



Identifying Health System Priorities for Equitable Access to Health Services in Low- and Middle-Income Countries

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ABSTRACT

In 2019, the World Health Organization announced that up to 5 billion people will be unable to access health care in 2030 if governments fail to sufficiently increase investments in health care. The three papers that comprise this dissertation explore themes of access to health care and priority setting to improve access via outreach and financial risk protection for the most vulnerable populations. They employ methods of economic evaluation and decision sciences to support decision-making towards these aims in resource-constrained settings.

Immunization remains one of the most effective interventions to reduce child morbidity and mortality, but is an essential health service that still fails to reach every child in low- and middle-income countries. Using a structural equation model informed by the literature on ‘decision space’ in health systems, Paper 1 examines whether the decentralized management structure of India’s intensified immunization program and its capacity to reach previously unimmunized children were related. Study results highlighted that a greater capacity to make decisions at local operational levels was associated with fewer planned vaccination sessions being implemented under the program at the subdistrict level, but was not related to the number of children vaccinated per session. Greater reductions in morbidity and mortality due to vaccine-preventable diseases may be derived from greater attention to programmatic management and organization to improve immunization coverage and access to other essential health services.

Achieving high levels of financial risk protection is another indication of adequate access to health care and continues to be an objective of health systems. Despite comprehensive social health protection schemes, some countries experience low claims of the entitlements provided through these schemes. Paper 2 investigates this phenomenon, examining the relationships between patients’ awareness of their benefits and their utilization of them in Cambodia. Study findings reveal that the majority of beneficiaries under the country’s public health protection scheme were aware of their entitlements, but chose to seek care from private rather than public providers, where services would be free of user fees. Microsimulations of interventions aimed at increasing patients’ awareness suggest that initiatives intervening on the decision of where to seek care (i.e., public vs. private facilities) may prove more fruitful towards increasing financial risk protection compared to interventions implemented within public facilities alone. Overall, interventions aimed at increasing awareness of entitlements were only associated with very small increases in user claims and suggest that beneficiary

awareness may not be a major barrier to access in this context as initially hypothesized.

With the increasing burden of costly non-communicable diseases, health policies will need to establish efficient and equitable policies that reduce financial barriers to accessing routine health services for the poor. Paper 3 explores the potential economic costs, health gains, and financial risk protection benefits associated with provision of diabetes-related care in the context of Cambodia's social health protection scheme, the Health Equity Funds. Using Markov modeling and cost-effectiveness analysis, the study points to how providing effective service and financial coverage for screening and treatment services for diabetes would lead to the substantial health and financial risk protection benefits for the Cambodian population. Examining the impact of health and financial benefits showed that such a policy would particularly benefit women and the poorest.

These three papers tackle burgeoning challenges in access to health care for children, the poorest, and women in lower-middle income settings, pointing to potentially effective and cost-effective solutions to improve access to address communicable and non-communicable diseases. Paper 1 highlights how the design of organizational structures for decision making may relate to improved outreach to increase access to immunization for hard-to-reach children. Paper 2 evaluates hypotheses on how to improve access to health services through appropriate use of health coverage, and Paper 3 determines the cost-effectiveness of reducing barriers to accessing non-communicable disease services among the poor. Together, these studies contribute to decision making regarding health systems strengthening interventions aimed at reducing access barriers and addressing population health needs in the unique contexts of low- and middle-income country settings.

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Acronyms

ACA	Affordable Care Act
ANM	Auxiliary Nurse Midwife
CFA	confirmatory factor analysis
CFI	comparative fit index
CHE	catastrophic health expenditure
CPA	Complementary Package of Activities
CVD	cardiovascular disease
DALYs	disability-adjusted life-years
DHS	Demographic and Health Survey
DIO	District Immunization Officer
DTP₃	diphtheria-tetanus-pertussis
ECEA	extended cost-effectiveness analysis
FPG	fasting plasma glucose
FRP	financial risk protection
GBD	Global Burden of Disease
GDP	gross domestic product
H-EQIP	Health Equity and Quality Improvement Project
HEF	Health Equity Funds
HMIS	health management information system
ICERs	incremental cost-effectiveness ratios
IMI	Intensified Mission Indradhanush

LMICs low- and middle-income countries

MI Mission Indradhanush

MICE multivariate imputation by chained equations

MOH Ministry of Health (Cambodia)

MoHFW Ministry of Health and Family Welfare (India)

MOIC Medical Officer In-Charge

MPA Minimum Package of Activities

NCDs non-communicable diseases

NGOs non-governmental organizations

OAD oral anti-diabetic drug

OD Operational District

OOP out-of-pocket

OR odds ratio

PCA principal components analysis

PPS probability proportional-to-size

PVD peripheral vascular disease

RI routine immunization

RMSEA root mean square error of approximation

RR relative risk

SDGs Sustainable Development Goals

SEM structural equation models

TLI Tucker-Lewis index

UHC universal health coverage

UIP Universal Immunization Program

UKPDS United Kingdom Prospective Diabetes Study

UNDP United Nations Development Programme

UNICEF United Nations Children’s Fund

USD United States dollars

WHO World Health Organization

YLD years of life lived with disability

YLL years of life lost

TO MY MOTHER, SIVANN CHHIV FELDHAUS, WHO INSPIRED THE PURSUIT OF THIS WORK
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1

Introduction

1.1 MOTIVATION

1.1.1 PERSISTENT BARRIERS TO ACCESSING HEALTH SERVICES AND DISPARITIES IN HEALTH

In 2019, the World Health Organization announced that up to 5 billion people will be unable to access health services in 2030 if governments fail to sufficiently increase investments in primary health care [1–3]. A definition that has been widely adopted when examining this dimension of the health system, Peters *et al.* define access to health services as ‘the timely use of services according to need’, and characterized, not only by the physical availability of appropriate services at geographically reachable facilities, but also by financial accessibility [4]. Ensuring access to health services for all is at the core of universal health coverage (UHC), an

objective of all United Nations Member States as part of the Sustainable Development Goals for 2030. UHC means that all people and communities can use the promotive, preventive, curative, rehabilitative, and palliative health services they need, of sufficient quality to be effective, while also ensuring that the use of these services does not expose the user to financial hardship [5]. It is explicitly defined to embody three related objectives: (1) equity in access to health services, (2) adequate quality of those services, and (3) protection against financial risk, meaning that the cost of using health services does not place families at risk of financial harm [5].

Between 2000 and 2015, service coverage for essential health services increased by about 20% around the world based on the trends of nine tracer indicators (i.e., basic sanitation, hypertension control, tobacco control, use of insecticide-treated nets, family planning, antenatal care visits, child immunization, HIV treatment, and tuberculosis treatment) used for the monitoring of progress towards UHC [6]. Despite improvements, efforts to monitor UHC show that inequalities in certain essential services persist. For example, across low- and lower-middle-income countries, only 17% of households in the poorest wealth quintile received at least six basic maternal and child health interventions compared to 74% in the richest quintile [6]. Similarly, service coverage for essential health services was greater for households in urban areas compared to those in rural areas [6]. These patterns suggest that, improvements in service coverage have not been evenly distributed and that to resolve such service gaps, focused efforts need to identify and address socioeconomic and physical barriers to access to health services for specific contexts.

Alongside improvements in service coverage in recent decades, there have been increases in the incidence of catastrophic health expenditure (CHE), defined as out-of-pocket (OOP) expenditures for health surpassing a certain threshold of household consumption or income [1, 7, 8]. Globally, the proportion of OOP spending for health exceeding 25% of income rose from 1.7% to 2.9% between 2000 and 2015, while health expenditure beyond 60% of median daily per capita income increased from 1.8% to 2.5% over the same time period [1]. Trends showing improved service coverage alongside increasing costs to families illustrate the focus of recent interventions on improving availability of health services and technologies to tackle communicable diseases. These interventions have had significant impacts on population health across low- and middle-income countries (LMICs). However, they alone fail to bring adequate and effective access to health care for all. Experts argue that most countries could achieve UHC by raising domestic resources to increase public spending on

health and/or reallocating spending towards primary health care [1].

Key objectives of health systems include improving population health, achieving adequate patient satisfaction, and ensuring financial risk protection [9]. As health systems realize improvements in service coverage, it is likely that the poorest, those most vulnerable to health and economic burdens, such as women and children, and those hardest to reach will continue to bear significant costs. These populations remain excluded from basic health care in many settings [10]. The continued inability of these groups to access health care will aggravate already existing health and economic disparities in LMICs. Policymakers must make decisions to adopt health policies that improve physical and financial access to health services towards UHC and health system objectives. Population and disease trends alongside resource constraints prompt a focus on strategies to continue enhancing physical availability of services while promoting sufficient financial risk protection for improved access to health care.

1.1.1.2 PRIORITY SETTING FOR HEALTH SYSTEM INTERVENTIONS

With ongoing epidemiological transitions from communicable to non-communicable diseases (NCDs) in many LMICs, the most vulnerable groups are increasingly dealing with a dual burden of disease. According to the 2017 Global Burden of Disease (GBD) Study, over 59% of deaths were attributable to NCDs and 31% were due to communicable diseases around the world [11]. NCDs often require long-term care, meaning regular access to health care services, or will otherwise result in severe outcomes, such as catastrophic health spending, disability, or death [12–14]. Communicable diseases require periodic prevention and curative services via primary health care, such as immunization services and treatments for childhood diseases. The distribution of disease burden indicates that health policies will need to consider how to equitably address the requirements of both acute and chronic disease care towards alleviating their health and economic impacts. To this end, LMICs will need to increase investments in primary care systems for financially sustainable improvements in access to health care.

Lower-middle-income countries are especially facing this increasing dual burden of disease; morbidity and mortality is increasingly due to NCDs rather than communicable diseases as seen in low-income countries. In India, about 33% of the disease burden measured in disability-adjusted life-years (DALYs) was attributable to communicable diseases and 56% to NCDs in 2017 [11]. In Cambodia, over 29% of DALYs were attributable

to communicable diseases, while about 58% were due to NCDs in 2017 [11]. Both nations are examples of countries with persistent challenges grappling with both preventable communicable diseases and NCDs as they pass through epidemiological transition. Despite steady progress, in 2016, an estimated 38% of children failed to receive all basic vaccinations during their first year of life in India [15]. Cardiovascular diseases made the largest contribution to mortality in the same year (28%) alongside 3% due to diabetes, which was slightly higher among women (3.4%) compared to men (2.9%) [16]. And trends in Cambodia parallel those observed in India. A 2014 national survey reported that only 6 in 10 children in Cambodia's poorest households are vaccinated compared to 9 in 10 in the wealthiest homes [17]. In 2018, cardiovascular diseases contributed to 24% of mortality, while diabetes also caused 3% of mortality in the country [18, 19].

Reforms towards UHC must consider policy options in light of health system objectives, strategically choosing investments that provide the most value. Multiple indicators are used to monitor country progress towards UHC, including the availability of essential health services based on tracer interventions that include reproductive, maternal, newborn and child health, infectious diseases, NCDs, service capacity, and access [20]. CHE is among accepted measures to monitor UHC goals for financial risk protection, defined as OOP health spending exceeding 10%, 25%, or 40% of a household's total consumption or income [7, 21]. Using these measures, it will be possible to determine the most cost-effective and equitable interventions to support priority setting towards achieving UHC.

Studies of interventions tackling the various barriers to accessing primary health care can inform decisions and support priority setting towards achieving the goals of 2030 and beyond. Interventions to improve physical and financial access to health care can address supply- or demand-side barriers. Addressing supply-side barriers may involve increased provision of essential care services, integrated outreach services, deconcentration of authority to respond to local needs, and improved management (i.e., functional supervision and feedback mechanisms) [22]. The design and implementation of Intensified Mission Indradhanush (IMI), a program of periodic intensification of routine immunization to reach unimmunized children in India, is an example of an effort to reduce supply-side barriers to accessing essential health services. Implementation of the Health Equity Funds (HEF) in Cambodia is one example of an attempt to reduce demand-side barriers to accessing health services, providing fee exemptions and other benefits to the poorest for a basic package of services [23]. Interventions to tackle demand-side barriers can include dissemination of information on health services

and/or financial protections for health, fee exemptions for health care, and subsidies for the poor [22]. Identifying which health system interventions can best improve access to primary health care can support strategic policy making.

1.2 OVERVIEW

The three papers that comprise this dissertation explore themes of access to health care and priority setting to improve access via outreach and financial risk protection for the most vulnerable populations. Within these programs, they specifically tackle interventions aimed at increasing access to health services, whether by improving coverage for services or financial risk. These interventions include programs involving managers of health programs targeting underserved populations, beneficiaries of social health protection schemes for the poor, and patients with NCDs in lower-middle-income countries. An examination of service coverage for mothers and children analyzes how health programs achieve increased levels of immunization by decreasing physical barriers to accessing care; another set of analyses consider how social health protection schemes can be most effective in reducing barriers to accessing health services. They employ methods within the realms of economic evaluation and decision sciences, including statistical analysis, structural equation modeling, and Markov modeling for cost-effectiveness analysis, to support priority setting and decision making for effective policy towards UHC.

1.2.1 PAPER 1

Immunization remains one of the most effective interventions to reduce maternal and child morbidity and mortality and, though considered an essential health service by the World Health Organization, fails to reach every mother and child in LMICs [24, 25]. Countries around the world have implemented various health programs aimed at increasing child immunization coverage. While a number of studies focus on the optimal approach to a program's offered package of services, less attention is given to local operations and implementation. In particular, there is limited understanding on how decision making among local actors, who run daily operations, ultimately affects overall performance of health systems in reaching their coverage goals. Given the persistent challenges of achieving goals for child immunization worldwide, there may be opportunities for enhancing existing systems to realize improvements with existing resources. Paper 1 attempts to

understand how a local manager's ability to make decisions is related to achieving specific program aims and what that might mean for programs and policy.

Using a structural equation model informed by the literature on 'decision space' in health systems, Paper 1 examines whether the decentralized management structure of India's intensified immunization program and its capacity to reach previously unimmunized children were related. Bossert's decision space approach provides a framework for systematically analyzing decentralization in terms of the range of effective choice, or decision space, wielded by local officials [26]. The analysis extends current approaches to contribute to the literature on how decision space and its related dimensions affect health system performance. Using survey data collected from interviews with managers across districts, sub-districts, and facilities tasked with implementation of Intensified Mission Indradhanush (IMI), this study conducts an in-depth examination of the decision space, institutional capacities, and accountability mechanisms functioning within IMI in India and assesses how these features relate to measurable performance of the immunization program.

1.2.2 PAPER 2

Achieving high levels of financial risk protection is another indication of adequate access to health care and continues to be an objective of health systems [9]. Despite establishing comprehensive social health protection schemes, some countries experience low claims of the entitlements provided through these schemes. As a result, in effect, the schemes are not reaching their ultimate potential to provide financial risk protection. This is the case in Cambodia. Policymakers and others have suggested that unexpectedly low utilization of HEF among beneficiaries may be due to a lack of awareness and understanding of the benefits of HEF. The extent to which HEF beneficiaries are aware of their entitlements under HEF remains unclear as does any relationships that exist between beneficiary awareness of entitlements, care seeking behavior, and user claims of benefits in this setting.

Paper 2 addresses this research gap, examining the relationships between patients' awareness of their benefits and their utilization of them in Cambodia. It aims to understand the role of user knowledge in care seeking and utilization in Cambodia by first comprehensively describing patient awareness of benefits and characterizing the role of awareness at each step of utilization (e.g., care seeking, utilization, and claim of HEF entitlement), and second, simulating hypothetical policy scenarios to identify effective interventions with

respect to beneficiary awareness. Study findings can help to improve the effectiveness of policies aiming to improve access to financial coverage for the poorest.

1.2.3 PAPER 3

With the increasing burden of expensive non-communicable diseases, health policies will need to establish efficient and equitable policies that reduce financial barriers to accessing routine health services for the poor. In Cambodia, diabetes caused nearly 3% of the country's mortality in 2016 and became the fourth highest cause of disability in 2017 [11, 19, 27]. Despite existing guidelines that public health facilities should offer diabetes screening and treatment, the majority of the population access diabetes-related care in the private sector, known to have high costs and remain largely inaccessible to the poor [28, 29]. To date, little is known about the extent to which the diabetes burden and subsequent care seeking for the disease contribute to catastrophic health expenditures among the poor. Similarly, the possible health and financial benefits of investments in effective service and financial coverage for diabetes-related services remain unclear in Cambodia.

With the aim of measuring the impacts on health and financial risk protection in a scenario in which such services were available through the public sector, Paper 3 presents a Markov model of the diabetes disease trajectory and cascade of care in the Cambodian health system. Using economic evaluation, the study then explores the potential economic costs, health gains, and financial risk protection benefits associated with effective service and financial coverage of diabetes-related care in the context of Cambodia's social health protection scheme, HEF [23]. Diabetes was selected as an NCD to focus on because of its clear definition, need for routine management, cost implications, and rapidly increasing burden in lower-middle-income countries. Study findings can point to the country's next steps in identifying potentially cost-effective policies to tackle the increasing health and economic burden of diabetes among the most vulnerable of Cambodia's population.

2

Examining the Decision Space of Local Health Managers to Reach the Unimmunized

2.1 BACKGROUND

2.1.1 DECENTRALIZATION, LOCAL GOVERNANCE, AND HEALTH SYSTEM PERFORMANCE

DRIVEN BY A CONVERGENCE OF POLITICAL AND ECONOMIC FACTORS in the late 1980s, major international development agencies advocated for decentralization reforms in health sectors as a means to improve its responsiveness, efficiency, and quality of services in low- and middle-income countries (LMICs) [30]. Popular

theoretical and normative arguments of local governance highlight the purported benefits of decentralization for public administration, local fiscal issues, and social capital [26]. Proponents argue that this mix of local flexibility and citizen accountability creates conditions for better allocation of resources, more efficient use of resources, and improved equity in public spending to result in greater access to health care and improved population health [26, 31, 32]. The published literature further acknowledges that the effectiveness of decentralization to achieve health system objectives depends on an adequate endowment of financial resources, institutional capacities to manage changing processes, and genuine accountability of local authorities to the interests of their constituents [33–38]. The necessity of each of these elements in realizing the effectiveness of decentralization reforms, and the degree to which the nature of relationships between elements may vary, emphasizes the complexity of tracking and understanding decentralization processes and their cascading effects. This complexity also results in challenges to conducting rigorous quantitative research on the impact of decentralization [39].

Despite widespread adoption of decentralization reforms, the impact of decentralization on health system attributes, such as access to health services, responsiveness to population health needs, and effectiveness in affecting health outcomes, remains unclear. A recent systematic review of studies on the effects of decentralization on health system performance reported mixed findings [39]. These mixed findings were attributed to the different ways in which researchers understood decentralization concepts and operationalized outcome measures [39]. Decentralization was conceptualized as the degree of control over fiscal resources, the timing of decentralization, the adoption of a decentralization framework, and the degree of mobilized health resources. Measures of health system performance included the change in the population of low-income individuals covered by public health insurance, delivery in health facilities, utilization of skilled birth attendants, coverage rates of immunization and complete immunization status among children, utilization of preventive and outpatient services, and out-of-pocket health expenditures. Specific country contexts and decentralization designs may also make measured effects relevant only to study settings. As a result of these varying approaches, the evidence remains inconclusive about the impact decentralization has on the performance of health systems.

The complex nature of the relationships between decentralization and health system inputs, performance, and outcomes makes it difficult to isolate and faithfully track the impact of decentralization reforms on health

system performance. Dwicaksono and Fox proposed a pathway linking decentralization with health system performance, and ultimately, health outcomes [39]. In their framework, decentralization policy dictates the decision space of decision makers in the health system, which subsequently allows for actors' decisions over finance, service organization, human resources, access rules, and governance rules [26]. Bossert defines 'decision space' as the degree of choice that local authorities exercise across the functional areas of the health system [26]. These choices determine inputs into the health system that result in health system performance and affect health outcomes at the individual or population level [39]. Addressing the issues presented above resulting from unstructured approaches to research on decentralization, Bossert's decision space approach provides a framework for systematically analyzing decentralization in terms of the range of effective choice, or decision space, wielded by local officials [26].

Evidence from previous studies of decision space in LMICs showed that different local-level health officials experience varying degrees of decision space despite seemingly uniform decentralization mandates [40]. This suggests that formal indications of decentralization may not be implemented in practice, emphasizing the importance of context in order to appropriately understand the impacts of decentralization. Determining the decision space of certain health functions (e.g., strategic and operational planning, service organization, governance, etc.) may also point to similar decision space across related functions, such as budgeting, human resource management, and service delivery, all of which have been shown to be significantly correlated with each other [41?]. If such is the case, understanding the decision space of a single or few health functions may hint at similar decision space across functions for health services delivery.

Many studies emphasize the relevance of decision space, yet other organizational features have been shown to be critical in affecting how decision space ultimately impacts health services delivery. Studies consistently point to the necessity of adequate capacity and accountability to effectively exercise decision space towards achieving desired outcomes [34, 42–44]. Bossert and Mitchell first outlined how decision space and institutional capacities tend to coincide with one another across health functions [34]. In a case study of Pakistan, they showed how institutional capacities can enable effective decision-making while increasing officials' ability to effectively respond to local priorities (Figure 2.1). They also showed that accountability motivated capacity building and can encourage appropriate priority setting and decision making. They did not find evidence of relationships between decision space and accountability, however, and suggested that such a find-

ing may be expected in cases in which local decision makers for health remain independent - for example, as government-employed administrators who do not share powers with elected officials.

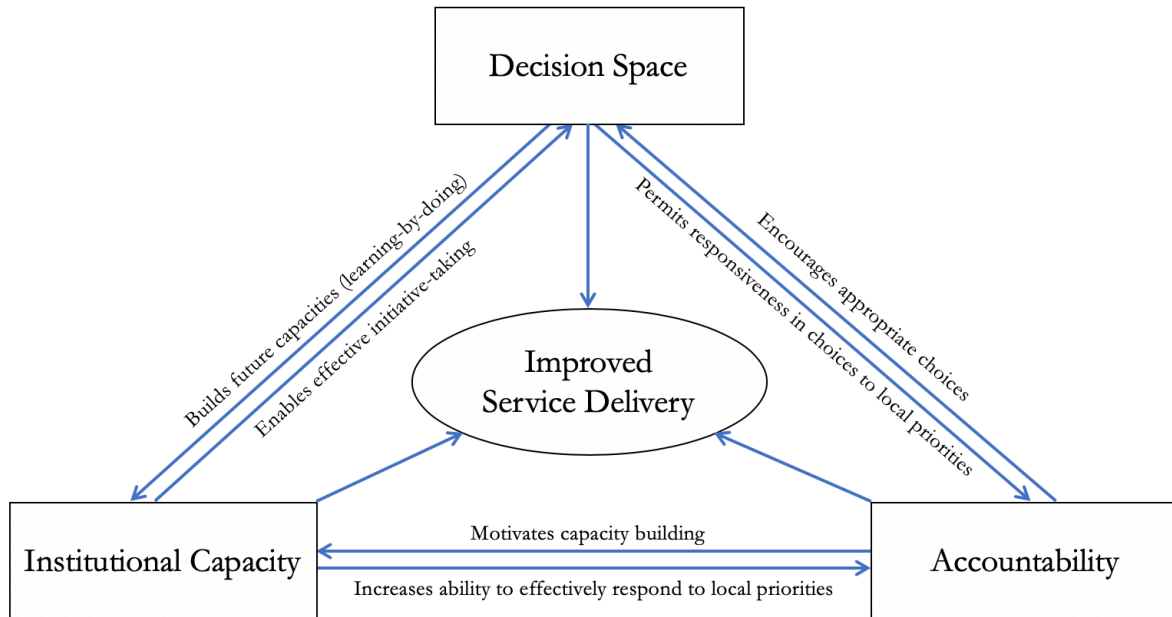


Figure 2.1: Conceptual framework of synergies between decentralization and service delivery
Source: Bossert & Mitchell (2011) [34]

Other studies build on the evidence for synergies across the decision space, capacity, and accountability dimensions. In Kenya, without relevant capacity building among priority-setting actors, reforms that aimed to share power and resources across regions to remedy historical inequities failed to meet objectives for community health care and, instead, succumbed to political interests [45]. Liwanag and Wyss argued that changes in decision space should be accompanied by necessary adjustments in capacities and accountability for good decision-making in order to optimize decentralization of the health system in the Philippines [46]. Despite increasing evidence for the significance of the synergies across framework dimensions, few articles explicitly address the interdependent relationships between decision space, institutional capacities, and accountability or detail the nature of these relationships [47]. More investigation exploring the nature of decision space and synergies between these dimensions for health system performance is needed. Innovations in approaches can further this area of research and our understanding of how to improve the delivery of health services.

