128
	(1.848)	(0.0148)	(0.0200)
District health facility density	38.35***	0.0635	0.0344
	(7.227)	(0.0433)	(0.0496)
District number of OPD visits	-0.0453***	0.0000219	-0.0000155
	(0.0115)	(0.0000576)	(0.0000644)
District p.c. CHF funds (TZS)	-0.140	-0.00158	-0.00140
	(0.127)	(0.000878)	(0.000943)
Adjusted R^2	0.291	0.444	0.021
AIC	1064.5	20.64	131.2
BIC	1079.6	35.71	146.3
Observations	91	91	91

Estimates based on OLS estimator. Cluster robust standard errors in parentheses: * p < 0.1, ** p < 0.05, *** p < 0.01

A.12.2 Multilevel and OLS specification for variable drugs availability with matched control group for periods 2011-2014 (with no PVS) and 2011-2017 (full period, including PVS from end of 2014 on)

	(1) 2011-2014 No PVS		(2) 2011-2017 Full period	
Estimated model	Multilevel with random intercepts for district/regions	Pooled OLS	Multilevel with random intercepts for district/regions	Pooled OLS
Post X Treatment group	1.541**	1.235**	1.940***	1.740**
	(0.607)	(0.535)	(0.594)	(0.605)
Post	-0.0496	0.144	-0.0638	0.120
	(0.540)	(0.519)	(0.548)	(0.547)
Treatment	-0.717		-0.775	
	(0.733)		(0.723)	
Health Center	1.456***	1.432***	1.374***	1.343***
	(0.248)	(0.300)	(0.224)	(0.278)
Hospital	2.089***	1.980***	2.062***	1.956***
	(0.448)	(0.395)	(0.374)	(0.359)
Health facility density	0.0122	0.0865*	0.0111	0.0808
	(0.0352)	(0.0441)	(0.0358)	(0.0466)
District population	-0.00000162	0.00000402	-0.00000152	0.00000426
	(0.00000311)	(0.00000330)	(0.00000312)	(0.00000328)
Urban area	-7.905***	-10.04***	-8.147***	-9.924***
	(2.616)	(2.592)	(2.536)	(2.537)
Share of pop. in 1st wealth quintile	0.396	0.330	0.366	0.294
	(0.391)	(0.406)	(0.375)	(0.402)
Share of pop. in 5st wealth quintile	-1.280	1.293	-1.279	0.343
	(1.474)	(2.381)	(1.356)	(1.680)
	-1.728	-1.131	-2.261	-1.649
District fixed effect	No	Yes	No	Yes
Standard errors	Robust	Clustered at district level	Robust	Clustered at district level
AIC	1683.8		1788.8	
BIC	1716.1		1821.7	
Observations	421		450	

Estimates based on multilevel model with random intercept (districts and regions), estimated using Maximum Likelihood with Expectation-Maximization algorithm. Heteroscedasticity-robust standard errors in parentheses; * p < 0.1, ** p < 0.05, *** p < 0.01.

A.12.4 DID specification with alternative treatment and control group for pooled drug stockout days over period 2011-2017 only with facilities observed in both waves

	(1) Treatment with only Mpwapwa [a)]	(2) Treatment with only Kondoa [a)]	(3) Control without Dodoma [a)]
Post X Treatment group	-141.7**	-168.7***	-150.0**
	(40.81)	(31.20)	(40.30)
Treatment	131.6*	43.18	64.10*
	(59.14)	(27.92)	(30.20)
Post	-141.2***	-147.7***	-155.4***
	(25.00)	(19.46)	(31.87)
Facility has active HF committee	-54.39	14.58	-7.612
	(39.44)	(42.79)	(48.89)
Urban area	1.591	33.00	-6.409
	(21.33)	(26.85)	(16.38)
Average yearly rainfall	0.0115	0.242	0.0729
	(0.317)	(0.228)	(0.245)
Health centre	55.98*	27.94	53.66*
	(27.12)	(16.95)	(23.60)
District hospital	-140.6**	-30.17	-70.22
	(35.55)	(41.07)	(68.89)
Distance from MSD store	24.47	34.15	64.49**
	(25.96)	(32.51)	(22.56)
Pop. share in lower wealth quintile	-4.247	-1.296	-2.596
	(2.340)	(1.493)	(1.854)
District health facility density	-0.199	6.463	22.98**
	(16.35)	(14.73)	(6.388)
District number of OPD visits	-0.00211	-0.00301	-0.00565*
	(0.00286)	(0.00296)	(0.00260)
District p.c. CHF funds (TZS)	0.298**	0.269***	0.295**
	(0.0795)	(0.0659)	(0.0979)
Bootstrapped p-value [b)]	0.089*	0.035**	0.01**
Adjusted R^2	0.171	0.140	0.193
AIC	2052.5	1800.6	2093.1
BIC	2068.0	1815.6	2108.7
Observations	166	148	170
Control group districts	Bahi Chamwino, Chemba Dodoma Kongwa	Bahi Chamwino, Chemba Dodoma Kongwa	Bahi Chamwino, Chemba Kongwa
Treatment group districts	Mpwapwa	Kondoa	Kondoa Mpwapwa
Baseline average [e)]	212.14	194.35	221.45
Baseline standard dev. [e)]	151.69	126.88	148.26

Notes: [a)] The dependent variable for all models is the sum of stockout days computed over the 3 months (90 days) prior to the survey dates (September 2011 for baseline and May 2017 for endline) across all 13 drugs considered and listed in Table 4. [b)] Bootstrapped p-values referred to the wild cluster procedure. [c)] Sample includes all health facilities observed in both baseline (2011) and endline (2017) surveys. [d)] Control variables included: active health facility committee, urban/rural area, facility type, distance from Medical Stores Department (MSD) warehouse, average yearly rainfall, share of people in poorest and richest wealth index quintiles, density of health facilities in district, number of OPD visits in district, district per capita CHF funds disbursed to health facilities. [e)] Baseline average and standard deviation referred to the dependent variable for the sample of facilities for year 2011. [f)] Estimates based on pooled OLS estimator. Cluster robust standard errors in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

A.12.5 DID specification for two placebo outcomes over period 2011-2017 only with facilities observed in both waves

	(1) Share of exmpted patients at facility	(2) Share of U5 sleeping under ITN
Post X Treatment group	-1.354	-0.0302
	(1.477)	(0.0177)
Treatment	-0.983	0.0193**
	(0.702)	(0.00619)
Post	-7.611***	0.141***
	(0.956)	(0.00764)
Facility has active HF committee	0.976*	0.00359
	(0.516)	(0.00531)
Urban area	1.173**	-0.0109*
	(0.518)	(0.00540)
Average yearly rainfall	0.00826**	-0.000264***
	(0.00418)	(0.0000557)
Health centre	1.245**	-0.00543
	(0.600)	(0.00351)
District hospital	-0.788***	-0.00571
	(0.160)	(0.00389)
Distance from MSD store	0.462	-0.0541***
	(0.554)	(0.0125)
Pop. share in lower wealth quintile	-0.183***	-0.000146
	(0.0646)	(0.000500)
Pop. share in higher wealth quintile	0.127	0.00233
	(0.306)	(0.00211)
District health facility density	-0.0000937	-0.000000971
	(0.0000589)	(0.000000856)
District number of OPD visits	0.0132***	-0.0000887**
	(0.00311)	(0.0000347)
District p.c. CHF funds (TZS)		0.910
Bootstrapped p-value c)	0.31	0.26
Adjusted R^2	-	0.910
AIC	423.3	-924.6
BIC	441.8	-905.4
Observations	160	182
Baseline average f)	3.34	0.50
Baseline standard dev. f)	0.99	0.38

Notes: a) The variable "Share of patients exempted from payment at facility" is based on data from the HPSS base- and endline surveys (2011 and 2017). The indicator was coded to a scale ranging from 0 to 100 (percent exempted). Appendix A6 includes further details about data sources b) The variable "Share of children U5 sleeping under ITN" is based on data from the Aids Indicator Survey (AIS) 2011 as well as the Malaria Indicator Survey (MIS) 2017, respectively. Estimates are based on the DHS cluster spatially closest to the heath facility based on the facility and cluster geocordinates. c) Bootstrapped p-values are based on the wild cluster procedure. d) Sample includes all health facilities observed in both baseline (2011) and endline (2017) surveys. e) Control variables included are presence of an active health facility committee, urban/rural area, facility type, distance from Medical Stores Department (MSD) warehouse, share of people in poorest and richest wealth index quintiles, density of health facilities in district, number of outpatient visits in district, district per capita community health funds disbursed to health facilities. f) Baseline average and standard deviation are based on the 2011 survey. h) Estimates based on ordered logistic model for column (1) and pooled OLS for column (2), with cluster robust standard errors in parentheses. Cluster robust standard errors in parentheses: * p < 0.1, ** p < 0.05, *** p < 0.01

A.12.6 DID specification for indicator of fulfilment of last MSD order fulfilment (prior to survey)

	(1) Last MSD order cycle delivered fully on time
Post X Treatment group	0.999
	(0.682)
Treatment	2.641***
	(0.797)
Post	1.829
	(1.143)
Facility has active HF committee	0.828
	(1.662)
Urban area	-1.145*
	(0.605)
Average yearly rainfall	0.00204
	(0.00388)
Health centre	-0.170
	(0.432)
District hospital	0.535
	(1.084)
Distance from MSD store	-1.036
	(0.802)
Pop. share in lowest wealth quintile	0.0295
	(0.0600)
District health facility density	-1.577***
	(0.349)
District number of OPD visits	0.000228***
	(0.0000270)
District p.c. CHF funds (TZS)	-0.00334
	(0.00352)
Adjusted R^2	
AIC	182.9
BIC	202.1
Observations	182

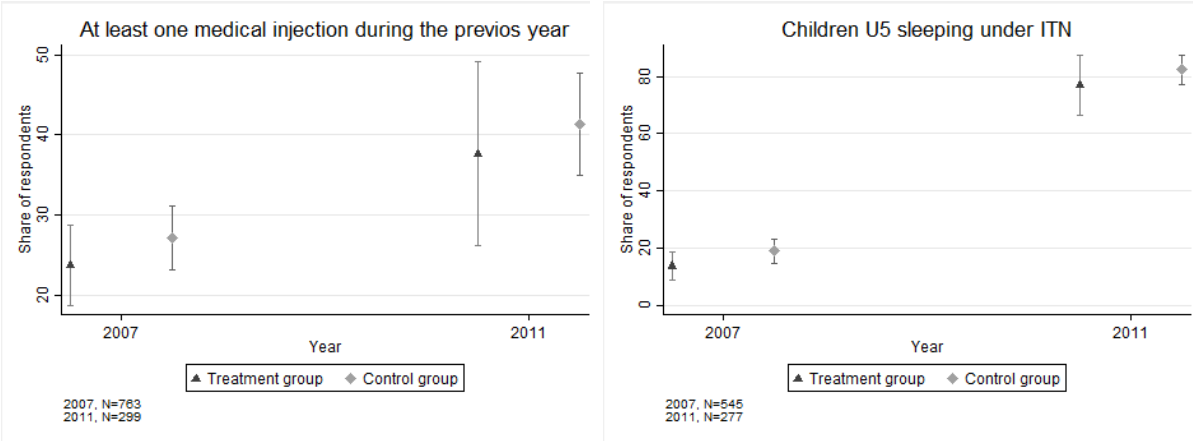
Estimates based on pooled OLS estimator. Cluster robust standard errors in parentheses: * p < 0.1, ** p < 0.05, *** p < 0.01

A.13 Parallel trends analysis

Difference in differences rests upon the parallel trends assumption. A way to assess this is testing for diverging pre-trends that may suggest violation of the hypothesis. However, our data do not allow for explicit testing of pre-trends. Thus, we rely on two specific indicators that should reflect health system efforts as well as general disease ecology.

The first indicator is the share of respondents in DHS AIS 2007 and 2011 surveys reporting a medical injection administered by a health worker. This indicator approximates – at least partially – the average utilization of drugs at health facilities across districts. The results are reported in the left box in figure below. The second indicator discussed is the share of children under five sleeping ITNs, still among DHS AIS 2007 and 2011 participating households. Under the National Treated Nets Programme (NATNETS), pregnant mothers in Tanzania can access discounted ITNs through vouchers distributed during the first visit to a Reproductive and Child Health clinic (Eze et al. 2014). The voucher scheme for ITNs targets pregnant mothers and their infants under five, the groups at higher risk from malaria. The scheme requires health facilities to obtain vouchers from district authorities, much like they obtain drug deliveries from the zonal MSD. The box on the right in figure below shows the results.

Figure: Share of participants reporting at least one medical injection and share of children sleeping under ITNs in 2007 and 2011 (pre-intervention)



Note: whiskers represent 95% confidence intervals. Source: DHS AIS (2007, 2011).

Data for the figures above were obtained from DHS surveys in 2007 and 2011. Although the DHS sampling framework is not designed to be representative at the district level, the data provide averages based on multiple random clusters of households in each district across the Dodoma region. Both boxes in the figure above show remarkably similar patterns in treatment and control areas, suggesting little difference in healthcare trends.

We remain cautious in interpreting the weak evidence emerging from these two figures. Firstly, we were only able to pool two pre-intervention observations, which do not provide much information about the trends in time. Secondly, if anything, the figures reveal something about trends in healthcare demand (medical injections) and health behaviours (ITN utilization), which requires assuming that these are indicative of healthcare utilization, including demand for drugs.

A.14 Qualitative evidence

In order to better grasp the mechanisms at work at the level of health facilities, we also analysed qualitative data collected in the two treatment districts of Kondoa and Mpwapwa. With the ethical approval from the Tanzanian National Institute for Medical Research, authorization from the local health authority in Dodoma and supported by HPSS team members, we purposely sampled 4 health facilities in each of the two districts where Sikika implemented the SAM intervention. Between May and July 2018, with the assistance of local facilitators and logistical support from the Ifakara Health Institute (IHI), we conducted focus group discussions with HFGCs and interviews with health facility staff in all the sampled facilities. With the consent of participants, all discussions were recorded and later transcribed in English by the facilitators.

The focus group discussions generally revealed positive feelings towards the SAM program. One participant expressed her/his sentiment about SAM as follows:
"SAM provides education about how to facilitate health services at their centres in district hospital meaning you should know the type of medicine that were bought, the money that was contributed to buy cars, maybe the seminars that were conducted about malaria or about promotion that concerns HIV issues, or about staffs who have been employed in the government post or nongovernmental dispensary. ... It builds one's capacity to talk with the health facility in charge so as he/she can know his/her rights." (HFGC member, Health Centre 1 in Kondoa District)

Facility staff also highlighted increased oversight of public facilities.
"For example if the civil servant has the habit of getting late at work SIKIKA teams make follow ups as they want to know why you are late, why expenditure doesn't go well." (Health facility staff, Health centre 2 in Kondoa District)
"They might want to see the stock of medicine. At some point they asked me to let them enter the stock medicine, at that time we had a worse situation, we didn't have the medicine and I lied that there is medicine. I felt very bad. It is an embarrassment." (Health facility staff, Health centre 3 in Kondoa District)

Further, the interviews suggested that SAM team members have been helpful in facilitating communication between health facility and district authorities:
".. they said they will bring it (the problem identified) to DMO [District Medical Officer, ed]. We were surprised, and sometimes we have been contacted by DMO in relation to those problems. Through their visits, questions, how they ask things, they lead to the improvement of the facility." (Health facility staff, Health centre 4, Kondoa District)

Interestingly, focus group participants and facility staff suggested potentially positive effects also on other domains targeted by Sikika's SAM program. In spite of the results from our quantitative analysis, one participant mentioned improvement in facility infrastructure:
"The other day they asked me to show them the maternity room; they asked where the dust bin was. And I responded to him we don't have places to bin the maternity waste. They complained a lot as a result of that act. We informed the in charge and they approved the budget to renovate and repair those things. There were some things which didn't have a priority but they make it a priority when they come." (Health facility staff, Health centre 4, Kondoa District)

During a focus group discussion, a HFGC member suggested that health facility budget ownership also benefited from Sikika's efforts:
"I should congratulate SIKIKA for their work in making sure that the budget came back to the health facility. The health facility budget was under district authority, but currently the budget is operated by the health facility itself, for instance in the case of buying medicine. In the past medicines were ordered by the district authority but currently the health facility committee works on that." (HFGC member, Health Centre 1 in Kondoa District)
Overall, qualitative data suggests that both health facility workers and the public appreciated the SAM program. The regular meetings appear to have resulted in increased feedback to facilities, and also may have increased both the direct social pressure from the community to perform well and indirect pressure through exchanges with the district office.

C Appendix to part V

A network analysis of patient referrals in two district health systems in Tanzania

Version 04.09.2020

A Online appendix

A.1 Health facility types and roles in the Tanzanian public sector

	Dispensary	Health centre	District referral hospital	Regional referral hospital
Number of public facilities across the country	~5200	~600	73 41 non-public designated	27
Level	Primary	Secondary	Tertiary	Tertiary
Refers patients to	Health centre in catchment area	District or regional referral hospitals	Regional referral or super specialized hospitals	National or super specialized hospitals
Suggested wards	1	3	7	9+
Suggested inpatient beds	-	20-30	100-175	176-450
Suggested number of staff	10-20	40-60	200-312	468-680
Most qualified cadres		Medical doctor	Specialized medical doctor (surgery)	Specialized medical doctors
Services covered	. OPD / Emergency . RCH clinic . Delivery . Community services . Laboratory	. OPD / Emergency . Eye care services . Primary oral health . RCH clinic . VCT service . CTC service . Home-based care . Community services . Laboratory . Mortuary . Pharmacy	. General medicine . Casualty and emergency . Surgery . Internal medicine . Obstetrics . Gynaecology . Physiotherapy . RCH clinic . Geriatric services . Nutrition . Oral health . Eye care services . Mental health . Laboratory . Radiology . Pharmacy . Nutrition	. General medicine . Casualty and emergency . Surgery . Internal medicine . Orthopaedic clinic . Obstetrics . Gynaecology . Physiotherapy . Paediatric . Dental clinic . CTC clinic . Ear, nose & throat clinic . RCH clinic . Geriatric services . Eye care services . Psychiatric clinic . TB ward . Intensive care unit . Sterilization . Laboratory . Mortuary . X-Ray . Pharmacy . Environmental health, food safety and sanitation

Source: Ministry of Health and Social Welfare. 2014. "Staffing Levels for Ministry of Health and Social Welfare Departments, Health Service Facilities, Health Training Institutions and Agencies 2014-2019." Dar es Salaam, Tanzania: United Republic of Tanzania.

The structure of public health service delivery in Tanzania is highly decentralized. The box summarizes facility types and roles as reflected by guidelines issued by the Tanzanian Ministry of Health. This pyramidal structure builds on a large number of dispensaries, facilities that cover catchment areas of about 6'000 to 10'000 people. According to official government guidelines, the most qualified cadres assigned to dispensaries are clinical officers and nurses. Staff is required to perform basic primary care procedures. At the secondary level, health centres cover about 50'000 people and are the first referral level from primary level facilities in their catchment areas, except for complicated

cases. Health centres are better equipped in terms of infrastructure and technology. Furthermore, health centres employ trained personnel including medical doctors, assistant medical officers, radiographer technologists, health laboratory and pharmaceutical technologists and assistant dental officers. The range of service providers is sensibly larger compared to dispensaries, as reflected by the box below. At the top of the structure, district and regional referral hospitals cover the full range of health services needed by the population, except for highly specialized care which is delegated to national and specialized referral hospitals. District and regional hospitals are the last referral point at the district and respectively regional level. They should receive referrals from secondary level facilities or – in rare complicated cases – directly from dispensaries.

A.2 Potential referral conditions addressed by the survey.

Area	**Description**
Childcare	
Emergency conditions	Issues related to triage and emergency conditions.
Diagnostic approaches	Specific issues related to the diagnosis of the condition affecting children.
Cough or difficulty breathing	Issues related to treatment of cough or difficulty breathing.
Diarrhoea	Issues related to treatment of diarrhoea.
Fever	Issues related to treatment of feverish conditions.
Severe acute malnutrition	Issues related to treatment of severe acute malnutrition.
Children with HIV/AIDS	Issues related to treatment of HIV/AIDS.
Surgical problems	Issues related to problems with surgical procedures.
Supportive care	Issues related oxygen therapy, choice of intravenous fluids and treatment of hypoglycaemia.
Non-communicable diseases	
Diabetes	Issues related to diabetes care.
Cancer	Issues related to treatment of any type of cancer.
Cardiovascular diseases	Issues related to treatment of cardiovascular diseases.
Chronic respiratory diseases	Issues related to treatment of any chronic respiratory disease.
Mental health conditions	Issues related to treatment of any mental health condition.

Note: the patient referral system was assessed in relation to clinical matters; referral related to pharmacology; advice related to clinical matter and advice related to pharmacology.

A.3 Survey questionnaire

Below we reproduce the paper version of the full questionnaire used during fieldwork between April and July 2018. The mention "*See list*" refers to the list of health facilities within the district/region. The data collection was performed using the ODK tablet version of the questionnaire.