2.1.2 IMPACTS OF DECENTRALIZATION ON CHILDHOOD IMMUNIZATION

While studies have highlighted that assessment of health system performance through macro-level indicators at the national level, useful information could come from restricting analyses to lower levels [44, 48]. A health program may be representative of the larger health system in many respects, to the extent that it engages financial and human resources from the same pools and operationalizes tasks using similar organizational structures. Studies examining the impact of decentralization on childhood immunization have been conducted and may reveal the broader effects of decentralization on public service provision, providing a means for testing its theoretical benefits [49].

In his study examining the impact of political decentralization on childhood immunization across 138 countries, Khaleghian found that decentralized countries have lower coverage rates than centralized countries, explaining that local political control on services that have public goods characteristics and inter-jurisdictional externalities may have negative impacts [49]. One explanation offered for these findings was that, without sufficient central direction to make immunization a health priority, local authorities may face a greater diversity of demands from the local community, driving negative impacts on immunization coverage. Another explanation focuses on the changing accountability structure between centralized and more decentralized settings: because health services, including immunization, are among the most visible manifestations of government presence at the local level, these services may be a key focus of public demands in low-income countries where fewer public services are offered. Indeed, each of these phenomena may be at play.

Studies of the decentralization of Indonesia's health system again emphasize the importance of good capacity and capability of local governments in achieving sufficient immunization coverage. Through their study of immunization status following fiscal decentralization, Maharani and Tampubolon showed that such reforms failed to improve the efficiency, quality, and equity of health services delivery. When increasing local discretion over funds also failed to improve outcomes, the wide variation in how budgets were used led authors to conclude that local capacity to manage budgets according to local needs was paramount in achieving reform objectives [42]. Taken together, these studies highlight key features of the decision space framework - decision space, accountability, and capacity - and their critical roles in health system performance.

2.1.3 STUDY OBJECTIVE

Extending current approaches to support research of how decision space and its related dimensions affect health system performance, this study conducts an in-depth examination of the decision space, institutional capacities, and accountability mechanisms functioning within the Intensified Mission Indradhanush (IMI) in India and assesses how these features relate to measurable performance of the immunization program. Based on the collection of survey data from IMI officials across managerial levels of the program, we quantitatively describe decision space, capacity, and accountability features of program implementation by considering them to be latent constructs driving individuals' perceptions and behaviors. Quantitative estimations of these constructs are then analyzed with respect to the outcomes of the IMI program using a structural equation modeling approach.

2.2 METHODS

2.2.1 CHILD IMMUNIZATION IN INDIA

India has 29 states and seven union territories with a total population of 1.28 billion (66% rural and 34% urban) [50]. Life expectancy at birth is nearly 69 years, while maternal mortality is 174 deaths for every 100,000 live births and the infant mortality rate is 39 deaths for every 1,000 live births [50]. The overall literacy rate of the population is 71% [50]. According to the Constitution of India, the provision of health services is the responsibility of the states. At the national level, the Ministry of Health and Family Welfare (MoHFW) establishes policies and guidelines for the implementation of country-wide programs. The states oversee the implementation and supervision of these various health programs and provide the relevant infrastructure and curative services. The district links state structures and peripheral level structures, such as community health centers, primary health centers, and subcenters within blocks, the administrative units below districts. The districts are responsible for working and coordinating with their states for the implementation and supervision of various programs, including immunization. State and district task forces are responsible for monitoring the national immunization program, called the Universal Immunization Program (UIP) launched in 1985. Within this organizational structure, the extent to which decision space, institutional capacity, and accountability varied across levels of the program was unclear, prompting examination of these features across

district, block (i.e., sub-district), and subcenter (i.e., health facility) levels of implementation.

UIP is tasked with reaching a birth cohort of about 26 million infants and 30 million pregnant women every year. The MoHFW funds the national immunization program, providing technical assistance and policy guidance to the states. UIP currently provides vaccines free of cost to protect against diphtheria, pertussis, childhood tuberculosis, poliomyelitis, measles and neonatal tetanus, hepatitis B, Hib, rotavirus (in selected states), and Japanese Encephalitis (in endemic areas). Despite being operational for over 30 years, UIP has been able to fully immunize only 65% of children in the first year of life. To improve immunization coverage, the MoHFW has implemented various intensification strategies and delivery system strengthening exercises. Its flagship program, Mission Indradhanush (MI), launched in December 2014. MI aimed to fully immunize more than 90% of newborns by 2020 through planned special drives during specified months alongside health systems strengthening initiatives to address equity issues in access to immunization. The program identified and focused efforts in underserved areas with inadequate health services and subsequently, increased full immunization coverage by 6.7% over its first two phases. However, this increase is not sufficient to achieve the objective of full immunization coverage of more than 90% of newborns by 2020. This compelled the initiation of need-based interventions through IMI drives based on comprehensive gap assessments.

IMI was a follow-up program of periodic intensification of the routine immunization (RI) implemented by the Government of India focused on low-coverage districts across India (see Appendix A.2) [15]. The aim of the program was to cover all children missed by the UIP and MI initiatives in select districts and urban cities to achieve 90% coverage by December 2018. These locations were recorded to have low immunization coverage at the time of IMI implementation under the following criteria: (i) estimated number of children who missed DTP₃/Pentavalent₃ > 13,000, or (ii) DTP₃/Pentavalent₃ < 70%. Data identified 170 districts and 17 urban cities to be included in IMI. Additional districts were included in the initiative based on states' requests.

Management of the program was decentralized to district and block levels [15]. Within each selected district or city, a process of microplanning was carried out to identify children with missing doses and outreach to communities to deliver immunization in the community at temporary vaccination sites during one week of each month for four consecutive months. Microplanning involved stakeholders at the district, block, and subcenter levels. Auxiliary Nurse Midwives (ANMs) posted at subcenters prepare a list of areas within their

subcenter catchment area requiring additional sessions under IMI and revise this list as needed in consultation with the block medical officer in-charge (MOIC). This list was then reviewed and finalized at the district level by the District Immunization Officer (DIO). Led by the national government, a monitoring framework replicating the polio accountability system was established to oversee IMI activities at the state, district, and block levels. Task forces for immunization at the state, district, and block levels were formed for regular planning and review of the routine immunization program, also tasked with oversight of IMI. Monitoring data was intended to be fed back to block, district, and state task forces for immediate corrective action and to guide programmatic decision making.

IMI consisted of four rounds of immunization conducted between October 2017 and January 2018. Each immunization drive was spread over seven working days with the exception of holidays, Sundays, and routine immunization days already planned. After the completion of these rounds, states were expected to undertake measures to sustain the gains achieved, thereby strengthening the RI system.

2.2.2 DATA COLLECTION

To assess decision space and its related dimensions of capacities and accountability structures, key informant interviews were conducted in a sample of IMI districts between July 2018 and January 2019. Five states with high concentration of IMI activity (Assam, Bihar, Maharashtra, Rajasthan, and Uttar Pradesh) were selected for inclusion in this study. Within these five states, 34 districts and six urban areas were selected. In Uttar Pradesh and Maharashtra, urban areas were selected at random. In Bihar and Rajasthan, IMI was conducted in only one urban district, both of which were included in this study. No urban districts in Assam were selected for IMI. To select rural districts within states, districts were grouped into divisions and divisions were selected at random using probability proportional-to-size (PPS) sampling. Within districts, a rule of selecting 30% of blocks at random was used. Within blocks, a rule of selecting 10% of subcenters at random was used. This process resulted in a total of 90 selected blocks and 289 selected subcenters.

Questionnaires were developed specific to district, block, and subcenter levels (see Appendix A.3). As this study was one component of a larger study assessing the cost and efficiency of the IMI program, these questionnaires were an addition to data collection activities. Data collectors were trained in best practices of qualitative interviewing, the study objectives, and objective of each question to ensure data quality and

consistency. The DIO, MOIC, and ANM at the district, block, and subcenter levels, respectively, were identified as key informants for the questionnaire. Questionnaires were adapted from past survey tools aimed at assessing decision space [51]. Similar to past studies, they were designed to assess variations in decision space, institutional capacities, and accountability over four types of health functions: strategic and operational planning, financial management, human resource management, service organization and delivery, and governance and/or local participation [34].

The theoretical foundations of decision space and these related dimensions described in Bossert (1998) and Bossert and Mitchell (2011) drove the design of survey questions. For example, questions on strategic and operational planning included, “What specific actions did you take in the development of the final IMI plan?” and questions on governance included, “Did you make changes to IMI planning or implementation based on feedback from your supervisor?” Such questions contributed to characterizing the degree of effective decision space of each respondent. Other questions, such as those inquiring on the training of respondents and frequency of communication with supervisor(s) informed assessments of capacity and accountability, respectively. Questionnaires were pilot tested in the first three districts visited for data collection and accordingly revised for clarity and appropriateness to the Indian context. The instrument also attempted to measure resources (e.g., availability of funds) as well as processes (e.g., programmatic training, supportive supervision, responsiveness to feedback, monitoring and evaluation activities). Questions also inquired about challenges in implementation of the program and engagement with communities being served.

Data collectors gathered information from key informants on the quantity of IMI activities (i.e., training and microplanning meetings, number of IMI sessions, and number of supervision visits) and resources (i.e., staffing of IMI sessions). Output data collected from reproductive and child health (RCH) registers at subcenters included counts of doses by antigen delivered between October 2017 and January 2018, the period of IMI implementation. Interviews were supplemented by IMI forms, microplans, and ANM records. Data from the Demographic Health Survey (DHS) 2015-16 was used to collate indicators for basic vaccination coverage, female literacy, urban and rural distribution, and wealth at the state level. Data was collected using paper forms, from which data was transferred into electronic format within 24 hours of interviews. Data was stored using Kobo Toolbox, a secure cloud-based data storage tool, and extracted from this database into Excel spreadsheets for analysis.

2.2.3 DATA ANALYSIS

OUTCOMES OF INTEREST

Three measures by which to assess performance were selected: (1) number of children vaccinated per session held, (2) number of vaccine doses delivered per session held, and (3) number of IMI sessions conducted as a proportion of planned sessions. Those children receiving vaccinations during the date range of IMI were assumed to have been vaccinated under the program. The number of children vaccinated per session alongside the number of vaccine doses delivered per session were selected as indicators of program efficiency. The number of IMI sessions conducted as a proportion of planned sessions acted as an indication of effectiveness in health planning and implementation. While these were not ideal outcome measures, each of these allowed for some characterization of IMI performance with respect to its objectives at the local level: to reach previously unimmunized children. An ideal indicator of performance would have been some indicator of the degree to which immunization delivery through IMI increased immunization coverage in program areas or the proportion of targeted children reached through IMI activities. At the time of this study, it was not possible to directly obtain such an indicator as it would require full knowledge of specific children reached and unreached by the program. Instead, these indicators provide absolute measures representing efficiency of service delivery in a given context and whether planning activities indeed lead to their successful implementation.

At the subcenter level, the number of children vaccinated per session held was computed using data from the RCH registers, in which ANMs recorded the dates of vaccination by child and antigen. The number of vaccine doses delivered per session held was computed similarly, counting each specific antigen delivered across all children recorded in the RCH register for each subcenter. The number of sessions held was reported by each subcenter as well as aggregated at block and district levels. The number of IMI sessions conducted was reported at each level and it was assumed that the total number of IMI sessions expected would have been the full 28 sessions for each subcenter. In some cases, however, this assumption may not be accurate. As part of the microplanning process, some areas may have initially planned to hold fewer IMI sessions based on need. While this outcome measure indicates the degree to which program areas adhered to the program protocol, it may also indicate the degree to which areas altered plans to fit local needs. Each of these measures have been used in the analyses outlined below subject to data availability by district, block, or sub-

center.

Because only respondents who were working during the implementation of IMI could speak to their roles, responsibilities, and experiences during IMI activities, only data from respondents present during IMI implementation were eligible for analysis. All data analysis was conducted in R (version 3.6.1).

DESCRIPTIVE QUANTIFICATION OF DECISION SPACE, INSTITUTIONAL CAPACITY, AND ACCOUNTABILITY

Using quantitative and qualitative responses collected by the questionnaires, data was coded into dummy variables representing key program indicators falling within the pre-defined domains of the decision space framework (Table 2.1) [26, 34]. Indicators (e.g., development of microplan, partner engagement, supervision of lower levels, etc. for strategic and operational planning) within each domain (e.g. strategic and operational planning, human resources management, service delivery and organization, and governance for the dimension of decision space) were summed for each observation. This mechanical process of scoring by simply counting the report of actions or tasks done removed the potential subjectivity typically inherent in qualitative coding. Summing the indicators within each domain resulted in a ‘domain score’ for each of the domains within each dimension (i.e., decision space, institutional capacity, and accountability). Domain scores were scaled between 0 and 2 for ease of interpretation and comparison within the sample and on the scale of past published literature [34]. A domain score of 0 in ‘strategic and operational planning’, for example, represents low or narrow decision space for decisions within this domain compared to the sample mean. Similarly, a score of 2 in this domain represents high or wide decision space for such decisions compared to the sample mean. For each observation, respective domain scores of each dimension were averaged to result in final composite scores for (i) decision space, (ii) institutional capacity, and (iii) accountability.

Information on respondents’ sociodemographic characteristics was collected, including age, sex, and highest level of education. ‘Institutional capacity’ was defined according to the definition set forth by Bossert and Mitchell as the ability of individuals or systems to perform appropriate functions effectively, efficiently, and sustainably across administrative, technical, and organizational dimensions [34]. Questionnaires collected information on capacity from respondents asking questions on their work experience, training, funding, adoption of technology, and infrastructure of facilities. ‘Accountability’ referred to the structures in place to

ensure that decisions made by non-elected officials (i.e., health managers) responded to local needs for immunization activities [34]. Measures of accountability considered the presence of a supervisor, that supervisor's specific actions over lower levels, and how communities participated in how program decisions were made. Together, these scores provide a quantitative heuristic indication of decentralization that can be compared across and within states, districts, blocks, and subcenters.

To gain an initial understanding of the framework dimensions and program performance, descriptive statistics and correlations between scores, state-level characteristics, and performance measures were analyzed. Correlations between indicators of decision space, capacity, and accountability and reported challenges of IMI implementation were also examined to explore any potential relationships between respondents' decision space, capacities, and accountability and their implementation experience of IMI. Correlations were considered statistically significant at $\alpha < 0.05$.

STRUCTURAL EQUATION MODEL: MEASUREMENT MODEL, SPECIFICATION, AND ESTIMATION

Structural equation modeling (SEM) combines factor analysis and regression analysis to analyze structural relationships between measured variables and latent constructs [52]. In the decision space framework, the dimensions of decision space, institutional capacities, and accountability mechanisms can be considered latent constructs, measured by a set of observed indicators. SEM is a theory-driven approach, requiring a theoretical framework or body of empirical results that form the basis of specification of the model [53]. The framework and literature applying the conceptualization of decision space provide a strong basis that prompts further exploration in this direction. For these reasons, the SEM approach was selected as an appropriate quantitative technique to explore how decentralization dimensions relate to observed metrics of performance. At this stage and given the observational data analyzed, the findings of this analysis do not presume to act as evidence for causation, but rather point towards additional tools to detect key relationships.

Confirmatory factor analysis (CFA), the first step of SEM in this case, uses a hypothesized model to estimate a covariance matrix representing survey respondents, which is then compared to what has been observed [54]. Each latent variable was defined by the corresponding set of discrete observed indicators collected in the survey data to reflect each framework dimension [55]. Sets of the indicators (i.e., items) collected from the survey data that were described to fall within the decision space, institutional capacity, and accountability

Table 2.1: Indicators comprising each framework dimension and domain

DECISION SPACE	INSTITUTIONAL CAPACITY	ACCOUNTABILITY
Strategic and operational planning	Education	Supervisor presence
Development of microplan	Highest educational qualifications obtained	Presence of direct supervisor
Partner engagement		Frequency of communication
Supervision of lower levels	Experience	
Staff training	Years in government service	Supervisor actions
Participation in review meetings	Years in present location	Feedback
Joint/consensus-based decision making		Checked logistics
Changes implemented during IMI	Management training	Checked supplies
<i>Microplan</i>	Number of trainings attended	Checked adherence to microplan
<i>Session site</i>	Ability to solve problems (self-assessed)	Conducted site visit
Community engagement	Sufficient training for role	House to house verification
Human resources management	Funding	Observed service delivery
Re-allocated human resources	Allocated funds	Motivated families
Staff training	Received sufficient funds	Checked registers*
Motivation of staff		
Changes implemented during IMI	Adoption of technology	Community participation
<i>Staff training</i>	Implementation of electronic registers	Influence of community
Service organization and delivery		
Coordination role		
Motivation of staff	Infrastructure*	
Changes implemented during IMI	Electricity	
<i>Session site</i>	Flush or pour toilet	
Changes made to RI	Pit latrine	
<i>Session site</i>	Usable toilet facilities	
<i>Number of sessions held</i>	Running water	
<i>Day of week of session</i>	Separate room for ANC	
<i>Inclusion of households/coverage*</i>	Standalone building	
Governance and local participation	Government/private building	
Supervisory actions	Owned/rented building	

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Table 2.1 – continued from previous page

DECISION SPACE	INSTITUTIONAL CAPACITY	ACCOUNTABILITY
<i>Checked logistics</i>		
<i>Checked supplies</i>		
<i>Checked adherence to microplan</i>		
<i>Conducted site visit</i>		
<i>House to house verification</i>		
<i>Observed service delivery</i>		
<i>Motivated families</i>		
Made changes based on feedback		
Community participation		
* Used for subcenter level only.		
Bolded text indicates domains within dimensions of decision space, institutional capacity, and accountability.		

dimensions in the literature were tested to identify measurement models that made theoretical sense, were reasonably parsimonious, and acceptably corresponded to the data (Table 2.1) [53]. The variance-covariance matrix of model parameters was used to estimate the model. When necessary, the nearest positive-definite covariance matrix was approximated using the Higham algorithm (2002) for computation of CFA results [56]. Based on the theory describing institutional capacity, educational qualifications are often included in the set of questions characterizing an assessment of capacity. For this reason, this indicator was included in the procedure determining which questions comprised the latent construct of capacity. However, as described in the study results, this indicator was ultimately not included as an item loading onto the variable of institutional capacity.

A regression model accounting for the interrelationships between the three latent variables defined by factor analysis - decision space, institutional capacity, and accountability - was specified to determine the relationship between these variables and outcomes of interest. Specification of the model followed the representation as shown in Figure 2.2, rooted in the theoretical foundations of decision space. In this simple structural model, decision space, institutional capacity, and accountability act as three separate latent variables that directly influence program performance. As noted in the SEM literature, however, it is possible that a number of equivalent or near-equivalent models exist for the same data. For this reason, equivalent and/or near-equivalent models were evaluated and discussed as potential representations of the relationships in question. Alternative models included one-factor models in which the decision space, institutional capacity, and accountability constructs were combined into a single latent variable, consideration of block-level and subcenter-level factors as separate latent variables, and the specification of indirect effects through latent constructs or between block and subcenter levels.

SEM techniques are well-known to require large sample sizes to support the robustness of findings. Due to concerns related to sample size and missing data, only block and subcenter levels were included for analysis using SEM techniques. For simplicity, models were assumed to be recursive, meaning that error residuals are uncorrelated and any effects are unidirectional without feedback loops [53]. Using the lavaan R package, maximum likelihood estimation was used to estimate the model [53]. Model fit was assessed using the Tucker-Lewis index (TLI), comparative fit index (CFI), and root mean square error of approximation (RMSEA), reported as relevant criteria for categorical data [54]. TLI and CFI values greater than 0.90, and RM-

SEA values below 0.08 were considered an acceptable fit [54].

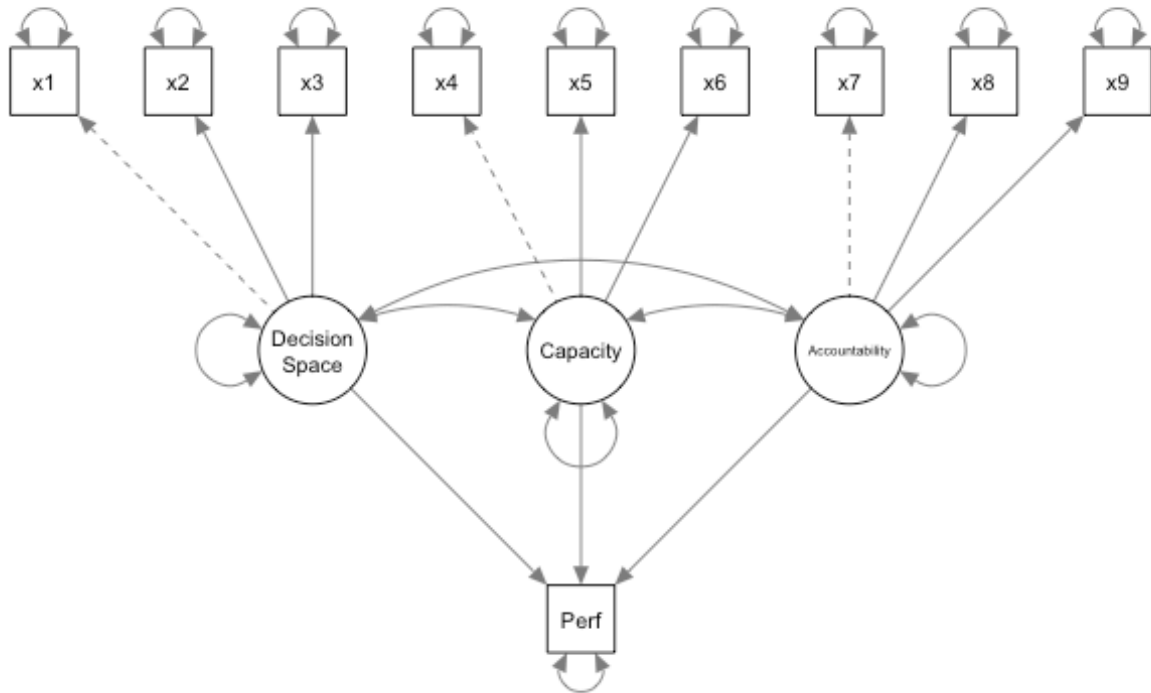


Figure 2.2: General structure of structural equation model relating framework dimensions to performance. Latent factors are presented in circles. Measured observed variables are presented in rectangles. Connecting lines indicate interconnected variables. Single-headed arrows indicate directed relationships. Double-headed arrows indicate undirected relationships, representing variances (if the line curves back from a variable to itself) or covariances (if the line curves from one variable to another). Dashed lines indicate the reference item by which values associated with other items are scaled for a variable.

2.2.4 ETHICAL CLEARANCE

Ethical approval for this study was received from the Institutional Review Board at the Harvard T.H. Chan School of Public Health.