Research title: Mapping patterns of district level health system governance network structure. Implications for social health protection, access to healthcare and health systems performance in Ghana and Tanzania

Section 1: Characteristics of the health facility

Q1	Name of the health facility	*See list*
Q2	Location (Village, Ward, District, Region)	
Q3	GPS coordinates	Latitude
		Longitude
Q4	Type	Dispensary □ Health center □ District hospital □ Regional hospital □
Q5	Total staff assigned	
Q6	Number of nurses	
Q7	Number of MDs	
Q8	Number of beds OPD	
Q9	Number of beds IPD	
Q10	Number of beds RCH clinic	
Q11	Does the facility store vaccines	Yes □ No □
Q12	Does the facility store other medicines?	Yes □ No □
Q13	Number of OPD visits last 3 months	
Q14	Number of IPD visits last 3 months	
Q15	Number of RCH clinic visits last 3 months	
Q16	Is there a private health facility close by (same village or ward)	No □ Yes □
Q16.1	Distance from private health facility	Up to 2 km □ From 3 to 10 km □ From 11 to 30 km □ More than 30 km □
Q17	Private pharmacy close by (same village or ward)	No □ Yes □
Q17.1	Distance from private pharmacy	Up to 2 km □ From 3 to 10 km □ From 11 to 30 km □ More than 30 km □
Q18	Is there a cascade supervision from higher level facility	No □ Yes □
Q18.1	What is the name of reference facility for cascade supervision	*See list*

Section 2: Relational data: child care services

Characteristics of the respondent

Q19	First Name and Last Name	
Q20	Date of birth	
Q21	Place of birth (Village, Ward, District, Region)	

Q22	Role in the facility / office	HF incharge ☐ MD ☐ Clinician ☐ Nurse ☐ Midwife ☐ Clinical assistant ☐ Other medical staff ☐ Administrative staff ☐ Department head ☐ Specify role: _____
Q23	For hospitals and health centers, in which department are you working?	
Q24	How long have you worked at this health facility?	Years _____ Months_____
Q25	Last highest educational title	
Q26	Place where last education was completed (District, Region)	
Q27	Number of nurses in the department	
Q28	Number of MDs in the department	
Q29	Number of beds OPD in the department	
Q30	Number of beds IPD in the department	
Q31	Number of beds RCH clinic in the department	
Q32	Is there any referral or advice given for clinical or pharmacological matters related to "**Emergency conditions**" of a sick child in the last 3 months? If yes, for the last event:	No ☐ Yes ☐
Q32.1	What was the type of interaction	Referral, clinical matter ☐ Referral, pharmacology ☐ Advice, clinical matter ☐ Advice, pharmacology ☐ Other (specify): _____
Q32.2	Which health facility / office? Select from the list.	*See list*
Q32.3	First and Last name of contact person	
Q32.4	Role of contact person in the facility / office	HF incharge ☐ MD ☐ Clinician ☐ Nurse ☐ Midwife ☐ Clinical assistant ☐ Other medical staff ☐ Administrative staff ☐ DMO office ☐ Specify role: _____
Q32.5	Relationship with the contact person	Only work-related ☐ Friend ☐ Family ☐ Former colleague ☐ Schoolmate ☐

Q32.6	How did you get in contact with the contact person	In person ☐ Phonecall ☐ Text message ☐ Email ☐ Regular mail ☐ Other (specify) _____ _____
Q32.7	How do you evaluate the success of the specific referral, on a scale from 1 to 4 where 1 is failure and 4 is complete success?	Failure Complete success ☐ 1 ☐ 2 ☐ 3 ☐ 4
Q33	Referral or advice for clinical or pharmacological matters related to "**Diagnostic approaches to sick child**" of a sick child in the last 3 months? If yes, for the last event:	No ☐ Yes ☐
Q33.1	Type of interaction	Referral, clinical matter ☐ Referral, pharmacology ☐ Advice, clinical matter ☐ Advice, pharmacology ☐ Other (specify): _____
Q33.2	Which health facility / office? Select from the list.	*See list*
Q33.3	First and Last name of contact person	
Q.33.4	Role of contact person in the facility / office	HF incharge ☐ MD ☐ Clinician ☐ Nurse ☐ Midwife ☐ Clinical assistant ☐ Other medical staff ☐ Administrative staff ☐ DMO office ☐ Specify role: _____
Q33.5	Relationship with the contact person	Only work-related ☐ Friend ☐ Family ☐ Former colleague ☐ Schoolmate ☐
Q33.6	How did you get in contact with the contact person	In person ☐ Phonecall ☐ Text message ☐ Email ☐ Regular mail ☐ Other (specify) _____ _____

Q33.7	How do you evaluate the success of the specific referral, on a scale from 1 to 4 where 1 is failure and 4 is complete success?	Failure Complete success ☐ 1 ☐ 2 ☐ 3 ☐ 4
Q34	Referral or advice for clinical or pharmacological matters related to "**Cough or difficulty in breathing**" of a sick child in the last 3 months? If yes, for the last event:	No ☐ Yes ☐
Q34.1	Type of interaction	Referral, clinical matter ☐ Referral, pharmacology ☐ Advice, clinical matter ☐ Advice, pharmacology ☐ Other (specify): _____
Q34.2	Which health facility / office? Select from the list.	*See list*
Q34.3	First and Last name of contact person	
Q34.4	Role of contact person in the facility / office	HF incharge ☐ MD ☐ Clinician ☐ Nurse ☐ Midwife ☐ Clinical assistant ☐ Other medical staff ☐ Administrative staff ☐ DMO office ☐ Specify role: _____
Q34.5	Relationship with the contact person	Only work-related ☐ Friend ☐ Family ☐ Former colleague ☐ Schoolmate ☐
Q34.6	How did you get in contact with the contact person	In person ☐ Phonecall ☐ Text message ☐ Email ☐ Regular mail ☐ Other (specify) _____ _____
Q34.7	How do you evaluate the success of the specific referral, on a scale from 1 to 4 where 1 is failure and 4 is complete success?	Failure Complete success ☐ 1 ☐ 2 ☐ 3 ☐ 4
Q35	Referral or advice for clinical or pharmacological matters related to "**Diarrhoea**" of a sick child in the last 3 months? If yes, for the last event:	No ☐ Yes ☐

Q35.1	Type of interaction	Referral, clinical matter ☐ Referral, pharmacology ☐ Advice, clinical matter ☐ Advice, pharmacology ☐ Other (specify): _____
Q35.2	Which health facility / office? Select from the list.	*See list*
Q35.3	First and Last name of contact person	
Q35.4	Role of contact person in the facility / office	HF incharge ☐ MD ☐ Clinician ☐ Nurse ☐ Midwife ☐ Clinical assistant ☐ Other medical staff ☐ Administrative staff ☐ DMO office ☐ Specify role: _____
Q35.5	Relationship with the contact person	Only work-related ☐ Friend ☐ Family ☐ Former colleague ☐ Schoolmate ☐
Q35.6	How did you get in contact with the contact person	In person ☐ Phonecall ☐ Text message ☐ Email ☐ Regular mail ☐ Other (specify) _____ _____
Q35.7	How do you evaluate the success of the specific referral, on a scale from 1 to 4 where 1 is failure and 4 is complete success?	Failure — Complete success ☐ 1 ☐ 2 ☐ 3 ☐ 4
Q36	Referral or advice for clinical or pharmacological matters related to "**Fever**" of a sick child in the last 3 months? If yes, for the last event:	No ☐ Yes ☐
Q36.1	Type of interaction	Referral, clinical matter ☐ Referral, pharmacology ☐ Advice, clinical matter ☐ Advice, pharmacology ☐ Other (specify): _____
Q36.2	Which health facility / office? Select from the list.	*See list*
Q36.3	First and Last name of contact person	

Q36.4	Role of contact person in the facility / office	HF incharge ☐ MD ☐ Clinician ☐ Nurse ☐ Midwife ☐ Clinical assistant ☐ Other medical staff ☐ Administrative staff ☐ DMO office ☐ Specify role: _____
Q36.5	Relationship with the contact person	Only work-related ☐ Friend ☐ Family ☐ Former colleague ☐ Schoolmate ☐
Q36.6	How did you get in contact with the contact person	In person ☐ Phonecall ☐ Text message ☐ Email ☐ Regular mail ☐ Other (specify) _____ _____
Q36.7	How do you evaluate the success of the specific referral, on a scale from 1 to 4 where 1 is failure and 4 is complete success?	Failure — Complete success ☐ 1 ☐ 2 ☐ 3 ☐ 4
Q37	Referral or advice for clinical or pharmacological matters related to "**Severe acute malnutrition**" of a sick child in the last 3 months? If yes, for the last event:	No ☐ Yes ☐
Q37.1	Type of interaction	Referral, clinical matter ☐ Referral, pharmacology ☐ Advice, clinical matter ☐ Advice, pharmacology ☐ Other (specify): _____
Q37.2	Which health facility / office? Select from the list.	*See list*
Q37.3	First and Last name of contact person	
Q37.4	Role of contact person in the facility / office	HF incharge ☐ MD ☐ Clinician ☐ Nurse ☐ Midwife ☐ Clinical assistant ☐ Other medical staff ☐ Administrative staff ☐ DMO office ☐ Specify role: _____

Q37.5	Relationship with the contact person	Only work-related ☐ Friend ☐ Family ☐ Former colleague ☐ Schoolmate ☐
Q37.6	How did you get in contact with the contact person	In person ☐ Phonecall ☐ Text message ☐ Email ☐ Regular mail ☐ Other (specify) _____ _____
Q37.7	How do you evaluate the success of the specific referral, on a scale from 1 to 4 where 1 is failure and 4 is complete success?	Failure — Complete success ☐ 1 ☐ 2 ☐ 3 ☐ 4
Q38	Referral or advice for clinical or pharmacological matters related to "**Children with HIV/AIDS**" in the last 3 months? If yes, for the last event:	No ☐ Yes ☐
Q38.1	Type of interaction	Referral, clinical matter ☐ Referral, pharmacology ☐ Advice, clinical matter ☐ Advice, pharmacology ☐ Other (specify): _____
Q38.2	Which health facility / office? Select from the list.	*See list*
Q38.3	First and Last name of contact person	
Q38.4	Role of contact person in the facility / office	HF incharge ☐ MD ☐ Clinician ☐ Nurse ☐ Midwife ☐ Clinical assistant ☐ Other medical staff ☐ Administrative staff ☐ DMO office ☐ Specify role: _____
Q38.5	Relationship with the contact person	Only work-related ☐ Friend ☐ Family ☐ Former colleague ☐ Schoolmate ☐
Q38.6	How did you get in contact with the contact person	In person ☐ Phonecall ☐ Text message ☐ Email ☐ Regular mail ☐ Other (specify) _____

Q38.7	How do you evaluate the success of the specific referral, on a scale from 1 to 4 where 1 is failure and 4 is complete success?	Failure — Complete success □ 1 □ 2 □ 3 □ 4
Q39	Referral or advice for clinical or pharmacological matters related to "**Surgical problems**" of a sick child in the last 3 months? If yes, for the last event:	No □ Yes □
Q39.1	Type of interaction	Referral, clinical matter □ Referral, pharmacology □ Advice, clinical matter □ Advice, pharmacology □ Other (specify): _____
Q39.2	Which health facility / office? Select from the list.	*See list*
Q39.3	First and Last name of contact person	
Q39.4	Role of contact person in the facility / office	HF incharge □ MD □ Clinician □ Nurse □ Midwife □ Clinical assistant □ Other medical staff □ Administrative staff □ DMO office □ Specify role: _____
Q39.5	Relationship with the contact person	Only work-related □ Friend □ Family □ Former colleague □ Schoolmate □
Q39.6	How did you get in contact with the contact person	In person □ Phonecall □ Text message □ Email □ Regular mail □ Other (specify) _____ _____
Q39.7	How do you evaluate the success of the specific referral, on a scale from 1 to 4 where 1 is failure and 4 is complete success?	Failure — Complete success □ 1 □ 2 □ 3 □ 4
Q40	Referral or advice for clinical or pharmacological matters related to "**Supportive care**" (e.g. nutritional management, breastfeeding, pain control) of a sick child in the last 3 months? If yes, for the last event:	No □ Yes □

Q40.1	Type of interaction	Referral, clinical matter ☐ Referral, pharmacology ☐ Advice, clinical matter ☐ Advice, pharmacology ☐ Other (specify): _____
Q40.2	Which health facility / office? Select from the list.	*See list*
Q40.3	First and Last name of contact person	
Q40.4	Role of contact person in the facility / office	HF incharge ☐ MD ☐ Clinician ☐ Nurse ☐ Midwife ☐ Clinical assistant ☐ Other medical staff ☐ Administrative staff ☐ DMO office ☐ Specify role: _____
Q40.5	Relationship with the contact person	Only work-related ☐ Friend ☐ Family ☐ Former colleague ☐ Schoolmate ☐
Q40.6	How did you get in contact with the contact person	In person ☐ Phonecall ☐ Text message ☐ Email ☐ Regular mail ☐ Other (specify) _____ _____
Q40.7	How do you evaluate the success of the specific referral, on a scale from 1 to 4 where 1 is failure and 4 is complete success?	Failure — Complete success ☐ 1 ☐ 2 ☐ 3 ☐ 4