2.3 RESULTS

2.3.1 PROFILE OF RESPONDENTS

A total of 24 districts, 61 blocks, and 279 subcenters were included for analysis. District-level managers tended to be older than at block and subcenter levels. All respondents at the district and block levels completed at least graduate level education. There was an increasing trend in the duration of government service from subcenter to district levels. At the district and block levels, men primarily held the DIO and MOIC roles, respectively, while all of the ANMs interviewed were female. Most often, respondents' roles in IMI involved development of the microplan in some way. Higher levels were more often involved in supervisory and coordination activities as well as partner (i.e., departmental stakeholders or international agencies) engagement, while subcenter managers interacted with communities more often. Nearly all district-level managers participated in IMI review meetings during its implementation. However, fewer block-level managers were involved in these meetings. A majority of respondents described a joint or consensus-based process of decision making regarding IMI implementation as opposed to consulting others for a final decision. Nearly all respondents indicated having a direct supervisor and communicating with that supervisor nearly everyday.

Table 2.2: Summary of survey responses by level

Indicator	District N = 24 (%)	Block N = 61 (%)	Subcenter N = 279 (%)
State			
Assam	4 (16.67%)	3 (4.92%)	28 (10.04%)
Bihar	3 (12.50%)	9 (14.75%)	44 (15.77%)
Maharashtra	4 (16.67%)	11 (18.03%)	60 (21.51%)
Rajasthan	3 (12.50%)	10 (16.39%)	30 (10.75%)
Uttar Pradesh	10 (41.67%)	28 (45.90%)	117 (41.94%)
Age (mean, years)	51.5	45.2	41.8
Sex			
Male	21 (87.50%)	55 (90.16%)	0 (0.00%)
Female	3 (12.50%)	6 (9.84%)	279 (100.00%)
Education			
Secondary school	0 (0.00%)	0 (0.00%)	123 (69.53%)
Graduate	15 (78.95%)	53 (86.89%)	68 (24.46%)
Post-Graduate	4 (21.05%)	8 (13.11%)	16 (5.76%)
Years in government service, mean	22.4	16.2	15.0

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Table 2.2 – continued from previous page

Indicator	District N = 24 (%)	Block N = 61 (%)	Subcenter N = 279 (%)
Years in present location, mean	11.75	6.1	7.8
Training received to implement IMI			
IMI microplanning and reporting workshop	17 (77.27%)	49 (84.48%)	7 (2.72%)
IMI communication session	9 (40.91%)	14 (24.14%)	0 (0.00%)
AEFI protocol training	5 (22.73%)	6 (10.34%)	0 (0.00%)
BRIDGE IPC skills training	3 (13.64%)	7 (12.07%)	16 (6.23%)
Media spokesperson training	3 (13.64%)	2 (3.45%)	0 (0.00%)
CSO orientation	1 (4.55%)	2 (3.45%)	0 (0.00%)
Health workers training	1 (4.55%)	3 (5.17%)	241 (93.77%)
Mobilizers training	1 (4.55%)	2 (3.45%)	16 (6.23%)
Sufficient funds allocated to district			
Yes	14 (58.33%)	38 (63.33%)	-
No	5 (20.83%)	15 (25.00%)	-
Don't know	5 (20.83%)	7 (11.67%)	-
Role in IMI planning			
Microplan development	16 (66.67%)	40 (65.57%)	213 (76.90%)
Training	7 (29.17%)	16 (26.23%)	0 (0.00%)
Supervision	4 (16.67%)	10 (16.39%)	0 (0.00%)
Coordination	11 (45.83%)	22 (36.07%)	0 (0.00%)
Partner engagement	13 (54.17%)	2 (3.28%)	0 (0.00%)
Community engagement	5 (20.83%)	13 (21.31%)	110 (39.71%)
Participated in IMI review meetings	23 (95.83%)	45 (76.27%)	-
Decision making process			
Joint decision	10 (43.48%)	19 (42.22%)	-
Others made final decision	9 (39.13%)	12 (26.67%)	-
Supervisor actions received			
Reviews microplan	10 (41.67%)	29 (51.79%)	169 (62.13%)
Provides feedback	12 (50.00%)	18 (32.14%)	2 (0.74%)
Conducts site visit	12 (50.00%)	27 (48.21%)	51 (18.75%)
Checks supplies	-	13 (23.21%)	133 (48.90%)
Conducts house verification	-	6 (10.71%)	57 (20.96%)
Motivates families	-	3 (5.36%)	95 (34.93%)
Motivates staff	-	7 (12.50%)	-
Checks logistics	-	-	47 (17.28%)
Observes service delivery	-	-	42 (15.44%)
Checks register	-	-	38 (13.97%)
Frequency of supervisor communication			
Almost daily	14 (58.33%)	40 (71.43%)	257 (93.12%)
2-4 times per week	5 (20.83%)	14 (25.00%)	6 (2.17%)
About once a week	2 (8.33%)	0 (0.00%)	4 (1.45%)
Less than 1 time per month	3 (12.50%)	0 (0.00%)	3 (1.09%)
Reported community participation	7 (29.17%)	8 (13.11%)	51 (18.35%)

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Table 2.2 – continued from previous page

Indicator	District N = 24 (%)	Block N = 61 (%)	Subcenter N = 279 (%)
Reported changes to RI			
Sites added	13 (56.52%)	19 (43.18%)	13 (9.70%)
Sessions added	2 (8.70%)	9 (20.45%)	35 (26.12%)
Additional households included in RI	2 (8.70%)	13 (29.55%)	69 (51.49%)
Improved follow up	6 (26.09%)	2 (4.55%)	3 (2.24%)
Adoption of electronic RCH registers			
Fully implemented	13 (54.17%)	45 (73.77%)	-
Began implementation	9 (37.50%)	11 (18.03%)	-
Have not started	1 (4.76%)	4 (7.55%)	-

Of the total 40 districts, 91 blocks, and 281 subcenters where data was ultimately collected, 24 districts (60%), 61 blocks (67%), and 279 subcenters (97%) were eligible for inclusion in this analysis. To be eligible for this analysis, respondents needed to have been involved in IMI. Reasons for non-inclusion included (i) being new in the DIO, MOIC, or ANM position, (ii) unavailability, absence, or refusal for interview, or (iii) not being involved in IMI implementation. The reduced proportion of respondents at the district and block levels reporting having been involved in IMI suggests that there is considerable turnover or migration in roles and/or stations at these levels. Fewer changes in human resources seems to happen at lower levels of implementation. At subcenters, most often, interviews could not be conducted because the ANM was too busy providing services during the time of the research team's visit. As expected due to its size and over-representation in the IMI program, sites in Uttar Pradesh comprised most of the sample.

Of those 24 districts eligible for analysis, 2% of data was missing with only 2 observations missing responses to as many as 3 or 4 questions. Observations eligible for analysis at the block level were missing 7% of data for the sample, while 9% of data was missing for the eligible subcenter observations. At the subcenter level, the majority of missing data was for the performance indicators of number of children vaccinated and number of vaccine doses delivered per session; 55% of subcenter observations were missing data for these performance measures. This data was gathered from the RCH registries, suggesting that not all subcenters consistently and routinely record this information as expected. For other data collected at the subcenter level, only 2% of the data for analysis was missing.

2.3.2 SUMMARY OF DECISION SPACE AND PERFORMANCE

Across district, block, and subcenter levels, the mean scores for institutional capacity and accountability hovered fairly close to 1 (moderate), indicating similar patterns for these dimensions across units within levels (Table 2.3). Because scores were scaled between 0 and 2, scores below 1, as was the case for decision space in districts and blocks, means that the difference between those reporting the highest levels of decision space and the average district or block was notable. Such results suggest that there were select districts and blocks with significantly higher decision space than others, but that the majority indicated lower decision space. Within the decision space dimension, human resources management was shown to have the lowest score. Institutional capacity as measured by experience in government service and length of time stationed in the respondents' present location was lower within block and subcenter levels compared to other indicators of capacity. The majority of subcenters reported high levels of supervision as measured by having a direct supervisor and frequency of communication, while community participation to the extent that it influenced IMI operations and implementation strategy remained relatively low across levels.

Table 2.3: Mean composite scores for dimensions and domains by level

Dimension / Domain	District N = 24	Block N = 61	Subcenter N = 279
Decision Space	0.70	0.67	0.97
Strategic and operational planning	0.89	0.85	1.16
Human resources management	0.37	0.37	-
Service delivery and organization	0.65	0.60	0.42
Governance and local participation	0.90	0.84	1.34
Institutional Capacity	1.06	1.08	0.99
Education	1.21	1.13	1.05
Experience in government service	0.96	0.59	0.58
Duration in present location	1.07	0.50	0.70
Additional training	0.92	1.63	1.46
Funding	1.48	1.45	-
Adoption of technology	1.52	1.68	-
Infrastructure*	-	-	1.28
Accountability	1.06	0.89	1.06
Supervision presence	1.56	1.73	1.91
Supervisory actions	1.42	0.74	0.93
Community participation	0.58	0.26	0.37

Note: Scores have been scaled for within-level comparisons only.

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Table 2.3 – continued from previous page

Dimension / Domain	District N = 24	Block N = 61	Subcenter N = 279
*Rural subcenters only			

Comparison of levels of decision space, capacity, and accountability measured across districts, blocks, and subcenters revealed variation by states, with the largest detected variation at the district level (Figure 2.3). At the district level, managers located in Rajasthan consistently reported lower scores on dimensions compared to those of other states. Respondents in Maharashtra consistently reported higher levels of dimensions, alongside managers in Assam. However, it is notable that the sample size at the district level was small. Analyses at the block level showed that managers in Rajasthan again reported lower levels of accountability, but respondents in Uttar Pradesh reported the lowest levels of decision space and institutional capacity. Results showed that subcenters had the least variation in framework dimensions as the interquartile range of estimates for each subcenter largely overlapped across states.

Regarding performance measures, the majority of districts and blocks reported vaccinating nearly all target beneficiaries identified in their catchment area. When examining all states together, the distribution of proportion of target children vaccinated appears similar; however, examination by state reveals differences (see Appendix A.4, Figure A.4.1). It should be noted that the sample sizes within states are considerably lower for those other than Uttar Pradesh. At the block level, a mean of nearly 91% of target children were reported to have received vaccinations during the four months of IMI. Subcenters completed a median of 39.3% (IQR 14.3%-96.4%) of the 28 planned IMI sessions. Analyzing the proportion of planned IMI sessions completed by state, however, reveals that the majority of respondents indicating having completed all sessions was in Uttar Pradesh, the state that makes up the majority of the sample (Figure 2.4). Limited between-state variability on this performance measure may highlight considerable contextual differences in Uttar Pradesh compared to other states and is important to recognize when interpreting the results of this analysis.

Trends for the number of children vaccinated per IMI session held were fairly similar with somewhat greater stability of estimates in Rajasthan and Uttar Pradesh (see Appendix A.4, Figure A.4.2). Blocks reported vaccinating a mean of over 9 ($\sigma = 5.4$) children and delivering a mean of over 14 ($\sigma = 11.0$) different vaccines per IMI session. The number of vaccine doses delivered per IMI session held were less consistent across levels and states (see Appendix A.4, Figure A.4.3). Overall, there were notable differences in estimates

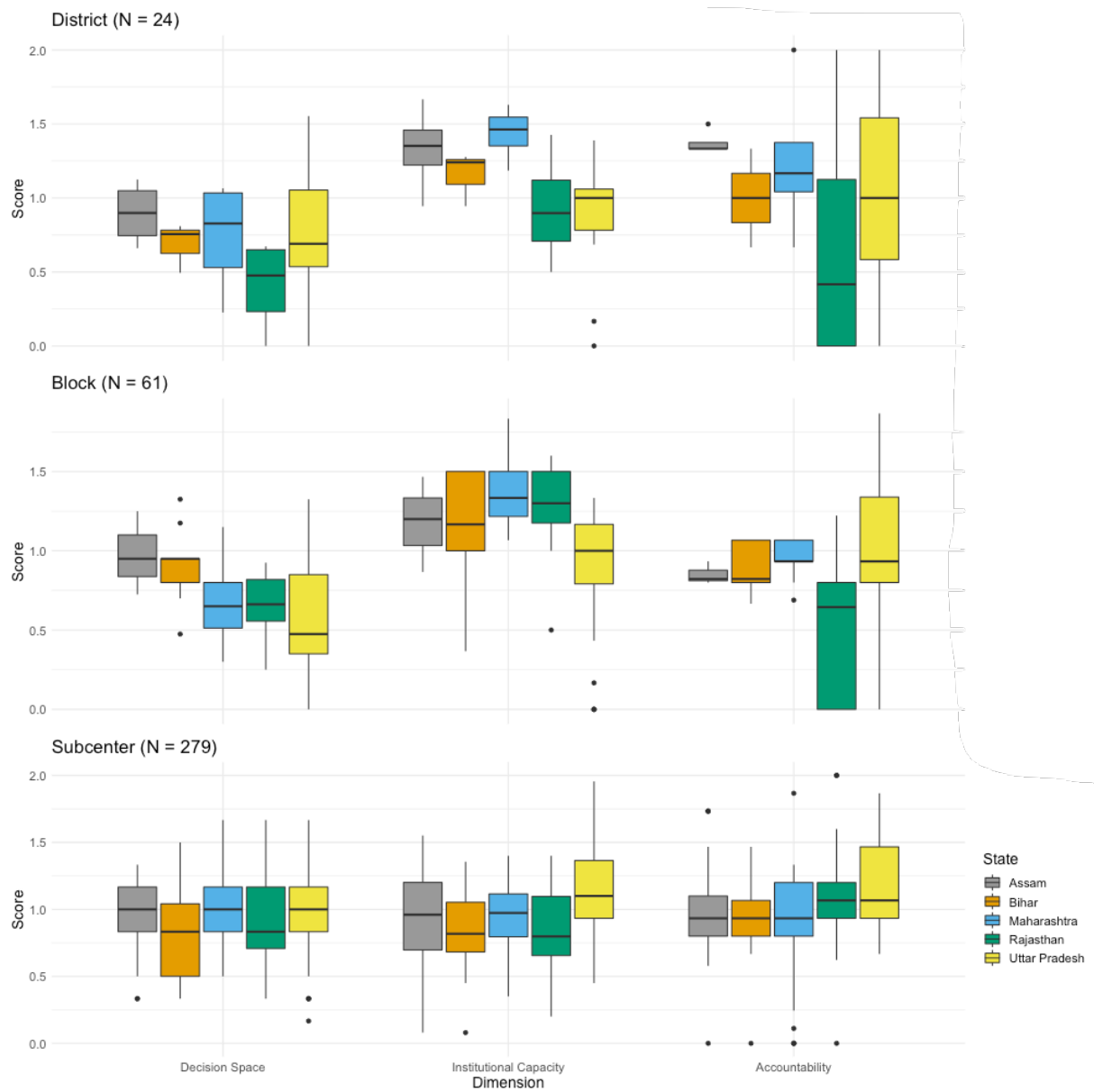


Figure 2.3: Decentralization scores by dimension and state

of performance measures by state and level at which data was collected. In states providing a larger sample size, the distributions of performance measures show greater overlap.

At the district level, dimensions of decision space, institutional capacity, and accountability were not correlated with measures of performance. However, individual indicators within dimensions were highlighted. Education ($\rho = 0.50, p = 0.03$) and number of years in government service ($\rho = 0.49, p = 0.02$) were correlated with the number of children vaccinated per session. Block-level analysis showed notably different

results.

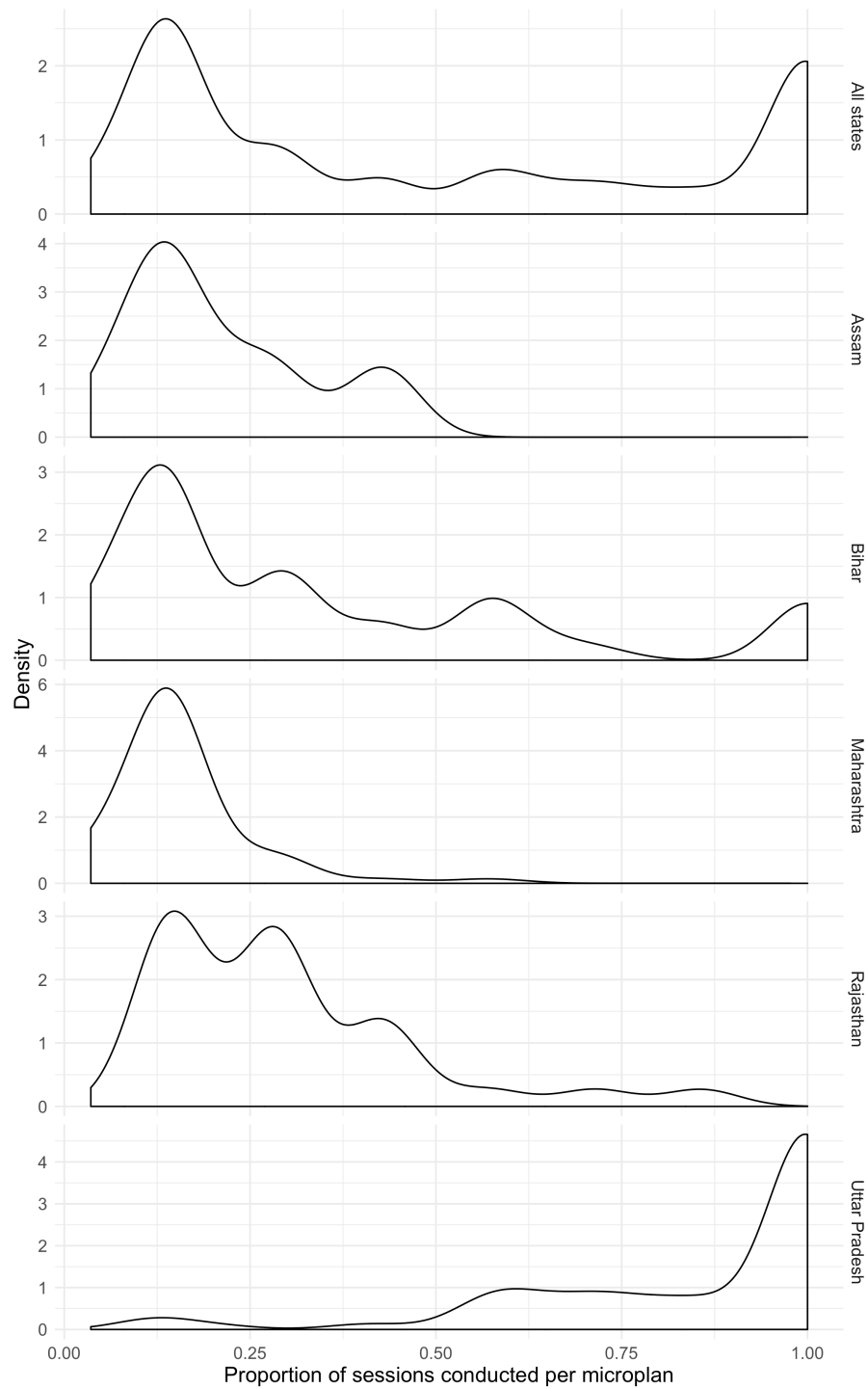


Figure 2.4: Density plot of the proportion of sessions conducted per IMI microplan by state based on data collected at the subcenter level

At the block level, decision space was significantly positively correlated with the number of children vaccinated ($\rho = 0.36, p = 0.008$) and number of vaccine doses delivered per session ($\rho = 0.34, p = 0.01$). Having a supervision presence at the block level was also correlated with the number of children vaccinated per session ($\rho = 0.29, p = 0.03$). Due to data availability, more correlations could be computed using proportion of IMI sessions held as a measure of performance ($n = 275$). At this level, decision space ($\rho = 0.16, p = 0.009$), institutional capacity ($\rho = 0.30, p < 0.001$), and accountability structures ($\rho = 0.32, p < 0.001$) were also highlighted as significantly positively correlated with the proportion of planned IMI sessions held.

Given the diversity of the Indian states, examination of the correlation between framework dimensions and state-level variables allowed for a general picture of potential relationships between broader contextual factors and decision space, capacity, and accountability. DHS indicators in correlation analyses included state-level existing immunization coverage, female literacy rate, percentage of urban areas, and wealth score [57]. District-level institutional capacity was positively correlated with female literacy rates ($\rho = 0.52, p = 0.009$) at the state-level. At the block level, there was greater decision space in poorer areas ($\rho = -0.28, p = 0.03$), while institutional capacity was greater in regions with higher female literacy, urban distribution, and wealth (Figure 2.5). Subcenters with lower decision space ($\rho = -0.14, p = 0.02$), institutional capacity ($\rho = -0.27, p < 0.001$), and accountability ($\rho = -0.22, p < 0.001$) had high existing immunization coverage across the state. This may indeed point to the positive impact of stronger centralization for the delivery of health services that have public goods characteristics, highlighted by Khaleghian [49]. Greater accountability at the subcenter level was also correlated with lower female literacy rates across the state ($\rho = -0.13, p = 0.04$). That statistically significant results arose from these analyses also illustrated that, indeed, detectable variation in decision space, capacity, and accountability exists within states. Nevertheless, there may be underlying factors driving detected correlations that have been hitherto impossible to consider when modeling these dimensions.

2.3.3 ASSOCIATIONS BETWEEN FRAMEWORK DIMENSIONS AND PROGRAM PERFORMANCE

Specification of the model (model A) was guided by the theory set out in Bossert's decision space framework, that the dimensions of decision space, institutional capacity, and accountability each influence service delivery

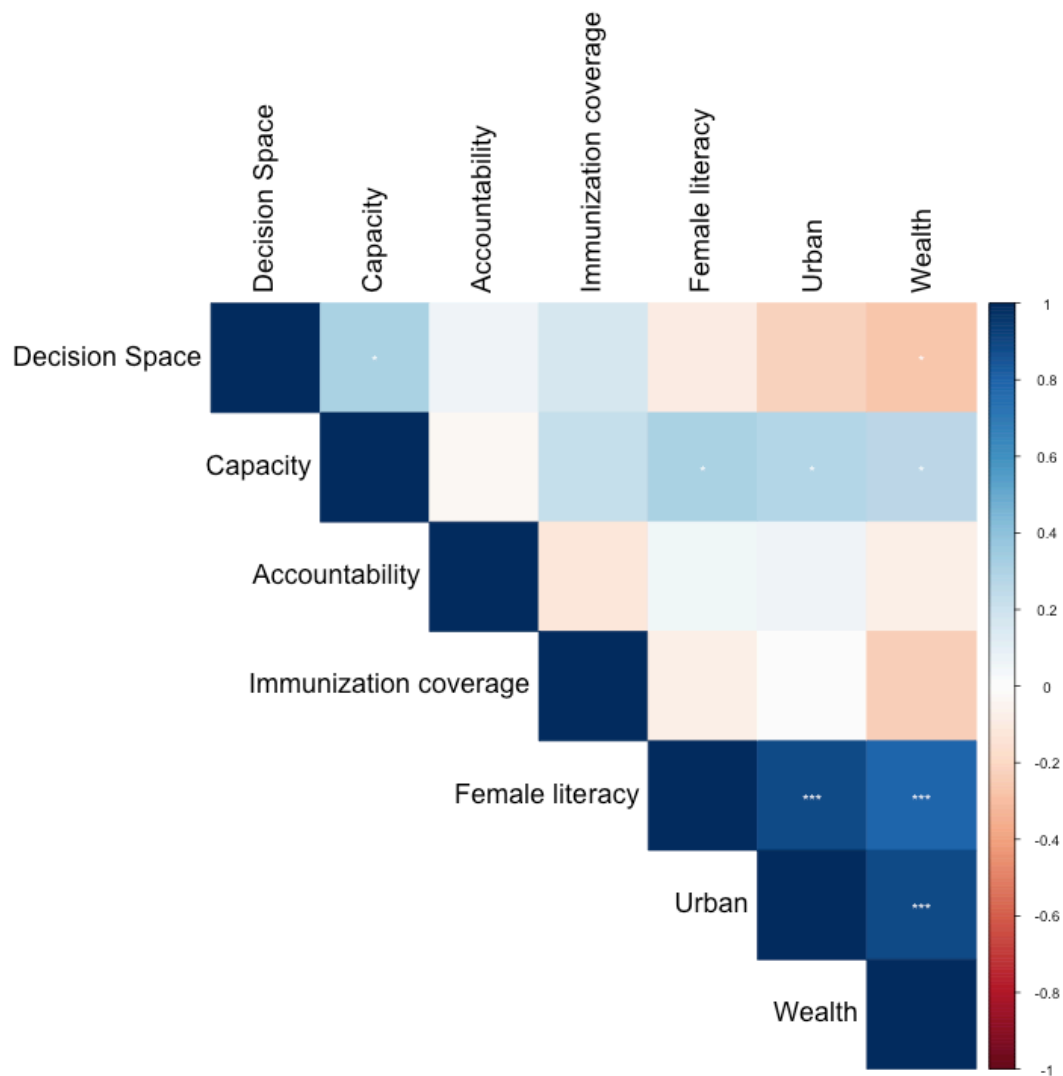


Figure 2.5: Correlation plot between state-level characteristics and block-level dimensions
Blue indicates positive correlation. Red indicates negative correlation. Color intensity indicates the strength of correlation.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

as well as have impacts on each other (Figure 2.1) [26, 34]. For model A, two questionnaire items significantly loaded onto each latent construct (Table 2.4). Based on results of the factor analysis, decision space was de-

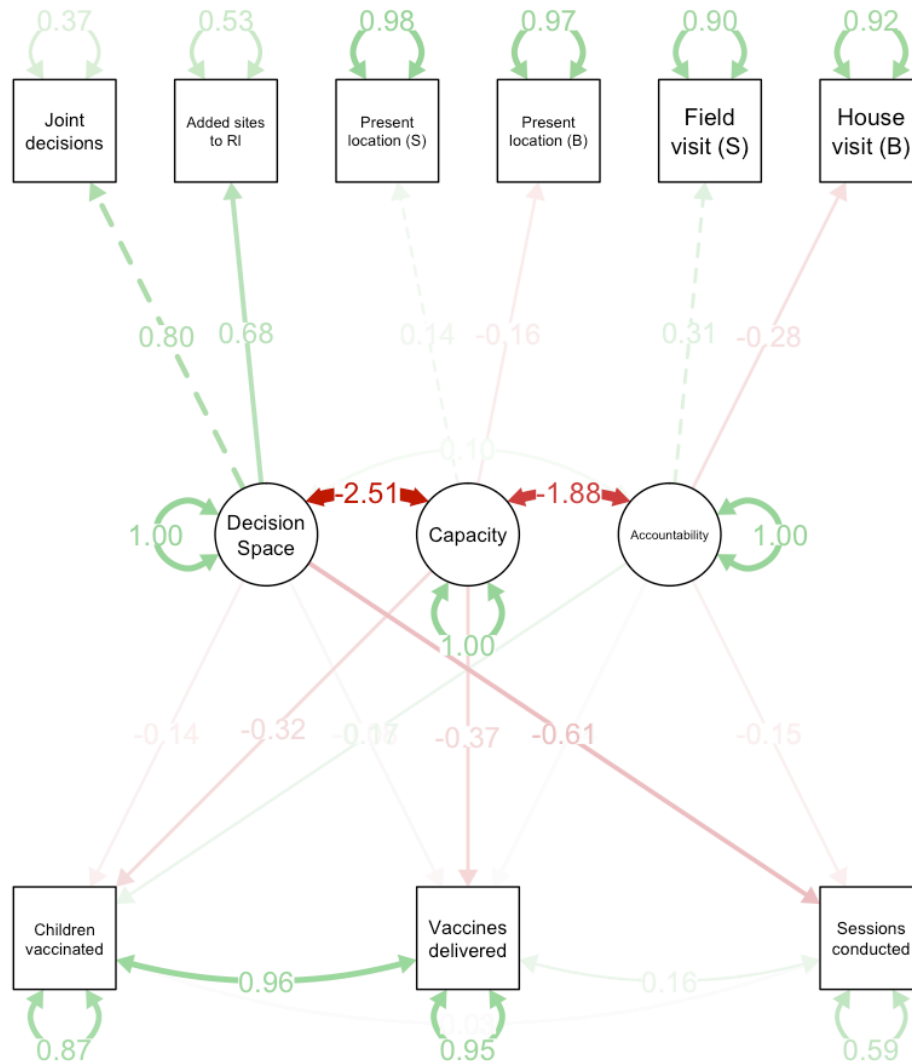


Figure 2.6: Path diagram for structural equation model with standardized estimates, Model A

Variances and covariances between variables are indicated by arrows and noted values. Red arrows indicate negative variances. Green arrows indicate positive variances.

B=Block-level indicators; S=Subcenter-level indicators.

finer by having a joint decision making process in place and having been able to add IMI session sites to the regular RI schedule as a result of the program. Institutional capacity was defined by the time an ANM and

MOIC had spent working in a location, suggesting that experience in the area and familiarity with its context was particularly relevant for this dimension. Because only these two indicators significantly loaded onto the latent variable of institutional capacity, other variables such as age, educational qualifications, and position title were considered sociodemographic characteristics of the respondent and were adjusted for in subsequent models. Accountability was defined by having had a supervisory field visit at the subcenter level and having conducted house visits to verify child immunization through IMI. These definitions differ from those used in other studies, being comprised of fewer indicators (i.e., fewer survey questions).

Three performance measures available at the subcenter level were included in the model, allowing for simultaneous estimation of relationships between the latent constructs of interest and these indicators. As expected, performance measures for the number of children vaccinated and number of vaccine doses delivered per session covary, meaning that the number of children vaccinated increased with increased vaccines delivered. This was accounted for in this specification. Figure 2.6 represents the relationships between variables in the model according to the specification of Model A and highlights the association between these two outcomes. Model results also illustrate the strong interrelationships between decision space and capacity and capacity and accountability. Only a slight association between decision space and accountability was revealed by the model.

The results of model A suggest that increased institutional capacity as measured by length of time staff has been stationed in a particular location is associated with fewer children and fewer vaccines delivered per session. At first glance, this appears to diverge from the theory that increased capacity drives increased outputs. However, understanding the context of IMI may play a key role in interpreting such findings. In this case, it is possible that areas with sufficient capacity to reach targeted children during RI have fewer children to reach during IMI implementation. Still, given that many areas were chosen for IMI due to poor immunization coverage, this may not explain such results in all cases. Institutional capacity was not associated with whether a subcenter completed all 28 IMI sessions. On the other hand, greater decision space was associated with completing fewer sessions than planned.

Controlling for the age, sex, position title, and education of the ANM and MOIC respondents in model A resulted in significant changes in the estimates, shown in Table 2.5. Due to the high correlation between number of children vaccinated and number of vaccine doses delivered per session, only the number of chil-

Table 2.4: Parameter estimates for model A (unadjusted for respondent characteristics)

	Unstandardized			Standardized
	Estimate (SE)	z	p	Estimate (SE)
	<u>Factor Loadings</u>			
<u>Decision Space</u>				
Joint decision making process	1.00 ⁺			0.45(0.80)
Added sites to RI	0.78(0.06)	14.11	0.000	0.35(0.80)
<u>Institutional Capacity</u>				
Time in current location (ANM)	1.00 ⁺			1.06(0.14)
Time in current location (MOIC)	−0.76(0.11)	−6.95	0.000	−0.81(−0.16)
<u>Accountability</u>				
Supervisory field visit (SC)	1.00 ⁺			0.12(0.31)
House verification (Block)	−0.73(0.13)	−5.56	0.000	−0.09(−0.28)
	<u>Regression Slopes</u>			
<u>Children per session</u>				
Decision Space	−2.66(5.58)	−0.48	0.634	−1.19(−0.14)
Institutional Capacity	−2.60(0.91)	−2.85	0.004	−2.75(−0.32)
Accountability	11.94(19.36)	0.62	0.537	1.47(0.17)
<u>Vaccines per session</u>				
Decision Space	−0.65(2.62)	−0.25	0.803	−0.29(−0.08)
Institutional Capacity	−1.23(0.43)	−2.85	0.004	−1.30(−0.37)
Accountability	1.15(8.34)	0.14	0.890	0.14(0.04)
<u>Prop. sessions conducted</u>				
Decision Space	−0.50(0.10)	−5.08	0.000	−0.22(−0.61)
Institutional Capacity	0.00(0.01)	−0.05	0.962	0.00(0.00)
Accountability	−0.46(0.37)	−1.25	0.212	−0.06(−0.15)
	<u>Fit Indices</u>			
CFI	0.98			0.98
TLI	0.95			0.95
RMSEA	0.09			0.09

⁺Fixed parameter

dren vaccinated per session and proportion of IMI sessions completed were included in this model. Controlling for age, sex, position title, and education of the ANM and MOIC respondents under the same model structure reveals no detectable relationship between institutional capacity and the number of children vaccinated per session. Decision space, however, remains statistically significantly associated with the proportion

of IMI sessions conducted in the same inverse direction though to a lesser degree compared to the unadjusted model. It is important to recall that Uttar Pradesh, which made up most of the sample and where decision space was detected to be lower than the average across states, was distinctly different from other states for this performance measure; a notable majority of respondents in Uttar Pradesh reported having completed all planned IMI sessions (Figure 2.4). It is possible that detection of the relationship between decision space and proportion of planned sessions completed is simply representative of these relative extremes across states in the sample.

Table 2.5: Parameter estimates for model A (adjusted for respondent characteristics)

	Unstandardized			Standardized
	Estimate (SE)	z	p	Estimate (SE)
	<u>Factor Loadings</u>			
<u>Decision Space</u>				
Joint decision making process	1.00 ⁺			0.45(0.81)
Added sites to RI	0.78(0.07)	11.79	0.000	0.35(0.69)
<u>Institutional Capacity</u>				
Time in current location (ANM)	1.00 ⁺			1.93(0.26)
Time in current location (MOIC)	-0.23(0.06)	-3.85	0.000	-0.44(-0.09)
<u>Accountability</u>				
Field visit (SC)	1.00 ⁺			0.11(0.27)
House verification (Block)	-1.15(0.24)	-4.68	0.000	-0.12(-0.38)
	<u>Regression Slopes</u>			
<u>Children per session</u>				
Decision Space	-7.92(16.93)	-0.47	0.640	-3.55(-0.41)
Institutional Capacity	-3.08(2.75)	-1.12	0.262	-5.93(-0.68)
Accountability	-17.24(57.52)	-0.30	0.764	-1.84(-0.21)
Age (ANM)	-0.06(0.04)	-1.82	0.069	-0.07(-0.08)
Current position (ANM)	0.23(2.06)	0.11	0.911	0.23(0.00)
Education (ANM)	1.36(0.79)	1.72	0.085	1.36(0.07)
Age (MOIC)	-0.20(0.04)	-5.63	0.000	-0.20(-0.21)
Sex (MOIC)	1.10(1.30)	0.85	0.397	1.10(0.03)
Current position (MOIC)	-4.49(0.74)	-6.04	0.000	-4.49(-0.26)
Education (MOIC)	0.45(0.91)	0.50	0.618	0.45(0.02)
<u>Prop. sessions conducted</u>				
Decision Space	-0.41(0.10)	-3.90	0.000	-0.18(-0.54)
Institutional Capacity	-0.02(0.02)	-0.96	0.336	-0.03(-0.09)
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Table 2.5 – continued from previous page

	Unstandardized			Standardized
	Estimate (SE)	z	p	Estimate (SE)
Accountability	−0.25(0.36)	−0.69	0.492	−0.03(−0.08)
Age (ANM)	−0.01(0.00)	−11.74	0.000	−0.01(−0.30)
Current position (ANM)	−0.42(0.05)	−8.91	0.000	−0.42(−0.20)
Education (ANM)	0.07(0.02)	3.71	0.000	0.07(0.09)
Age (MOIC)	0.00(0.00)	−4.71	0.000	0.00(−0.10)
Sex (MOIC)	0.00(0.03)	0.09	0.925	0.00(0.00)
Current position (MOIC)	0.60(0.02)	34.87	0.000	0.60(0.88)
Education (MOIC)	0.10(0.02)	4.80	0.000	0.10(0.11)
<u>Fit Indices</u>				
CFI	0.72			0.72
TLI	0.56			0.56
RMSEA	0.17			0.17

⁺Fixed parameter

2.3.4 MODEL EVALUATION AND COMPARISON

To explore the possibility of equivalent or near-equivalent models that may also reasonably explain the relationships between decision space, institutional capacity, and accountability and performance measures, three additional models were tested. Each model represents structural relationships that may potentially result in observed outcomes that may be supported by existing theory. These models, B, C, and D, are illustrated in Appendix A.4: Figures A.4.7, A.4.8, and A.4.9. Model B employs a one-factor measurement model, in which ‘decentralization’ is the latent construct represented by three items, one from each of the framework dimensions of decision space, institutional capacity, and accountability. Making decisions on a joint or consensus basis, professional experience of respondents at the subcenter level, and community participation loaded onto the factor used in the subsequent regression analysis. Model C separated the dimension of decision space into block-level and subcenter-level factors. Together, these latent constructs were regressed onto the performance measures of interest. In model D, a hierarchical relationship between block-level and subcenter-level decision space was tested. In this model, the latent variable of decision space at the block level was regressed onto its counterpart at the subcenter level, which only then was regressed onto performance outcomes. The variance-covariance matrix used for estimation of all models presented in this paper is outlined in Appendix A.6.

Assessment of the fit measures for all models presented in this paper demonstrate that models A and B

performed well in terms of CFI and TLI (Table 2.6). Model A performs slightly better than model B with the RMSEA measure suggesting that a fit may be close to meeting the threshold acceptance for this measure. However, no model performed well in terms of RMSEA. Models C and D failed to reach the accepted thresholds for model fit, with model D performing considerably worse than model C.

Table 2.6: Fit measures for all (unadjusted) models evaluated

Fit measure	Model A	Model B	Model C	Model D
<i>df</i>	15	6	20	63
CFI	0.977	0.974	0.852	0.501
TLI	0.946	0.935	0.734	0.382
RMSEA	0.092	0.131	0.206	0.189
<i>p</i> -value	0.007	0.001	0.000	0.000

2.4 DISCUSSION

2.4.1 SUMMARY OF KEY FINDINGS

Similar to other studies of decision space, quantitative measures illustrated that, despite the formal protocol outlined for IMI, there was reasonable variability in decision space, capacity, and accountability across states. Correlation analysis showed relationships between block-level decision space, specific features generally categorized into the dimension of institutional capacity, the number of children vaccinated, and vaccines delivered per session. However, CFA for data collected at block and subcenter levels revealed that not all indicators typically categorized into the umbrellas of decision space, capacity, and accountability loaded onto factors as expected. Rather, parsimonious measurement models most often resulted in the best goodness-of-fit measures; each latent factor in model A was generated based on two items and resulted in the SEM having the best fit to the data among those evaluated.

It is important to keep in mind that the relationships shown by model A do not point to causality as we are constrained by our limited knowledge of the exact mechanisms at play as well as temporality of the phenomena in question. Rather, this structural model revealed decision space and institutional capacity to be

statistically significantly associated with the proportion of total IMI sessions completed over the four-month duration and the number of children vaccinated and vaccines delivered per session, respectively.

The inverse relationship detected between decision space and proportion of sessions conducted could be reasonable in the event that those immunization managers having the ability to decide whether or not to conduct sessions actually conduct fewer sessions based on the information available to them. For example, in some areas, the lack of a subcenter building or other infrastructure limited staff in their ability to implement IMI. In other areas, safety from violence was a concern among staff when conducting IMI sessions. It is possible that certain areas initially planned to hold fewer than 28 IMI sessions in their area, which would indeed be indicative of greater decision space over this aspect of strategic planning and implementation for IMI. It is also possible that those with higher levels of decision space did not consider IMI activities a priority given their other responsibilities, leading to fewer sessions implemented. Alternatively, because the latent variable of decision space includes having the ability to add sites to RI in its definition, the addition of IMI sites to RI may mean that these sessions were no longer considered as IMI session, but rather as regular RI activities.

Similarly, those with greater individual capacity at these levels may have more difficulty finding additional children to vaccinate should their performance during RI sessions be high given the resources available to them or a distinctly challenging environment. When controlling for other characteristics of respondents, however, the association between institutional capacity and the number of children vaccinated per session disappeared. Still, these potential explanatory scenarios are worth considering since the fit of the model when controlling for respondent characteristics was poor. This also suggests that there may be other contextual or respondent features that may be missing from the current model that would help improve the characterization of the relationships between decision space, capacity, accountability and each of these outcomes. Thus, these findings should be interpreted with caution and warrants further study.

Examination of the interdependent relationships between decision space, institutional capacities, and accountability revealed that study findings parallel those of previous studies. Similar to the findings of Bossert and Mitchell, model results showed strong associations between decision space and capacity and capacity and accountability, while accountability and decision space were not strongly associated with each other [34]. Findings differed in the direction of association, however. Decision space and institutional capacity covaried significantly, but showed that as decision space increased, capacity decreased. Alongside this relationship,

the model showed that capacity and accountability also covaried inversely to a lesser degree. These different findings may be explained by how the latent variable of capacity was defined in the model.

The factor analysis that drove the definition of the latent dimensions in this model resulted in a different definition of institutional capacity than was posited in Bossert's and Mitchell's study in Pakistan [34]. Considering that capacity was defined by the time a health worker had spent in a particular location, it may be that new individuals were brought into challenging areas or to replace health officials failing to reach coverage goals. As capacity is currently measured in the model, such an occurrence would result in low indications of capacity despite wide decision space and high accountability processes in place. High levels of accountability would further support such a narrative as detection of poor performance of previous human resources allocated to the area would prompt reassignment of health officials. These results demonstrate the nuance required in interpretation of findings from these types of models as well as highlight how these models can capture organizational behaviors and relationships. Finally, it contributes to the evidence that these three features of decentralization remain intimately related, further quantifying them to compare the degree of the relationships to each other.

2.4.2 IMPLICATIONS OF FINDINGS FOR IMMUNIZATION PROGRAMS AND HEALTH SYSTEMS

Research to-date largely agrees that relationships or synergies exist between the dimensions, as first posited by Bossert and Mitchell (2011), across different contexts [34, 47]. Using a structural equation model, the findings of this study support earlier findings of the strong interrelationships between decision space and capacity as well as capacity and accountability, and that accountability and decision space are less related. The fact that implementation of an alternative approach supports earlier findings adds robustness to these conclusions in the literature. The analysis presented in this paper is a first example of how the decision space approach can use structural equation modeling to detect linkages between features of decentralization and outcomes of interest. Differences in which observed items were included in latent variable definitions compared to previous studies may be attributable to the modeling approach or nature of the questions asked. Yet, such alternative approaches provide perspectives that contribute to further understanding how these latent constructs operate in the delivery of health services. Its findings contribute to both the decision space and immunization literature, expanding the tools for the analysis of decision space and its related features as well as providing insights

into how organizational and management structures can influence the outcomes of immunization delivery.

Considering how decentralization of management influences processes to achieve immunization coverage and the delivery of other critical health services can provide key insights into the functioning of the broader health system. Studying the IMI program was a singular opportunity in that the initiative allocated responsibilities to lower levels through the adoption of microplanning procedures and required the measurement of specific outcomes as indicators of performance. Study findings, by highlighting the role of lower level management, emphasizes additional opportunities for improvement of immunization programs through enabling effective decision making to reach more people with essential health services. In particular, delegation of appropriate decision space and engaging in capacity building were highlighted at block levels and establishing accountability mechanisms at the lowest levels as predictors of performance measures. More evidence is needed to substantiate these findings, however. Future research could provide greater evidence for directionality of direct and indirect effects, interaction effects, and/or mediators of relationships.

Institutional capacity, based on the models in this study, was defined by the experience an individual had in a particular context and role. Considering how the health system and its programs continue to develop and motivate their staff may be critical in promoting the effectiveness of health service delivery and improving adequate access to essential services. Similarly, it may be important to purposefully and strategically allocate decision space to ensure achievement of appropriate program goals. In scenarios of increased decision space, it will be important to identify motivations and frameworks for health workers' decision making in order to predict its effects. In the IMI context, increases in decision space was associated with fewer IMI sessions conducted. IMI sessions could have been absorbed into RI activities rather than being considered to be part of IMI, successfully driving more sustained improvements in access to these essential health services. In this case, the program exemplifies improved long-term outcomes towards increased access to health services among populations formerly unreachable. In cases in which managers made decisions based on local information, it is additionally possible that initiatives to support health workers based on their specific contextual challenges could further improve outcomes of the program.

2.4.3 LIMITATIONS AND FUTURE RESEARCH

Limitations of this analysis may include the sample size of the data studied. SEMs require large sample sizes to generate consistent results and motivated this study to use the subcenter-level performance outcomes of interest. As a result, the models reveal less about the aggregate performance outcomes at the district and block levels. Examination of the outcomes of interest at each level of the data reveal some of this inconsistency in measurement. The distributions of measures of performance reasonably overlap across districts, blocks, and subcenters within some states for some indicators, but not all. Uttar Pradesh also comprises a majority of the sample analyzed, and as a result, phenomena in this region may be driving some of the findings presented here disproportionately more than other states included. Future research would benefit from a larger sample size as well as more states included in the sample. Ideally, all 187 areas included in IMI would have been included for this study as well as all relevant managers of the program reached.

SEMs in this paper were assumed to be recursive and models were simplified to increase the likelihood of model convergence. Nevertheless, it is possible that a non-recursive, more complex model would more appropriately convey the relationships occurring in decentralized health systems. This was a first iteration towards understanding how such a health system could be best represented using a structural model and may continue to be built upon in future research.

Since data was collected using key informant interviews with open-ended questions and retrospective review of records, this study is subject to the limitations imposed by these methods of data collection. For example, responses gathered via interview may be influenced by the interviewer herself. In the case of this study, tool development processes and researcher training aimed to minimize the potential effect of bias as a result of interviewing or questionnaire design. Interviews were conducted among staff in lower level management roles. It is possible that respondents' answers may have been influenced by their superiors should it have been impossible to conduct the interview in a private setting. Questions that were believed to be unduly biased by such a presence have been removed from the analysis for this reason.

The fact that only data from respondents present during the implementation of IMI could reasonably be used for analysis may contribute to selection bias. It is possible that there were random staffing changes that would not have contributed to bias. However, it may also be that less successful managers vacated their positions or more successful managers moved into different positions in short periods of time. Indeed, in districts

and blocks, 60% and 67% of data was eligible for inclusion, respectively. Such scenarios could prevent the detection of certain relationships or otherwise bias study estimates. For example, in a hypothetical scenario in which data for less successful managers who would have reported lower decision space and institutional capacity were missing, our study may have overestimated the negative association between these dimensions and performance measures. Similarly, if most of the data missing were due to the movement of successful managers who would have reported low levels of decision space and capacity to other positions, analyses would have underestimated the magnitude of these relationships.

As is often a limitation in the evaluation of immunization programs, it remains challenging to measure improvements in immunization coverage without a reliable denominator representing the total number of children that need immunization services. This was particularly difficult to measure at lower levels, such as block and subcenter levels, without sufficient granularity in the data available. For this reason, change in immunization coverage was not used as a measure of performance of IMI, though this would have been ideal. Instead, proxy measures better representing program efficiency, planning, and implementation were used to assess IMI performance.