Section 3: Relational data: care for chronic conditions

Characteristics of the respondent

Q41	First Name and Last Name	
Q42	Date of birth	
Q43	Place of birth (Village, Ward, District, Region)	
Q44	Role in the facility / office	HF incharge ☐ MD ☐ Clinician ☐ Nurse ☐ Midwife ☐ Clinical assistant ☐ Other medical staff ☐ Administrative staff ☐ Department head ☐ Specify role: _____
Q45	For hospitals and health centers, in which department are you working?	
Q46	How long have you worked at this health facility?	Years _____ Months_____
Q47	Last highest educational title	
Q48	Place where last education was completed (District, Region)	
Q49	Number of nurses in the department	
Q50	Number of MDs in the department	
Q51	Number of beds OPD in the department	
Q52	Referral or advice for clinical or pharmacological matters related to the diagnosis or treatment of a patient affected by "**Diabetes**" in the last 3 months? If yes, for the last event:	No ☐ Yes, diagnosis ☐ Yes, treatment ☐
Q52.1	Type of interaction	Referral, clinical matter ☐ Referral, pharmacology ☐ Advice, clinical matter ☐ Advice, pharmacology ☐ Other (specify): _____
Q52.2	Which health facility / office? Select from the list.	*See list*
Q52.3	First and Last name of contact person	
Q52.4	Role of contact person in the facility / office	HF incharge ☐ MD ☐ Clinician ☐ Nurse ☐ Midwife ☐ Clinical assistant ☐ Other medical staff ☐ Administrative staff ☐ DMO office ☐ Specify role: _____
Q52.5	Relationship with the contact person	Only work-related ☐ Friend ☐ Family ☐

		Former colleague ☐ Schoolmate ☐
Q52.6	How did you get in contact with the contact person	In person ☐ Phonecall ☐ Text message ☐ Email ☐ Regular mail ☐ Other (specify) _____ _____
Q52.7	How do you evaluate the success of the specific referral, on a scale from 1 to 4 where 1 is failure and 4 is complete success?	Failure — Complete success ☐ 1 ☐ 2 ☐ 3 ☐ 4
Q53	Referral or advice for clinical or pharmacological matters related to the diagnosis or treatment of a patient affected by "**Cancer**" in the last 3 months? If yes, for the last event:	No ☐ Yes, diagnosis ☐ Yes, treatment ☐
Q53.1	Type of interaction	Referral, clinical matter ☐ Referral, pharmacology ☐ Advice, clinical matter ☐ Advice, pharmacology ☐ Other (specify): _____
Q53.2	Which health facility / office? Select from the list.	*See list*
Q53.3	First and Last name of contact person	
Q53.4	Role of contact person in the facility / office	HF incharge ☐ MD ☐ Clinician ☐ Nurse ☐ Midwife ☐ Clinical assistant ☐ Other medical staff ☐ Administrative staff ☐ DMO office ☐ Specify role: _____
Q53.5	Relationship with the contact person	Only work-related ☐ Friend ☐ Family ☐ Former colleague ☐ Schoolmate ☐

Q53.6	How did you get in contact with the contact person	In person ☐ Phonecall ☐ Text message ☐ Email ☐ Instant messaging ☐ Regular mail ☐ Other (specify) _____ _____
Q53.7	How do you evaluate the success of the specific referral, on a scale from 1 to 4 where 1 is failure and 4 is complete success?	Failure — Complete success ☐ 1 ☐ 2 ☐ 3 ☐ 4
Q54	Referral or advice for clinical or pharmacological matters related to the diagnosis or treatment of a patient affected by a "**Cardiovascular disease**" in the last 3 months? If yes, for the last event:	No ☐ Yes, diagnosis ☐ Yes, treatment ☐
Q54.1	Type of interaction	Referral, clinical matter ☐ Referral, pharmacology ☐ Advice, clinical matter ☐ Advice, pharmacology ☐ Other (specify): _____
Q54.2	Which health facility / office? Select from the list.	*See list*
Q54.3	First and Last name of contact person	
Q54.4	Role of contact person in the facility / office	HF incharge ☐ MD ☐ Clinician ☐ Nurse ☐ Midwife ☐ Clinical assistant ☐ Other medical staff ☐ Administrative staff ☐ DMO office ☐ Specify role: _____
Q54.5	Relationship with the contact person	Only work-related ☐ Friend ☐ Family ☐ Former colleague ☐ Schoolmate ☐
Q54.6	How did you get in contact with the contact person	In person ☐ Phonecall ☐ Text message ☐ Email ☐ Regular mail ☐ Other (specify) _____ _____

Q54.7	How do you evaluate the success of the specific referral, on a scale from 1 to 4 where 1 is failure and 4 is complete success?	Failure — Complete success ☐ 1 ☐ 2 ☐ 3 ☐ 4
Q55	Referral or advice for clinical or pharmacological matters related to the diagnosis or treatment of a patient affected by a "**Chronic respiratory disease**" in the last 3 months? If yes, for the last event:	No ☐ Yes, diagnosis ☐ Yes, treatment ☐
Q55.1	Type of interaction	Referral, clinical matter ☐ Referral, pharmacology ☐ Advice, clinical matter ☐ Advice, pharmacology ☐ Other (specify): _____
Q55.2	Which health facility / office? Select from the list.	*See list*
Q55.3	First and Last name of contact person	
Q55.4	Role of contact person in the facility / office	HF incharge ☐ MD ☐ Clinician ☐ Nurse ☐ Midwife ☐ Clinical assistant ☐ Other medical staff ☐ Administrative staff ☐ DMO office ☐ Specify role: _____
Q55.5	Relationship with the contact person	Only work-related ☐ Friend ☐ Family ☐ Former colleague ☐ Schoolmate ☐
Q55.6	How did you get in contact with the contact person	In person ☐ Phonecall ☐ Text message ☐ Email ☐ Regular mail ☐ Other (specify) _____
Q55.7	How do you evaluate the success of the specific referral, on a scale from 1 to 4 where 1 is failure and 4 is complete success?	Failure — Complete success ☐ 1 ☐ 2 ☐ 3 ☐ 4
Q56	Referral or advice for clinical or pharmacological matters related to the diagnosis or treatment of a patient affected by a "**Mental illness**" in the last 3 months? If yes, for the last event:	No ☐ Yes, diagnosis ☐ Yes, treatment ☐

Q56.1	Type of interaction	Referral, clinical matter ☐ Referral, pharmacology ☐ Advice, clinical matter ☐ Advice, pharmacology ☐ Other (specify): _____
Q56.2	Which health facility / office? Select from the list.	*See list*
Q56.3	First and Last name of contact person	
Q56.4	Role of contact person in the facility / office	HF incharge ☐ MD ☐ Clinician ☐ Nurse ☐ Midwife ☐ Clinical assistant ☐ Other medical staff ☐ Administrative staff ☐ DMO office ☐ Specify role: _____
Q56.5	Relationship with the contact person	Only work-related ☐ Friend ☐ Family ☐ Former colleague ☐ Schoolmate ☐
Q56.6	How did you get in contact with the contact person	In person ☐ Phonecall ☐ Text message ☐ Email ☐ Regular mail ☐ Other (specify) _____ _____
Q56.7	How do you evaluate the success of the specific referral, on a scale from 1 to 4 where 1 is failure and 4 is complete success?	Failure — Complete success ☐ 1 ☐ 2 ☐ 3 ☐ 4

Section 4: Relational data: administrative issues

Characteristics of the respondent

Q57	First Name and Last Name	
Q58	Date of birth	
Q59	Place of birth (Village, Ward, District, Region)	
Q60	Role in the facility / office	HF incharge ☐ MD ☐ Clinician ☐ Nurse ☐ Midwife ☐ Clinical assistant ☐ Other medical staff ☐ Administrative staff ☐ Department head ☐ Specify role: _____
Q61	For hospitals and health centers, in which department are you working?	
Q62	How long have you worked at this health facility?	Years _____ Months_____
Q63	Last highest educational title	
Q64	Place where last education was completed (District, Region)	
Q65	Number of employees dealing with administrative issues	
Q66	Number of members in the HFGC	
Q67	Is there a cascade coaching system in place for medicine management?	No ☐ Yes ☐
Q68	What is the name of reference facility for cascade supervision	*See list*
Q69	What is the name of the person in charge of cascade coaching?	
Q70	Advice, request or authorization with regards to "**Budgeting for investments in the facility**" in the last year. If yes, for the last event:	No ☐ Yes, advice ☐ Yes, request ☐ Yes, authorization ☐
Q70.1	Which health facility / office? Select from the list.	*See list*
Q70.2	First and Last name of contact person	
Q70.3	Role of contact operator	HF incharge ☐ MD ☐ Clinician ☐ Nurse ☐ Midwife ☐ Clinical assistant ☐ Other medical staff ☐ Administrative staff ☐ DMO office ☐ Specify role: _____

Q70.4	Relationship with the contact person	Only work-related ☐ Friend ☐ Family ☐ Former colleague ☐ Schoolmate ☐
Q70..5	How did you get in contact with the contact person	In person ☐ Phonecall ☐ Text message ☐ Email ☐ Regular mail ☐ Other (specify) _____ _____
Q70.6	How do you evaluate the success of the specific contact, on a scale from 1 to 4 where 1 is failure and 4 is complete success?	Failure — Complete success ☐ 1 ☐ 2 ☐ 3 ☐ 4
Q71	Advice, request or authorization with regards to "**Allocation or management of human resources**" in the last year. If yes, for the last event:	No ☐ Yes, advice ☐ Yes, request ☐ Yes, authorization ☐
Q71.1	Which health facility / office?	*See list*
Q71.2	First and Last name of contact person	
Q71.3	Role of contact operator	HF incharge ☐ MD ☐ Clinician ☐ Nurse ☐ Midwife ☐ Clinical assistant ☐ Other medical staff ☐ Administrative staff ☐ DMO office ☐ Specify role: _____
Q71.4	Relationship with the contact person	Only work-related ☐ Friend ☐ Family ☐ Former colleague ☐ Schoolmate ☐
Q71.5	How did you get in contact with the contact person	In person ☐ Phonecall ☐ Text message ☐ Email ☐ Regular mail ☐ Other (specify) _____ _____

Q71.6	How do you evaluate the success of the specific contact, on a scale from 1 to 4 where 1 is failure and 4 is complete success?	Failure — Complete success ☐ 1 ☐ 2 ☐ 3 ☐ 4
Q72	Advice, request or authorization with regards to "**Drug management**" in the last year. If yes, for the last event:	No ☐ Yes, advice ☐ Yes, request ☐ Yes, authorization ☐
Q72.1	Which health facility / office? Select from the list.	*See list*
Q72.2	First and Last name of contact person	
Q72.3	Role of contact operator	HF incharge ☐ MD ☐ Clinician ☐ Nurse ☐ Midwife ☐ Clinical assistant ☐ Other medical staff ☐ Administrative staff ☐ DMO office ☐ Specify role: _____
Q72.4	Relationship with the contact person	Only work-related ☐ Friend ☐ Family ☐ Former colleague ☐ Schoolmate ☐
Q72.5	How did you get in contact with the contact person	In person ☐ Phonecall ☐ Text message ☐ Email ☐ Regular mail ☐ Other (specify) _____ _____
Q72.6	How do you evaluate the success of the specific contact, on a scale from 1 to 4 where 1 is failure and 4 is complete success?	Failure — Complete success ☐ 1 ☐ 2 ☐ 3 ☐ 4
Q73	Advice, request or complaint with regards to "**Leakage of funds or corruption-related offenses that took place at the health facility**" in the last year. If yes, for the last event:	No ☐ Yes, advice ☐ Yes, request ☐ Yes, complaint ☐
Q73.1	Which health facility / office? Select from the list.	*See list*
Q73.2	First and Last name of contact person	