Study findings are limited by the extent to which measured outcomes successfully represent program performance. All else being equal, measures of the number of children vaccinated per session and the number of vaccine doses delivered per session that are greater indicate more output per session, which would correspond with more efficiently using resources. However, these outcomes depend on baseline coverage, population size, and population density. Areas with low populations will reasonably report lower numbers of children vaccinated and vaccine doses delivered. Likewise, in areas with higher baseline coverage, the maximum possible number of IMI doses delivered will also be smaller. Unfortunately, we were not able to account for these factors, such as through estimated population size or number of target beneficiaries by area, in this analysis.

When considering the proportion of planned IMI sessions completed, a higher proportion would reasonably indicate good performance according to program planning. In settings where managers have higher decision space, managers may have the flexibility to only plan sessions that are needed. Having the data to confirm interpretations of this outcome of interest would further strengthen conclusions in regards to program performance as measured by strategic planning and effective implementation. Furthermore, the outcome detailing the number of vaccine doses delivered was collected based on matching the dates of IMI implemen-

tation with those recorded in the RCH registers. There may be inaccuracies in which doses were delivered for IMI versus RI as a result. It may also be possible that not all IMI doses were recorded in these registers. Greater accuracy of such data would strengthen the findings of studies assessing such outcomes to characterize program performance.

Future research should aim to build on this work and address its limitations. Larger sample sizes or pooled datasets may provide improved opportunities to examine features of decentralization and health system performance using SEM approaches. Considering how approaches could be applied using data from routinely administered or widely used surveys may be a way to address this challenge. Given the highly contextual nature of decentralization, it may remain challenging to achieve high external validity in this area. Yet, systematic approaches to analysis can yield a consistent framework by which to assess and understand research findings. This study supports the evidence in the literature that relationships exist between decision space and institutional capacity as well as between institutional capacity and accountability structures, while there is less connection between decision space and accountability. This consistent finding may be applicable to other settings. Researchers planning to implement any of the approaches outlined in this paper should carefully consider the theoretical structure of decision space, institutional capacity, and accountability mechanisms with respect to outcomes of interest for their setting at the study conceptualization and design stage. Development of the data collection tool, typically a questionnaire delivered to key informants, remains critically important in the study of these dimensions since reasonable proxy measures for these constructs are often challenging to obtain otherwise.

In line with recommendations for conducting CFA and SEM analyses, strong theory should drive model decisions and testing. Also characteristic of SEM is a process of re-specification should models have poor fit, fail to converge, or result in Heywood cases (i.e., a parameter estimate with an illogical value, such as negative variances or correlations greater than 1) [53]. For this reason, using simulated data to explore whether the types of data expected are suitable for these modeling procedures can support the development of appropriate study tools and improve the probability of data usability and relevance to the research question.

2.5 CONCLUSIONS

Study findings emphasize the potential role of institutional capacity and/or decision space to implement health delivery systems efficiently and effectively for improved access to health services. Because of the detected relationships between these features and program performance, health systems should consider the impact that management structures for the delivery of health services have on access, efficiency, and effectiveness. Indicators included in theory-driven composite scores for decision space, institutional capacity, and accountability do not all load significantly onto these latent constructs. Rather, simplified models may provide more appropriate measures of these variables. Analyses confirm the associations, or what has been called synergies in the literature, between these three dimensions and highlight the role of decision space and institutional capacity at higher levels and that of accountability at the lowest levels of management. Given the possibility for greater insights and understanding into the relationships between decision space, capacity, and accountability for service delivery, research should continue to explore the potential of innovative approaches to inform strategic planning and implementation of health policies and programs.

3

Role of User Benefit Awareness in Health Coverage Utilization Among the Poor

3.1 BACKGROUND

3.1.1 ACHIEVING UNIVERSAL HEALTH COVERAGE IN CAMBODIA

AS ONE OF THE TARGETS SET BY THE 2015 SUSTAINABLE DEVELOPMENT GOALS (SDGs), achieving universal health coverage (UHC) aims to promote good health, poverty reduction, and a foundation for long term economic development [58]. UHC ensures that all people have effective access to necessary health ser-

vices of adequate quality, meaning that such services are both physically available and do not expose individuals to financial hardship [58]. Cambodia has seen steady improvements in population health, largely attributed to its strengthening economy, which grew at a rate of 7.7% per year between 2001 and 2010 and attained lower-middle income status in 2015 [59, 60]. Towards advancing its pursuit of UHC, in March 2016, the Royal Government of Cambodia committed to achieving UHC through its Social Health Protection Framework [61]. The country's UHC service coverage index, constructed using 14 tracer indicators and intended for use for monitoring UHC status for the SDGs, was 52% in 2015 and highlights room for improvement in service delivery [20, 62]. The Royal Government of Cambodia recognizes the need to reduce inequalities in care due to geography and income and continues to move towards service delivery reforms to strengthen preventive and primary care as well as address social determinants of health [63].

Despite these efforts and the country's continued economic growth, Cambodia faces persistent barriers to realizing UHC, including challenges in realizing adequate financial risk protection for individuals accessing them [59, 60]. Out-of-pocket (OOP) expenditures on health remain high in the country, having stagnated around 60% of total health expenditures since 2002 [23]. In 2017, the share of OOP spending was estimated to be between 62% and 74% and about 5% of households experienced catastrophic health expenditures, i.e., OOP expenditures exceeded 40% of household income, in 2014 [63–66]. Cambodia's persistently high OOP expenditures and catastrophic health expenditures alongside low levels of health services utilization among the poor suggests that a significant proportion of the population faces a significant burden in accessing health services. The country's high OOP expenditures and poverty rate of 18% point to the poorest as being the most at-risk by the lack of effective financial risk protection [23, 60]. Such challenges emphasize the role of social protections in ensuring adequate financial access to health care services. Examination of Cambodia's health financing and financial risk protection strategies for the country's most vulnerable populations is among the next steps towards greater evidence-based policymaking for UHC.

3.1.2 STATE OF HEALTH FINANCING AND FINANCIAL RISK PROTECTION

Total health expenditure was 6% of GDP in 2016, below the average 9% of the Southeast Asia region, with government spending accounting for 22% of that expenditure (corresponding to 1.3% of GDP) [58, 67]. Total health expenditures were higher in Cambodia than other countries in Southeast Asia, including Viet-

nam (5.7% of GDP), Lao People's Democratic Republic (2.8%), and Thailand (3.8%) [67]. However, in these neighboring countries, government spending accounted for a considerably greater proportion of health expenditures, 47%, 32%, and 78%, respectively [67]. Health financing in Cambodia remains heavily reliant on donor funding, which comprised 18% of total health expenditure in 2014 [63].

When structural and organizational reforms began in the mid-1990s, health financing reforms were a central focus of efforts to move towards UHC with the aim to eliminate financial barriers to access. User fees for public health facilities were introduced in 1996 with the aim of generating additional facility revenues, 60% of which are allocated to staff incentives. These user fees often provide facilities with a large proportion (30-50%) of additional operating revenues going towards staff incentives and supplies [23, 68]. While successfully raising much needed revenues for public facilities, it was recognized that user fees imposed significant barriers to accessing care among vulnerable populations, namely the rural poor.

DEVELOPMENT AND IMPLEMENTATION OF THE HEALTH EQUITY FUNDS

Beginning in the early 2000s, health financing policies in Cambodia focused on reducing barriers to accessing health services, including user fee exemptions for the most vulnerable populations. The aim was to develop a comprehensive system of social protection based on social health insurance. The Health Equity Funds (HEF), initially run by government and development partners, remain the major health financing effort aimed at providing financial risk protection and main social protection scheme for the poor in Cambodia [23, 68]. Rather than pooling risk, HEF is a funding pool financed by the government and partners that subsidizes user fee exemptions, hospitalization costs, transport costs, and other expenditures related to health and care seeking. Implicit in the user fee reimbursement to health providers, HEF provides coverage for a standard package of health care services that includes diagnosis, treatment, prevention, health promotion, and rehabilitation at health centers and referral hospitals [23].

Beneficiaries are pre-identified at home (prior to seeking care) by the IDPoor survey, a household survey implemented nationally on a regular basis, or by a post-identification process carried out at health facilities [69]. To be considered eligible for HEF, the IDPoor survey would have had to identify a household as being sufficiently poor. The exact criteria for identification as poor through the IDPoor program is not publicly released, however. Upon identification, individuals should receive a card indicating their entitlement to HEF

benefits. HEF covered 75-80% of its target population in 2013 and is operated at the district level with administrative support at the national level [23, 68, 70].

In 2012, the total cost of HEF implementation was US\$9.5 million with an average cost of US\$8.40 per visit to health facilities [23]. Average medical costs were US\$29.32 per inpatient case and US\$1.94 per outpatient case. As the country moves towards middle-income status, however, many donors and development partners have started or will soon begin reducing their financial and operational support for HEF [23]. These processes have already begun with the transfer of management for HEF to the government, making questions about program sustainability and effectiveness ever more relevant.

IMPACT OF THE HEALTH EQUITY FUNDS

Impact evaluations to date have shown that HEF successfully improved access to health services for the poor, reduced OOP health spending by 29% and household-related debt by 25%, and increased public health facility utilization [23, 68]. Despite expectations of considerable need based on disease burden, utilization of HEF benefits hovered only between 16% and 25% across public health facilities [71]. Persistently low HEF utilization remains a challenge to achieving UHC under the social protection scheme. Studies have consistently found that a substantial proportion of HEF beneficiaries still seek care from private providers, incurring considerable OOP expenses as a result [72–74].

Despite slight increases in the utilization of public facilities overall, HEF did not have an effect on utilization among poor households (i.e., the bottom two income quintiles) [68]. Notably, the richest 40% experienced the largest positive impacts in public sector utilization as a result of HEF, especially when combined with voucher schemes [68]. Assuming that the burden of disease in Cambodia is generally the same across income groups, or even worse for the poor, these findings suggest that health care utilization among the poor remains lower than should be expected. This also poses, and potentially aggravates, the persistent problem of inequitable social and health outcomes in the country; the country's Gini index remains relatively high and worsening, estimated to be 36.0 in 2013 [60].

Nevertheless, the adoption and implementation of HEF in Cambodia has largely been hailed as a success. The literature agrees that HEF contributed to decreased OOP expenditures for HEF beneficiaries and may have led to equity improvements among poor mothers and their children [23, 69]. Past research also points to

the potential effects of having extended HEF to health centers, quality improvement measures, and increasing awareness of HEF entitlements via the implementation of IDPoor efforts that occurred over the same period as HEF implementation. The same research, however, suggests the possibility that limited awareness of HEF entitlements and benefits remains a non-financial factor affecting uptake of maternal and child health services at public facilities [69]. While there have not been interventions aimed specifically at raising awareness of HEF entitlements and related benefits, HEF continues to have close linkages to the IDPoor program, which is well-known and widely accepted across the country [69].

Comparing donor- and government-implemented HEF programs across the country also highlights differences in impact [68]. As the country transitions to less dependence on donor support, it is critical to understand the mechanisms by which HEF drives positive impacts on appropriate health care utilization and financial risk protection.

3.1.3 FACTORS AFFECTING HEALTH SERVICES UTILIZATION

Utilization of health services is often used as an operational proxy for access to health care, defined by Peters *et al.* (2008) as “the timely use of services according to need” [75]. Understanding health care utilization requires an understanding of why and how people seek health care. The Andersen health care utilization, or care seeking behavior, model has been often used as a framework to understand demand-side care seeking behavior as a mechanism of health care utilization [76]. This model has been extensively used in studies investigating health care utilization for different areas of the health system and diseases. The behavioral model incorporates both individual and contextual determinants of health and service utilization; an individual’s use of health services is a function of three dimensions of his or her characteristics: (1) predisposing characteristics, (2) enabling resources, and (3) need. Individual-level predisposing factors include demographic characteristics, such as age, sex, education, occupation, ethnicity, social relationships, and mental factors, such as health beliefs, attitudes, values, and knowledge of health and health services. Contextual predisposing factors refer to the demographic and social composition of communities, collective and organizational values, cultural norms, and political perspectives [77].

Individual enabling factors involve an individual’s income and/or wealth available to spend on health services and whether he or she has a regular source of care and the type of source. These factors also encompass

transportation, travel time, and waiting time in accessing health care. Need factors at the individual level refer to perceived need for health services and professionally evaluated need for health care. These factors also include environmental needs, such as population health indices (e.g., mortality, morbidity, disability, etc.) [77, 78]. Contextually, enabling factors refer to community resources, such as per capita community income, affluence, rate of health insurance coverage, the relative price of goods and services, and provider payment mechanisms. It can involve the physician and hospital density, office hours, provider mix, quality management oversight, outreach and education programs, and health policies [77]. Together, contextual and individual characteristics drive health behaviors, such as personal health practices and use of health services, according to the Andersen model. These health behaviors then result in outcomes, such as perceived health status, evaluated health status, and consumer satisfaction [76].

The Andersen behavioral model does not specify the role of financial risk protection. However, studies in low- and middle-income countries (LMICs) have consistently shown that health care utilization increases with the introduction of health insurance or other forms of social health protection for the poor [79–81]. This suggests that individuals' awareness of financial coverage for health services may be an enabling factor leading to greater use of health services. In a context that recognizes and values financial access to care as a key feature of UHC, financial risk protection becomes an important outcome of health care seeking and in this study will be added to our conceptual framework as an outcome of health care utilization. If user awareness of coverage benefits can positively influence necessary health care utilization, it becomes critical to understand how to increase awareness of entitlements among beneficiaries of social health protection schemes. Through this mechanism, it may be possible to positively influence individuals to seek care when they need it, providing adequate financial access towards effective coverage and UHC.

BENEFICIARY KNOWLEDGE OF HEALTH INSURANCE BENEFITS

Health insurance coverage has consistently been classified as an enabling factor across studies. Several studies found that having health insurance significantly increases the likelihood of service use or decreased delay of care seeking across different population groups in high-income settings [77]. These findings point to an underlying assumption that, upon receiving health insurance coverage, individuals understand their benefits, and therefore, seek care. In many private or competitive health insurance markets, users play an active

role in their own enrollment, comparing policies to choose which may be best for their needs. This process plays an educational role, by which users become aware of the benefits under their health coverage plan. In schemes with automatic enrollment based on specific eligibility criteria, such as HEF in Cambodia, it is no longer necessary for beneficiaries to become aware of their coverage benefits as a product of the enrollment process. HEF beneficiaries, for example, are identified by designated government staff, enrolled based on judgement and eligibility measures that may be sufficiently vague to those being enrolled. Nevertheless, for health coverage to prompt greater care utilization as well as utilization of its coverage benefits, some level of user knowledge or awareness of these benefits should be present.

Much of the literature surrounding patients' knowledge or understanding of health benefits centers around the uptake or enrollment in insurance. In the Cambodian case, as nearly 80% of the target population is enrolled in HEF, uptake is not the primary question of relevance. Rather, subsequent utilization of those benefits upon being enrolled becomes important to ensuring effective access to care. A cross-sectional survey of women seeking contraceptive care in the US determined that knowledge of relevant benefits under the Affordable Care Act (ACA) was associated with a significant increase in interest in long-acting reversible contraception [82]. A survey of beneficiaries in the US military health system determined that patients' understanding of their coverage was associated with a small, but statistically significant, contributor to their satisfaction with the care received [83]. The role of user awareness of benefits for subsequent utilization of services is less understood in LMICs and may be relevant for the Cambodian context.

Existing research points to a role of knowledge and awareness of health benefits in the way patients use and understand their care [84]. In Cambodia, among the challenges in realizing UHC is achieving effective coverage for health care services among the poorest through HEF. To address the problem of low HEF utilization, which limits appropriate care utilization and thwarts the objective of financial risk protection for the poorest, understanding beneficiaries' awareness and its relationship to health care utilization can inform key policies on the path to UHC.

3.1.4 STUDY OBJECTIVE AND SPECIFIC AIMS

This study aims to understand the role of user knowledge in care seeking and utilization in Cambodia by: (i) comprehensively describing patient awareness of benefits, (ii) characterizing the role of awareness at each step

in utilization (e.g., care seeking, utilization, and claim of HEF entitlement) using a series of regression models, and (iii) simulating hypothetical policy scenarios to identify the best options with respect to beneficiary awareness. In achieving these specific aims, this work systematically presents how beneficiaries understand their entitlements as well as explores how this awareness relates to health care utilization and financial risk protection for health.

3.2 METHODS

3.2.1 DATA SOURCES

This study used nationally representative data collected in 2016 as part of the impact evaluation of the Health Equity and Quality Improvement Project (H-EQIP) in Cambodia [71]. The primary objective of H-EQIP was to improve the quality of health care services and financial protection for vulnerable groups. Evaluation activities included a household survey capturing information on household composition, sociodemographic characteristics, health status, health care utilization and expenditures, social health protection status and utilization, and health outcomes (i.e., mortality). The evaluation implemented a multistage stratified sampling design based on randomization at the district level. Seventy of the country's 100 operational districts (ODs), which included 2,506 households (HEF and non-HEF) and 12,344 individuals across 140 villages, were surveyed. Households were eligible for the survey if at least one household member was a woman between 15 and 49 years of age that had had at least one pregnancy event in the 24 months prior to the survey. A detailed description of the sampling strategy has been previously published [71].

When comparing results to national surveys, the eligibility criteria for the inclusion of households in this survey must be considered. Analyses that propose to use or compare this data to national surveys should also restrict those data to include only households with pregnant women or mothers with children below two years of age.

Survey questions on awareness of HEF benefits were asked to self-reported HEF beneficiaries included in the household survey sample (Appendix B.1). Questions inquired into respondents' awareness of financial coverage for services at public health centers and hospitals, maternal delivery and medicines at public facilities, transport costs for delivery and hospitalization, money for caregiver meals, and the possibility to use the HEF

card outside of their district of residency.

3.2.2 OUTCOMES OF INTEREST

In understanding the role of awareness of HEF benefits on patient behaviors, four outcomes were of interest in this study: (1) choice to seek care, (2) public sector health care utilization, (3) patients' claims or utilization of HEF benefits, and (4) whether OOP payments were made for health services. Care seeking behavior was defined as respondents having reported going to any health facility, health personnel, or traditional healer for an illness or injury. Formal health care utilization in the public sector was specified as respondents' reporting having sought treatment from a public health care provider (e.g., national hospital, provincial hospital, referral hospital, health center, or health post) for an illness or injury in the past 12 months. Utilization of benefits was determined by respondents' having reported using a card to receive free health care services.

Respondents were asked whether they had paid OOP expenditures for an illness or injury in the past two weeks. OOP expenditures were considered as a dichotomous outcome, i.e., whether an individual had paid any amount out-of-pocket. OOP expenditures could include official provider fees, laboratory and x-ray fees, unofficial fees, transportation, medicine, and other reported expenditures. Descriptive statistics exploring respondents' awareness of HEF benefits, their care seeking behaviors, and utilization patterns were generated as a first step to understanding the nature of these features.

3.2.3 PATHWAYS TO HEALTH CARE AND COVERAGE UTILIZATION

There are a number of points at which beneficiaries must make decisions along the pathway to using health care and claiming HEF benefits (Figure 3.1). While the choice to enroll is not relevant to the Cambodian case, access to covered services and the choice of provider have been identified as points at which users drop off along the sequence from illness to receiving appropriate care and claiming their benefits [85]. Awareness of HEF benefits may influence the initial decision to seek care, choice of provider (i.e., public or private), and whether to claim HEF benefits at the health facility. Whether use of the HEF card translates to sufficient financial risk protection by eliminating OOP expenditures remains another step towards effective coverage.

It is possible to hypothesize mechanisms by which awareness of benefits influences user decision making based on when a user becomes aware of his or her entitlements under HEF. Because of the various processes

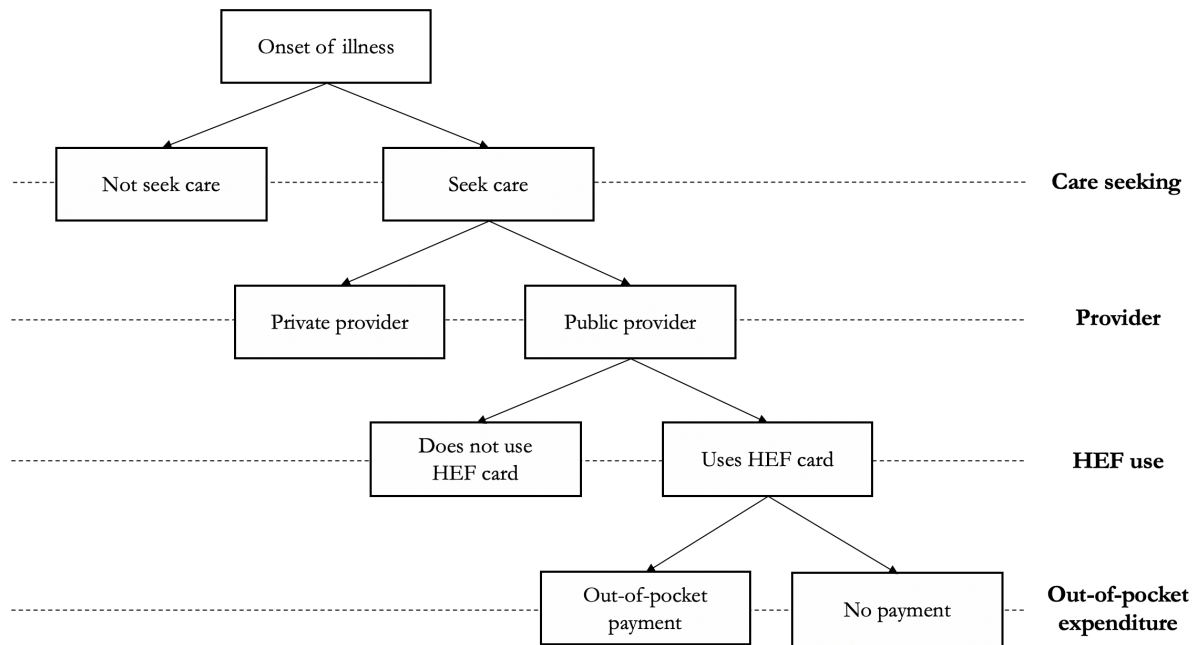


Figure 3.1: Decision points between onset of illness to using HEF card potentially influenced by awareness of benefits

by which HEF operates, there are multiple possibilities for at which point a patient becomes aware of HEF and, consequently, how awareness of coverage benefits plays a role in health care utilization. The process of identification in HEF implementation (IDPoor) refers to the identification of HEF eligible households, which may happen in communities (i.e., pre-identification) or upon seeking care at a public health facility (i.e., post-identification). This ambiguity in timing makes it impossible to identify any causal relationship using this data source for this context. As part of the identification process, protocol outlines that implementers should adequately explain the benefits to which covered households are entitled.

3.2.4 UNDERSTANDING USER AWARENESS OF HEF BENEFITS

Correlation analysis of awareness indicators was conducted to detect the degree to which awareness of specific features of HEF benefits were related to each other. Subsequently, an overall index for awareness of HEF benefits was constructed based on principal components analysis (PCA) of responses to awareness-related questions. The awareness index was constructed using an optimally-weighted linear combination of the inputs (i.e., the seven survey questions concerning awareness of HEF benefits) based on PCA results and scaled

to a range between values 0 and 1 for ease of interpretability. This index allowed for a descriptive comparison of awareness levels across the sample population, but was not used in regression analyses in an effort to understand beneficiaries' awareness of each specific HEF entitlement individually.

For each outcome of interest, regression models were specified to characterize their relationship with beneficiaries' awareness of HEF benefits. Multiple logistic regression models were specified in which variables included were selected based on the categories outlined by the Andersen behavioral model of health care utilization. Population characteristics included in the models were age, sex, education, ethnicity, income quintile, and variables related to the awareness of HEF benefits. Outcomes of interest were reported in the survey as the number of illnesses / injuries for which a respondent sought outpatient or inpatient care. Outcomes of interest were assigned to be dichotomous variables. Detailed definitions of outcomes of interest based on survey questions are outlined in Appendix B.2. Each survey question asking about awareness of specific HEF benefits were included as separate indicators in regression analyses.

The sample used for regression analyses was restricted to those reporting illness or injury in the 12 months prior to the survey. This restriction was necessary due to questionnaire design. Nevertheless, this was considered appropriate as illness or injury was assumed to initialize steps towards HEF utilization. Furthermore, with each model, the population was limited to individuals representing each subsequent stage of the pathway to HEF utilization (Figure 3.1). For example, care seeking behavior was analyzed among those reporting onset of illness or injury in the past 12 months. Choice in provider was analyzed among those reporting having sought care for their reported illness or injury and HEF utilization at point-of-service was modeled for those who sought care at public facilities.

Fixed effects at the district level were specified to account for environmental factors that may contribute to health care utilization, such as community-based influences, objective quality of care at facilities, and other unmeasured variables at the district level. Because of the distinct nature of care seeking for outpatient versus inpatient care, separate sets of regression models were specified for each type of care sought. Repeated 10-fold cross validation was implemented with three repeats to determine how accurately regression models predicted outcomes of interest. Clustered robust standard errors were computed to account for the clustered household survey design. Results were considered statistically significant at the $\alpha < 0.05$ level. All analyses were conducted in R (version 3.6.1).

3.2.5 SIMULATION OF INTERVENTIONS AND UNCERTAINTY ANALYSIS

Simulations of hypothetical interventions were carried out using the previously described models to reveal how changes in levels of awareness due to policy interventions may affect outcomes of interest along the pathway to health care seeking and HEF utilization for outpatient care in Cambodia (i.e., number of individuals seeking outpatient care in the public sector and number of individuals subsequently claiming benefits under HEF for that care). OOP was not considered as an outcome of simulations as survey questions asked about this information over a more recent time period, resulting in a considerably smaller sample size for model fitting. To generate full populations for simulation, missing predictors in the survey sample were imputed by multivariate imputation by chained equations (MICE) [86]. MICE is a method for dealing with missing data that uses regression models of observed variables in the data to predict missing values. Imputation of missing data allowed for a full simulated population based on the existing information in the dataset. Ten iterations of MICE were conducted on the survey data to account for potential uncertainty of the imputed indicators.

Two hypothesized interventions were simulated: (1) a campaign whereby HEF benefits were widely publicized to the general population, and (2) dissemination of similar information via public facilities. Simulations reproduced how such interventions would impact awareness of HEF entitlements among beneficiaries. Upon implementation of a mass media campaign to the general population, for example, or other passive informational intervention, it remains likely that only a proportion of the target audience would be reached. For instance, a general informational campaign may randomly reach 70% of HEF beneficiaries prior to illness or injury that would prompt the decision to seek care. Some subset of those 70% reached may have already been aware of HEF entitlements, while the other subset would become aware as a result of the intervention. This simulation attempted to replicate how the aforementioned interventions would be implemented in practice. Thus, rather than increasing awareness directly to be a constant, changes in awareness were applied via this mechanism of those reached.

It is challenging to determine the proportion of a targeted population reached by mass media or other such informational campaigns and data is not available to directly inform estimates on the proportion of HEF beneficiaries that would receive information on their entitlements through mass media or other dissemination strategies targeting the general public. However, nearly 70% of Cambodia's population reported having access to a television in 2014, though poorer households are significantly less likely to own a television compared to

wealthier households [87]. Still, this indicator could be considered a proxy of access to information through common campaign media. Thus, in this simulation, each intervention was optimistically assumed to reach 70% of the population. In other words, a randomly selected 70% of the population would have experienced the intervention and, thereafter, became aware of specific benefits publicized by the campaign.

Sets of HEF benefits were identified based on the results of the previously described correlation analysis. Simulations predicted outcomes of interest under scenarios of the previously described interventions that focused messages on the following sets of HEF benefits: (a) free services at public health centers and hospitals, (b) free services at public health centers and hospitals and coverage for maternal delivery and medicines, (c) reimbursement for transportation for delivery and hospitalization and funds for caregiver meals, and (d) all HEF benefits. Thus, a total of eight different intervention scenarios were simulated. Changes in outcomes of interest based on adjustments in awareness levels were compared to identify opportunities for improved access to public sector care and greater financial risk protection through HEF utilization.

To account for model uncertainty, bootstrapping of the original, non-imputed survey dataset was conducted to generate 100 different samples of observations selected from the original dataset stratified by district. Logistic regression models were trained on each bootstrapped sample using only complete observations; districts with fewer than five complete observations were removed for model fitting. These models were then used to predict outcomes of interest. This uncertainty analysis resulted in 1,000 simulations of each intervention scenario and provided 95% confidence intervals for simulation predictions.

3.2.6 ETHICAL CLEARANCE

Ethical approval for this study was received from the Institutional Review Board at the Harvard T.H. Chan School of Public Health.

3.3 RESULTS

3.3.1 PROFILE OF HEF BENEFICIARIES

A total of 11,978 respondents (97%) in the household survey indicated their HEF status. Among these individuals, 5,473 respondents (44%) were identified as those under HEF coverage. Among those identified as

HEF beneficiaries, 3,617 respondents (66%) reported having an illness or injury in the past 12 months, 3,533 individuals (65%) reported seeking formal care for that illness or injury, and 1,230 people (22%) reported ever seeking care in the public sector. Most of the sample was made up of children and younger respondents under 20 years of age and, as would be expected to be eligible for coverage, HEF beneficiaries tended to be poorer than the overall household sample. As a proportion of total HEF beneficiaries that were ill or injured in the past 12 months, only 25% ultimately claimed their HEF entitlements, while 43% would pay some amount of health expenditure out-of-pocket. Of those who sought care from a public provider, however, a majority claimed HEF entitlements at the point of service for either inpatient or outpatient care. Among those who reported paying some amount of OOP health expenditure in the past two weeks, there was considerable variation in how much was paid, from just over US\$2 to approximately US\$13.60.

Table 3.1: Summary of sample population

Indicator	HEF beneficiaries (N = 5,473)	Illness/Injury past 12 months (n = 3,617)	Sought care (n = 3,533)	Sought care at public provider (n = 1,230)
Sex				
Male	2,562 (47%)	1,608 (44%)	1,558 (44%)	514 (42%)
Female	2,911 (53%)	2,009 (56%)	1,975 (56%)	716 (58%)
Age				
<10 years	1,597 (31%)	1,111 (32%)	1,126 (33%)	459 (40%)
11-20 years	904 (18%)	554 (16%)	510 (15%)	132 (11%)
21-30 years	890 (17%)	509 (15%)	498 (15%)	141 (12%)
31-40 years	753 (15%)	545 (16%)	519 (15%)	189 (16%)
41-50 years	399 (8%)	294 (8%)	288 (9%)	96 (8%)
51-60 years	284 (6%)	212 (6%)	212 (6%)	78 (7%)
>60 years	316 (6%)	235 (7%)	222 (7%)	67 (6%)
Education				
Never attended	1,044 (25%)	727 (20%)	672 (19%)	245 (20%)
Primary school	2,481 (60%)	1,683 (47%)	1,656 (47%)	544 (44%)
Secondary school	630 (15%)	390 (11%)	372 (11%)	94 (8%)
Ethnicity				
Khmer	5,065 (93%)	3,395 (94%)	3,316 (94%)	1,165 (95%)
Other	408 (7%)	222 (6%)	217 (6%)	65 (5%)
Income quintile (KHR)				
<348,000	1,365 (25%)	948 (27%)	898 (26%)	302 (25%)
348,000 - 1,030,000	1,364 (25%)	942 (27%)	899 (26%)	350 (29%)
1,030,000 - 2,310,000	1,071 (20%)	670 (19%)	660 (19%)	233 (19%)
2,310,000 - 4,990,000	917 (17%)	586 (17%)	576 (17%)	216 (18%)
4,990,000 - 199,000,000	656 (12%)	397 (11%)	412 (12%)	101 (8%)

Continued on next page

Table 3.1 – continued from previous page

Indicator	HEF beneficiaries (N = 5,473)	Illness/Injury past 12 months (n = 3,617)	Sought care (n = 3,533)	Sought care at public provider (n = 1,230)
Utilization, past 12 months				
Outpatient care	-	-	3,035 (86%)	1,029 (84%)
<i>Always used HEF card</i>	-	-	-	819 (67%)
<i>Ever used HEF card</i>	-	-	-	903 (73%)
Inpatient care	-	-	478 (14%)	285 (23%)
<i>Always used HEF card</i>	-	-	-	215 (17%)
<i>Ever used HEF card</i>	-	-	-	232 (19%)
Out-of-pocket expenditure				
Paid OOP in past 2 weeks	1,941 (35%)	1,568 (43%)	1,561 (44%)	609 (50%)
Amount paid, KHR (mean ± SD)	8,194 ± 47,394	9,043 ± 37,969	9,474 ± 38,999	9,125 ± 36,617
Awareness of HEF benefits	1,191 (22%)	828 (23%)	782 (22%)	312 (25%)
Health center services	4,516 (83%)	3,012 (83%)	2,754 (83%)	1,032 (89%)
Hospital services	4,257 (78%)	2,842 (79%)	2,606 (79%)	974 (84%)
Delivery	4,215 (77%)	2,792 (77%)	2,563 (78%)	954 (82%)
Medicines	4,485 (82%)	2,969 (82%)	2,724 (82%)	1,027 (89%)
Transport for delivery	3,284 (60%)	2,245 (62%)	2,086 (63%)	760 (66%)
Transport for hospitalization	3,133 (57%)	2,111 (58%)	1,950 (59%)	725 (62%)
Caregiver meals	3,067 (56%)	2,040 (56%)	1,882 (57%)	736 (63%)
Use outside of district	2,542 (46%)	1,757 (49%)	1,642 (50%)	630 (54%)

3.3.2 AWARENESS OF HEF BENEFITS

Across population subgroups, levels of awareness of HEF benefits were similar (Table 3.1). About 22% of HEF beneficiaries reported awareness of all entitlements under HEF and nearly 38% reported awareness of seven out of eight of the entitlements. Over 75% of beneficiaries reported being aware of free services at public health centers and hospitals, while 67% reported awareness of such free services in addition to coverage for maternal delivery and medicines. Nearly 52% of respondents covered by HEF were aware of reimbursement for transportation for both delivery and hospitalization. Beneficiaries were most often aware of free services available at public health centers and hospitals as well as for delivery and medicines. Less often, HEF beneficiaries were aware of reimbursement for transportation when seeking care for delivery or hospitalization or for caregiver meals during a hospitalization stay. Respondents were least aware of the fact that their HEF card could be used at public facilities outside of their district of residence.

Further examination of awareness of HEF benefits revealed that respondents were often aware of sets of benefits (Figure 3.2). Those who were aware of free services at public health centers were often also aware

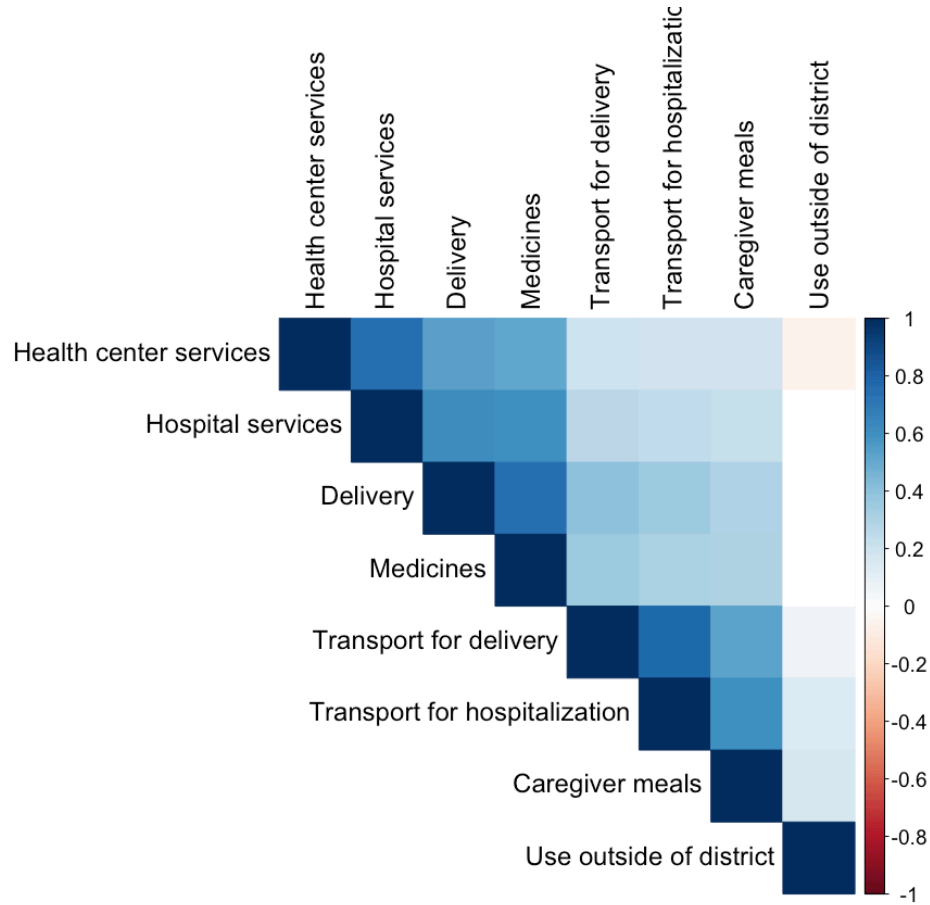


Figure 3.2: Correlation of awareness of HEF benefits

Darker colors represent higher degrees of significant correlation with blue representing positive correlation and red representing negative correlation between two features of awareness among HEF beneficiaries ($p < 0.05$).

of free services at public hospitals ($\rho = 0.73$) and coverage of maternal delivery ($\rho = 0.53$) and medications ($\rho = 0.52$). Similarly, those who were aware of reimbursement for transportation to public facilities for delivery were also aware of such reimbursements for hospitalization ($\rho = 0.78$) and often knew about funds available for meals for caregivers staying with patients at the hospital ($\rho = 0.53$). Considerably fewer respondents were aware of being able to use their card for services outside of their district of residence and, as a result, this did not positively correlate with any other points of HEF benefits knowledge. On the contrary, those who were aware of having free services at their local public health center were slightly less likely to respond affirmatively to the ability to use their HEF card outside of their district ($\rho = -0.07$). However, about 36% of responses for the question on whether respondents were aware that the HEF card could be used out-

side of a respondent's district were unanswered and should be interpreted with caution. PCA excluded this question and was conducted using only seven of the eight questions on awareness of HEF benefits included in the questionnaire.

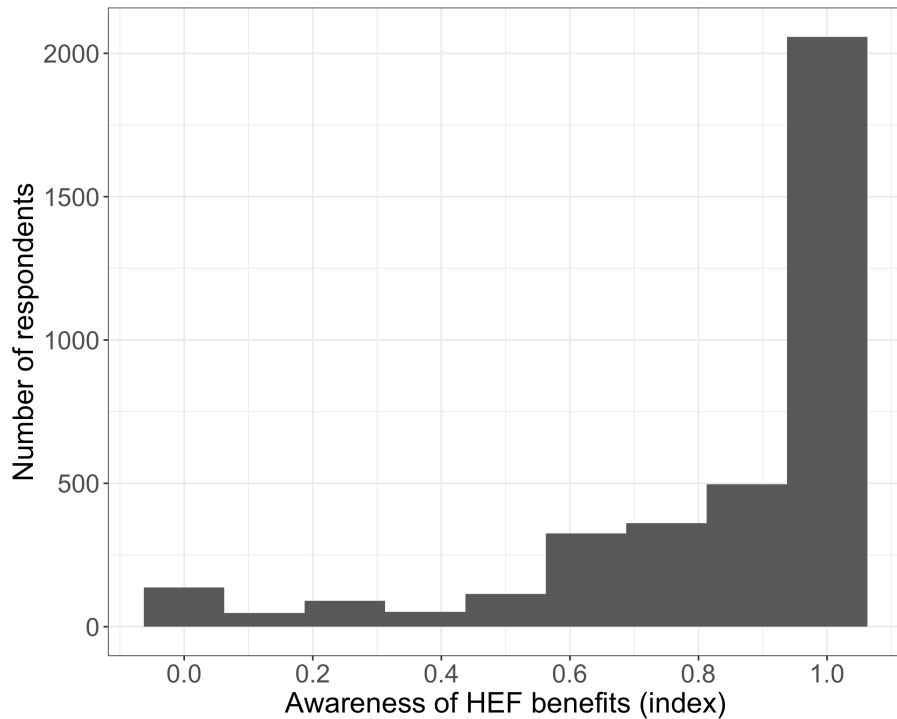


Figure 3.3: Frequency of respondents by awareness index for HEF benefits

0 = No awareness of benefit

1 = Full awareness of benefit

PCA revealed that about 91% of the variation across these seven questions can be captured in a single principal component. The mean awareness index among HEF beneficiaries was 0.83 ± 0.26 , indicating generally high awareness of HEF entitlements. Figure 3.3 also illustrates that most respondents reported being aware of nearly all HEF benefits.

3.3.3 PATTERNS OF CARE SEEKING AND UTILIZATION BEHAVIOR

Almost all (98%) respondents sought care upon onset of illness or injury with most seeking outpatient care. For those having at least some primary schooling, the odds of seeking care were over 1.5 times greater than among those who had never attended school. Most care seeking was for outpatient care rather than inpatient care. Among those seeking outpatient care, the majority of respondents (66%) sought care from a private

provider. About 36% of those who sought outpatient care sought outpatient care from a public provider at least once, while almost 20% always sought care in the public sector when they sought care for an illness or injury in the past 12 months. Nearly 26% of respondents indicated that they sought care more often from public providers compared to private providers. In general, women were more likely to have sought outpatient care from public providers (Appendix B.3, Table B.3.2). Individuals in the second income quintile had greater odds of having sought outpatient care from a public provider compared to the poorest in the sample.

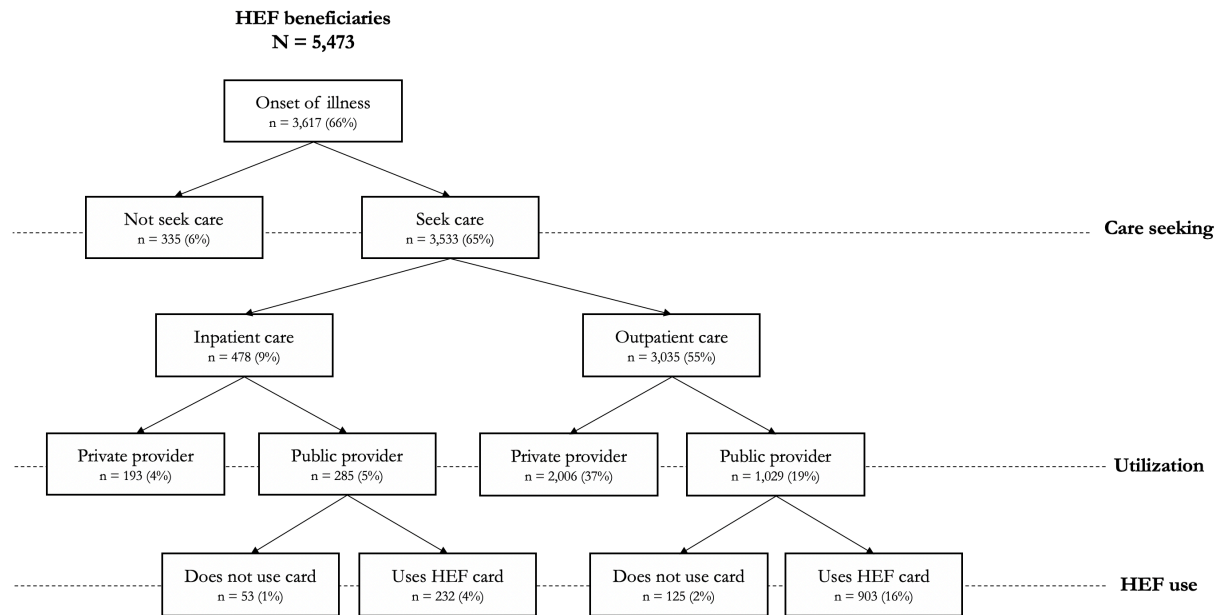


Figure 3.4: Proportions of the sample population observed at each point of decision making
OOP expenditure not shown as survey question referred to past two weeks only.

Table 3.2: Odds ratios for awareness predictors of care seeking among those ill or injured in the past year

<i>Dependent variable:</i> <i>Sought health care</i> <i>(outpatient or inpatient)</i>	
Health center services	0.287 (0.027,3.107)
Hospital services	1.452 (0.150,14.089)
Delivery	1.219 (0.359,4.135)
Continued on next page	

Table 3.2 – continued from previous page	
<i>Dependent variable:</i>	
<i>Sought health care</i>	
<i>(outpatient or inpatient)</i>	
Medicines	0.327 (0.087,1.235)
Transport for delivery	1.687 (0.669,4.254)
Transport for hospitalization	0.923 (0.333,2.560)
Caregiver meals	1.476 (0.711,3.067)
Observations	1,877
Log Likelihood	-496.308
Akaike Inf. Crit.	1,164.615
Prediction Accuracy	0.9032
<i>Note:</i> *p<0.05; **p<0.01; ***p<0.001	
Certain awareness predictors omitted due to missingness.	
District-level fixed effects and additional covariates (see Appendix B.3 for full model).	

Awareness of free services at public health centers was associated with increased odds of ever having visited a public provider (OR = 2.088, Table 3.3). However, awareness of free services at public hospitals was associated with reduced odds of seeking outpatient care at a public facility for illness or injury in the past 12 months (OR = 0.341). Awareness of financial coverage for medicines increased the odds of always seeking outpatient care at public facilities by more than 3.4-fold.

The sample sizes available to analyze inpatient care were smaller than those available for outpatient care, which may contribute to less reliable model coefficient estimates. No sociodemographic characteristics were statistically significantly associated with outcomes of interest. Awareness of free hospital services was associated with significantly greater odds of always seeking inpatient care at a public facility (Table 3.4).

Table 3.3: Odds ratios for awareness predictors of public provision and HEF claims for outpatient care

	<i>Dependent variable: Outpatient care</i>			
	Ever visited public provider (1)	Always visited public provider (2)	Ever used HEF card (3)	Always used HEF card (4)
Health center services	2.088* (1.086,4.014)	1.814 (0.769,4.283)	0.173 (0.00001,3,073.535)	1.022 (0.040,25.975)
Hospital services	0.341* (0.148,0.788)	0.319* (0.130,0.783)	0.219 (0.00002,2,508.104)	0.098 (0.002,4.433)
Delivery	0.540 (0.212,1.376)	0.705 (0.274,1.812)	0.717 (0.027,18.753)	1.343 (0.119,15.184)
Medicines	2.780 (0.852,9.077)	3.458* (1.095,10.917)		2.550 (0.190,34.270)
Transport for delivery	1.460 (0.670,3.182)	1.262 (0.624,2.550)	0.592 (0.114,3.070)	1.354 (0.423,4.337)
Transport for hospitalization	0.689 (0.287,1.658)	0.814 (0.383,1.730)	4.052 (0.646,25.393)	1.695 (0.413,6.950)
Caregiver meals	1.305 (0.744,2.291)	1.031 (0.566,1.877)	0.375 (0.123,1.146)	0.332* (0.137,0.805)
Observations	1,555	1,555	588	609
Log Likelihood	-863.512	-649.248	-106.496	-205.815
Akaike Inf. Crit.	1,897.023	1,468.497	370.992	571.630
Prediction Accuracy	0.6711	0.7938	0.8793	0.7882
<i>Note:</i>			* p<0.05; ** p<0.01; *** p<0.001	
Certain awareness predictors omitted due to missingness.				
District-level fixed effects and additional covariates (see Appendix B.3 for full model).				