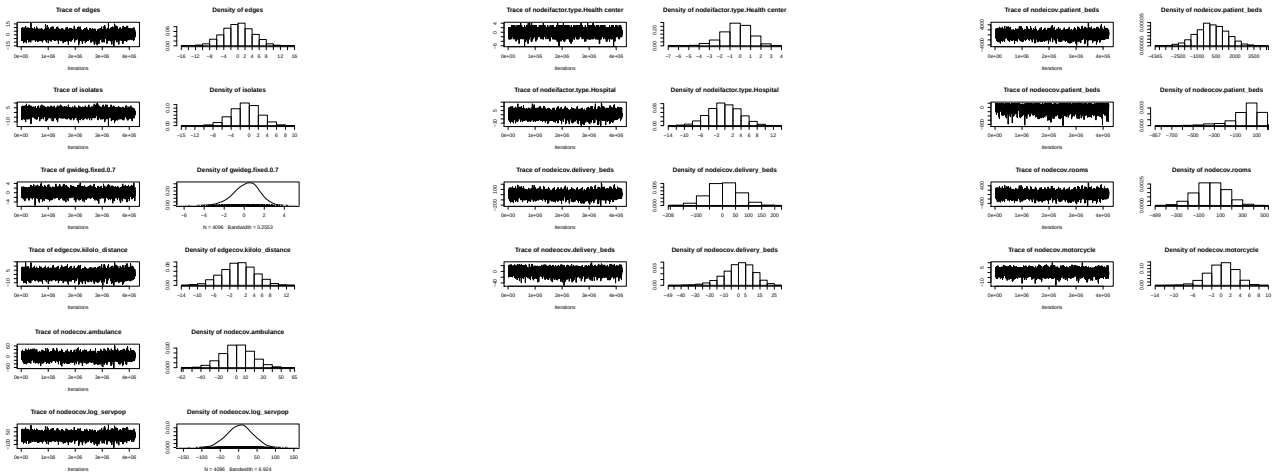
Q73.3	Role of contact operator	HF incharge ☐ MD ☐ Clinician ☐ Nurse ☐ Midwife ☐ Clinical assistant ☐ Other medical staff ☐ Administrative staff ☐ DMO office ☐ Specify role: _____
Q73.4	Relationship with the contact person	Only work-related ☐ Friend ☐ Family ☐ Former colleague ☐ Schoolmate ☐
Q73.5	How did you get in contact with the contact person	In person ☐ Phonecall ☐ Text message ☐ Email ☐ Regular mail ☐ Other (specify) _____ _____
Q73.6	How do you evaluate the success of the specific contact, on a scale from 1 to 4 where 1 is failure and 4 is complete success?	Failure — Complete success ☐ 1 ☐ 2 ☐ 3 ☐ 4

A.4 Density of responses for specific categories of care, by district

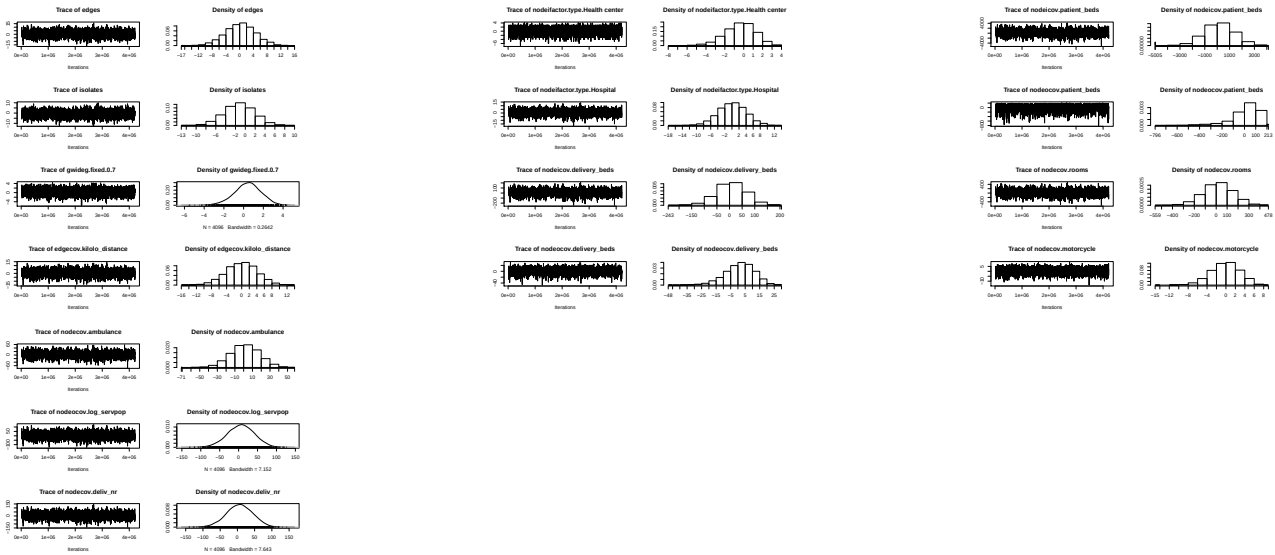
Question	Kilolo DC (Iringa) N=42	Msalala DC (Shinyanga) N=27
Child care		
Emergency conditions	12 referrals	10 referrals
Diagnostic approaches	9 referrals	11 referrals
Cough or difficulty breathing	1 referrals	12 referrals
Diarrhoea	1 referrals	6 referrals
Fever	9 referrals	17 referrals
Severe acute malnutrition	12 referrals	14 referrals
Complications related to HIV/AIDS	5 referrals	11 referrals
Surgical problems	0 referrals	1 referral
Supportive care	2 referrals	7 referrals
Treatment of NCD's		
Diabetes	13 referrals	4 referrals
Cancer	1 referrals	5 referrals
Cardiovascular disease	29 referrals	10 referrals
Chronic respiratory disease	2 referrals	15 referrals
Mental illness	3 referrals	1 referral

A.5 Diagnostic and goodness of fit outputs for Exponential Random Graph Models (ERGMs)

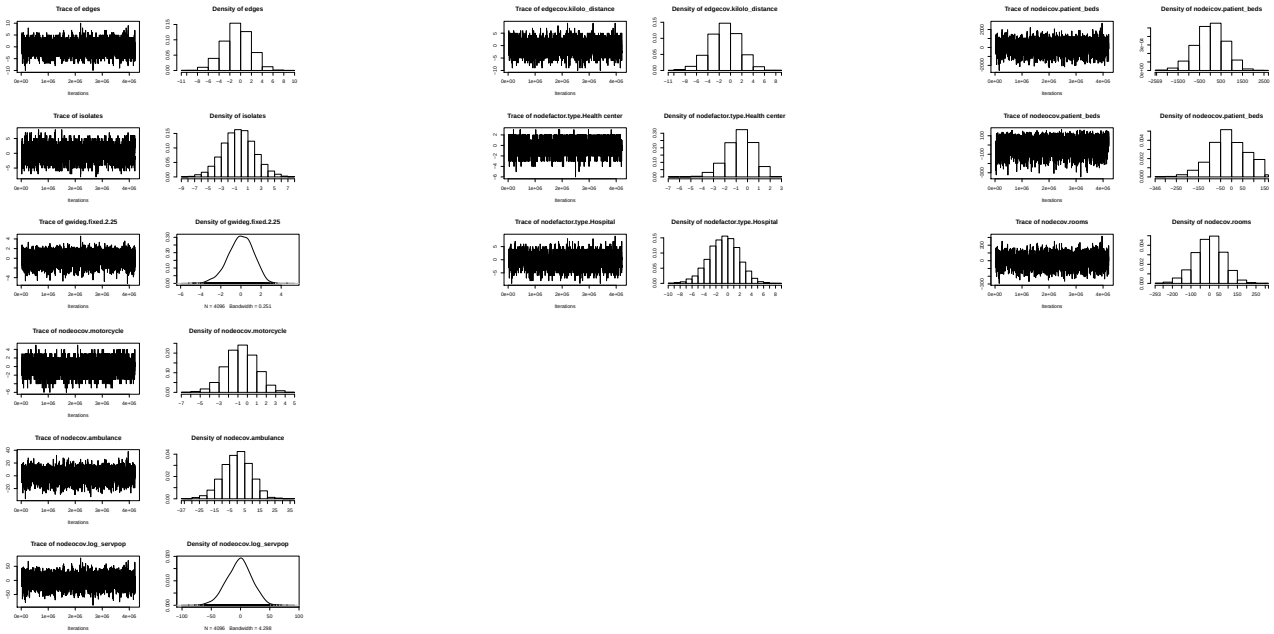
A.5.1 Diagnostics ERGM for Kilolo, Childcare, model 1



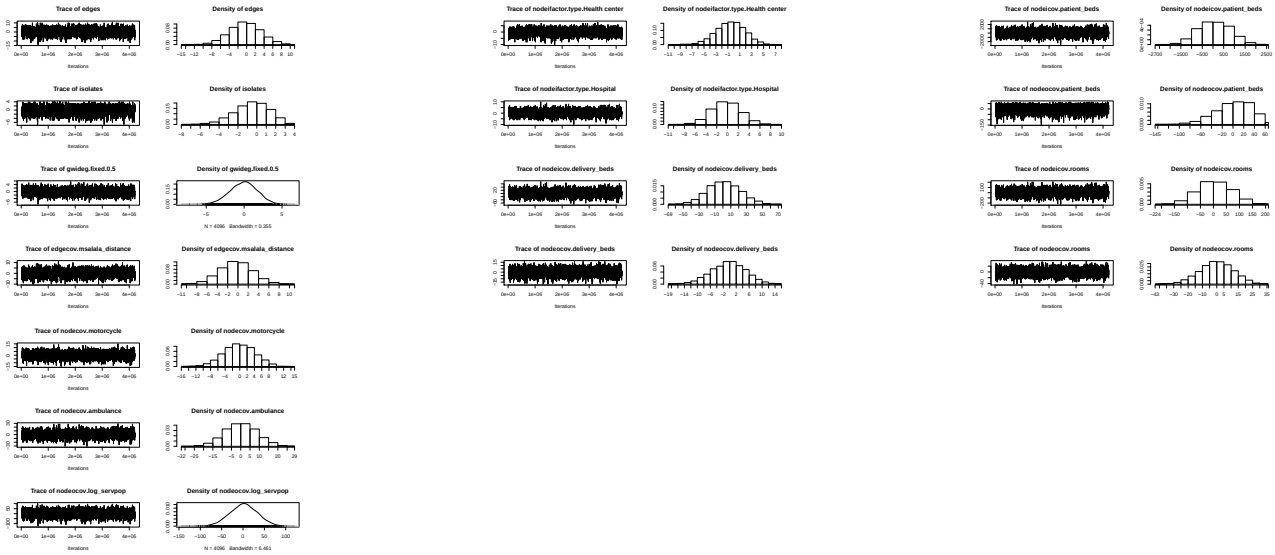
A.5.2 Diagnostics ERGM for Kilolo, Childcare, model 2