3.3.4 EXAMINING HEF UTILIZATION AND HEALTH EXPENDITURE

About 30% of those seeking outpatient care ultimately claimed their entitlements under HEF coverage, while approximately 49% of those seeking inpatient care claimed their HEF benefits. Figure 3.4 illustrates the decision points at which beneficiaries drop off along the pathway to HEF utilization. Among those who claim their HEF benefits for inpatient or outpatient care, a large proportion always use their HEF card at point of service. Nearly 80% of those seeking outpatient care at a public facility always used their HEF card to claim

benefits and almost 88% had ever used their HEF card. Among those seeking inpatient care, over 75% always claimed HEF benefits for their care, while more than 81% claimed inpatient entitlements at least once for their illness or injury.

Table 3.4: Odds ratios for awareness predictors of public provision and HEF claims for inpatient care

	<i>Dependent variable: Inpatient care</i>			
	Ever visited public provider (1)	Always visited public provider (2)	Ever used HEF card (3)	Always used HEF card (4)
Health center services	1.424 (0.114,17.715)	0.323 (0.056,1.859)	0.932 (0.133,6.510)	0.543 (0.037,8.049)
Hospital services	8.023 (0.343,187.813)	38.071** (3.571,405.913)		
Delivery	2.243 (0.119,42.322)	6.834 (0.091,514.574)	35.312 (0.074,16,959.370)	6.935 (0.102,472.070)
Medicines	0.165 (0.012,2.289)	0.056 (0.001,3.214)	0.038 (0.001,2.805)	0.029* (0.001,0.912)
Transport for delivery	1.779 (0.170,18.587)	0.726 (0.065,8.129)	1.021 (0.259,4.034)	0.058 (0.003,1.194)
Transport for hospitalization	0.598 (0.071,5.045)	1.110 (0.106,11.675)		66.333 (0.760,5,792.215)
Caregiver meals	4.858 (0.907,26.012)	5.494 (0.752,40.140)	0.670 (0.192,2.333)	0.244 (0.054,1.105)
Observations	248	248	256	186
Log Likelihood	-80.875	-70.656	-77.277	-59.454
Akaike Inf. Crit.	323.750	303.312	290.554	258.909
Prediction Accuracy	0.6412	0.7118	0.6829	0.6129

Note:

*p<0.05; **p<0.01; ***p<0.001

Certain awareness predictors omitted due to missingness.

District-level fixed effects and additional covariates (see Appendix B.3 for full model).

Regression results showed that no variables included in the model was statistically significantly predictive of having ever used the HEF card to claim benefits. Awareness of funds for caregiver meals reduced the odds of always claiming benefits (OR = 0.332, Table 3.3). This may suggest that, by the time an individual chooses to seek care at a public facility, these remaining variables do not considerably alter their decision to claim their HEF entitlements. Rather, much of the decision to claim HEF benefits may have already been made prior to

this point in time. Similarly, at the stage in the pathway to utilization, having decided to seek care at a public facility, none of the variables included in the model significantly influenced the whether or not an individual paid any health expenditures OOP (Appendix B.3, Table B.3.4). Data on OOP expenditures was collected for the past two weeks rather than the past 12 months, as for other outcomes of interest. For this reason, the sample size of respondents remains small.

3.3.5 SIMULATIONS OF AWARENESS INTERVENTIONS

A total of 62 districts were included in simulations; eight districts were excluded from the fitting of the simulation models (Kampong Tralach, Baray/Santuk, Ponhea Leu, Chaktomouk, Preaek Phnov, Kampong Speu, Ang Rokar, and Svay Rieng) due to too few complete observations within a district on which to stably fit models. Mean differences in outcomes of interest were statistically significantly different compared to no intervention, though in many cases, the change was small. Without intervention, simulation models predicted that 25.8% of the population would seek outpatient care at public facilities, of which 96.7% would subsequently claim benefits using their HEF card.

Under intervention 1 (i.e., a general informational campaign), the population would become aware of HEF benefits prior to seeking care. As a result, the proportions of the population seeking outpatient care in the public sector would change slightly, ranging between means of 24.5% (1a) and 28.0% (1c) (Figure 3.5). Consistently across interventions, the majority of those seeking outpatient care in the public sector subsequently used their HEF card to claim benefits. Scenarios in which messages delivered focused on free public health center and hospital services as well as coverage for maternal delivery and medicines (b) resulted in greater benefits claimed as a proportion of individuals seeking public outpatient care compared to messages about free services alone. However, the scenario representing a general informational campaign that disseminated messages on reimbursement for transportation and funds for caregiver meals (1c) resulted in the highest public care seeking and HEF utilization overall at 28.0% and 27.1% of the population, respectively, a ~2% increase from the no intervention scenario. Scenarios in which intervention messages included free hospital services considerably reduced the the proportion of the population seeking care in the public sector, mirroring the model results noted in Table 3.3 in which awareness of free hospital services reduced the odds of having ever visited a public provider.

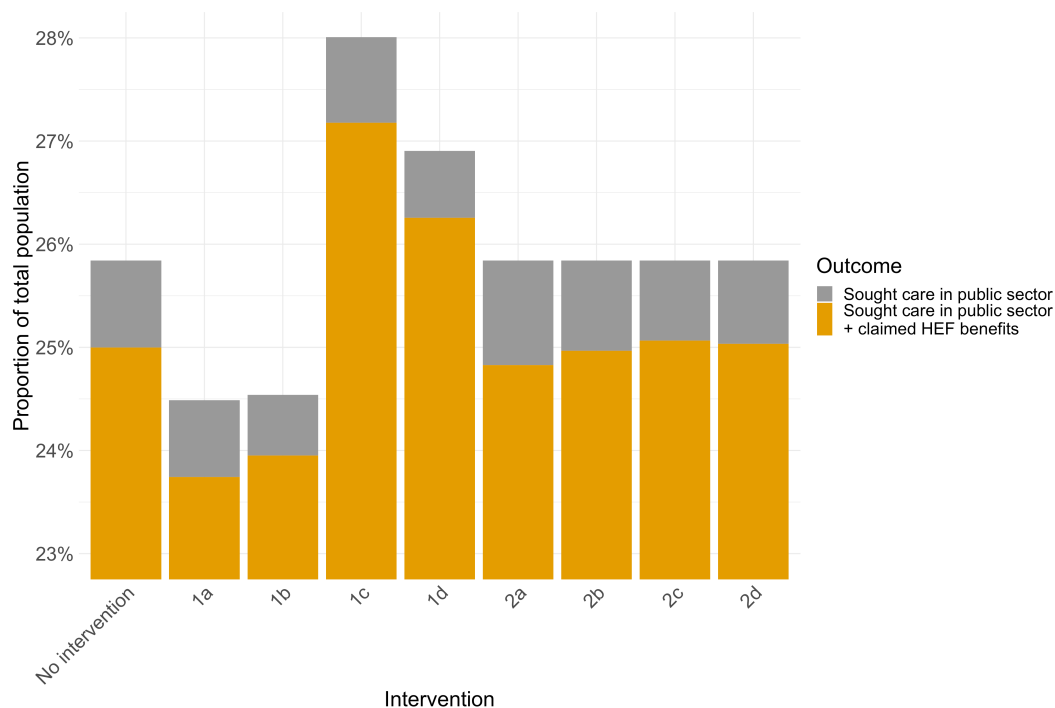


Figure 3.5: Predicted proportions of outcomes of interest for outpatient services by intervention
 Note: The range of the outcome of interest illustrated on this plot is 23% to 28% to sufficiently illustrate differences across intervention strategies.

Interventions:

- 1 General informational campaign
- 2 Dissemination via public facilities

Messages on HEF benefits:

- a Free public health center and hospital services
- b Free public health center and hospital services, coverage for maternal delivery and medicines
- c Reimbursement for transportation for maternal delivery and hospitalization and funds for caregiver meals
- d All benefits

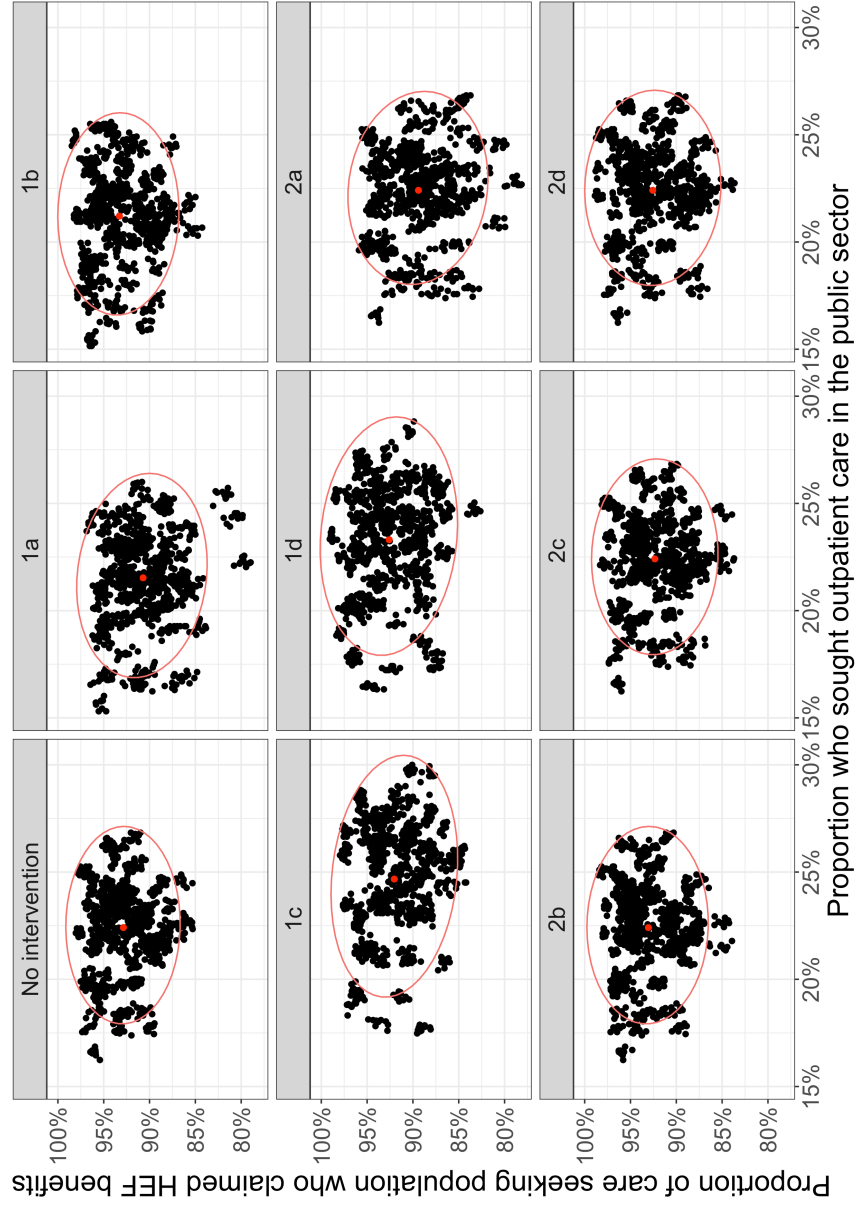


Figure 3.6: Proportion of bootstrapped sample that sought public outpatient care versus claimed HEF benefits
Red point indicates mean value. Red ellipse indicates 95% confidence interval.

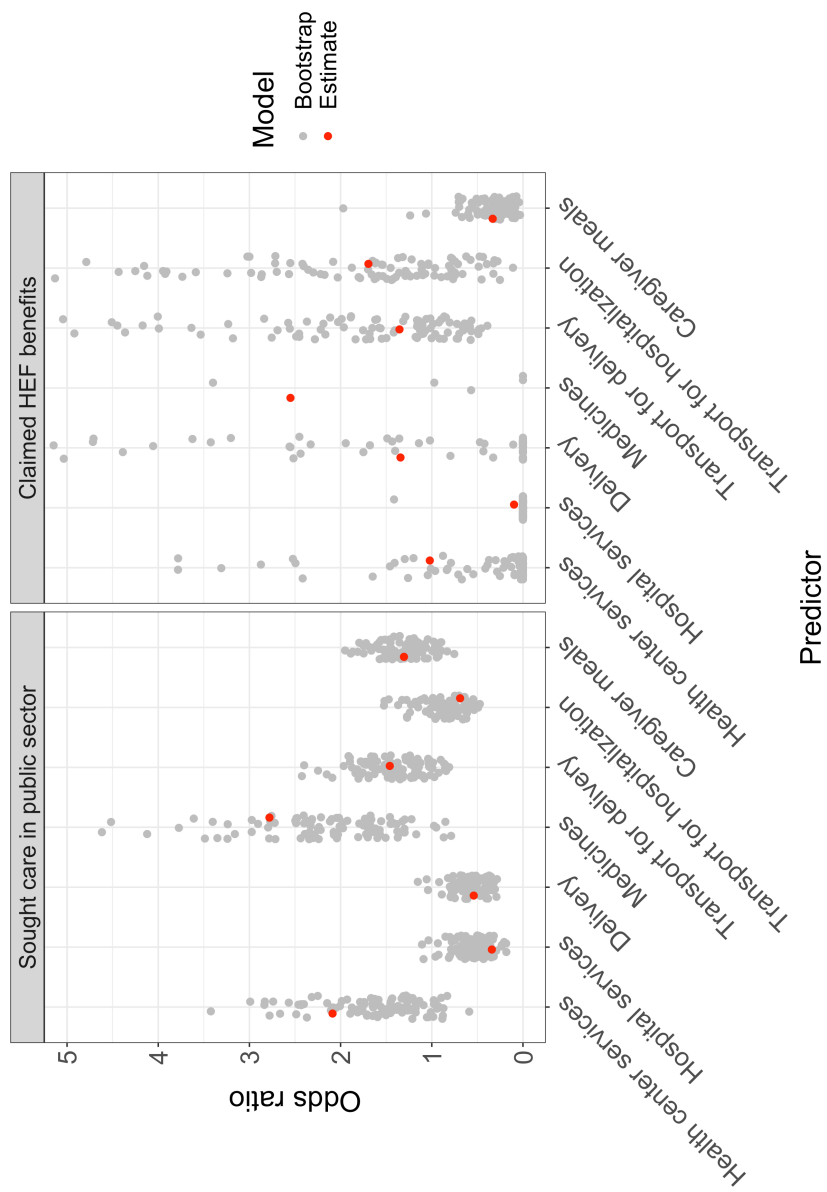


Figure 3.7: Odds ratios for awareness predictors across models fit on survey dataset and bootstrapped samples

In the case in which information on HEF benefits were disseminated through public facilities, as expected, the proportion of patients seeking care in the public sector would remain the same as in a scenario of no intervention. The proportion of individuals claiming HEF benefits at point-of-service would change only slightly, within 1%. An estimated 96.2% of patients seeking public health care services were predicted to claim HEF benefits when receiving messages on free public health center and hospital services (a) to 96.9% when receiving messages on all benefits (d). The results of this simulation suggest that the decision to seek care from a public provider closely corresponds to the decision to claiming HEF benefits at point-of-service, and indeed, may be intertwined. Overall, the scenario corresponding to a general informational campaign reaching 70% of the population and disseminating messaging on transportation reimbursements and funds for caregiver meals was most effective in increasing care seeking in the public sector and HEF utilization.

Analyzing uncertainty in outcome predictions revealed that there was greater uncertainty surrounding predictions on who claims HEF benefits. The widest 95% confidence intervals for predictions of the proportion of individuals seeking care at public facilities were from about 20% to 30% for the scenario representing a general informational campaign disseminating messages on free public health center and hospital services and coverage for maternal delivery and hospitalization (1b) and from about 18% to 28% when disseminating messages on transportation reimbursement and funds for caregiver meals (1c). Figure 3.6 demonstrates clustering of model predictions suggesting potential clustering of models depending on features of imputed samples. Simulations across scenarios suggest consistency within 10 percentage points of outcome predictions. The mean predictions of outcomes of interest across models fit on bootstrapped samples were lower than those predicted using the model fit on the raw survey dataset. In the case of no intervention, the mean proportion of patients seeking care in the public sector was 22.7% with 92.9% of those people predicted to claim HEF benefits. Despite the lower predicted values, the trends across interventions remained the same. The scenario of a general informational campaign focused on messaging about transportation reimbursement and funds for caregiver meals (1c) resulted in the most public sector care seeking (25%) and overall HEF utilization at point-of-service (23%).

Notably, predictions based on the models reported in Table 3.3 lay at the edge of 95% confidence intervals computed based on models of bootstrapped samples, shown in Figure 3.6. This suggests reasonable uncertainty surrounding model predictions as a result of missing data and/or inconsistency in model estimates.

Comparing model coefficients across the models fit on bootstrapped samples and those fit on the raw data revealed a range of odds ratios for each predictor of interest (Figure 3.7). There was a wide range of coefficient estimates for the models predicting whether a patient claimed HEF benefits at point-of-service, while estimates to predict care seeking in the public sector were relatively more consistent.

3.4 DISCUSSION

3.4.1 SUMMARY OF KEY FINDINGS

Study findings revealed that a high proportion of HEF beneficiary households with pregnant mothers or children under two years of age were indeed aware of their entitlements under the national social protection scheme, especially entitlements related to free services at public health centers and hospitals as well as coverage for maternal delivery and medicines. Individuals' knowledge of certain entitlements corresponded to their awareness of other benefits. For example, those who are aware of free services available at public health centers, are also most often aware of corresponding free services at public hospitals. Similarly, those aware of reimbursement for transportation for maternal delivery are likely also aware of reimbursement for transportation for hospitalization. Awareness of HEF entitlements did not vary across the population by sociodemographic characteristics.

Nearly all respondents reporting illness or injury in the past 12 months sought care for their condition. Most respondents sought care from a private provider. However, being aware of free services at public health centers was associated with twice the odds of ever having visited a public provider for outpatient care compared to those who were not aware of this entitlement under HEF. Awareness of hospital services was significantly associated with a decreased odds of having visited a provider for outpatient care. This may indicate individuals going straight to hospitals, bypassing outpatient care, when they are aware that hospital services would be free. Those aware of receiving financial coverage for medicines were also more likely to have always sought outpatient care from public facilities.

Analyses of inpatient outcomes of interest revealed a strong relationship between awareness of free services at public hospitals and having always visited a public provider. Despite generally high awareness of HEF entitlements, less than half of respondents reported ultimately using their HEF card to claim benefits at point-

of-service. If the decision had already been made to go to a public provider, however, it was likely that HEF benefits were claimed. Findings suggest that those who did use their HEF card, did so consistently. This may point to knowledge or experience of using their card to claim benefits in addition to awareness of specific entitlements under coverage as key features of the pathway to HEF utilization.

It is generally accepted that women of reproductive age typically have greater knowledge and contact with the health care system. This study was also not able to establish causal relationships based on the data available. Therefore, it is possible that, rather than awareness of HEF entitlements driving care seeking behaviors, awareness levels may be otherwise explained by respondents' past contacts with the public providers of the health system. Interpretations of study findings should consider their applications with respect to this population and to the extent that this population can be representative of the general population.

3.4.2 USER AWARENESS OF COVERAGE AND IMPROVING ACCESS TO HEALTH CARE

Existing literature generally agrees that health insurance improves access, utilization, and financial risk protection for health care in LMICs [88]. Our findings suggest that it may be possible to improve access to care through increased user awareness of coverage benefits, though increases in utilization at public facilities and financial risk protection via more benefit claims may be small. Studies in other LMIC settings, such as Colombia, have described an “awareness effect” of insurance coverage, in which having explicitly defined benefits and a physical membership card encourages greater utilization of formal health services [84, 89]. Indeed, an assessment conducted in 2015 found that, though only 46% of the poor held a HEF card, having the card increased the likelihood of a household seeking care at a public facility by 34% [23]. Focusing efforts on ensuring that beneficiaries have physical cards and are informed of entitlements upon enrollment in the scheme may be a beneficial alternative to informational campaigns aimed at improved utilization and access to care. It is debatable whether such an effect can be considered an environmental factor or enabling resource in the context of the Andersen behavioral model of health care utilization. This effect has features of the external community and health care system that promote awareness and acceptance of health coverage as well as the physical card allowing ownership of entitlements. Further exploration of an awareness effect of this nature would require understanding how beneficiaries receive and use their HEF card within a household or community.

While it is possible that the process of using one's HEF card at facilities may be influencing adequate utilization, the point at which patients tend to drop off along the pathway towards HEF utilization suggests that efforts focused on encouraging care seeking in the public sector may prove most fruitful. In LMICs where user awareness and utilization has been studied, beneficiaries or potential beneficiaries tend to have low levels of awareness of their benefits under insurance schemes [90, 91]. This study showed that this is not the case in Cambodia. In fact, the majority of beneficiaries consistently reported knowing about entitlements under HEF coverage with the highest levels of awareness surrounding free services at public health centers and hospitals. The concentrated awareness on these two main provisions of HEF makes sense when considering existing literature about how individuals understand health insurance coverage; a study of consumers' knowledge of health insurance in the United States reported that the majority of families understand only one or two simple benefits of their coverage [92].

Despite generally high levels of awareness, however, the majority of patients covered by HEF continue to seek care from private providers. This finding was consistent with past studies, which have reported high utilization of private providers as high as 85% in rural areas and 77% of OOP spending [23]. Regardless of the promise of greater financial risk protection through HEF coverage, it seemed that households were either more willing to pay OOP for health services from private providers or possibly faced other barriers to accessing care, such as distance to public facilities. Care seeking in the private sector resulting in financial hardship can be considered as issues related to access to care due to poor perceptions of public health services or stigma associated with utilization of health coverage. Efforts to identify or address these issues in Cambodia may advance initiatives to improve financial risk protection and appropriate utilization of health services.

3.4.3 LIMITATIONS OF THIS STUDY

Potential limitations of this study include missing data across variables of interest. For example, nearly 23% of HEF beneficiaries who reported illness or injury in the past 12 months were missing information on highest education completed. About 3% of this sample was missing information on the seven awareness indicators included in regression analyses. Relatedly, missing data contributed to reductions in the sample sizes available for model fitting for various outcomes of interest, particularly those related to HEF utilization. Multivariate imputation was used to build a complete sample for simulations of policy scenarios, however, there may still

be undetectable bias in the estimates of relationships shown in regression models.

Another limitation of the study related to the nature of survey questions. Questions on OOP health expenditures only asked respondents about illness or injury in the two weeks prior to the survey, rather than the past 12 months as was the case for other survey questions of interest in this study. For this reason, the analysis on OOP health expenditures and what can ultimately be said about effective financial risk protection remains limited. Additionally, survey questions asked about respondents' knowledge of HEF benefits in a uniform way and only about true HEF entitlements (Appendix B.1). Thus, it is possible that the levels of awareness of HEF entitlements was not accurately representative of true knowledge or may have been artificially inflated due to this survey strategy. The combination of relatively small sample sizes and limited variation in awareness levels for particular outcomes of interest resulted, in some cases, in nearly perfectly predictive relationships. In such cases, it was impossible to estimate any existing relationships between awareness and outcomes of interest.

Uncertainty analyses revealed that model estimates for the outcome of claiming HEF benefits were fairly unstable, with a wide range of results when examined with bootstrapped samples. This may be due to the fact that the number of HEF beneficiaries who sought care at public providers was fairly small and reported limited variation in awareness. These issues may indeed be closely related; those who claim HEF entitlements may have more consistent awareness of their benefits. A limitation of this study remains that the data does not allow for causal inference. That is, only associations between awareness and care seeking behavior and HEF utilization can be detected. We hope that future surveys will consider causally assessing the influence of user knowledge and understanding of coverage benefits on their care seeking behaviors and improving financial risk protection among this population.