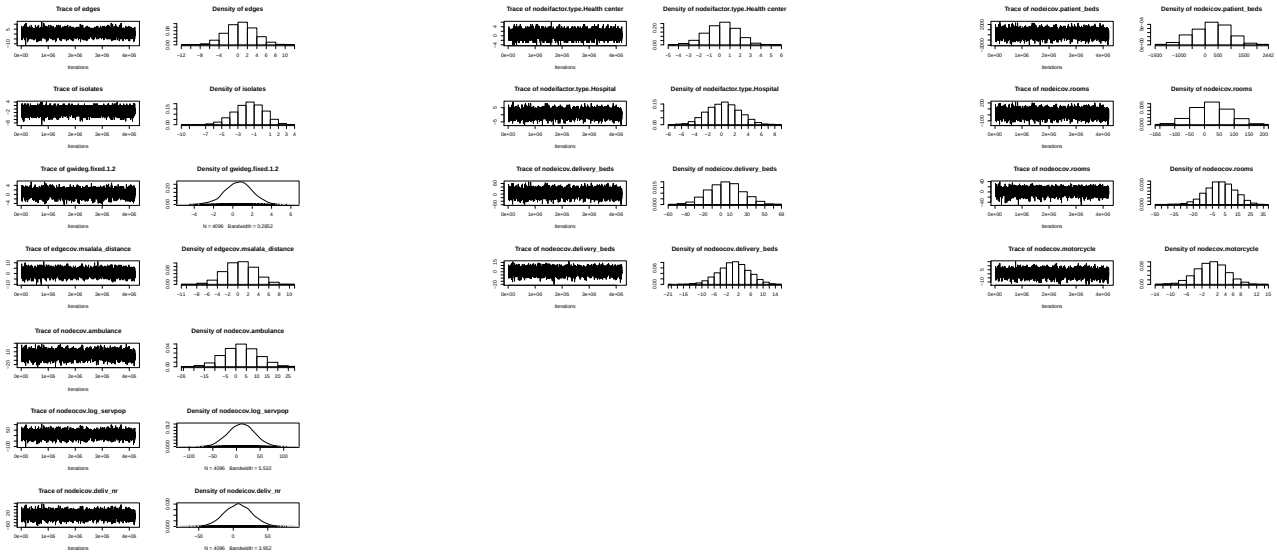
A.5.3 Diagnostics ERGM for Kilolo, Treatment of NCDs



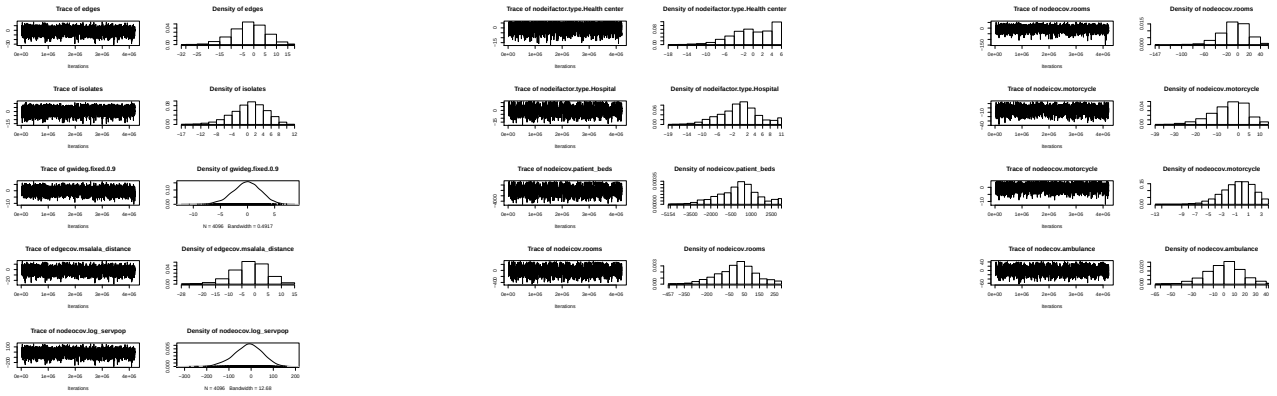
A.5.4 Diagnostics ERGM for Msalala, Childcare, model 1



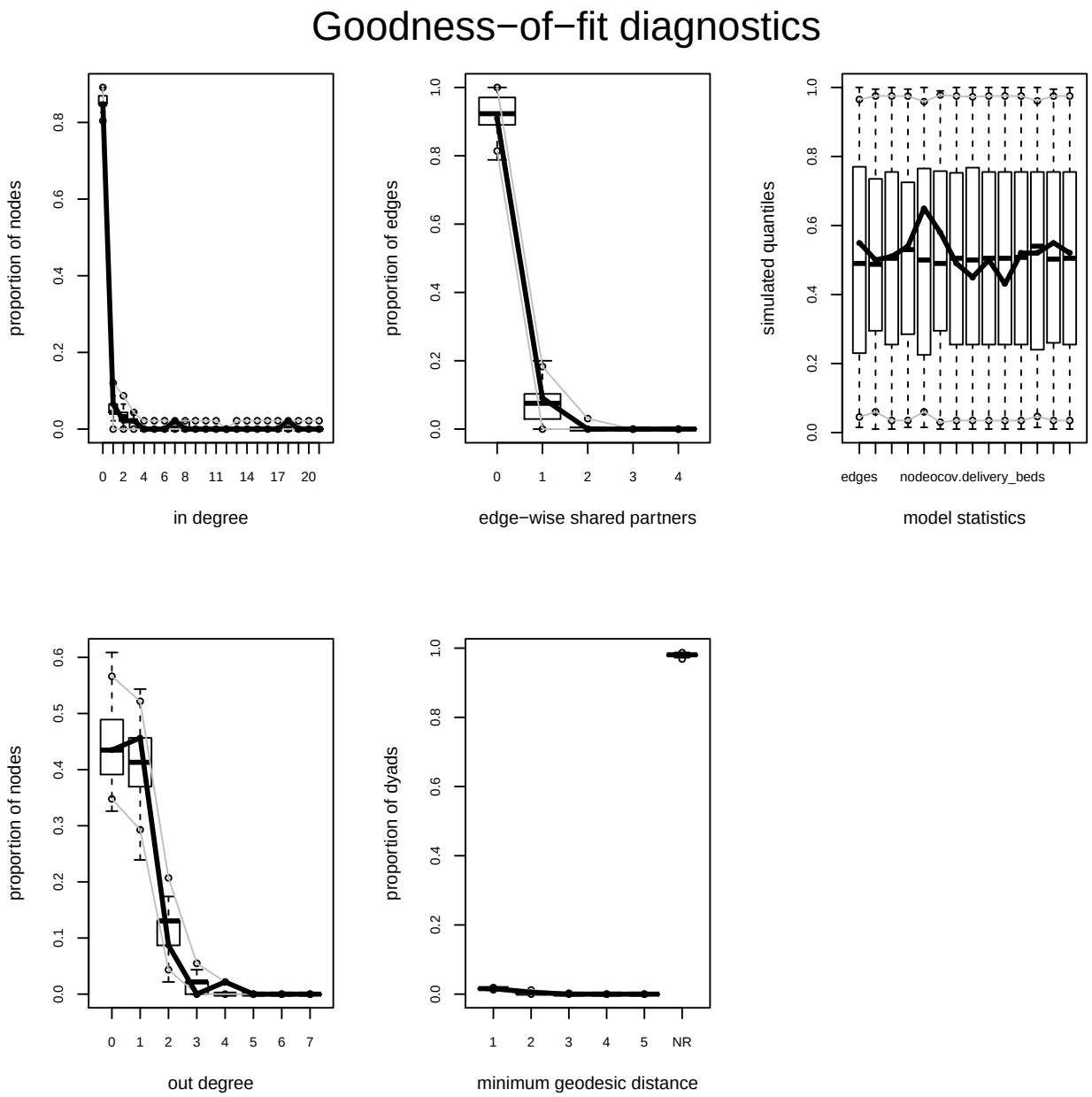
A.5.5 Diagnostics ERGM for Msalala, Childcare, model 2



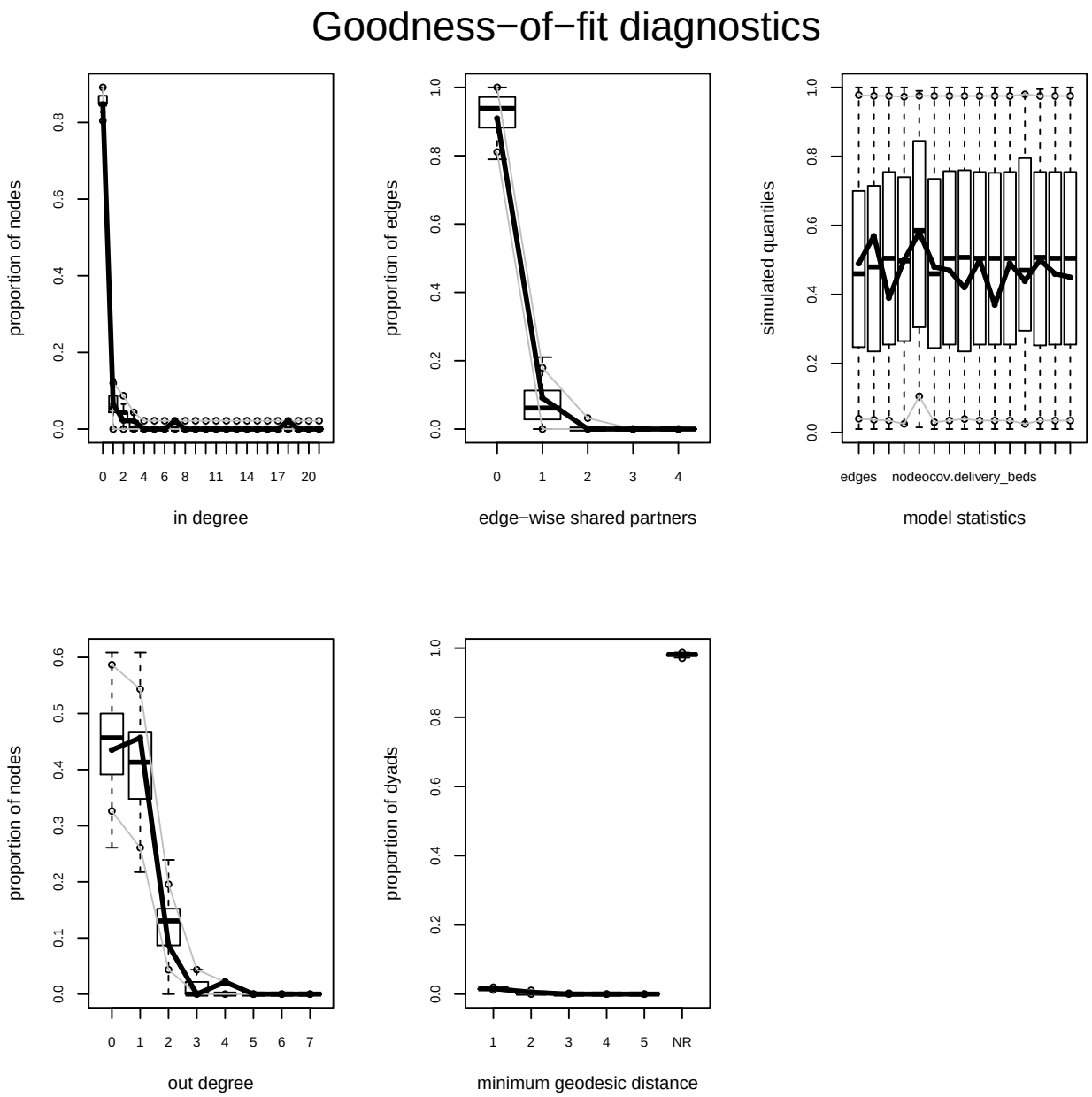
A.5.6 Diagnostics ERGM for Msalala, Treatment of NCDs



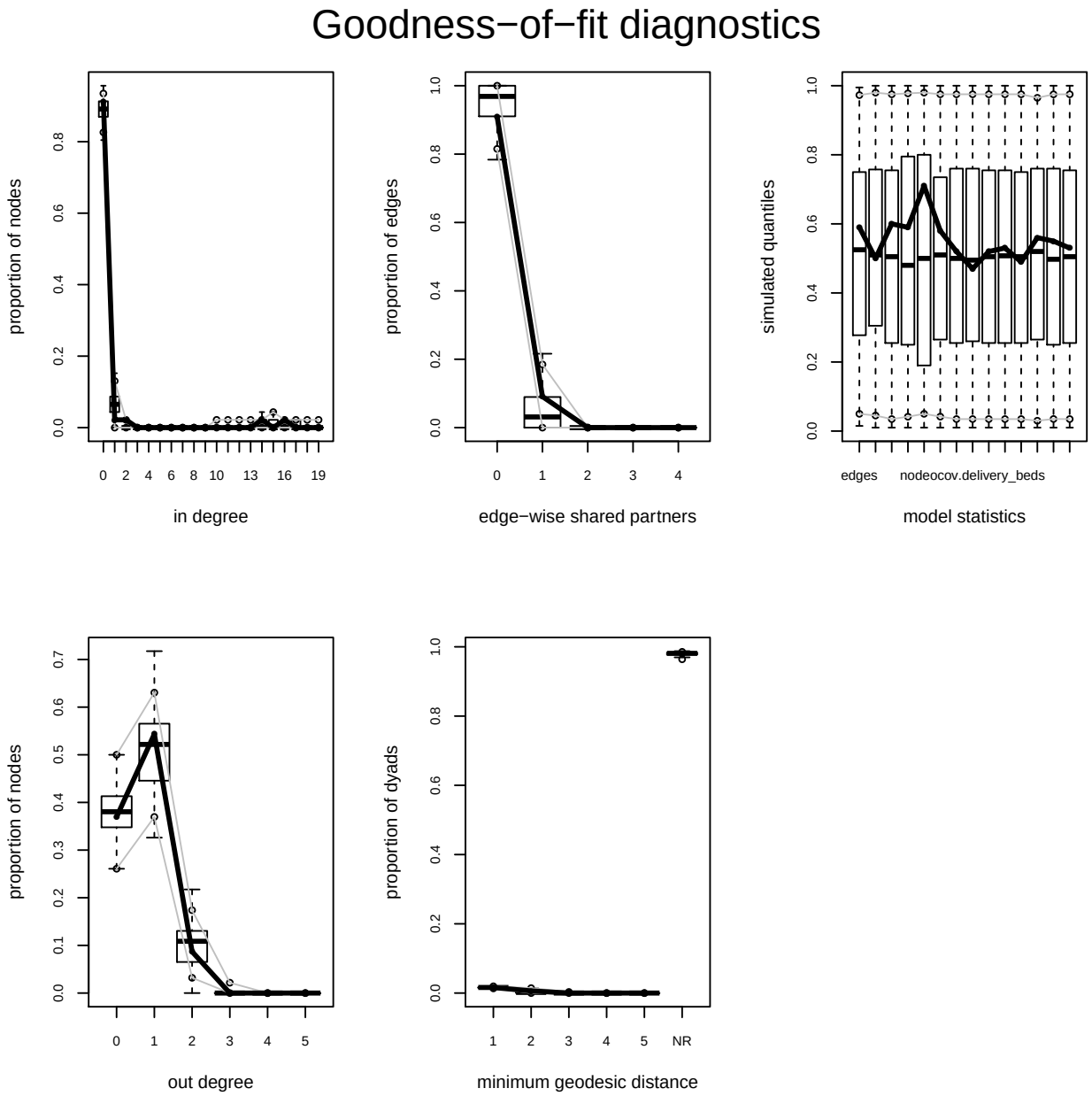
A.5.7 GOF ERGM for Kilolo, Childcare, model 1



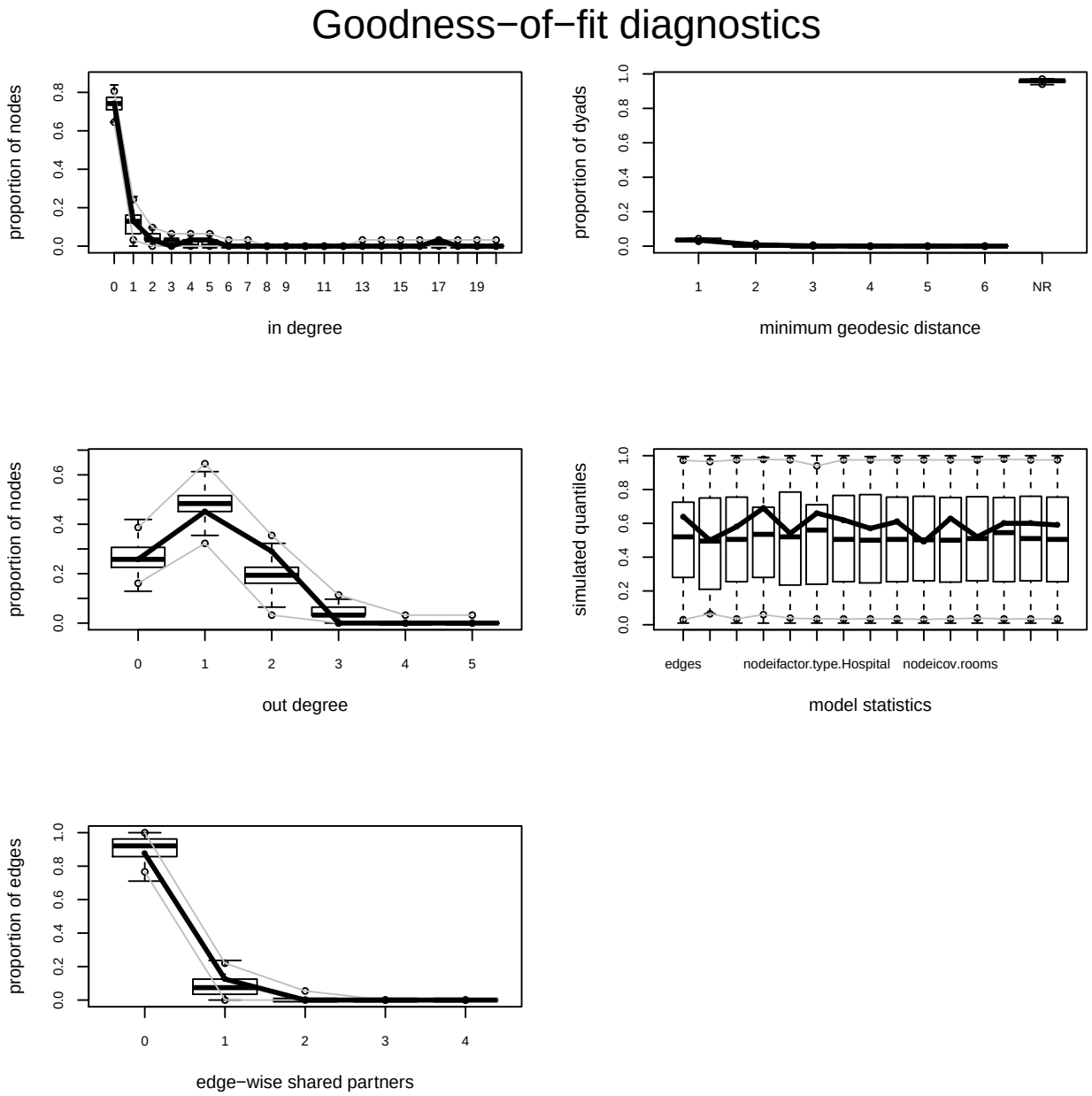
A.5.8 GOF ERGM for Kilolo, Childcare, model 2



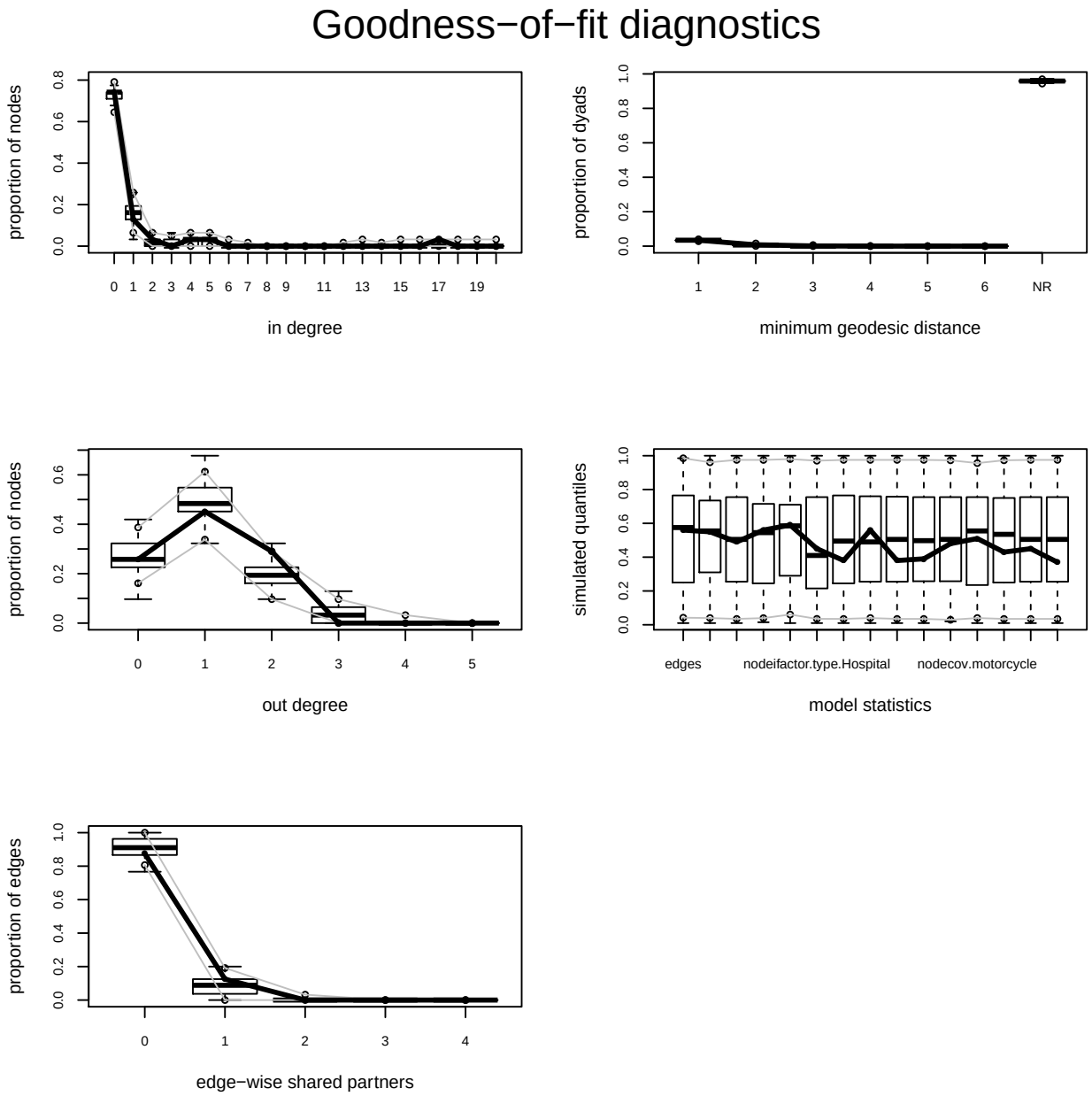
A.5.9 GOF ERGM for Kilolo, Treatment of NCDs



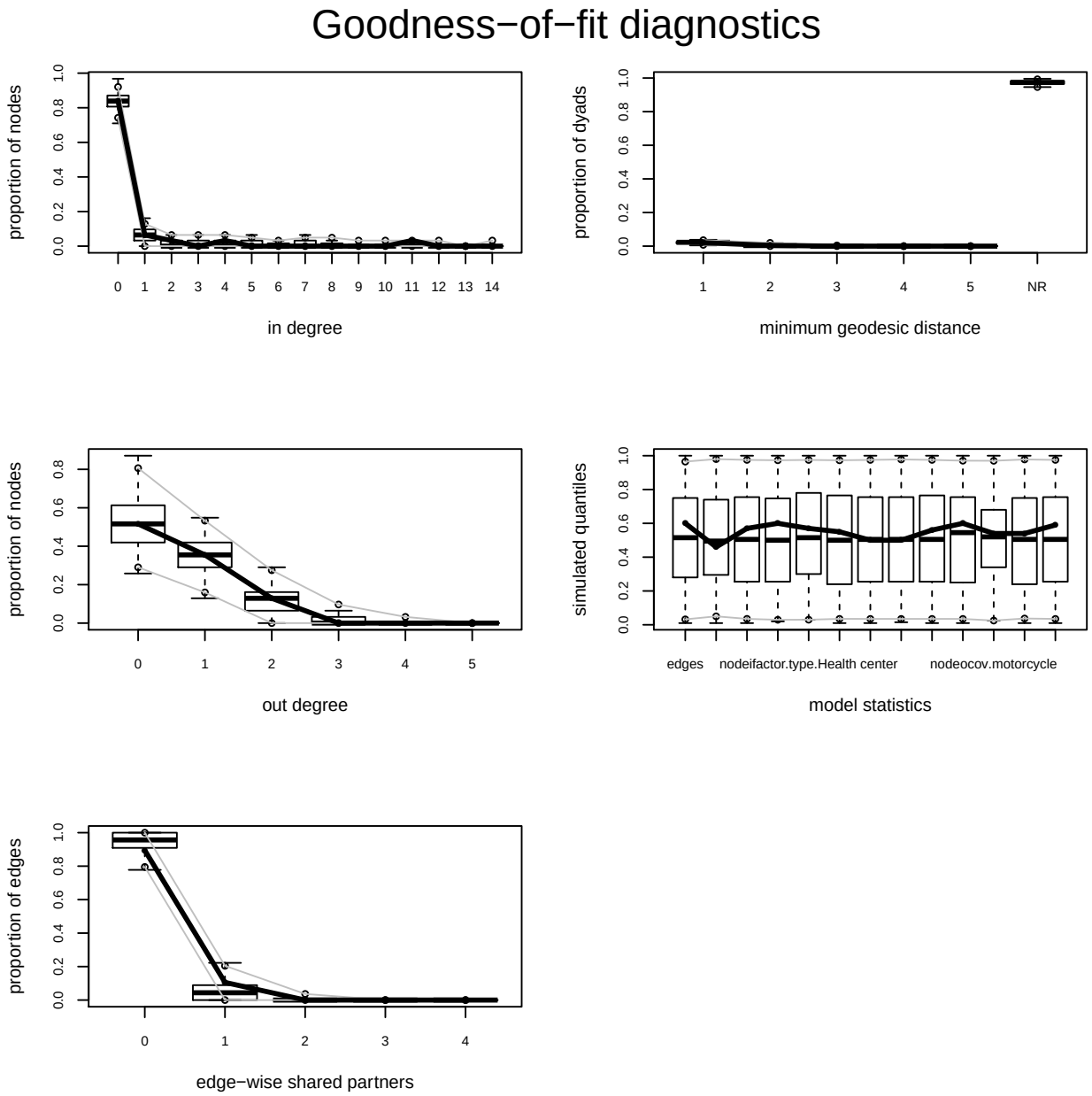
A.5.10 GOF ERGM for Msalala, Childcare, model 1



A.5.11 GOF ERGM for Msalala, Childcare, model 2



A.5.12 GOF ERGM for Msalala, Treatment of NCDs



A.6 Interpretation of ERGM coefficients: simple numerical example

Tables 3 and 4 illustrate the features of our referral networks. The network of referrals for treatment of NCDs in Kilolo has 46 nodes (facilities) and 33 observed edges (referrals). Thus, the potential number of directed edges is

$$N \times (N-1) = 46 \times 45 = 2070$$

Accordingly, the density of the network is

$$\frac{33}{2070} = 0.015942$$

In an ERGM framework, modelling network formation only as a function of the number of edges would result in the following output.

	Model 1
edges	-4.12^{***}
	(0.18)
AIC	340.63
BIC	346.27
Log Likelihood	-169.32

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

This model assumes that ties appear randomly between pairs given the number of existing edges and nodes. The coefficient associated to edges is significant and equal to -4.12. If we apply the inverse-logit function

$$L^{-1}(\alpha) = \frac{e^{\alpha}}{1+e^{\alpha}}$$

to the coefficient for "edges" above, we obtain exactly 0.015942, which is the value for density.

D Curriculum Vitae

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Born 1987

Education

December 2019	Doctor of Philosophy (Ph.D) in Public Health with specialization in Health Economics	University of Basel (Unibas), Swiss Tropical and Public Health Institute (Swiss TPH), Switzerland
March 2016	Master of Science (MSc.) in Economics	University of Lausanne (Unil), Faculty of Business and Economics (HEC), Switzerland
September 2012	Bachelor of Arts (B.A.) in Economics (with honors)	Università della Svizzera Italiana (USI), Faculty of Economics, Switzerland
September 2011	Bachelor of Science (BSc.) in Business Administration	University of Applied Sciences and Arts of Southern Switzerland (SUPSI), Department of Business and Social Sciences (DSAS), Switzerland

Research positions

02.2020 - to date	University of Manchester, Centre for Primary Care and Health Services Research (CPCHSR), Health Organization, Policy and Economics (HOPE) group, UK	Research Fellow in Health Economics
09.2016 - 02.2020	SUPSI, DEASS, Switzerland	Doctoral fellow (PhD student)
09.2013 - 08.2016	SUPSI, Department of Business Economics, Health and Social Care (DEASS), Switzerland	Teaching and research assistant

My Research

Who - I'm an Applied Economist working on Health
What - My current research interests are: policy evaluation, health systems and services research (focus on cancer screening detection), analysis of spillover effects in health, economics of health systems governance (focus on primary healthcare provision in LMICs), and development (health) economics
How - I use econometric and network analysis tools working comfortably across platforms (especially R and Stata).

Teaching experience

2016-2019: Introductory Health Economics and Policy (Bachelor level) [SUPSI, Switzerland], Lecturer; Health Policy (Master level) [USI, Switzerland], Lecturer.
2013-2016: Macroeconomics (Bachelor level), Teaching Assistant [SUPSI, Switzerland]; Research Methods (Bachelor level), Teaching Assistant [SUPSI, Switzerland].

Professional experience (non-academic)

09.2008 - 12.2015	Lugano Pallanuoto, Switzerland [Sports, Waterpolo team]	Team manager élite and youth teams (*pro bono*)
11.2010 - 08.2013	Aziende Industriali di Lugano (AIL) SA, Switzerland [Multiutility company]	Assistant to CFO
09.2006 - 11.2010	City of Lugano, Switzerland [Local government authority]	Administrative employee

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Conferences and seminars

2021 Health Economists' Study Group Winter 2021 meeting, LSHTM (virtual), paper discussion.

2019 PhD students meeting Swiss TPH, Basel (Switzerland), seminar presentation; International Health Economics Association (iHEA) 12th World Congress, Basel (Switzerland), long oral presentation; Association Latine pour l'Analyse des Systèmes de Santé (ALASS) XXX Annual Congress, Montréal (Canada), oral presentation; HEHSR Unit meeting Swiss TPH, Basel (Switzerland), seminar presentation; 4th European Conference on Social Networks, Zurich (Switzerland), poster slam session; Advances in Infection Biology, Epidemiology and Global Public Health, Swiss TPH, Basel (Switzerland); seminar presentation; 24th National Congress of the Italian Health Economics Association, Pisa (Italy), oral presentation.

2018 5th Global Symposium on Health Systems Research, Liverpool (UK), oral presentation; Swiss Public Health Conference, Neuchâtel (Switzerland), science flash talk; SUPSI DEASS Brown Bag seminar, Manno (Switzerland), seminar presentation; HEHSR Unit meeting Swiss TPH, Basel (Switzerland), seminar presentation.

Working papers

with Luke Munford. Corona and Coffee on your commute: A spatial analysis of COVID-19 mortality in England between March and July 2020. *Submitted*.

with Carlo De Pietro. Deductible choice and selection on moral hazard: An instrumental variable approach using Swiss Household Panel Data. *Submitted*.

with Rachel Meacock, Jack Elliott, Søren R. Kristensen, Phillip Britteon, David Lugo Palacios and Matt Sutton. Classifying spillover effects from healthcare interventions: A scoping review and framework. *Work in progress*.

Publications

Igor Francetic, Günther Fink, Fabrizio Tediosi. (Forthcoming). Impact of social accountability monitoring on health facility performance: Evidence from Tanzania *Accepted for publication at Health Economics*. 10.1002/hec.4219

Igor Francetic, Fabrizio Tediosi, August Kuwawenaruwa. (Forthcoming). A network analysis of patient referrals in two district health systems in Tanzania. *Accepted for publication at Health Policy and Planning*. 10.1093/heapol/czaa138

Igor Francetic, Fabrizio Tediosi, Paola Salari, Don de Savigny. 2019. Going Operational with Health Systems Governance: Supervision and Incentives to Health Workers for Increased Quality of Care in Tanzania. *Health Policy and Planning*. 10.1093/heapol/czz104.

Igor Francetic. 2019. Governance to address health systems pitfalls of antibiotics overuse in low- and middle-income countries. *International Journal of Public Health* 64 (8):1127-28. 10.1007/s00038-019-01292-3.

Carlo De Pietro, Igor Francetic. 2018. E-Health in Switzerland: The Laborious Adoption of the Federal Law on Electronic Health Records (EHR) and Health Information Exchange (HIE) Networks. *Health Policy* 122 (2): 69–74. 10.1016/j.healthpol.2017.11.005.

Contributions to books

Igor Francetic. 2020. *Health Reforms In Tanzania: From Self-Reliance To Donor Dependency and Efforts to Return to Self-Reliance*. In Kieke Okma, Tim Tenbensel (Eds.). *Health Reforms Across the World: The Experience of Twelve Small and Medium-sized Nations with Changing Their Healthcare Systems*. Chapter 2, pp. 55-73. World Scientific, Singapore. 10.1142/9789811208928_0003.

Language skills

Italian (native), Croatian (native), English (full professional proficiency), French (good), German (fair)

Software and programming skills

LaTeX, R, Stata, MATLAB/Octave, ArchGIS, QGIS

Last update: 2021-01-01