This study did not consider the mechanisms or processes by which HEF benefits are claimed. For example, the data provided little insight into how beneficiaries obtain or regularly use their HEF card. It is possible that beneficiary cards are managed by a head of household or community, which would add further complications to convenient use of the card at point-of-service. It is also possible that difficulties arise upon using the card at certain facilities and other studies have alluded to stigma associated with IDPoor designation and use of HEF benefits. The implications of potential stigma and difficulties of claiming coverage benefits alongside existing challenges of appropriate allocation of human and financial resources may drive patients' perceptions

of lower quality of care at public facilities, leading to lower care seeking at public facilities. However, these other factors were not a focus of this study.

Finally, it is important to recall that the sample considered in this study selected households with pregnant women and/or mothers with children below two years of age. Thus, study findings and implications of this research remain relevant to this subset of the population and the extent to which this subgroup can represent the Cambodian population.

3.4.4 IMPLICATIONS FOR POLICY AND RESEARCH

Beneficiary entitlements under HEF coverage are fairly simple, covering the standard package of outpatient and inpatient services available in the public sector of Cambodia's health system as well as selected costs incurred as a result of individuals' actions to seek care. The generally high levels of awareness of HEF entitlements among beneficiaries may hint at the benefits of simplicity in benefit design for health insurance or other social health protection schemes. In other words, it seems unlikely that the complexity of benefits provided under HEF hindered beneficiaries from understanding their entitlements or using HEF at health facilities. More likely, other barriers to claiming HEF benefits contribute to low HEF utilization in Cambodia.

This study expanded on the often used Andersen health care utilization model, including financial risk protection as an outcome of interest when examining patient awareness of coverage benefits and utilization in a health system. On the path to UHC, access and equity have become key features of health policies and the addition of this outcome to our framework of analysis aimed to represent that evolution. With this addition, the framework illustrates the linkage between user knowledge or awareness of health benefits and improved access to health services, the ultimate aim of HEF and other social protection schemes for health. Implementing the framework using a microsimulation allows us to grasp the impact beneficiary awareness could have on relevant outcomes. In many settings, microsimulation may be a favorable approach where data detailing the effects of all possible policies or interventions is not available and experimental testing is not possible. Such is the case for HEF in Cambodia and these simulations point to potential policy actions and further research to improve access and utilization of health services and entitlements.

Simulation of informational interventions highlighted the differential impacts of strategies distinct in key features as well as peculiarities in the data. A simulated general informational campaign focused on informing

the population about reimbursements for transportation and funds for caregiver meals resulted in the greatest increases in outpatient care seeking in the public sector and HEF utilization compared to no intervention. Notably, the baseline awareness of these particular entitlements was considerably lower compared to awareness levels for other benefits, such as free services at public health centers and hospitals. It is possible that the most effective interventions to increase awareness should focus on the less well-known benefits to encourage greater increases in care seeking at public facilities and subsequent HEF utilization. On the other hand, it is possible that these features of transportation reimbursement and funds for caregiver meals best respond to key barriers to accessing care among the poorest and, therefore, lead to the greatest increases in appropriate care seeking and HEF utilization in that population group.

Regression models and trends in simulation results point to the decision of where to seek care as the critical point in the pathway to HEF utilization. Results suggest that, when aware that hospital services are covered, users bypass lower level outpatient services for higher levels, seeking care at hospitals. Interventions that prompt appropriate care seeking in the public sector may do the most to improve HEF utilization and subsequently improve access to care through sufficient financial risk protection. This emphasizes the relevance of policies and interventions that go beyond public facilities to reach individuals as they make the decision to seek health care.

Even in the scenario with the greatest impact, however, outpatient care seeking in the public sector alongside HEF utilization remained low overall, reaching just 28% from just under 26%. The small increase in HEF utilization resulted under optimistic simulated conditions, in which 70% of the population was reached by the informational campaign. Yet, it would arguably be challenging to reach this proportion of the population, and particularly challenging to reach the poorest who would be covered under HEF, via mass media alone. Efforts for an effective informational campaign targeting HEF beneficiaries could involve informational dissemination through community meetings and peer groups. Still, the simulated return appears to be minimal. This suggests that interventions to increase awareness of HEF benefits in terms of user knowledge should not be implemented for this population. Other focuses of interventions may include improving the distribution of physical HEF cards, quality of care, and appropriate allocation of human resources to public health facilities.

3.5 CONCLUSIONS

Efforts to improve financial risk protection for appropriate health care utilization can improve access to care and move Cambodia closer to achieving UHC. In examining the pathway to health coverage utilization, this study revealed that most beneficiaries are aware of their entitlements, but continue to seek care from private rather than public providers, which contributes to increased financial risk. While promoting awareness of certain features of HEF coverage, such as reimbursements for transportation to facilities, may induce significant but small improvements, simulation of potential policy interventions further supported that encouraging care seeking in the public sector may be the first step towards improved HEF utilization, greater financial risk protection, and improved access to care. Interventions targeting HEF beneficiaries before individuals have decided where to seek care would be most effective in increasing utilization in the public sector and subsequent utilization of the national social protection scheme. Future research should focus on the causal and process factors influencing coverage utilization beyond affordability concerns.

4

Alleviating the Health and Financial Burden of Diabetes with the Health Equity Funds

4.1 BACKGROUND

4.1.1 HEALTH AND ECONOMIC BURDEN OF DIABETES

GLOBALLY, THE PREVALENCE OF DIABETES AMONG ADULTS ROSE from 5% in 1980 to 9% in 2014 and has been rapidly rising in low- and middle-income countries (LMICs) [93, 94]. In Cambodia, diabetes caused nearly 3% of the country's mortality in 2016 and became the fourth highest cause of disability in 2017 [11,

19, 27]. The epidemiological distribution of the disease across population groups, however, is varied, and the burden of diabetes in Cambodia remains unexpectedly high given the generally traditional lifestyle in rural areas, where 80% of the population resides. While overall diabetes prevalence has been estimated at 6%, a survey of rural and semi-urban communities in 2005 revealed diabetes prevalences of 5% and as high as 11%, respectively [19, 95]. The 2010 STEPS Survey reported a prevalence of 3% among adult Cambodians (25-64 years), with lower prevalence (1%) among younger adults (23-34 years) and higher prevalence (6%) among older adults (55-64 years) [96]. Prevalence of diabetes among women (3.3%) has also been reported to be higher than men (2.5%), and projections have estimated an 82% increase in the country's diabetes burden from 2008 to 2028 [97].

Despite high diabetes prevalence, most diabetics in the country are not aware of their condition. Most diabetics remain undiagnosed until the onset of severe complications and medications and treatments to manage the disease are frequently only available from private providers for those who can afford it [95, 97]. Prior to a survey conducted by King *et al.*, in which researchers tested patients for diabetes, about two-thirds of diabetes cases were undiagnosed [95]. Late diagnosis of diabetes can limit effective management and delay care seeking until severe complications arise, leading to poor health outcomes as well as high costs to patients and the Cambodian health system.

Management of diabetes and its related complications is generally associated with high costs [98]. Economic costs to the Cambodian government to cover all patients in Cambodia were projected to increase from USD 6 million in 2008 to USD 11 million in 2028 [97]. These costs include financial costs associated with screening, diagnosis, treatment, and management as well as costs attributable to lost productivity among the working-age population [99]. Studies focused on LMICs report that annual inpatient and medication costs are the most expensive aspects of diabetes care [100]. Thus, strategies to tackle the health and economic burden due to diabetes must consider the long-term cost implications of developing health services for prevention and control.

The economic burden of diabetes has distinctly different implications for different population subgroups. Non-communicable diseases (NCDs) like diabetes can disproportionately affect the poor with the potential to worsen financial stability and undermine poverty reduction efforts [27]. For example, a case study of diabetes in Sudan demonstrated that annual mean expenditures were 85% higher among adults with diabetes

and that this population was also significantly more likely to experience adverse social effects, such as inability to carry out paid work or continue educational activities [101]. Evidence from Mexico further showed that the economic burden of diabetes drives significant health disparities due to high out-of-pocket (OOP) expenditures that have far-reaching implications for health systems, families, and patients [102]. A chronic and expensive disease, diabetes closely links health status, poverty, and economic development. Identifying cost-effective strategies that provide sufficient access to health care and account for the unique resource constraints of LMIC settings will be critical into the future.

4.1.2 DIABETES-RELATED SERVICES AND CARE DELIVERY IN CAMBODIA

Despite the adoption of the National Strategic Plan for the Prevention and Control of Noncommunicable Diseases 2013-2020 in Cambodia, evidence-based national diabetes guidelines are not available in the country and diabetes-related medicines, procedures, and basic technologies for diabetes care and management are often not available in health facilities. Primary care facilities rarely maintain stocks of diagnostic tests related to screening or diabetic drug therapies and are generally unable to provide treatments for diabetes-related complications [19]. The failure to address the increasing diabetes burden can intensify existing challenges. A recent study showed that diabetes increases susceptibility to infection and worsens outcomes of infectious diseases, provoking a double burden in countries continuing to fight major communicable diseases, as is the case in Cambodia [103]. In fact, over 29% of disability-adjusted life-years (DALYs) in the country were attributable to communicable diseases in 2017 [11]. Strategic investments in the strengthening of health systems could mean far-reaching positive impacts on the quality and effectiveness of primary health care services, largely tasked with the prevention and regular management of chronic diseases, including diabetes, as well as indirectly strengthen capacity to tackle communicable diseases.

The Ministry of Health (MOH) and various non-governmental organizations (NGOs) have undertaken programs aimed at testing the feasibility of patient-centered, integrated diabetes care and management in the country [104, 105]. Programs for diabetes care and management have focused on similar general features, including increasing access to screening and laboratory testing, appropriate outpatient services (i.e., individualized patient consultations and/or counseling), and prescribed routine medication. Former or current care programs have varied primarily in the degree of intensity of management as well as implementation. For ex-

ample, between 2002 and 2009, a subsidized outpatient diabetes treatment program initiated by Médecins Sans Frontières in collaboration with the MOH routinely saw and tracked patients for various glucose and complications testing until patients were lost to follow-up [104]. Another program initiated by MoPoTsyo, a Cambodian NGO, provided diabetes support through community-based peer educators and access to local medical outpatient consultation, laboratory testing, and a revolving drug fund [105–107]. In this case, peer educators facilitated patient self-management, meeting with patients individually for screening, ongoing education, and other support. Despite successes of the programs, such interventions have not been adopted as long-term, ongoing interventions or programs.

4.1.3 ROLE FOR PUBLIC SOCIAL PROTECTION SCHEMES IN DIABETES CARE AND MANAGEMENT

Diabetes requires routine patient-centered care and management, which would typically occur in primary care facilities. However, such regular care can be difficult to maintain in LMICs as a result of high economic costs and other barriers to access, especially among the poorest. Furthermore, over 80% of the total health expenditure in Cambodia is spent on secondary and tertiary care, while only about 20% is spent on public and private primary health care services [108]. This may suggest that, instead of regularly accessing care for their condition, individuals access care upon the onset of moderate to severe complications. Providing sufficient financial risk protection from routine health care expenditures may be part of the solution towards effectively tackling the diabetes burden and motivating individuals to appropriately seek care to effectively manage their condition. There may be a role for social protection schemes to encourage diabetes-related care seeking and service provision in LMICs through primary care facilities. Providing adequate financial risk protection for chronic diseases, however, can be challenging due to high costs that are typically expected to span over long periods of time.

In Cambodia, the Health Equity Funds (HEF) act as the main social health protection scheme, operating at the district level and providing additional coverage for non-medical costs, including transportation and caregiver meals, for care seeking for selected health services [23, 109]. Established in 2000 to reduce barriers to accessing care among the poor, HEF was used to fund user fee exemptions at public health facilities for this population [23]. Beneficiaries are identified at home prior to seeking care by a national survey (IDPoor) or, when necessary, at health facilities upon seeking care [69, 110]. A standard set of services included in the

Minimum Package of Activities (MPA) and Complementary Package of Activities (CPA) are provided free to beneficiaries at point of service with HEF directly reimbursing the facility for any related costs [23]. In theory, diabetes screening and drug therapies are included as essential services and medicines in the Guidelines on MPA for Health Center Development distributed by the MOH [28, 111]. Yet, recent studies have demonstrated that HEF in Cambodia offers very limited financial access to medicines for patients with diabetes, particularly in rural areas [29]. These studies showed that diabetes patients rely heavily on private health services, known to drive high OOP expenditures and contribute to negative consequences on access and adherence to treatment [29]. Thus, limited availability of diabetes screening, testing, and therapies alongside high fees make such services inaccessible to much of Cambodia's population.

Diabetes is characterized by stages of disease that require differential care and management, such as diagnostics and laboratory testing, glycemic control using drug therapies, and treatment of diabetes-related complications. The steps of this disease progression are inextricably linked, with earlier stages influencing later stages. Early detection and diagnosis is often associated with improved management and prognosis [112]. Many health programs promote the value of intensive diabetes screening initiatives. However, while free screening or other improvements in access to screening and laboratory testing can increase diagnosis of existing diabetes cases, if patients cannot then access appropriate treatment and/or management programs, there may be limited, or even negative, impacts on health status. For example, according to the Global Burden of Disease (GBD) Study 2017, uncomplicated diabetes is associated with a disability weight of 0.049 due to the impacts of psychological worry and daily medication taken for the condition that minimally affects everyday life [11]. Thus, diagnosis alone can drive negative impacts on health and well-being. These linkages require that social policies strategically consider the details of intervention coverage across the different stages of disease. Such details may include which essential services to cover, the extent to which those services are covered, the duration of time over which they are covered, and for which populations.

Benefit design of health insurance and other social protection schemes has been shown to influence patient and provider behaviors, affecting health services utilization and provision [89, 113–116]. Design of benefit packages targeting chronic diseases should consider the pathway by which policies affect and/or incentivize patient behavior and care seeking in order to optimize population health, economic costs, adequate access, and financial risk protection. In the case of diabetes, for example, if cost remains a barrier to accessing particu-

lar services, such as fasting plasma glucose (FPG) tests and medications, reducing these barriers may encourage their utilization. If providers expect to receive sufficient reimbursement for the provision of diabetes-related services, they may be incentivized to offer such services [117–119]. In this way, benefit design of essential health services packages and social protection schemes can have an impact on diabetes diagnosis, appropriate treatment, and glucose control to prevent the burdensome complications associated with the disease.

As Cambodia’s major health protection scheme for the poor, HEF provides coverage to about 75% of its target population; about 17% of the total population were covered through a social or voluntary health scheme in 2015 [23]. Studies have shown that HEF are effective in increasing access to health services and financial risk protection for the poor [68, 72, 120, 121]. Allocating sufficient resources for the care and management of diabetes under HEF may be one way to tackle the increasing burden of diabetes in Cambodia, especially among the poor. However, understanding the costs, benefits, and feasibility of strategies for HEF coverage to contribute to alleviating the growing diabetes burden will be critical to long-term financial sustainability and effectiveness. Such an approach has yet to be explored and little is known about whether promoting changes in behavior under HEF coverage will translate to relevant impacts on population health and financial risk protection for the poorest.

4.1.4 STUDY OBJECTIVE

In this study, we aim to estimate the health and financial impacts of strategies to provide financial coverage for diabetes care and management services through HEF in Cambodia under a scenario in which supplies for diabetes-related services are widely available. As a first step, we focus on how increased availability of such services would impact the poorest in the population, since these households may be most at risk for catastrophic health expenditures. We also highlight the differential impacts of strategies on men and women that may be important for appropriate policy design for access to diabetes care. Based on these estimates, we intend to determine optimal strategies to tackle the burgeoning diabetes burden, while ensuring financial security for the country’s poorest.

4.2 METHODS

4.2.1 CAMBODIAN HEALTH SYSTEM CONTEXT

Cambodia is a lower middle-income country (GDP per capita: 2017 USD 1,384) in Southeast Asia with a population of approximately 16 million, 80% of which live in rural areas [23, 67]. Life expectancy was 67 and 71 years for men and women, respectively, and under-five mortality was 28 per 1,000 live births in 2018 [122, 123]. Despite considerable economic growth in the past two decades, Cambodia's poverty rate remains high: about 18% of the Cambodian population was living under the international poverty line (\$1.90 per day, 2011 purchasing power parity) in 2014 [60]. Total health expenditure was estimated to be about US\$78 per capita in 2016, financed by individuals' OOP payments (60%), the government (20%), and donors (20%) [124, 125]. Total health expenditure was 6% of GDP in 2016, below the average 9% of the Southeast Asia region, with government spending accounting for 22% of that expenditure (corresponding to 1.3% of GDP) [58, 67]. For comparison, the mean proportion of government expenditure on health as a percentage of total health expenditure was about 34% in Southeast Asia and about 43% in other lower-middle-income countries [58].

The MOH leads health system planning and development, being solely responsible for the organization and delivery of government health services [23]. A centralized authority, the Directorate General for Health, oversees 24 provincial health departments, which includes 81 operational districts (ODs) across the country. Each OD is comprised of a referral hospital delivering a designated CPA and multiple health centers providing the MPA [23]. Hospitals are designated based on the CPA services available: CPA1 facilities are referral hospitals, generally district hospitals, that offer an obstetric service, but no surgery; CPA2 hospitals comprise a higher level of care, providing emergency care services and surgery with general anesthesia; and CPA3 hospitals are those with the most services available, including surgery and multiple specialized services [126].

Health centers provide maternal, neonatal, and child health services, treatment and prevention of communicable diseases, treatment and prevention of NCDs and injuries, and outreach activities that serve populations of 100,000 to 200,000 people and are intended to act as gatekeepers to higher levels of care (i.e., district referral, provincial, and national hospitals) [59, 111, 126]. However, patients often bypass the referral system, directly seeking care from hospitals or other sources of health care [23]. As of 2015, services for NCDs

were developing with prevention and control activities managed by the Department of Preventive Medicine of the MOH. In response to the increasing NCD burden and related risk factors, the MOH established the National Strategic Plan for the Prevention and Control of Noncommunicable Diseases 2013-2020 [27].

4.2.2 INTEGRATING DIABETES TRAJECTORY AND CARE DELIVERY IN A MARKOV MODEL

We conducted a microsimulation study of diabetes in Cambodia using a Markov model to compute costs related to diabetes care and management from a societal perspective (Figure 4.1) [127, 128]. The model of care outlined in this paper follows a general structure of patients undergoing diabetes screening and testing, receiving and regularly taking appropriate drug therapies, and receiving treatment for related complications. The model simulated 45 years of individuals' lives, iterating over the probabilities of disease states until the end of the time horizon or until the individual's death due to diabetes or other causes (i.e., all-cause mortality). For each cycle of the model, each representing one year's time, a Markov chain was constructed based on an individual's characteristics and transition probabilities between disease states. A random sample was obtained from this distribution to determine the annual disease state of an individual. Because diabetes more commonly develops at older ages, ages included in the model were restricted to those between 25 and 69 years. New individuals were not introduced (i.e., upon death, individuals in the population were not replenished) over the course of the model's time horizon.

Initial states characterizing the population entering the microsimulation were derived based on current population distributions for sex, age, income, and diabetes burden derived from information reported by the 2014 Demographic and Health Survey, 2017 Cambodian Socio-Economic Survey, and the 2017 Global Burden of Disease (GBD) Study [11, 129, 130]. The WHO Global Health Observatory reports age- and sex-specific all-cause mortality for Cambodia in five-year age groups; mortality was assumed to be constant across each five-year interval by which data were available and did not evolve for age or epidemiological changes over the course of the model's time horizon [65]. Age- and sex-specific diabetes incidence and mortality data for Cambodia were obtained from the 2017 GBD [11]. A gamma distribution was used to simulate individuals' annual income in the country, informed by the national average monthly income for 2017 alongside the Gini coefficient of 36.0 for 2013 [130, 131]. General disability weights for diabetes-related disease states were also obtained from the GBD Study 2017 [11].

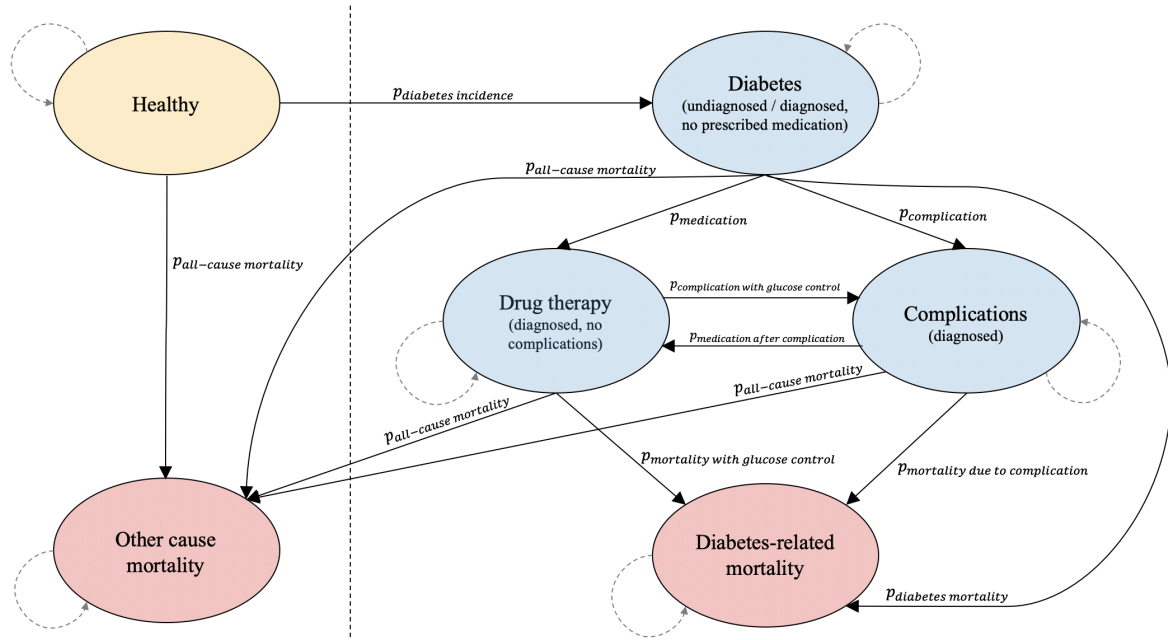


Figure 4.1: Simplified representation of the Markov model integrating disease and care delivery states

‘Drug therapy’ state includes oral anti-diabetic drug therapy and insulin therapy options. ‘Complications’ state entails incidence of major complications and subsequent treatment.

The model considers care seeking behavior based on data available for household care seeking for the most recent illness as well as the type of facility visited [72, 132]. For an individual to be diagnosed with diabetes, an individual is required to have visited a health facility, been screened with a FPG test, and received laboratory testing results. Probability of treatment with oral anti-diabetic drug (OAD) or insulin therapies was informed by the proportion of diabetes patients on medication prior to enrollment in a diabetes management program in Cambodia [105]. In the model, it was possible to be diagnosed with diabetes and remain untreated; this represents cases in which diabetes has been diagnosed and the provider gives a diet consultation rather than drug prescription. The impact of changes in behavior and diet are challenging to capture and the existing literature remains inconclusive regarding how likely diabetic patients successfully improve their diets or other lifestyle habits. This model conservatively assumes only a small reduction in relative risks of subsequent complications ($RR = 0.90$), which is also tested in the uncertainty analysis. The effects of glucose control on mortality and/or incidence of complications were understood as representative of the impact of either OAD or insulin regimens. Because medication adherence is a significant factor in successful control of glucose levels, degree of OAD or insulin adherence is also considered in the model. Parameters representing OAD were

derived from information on metformin, the likely candidate for OAD therapies in this setting.

Just as an individual can remain untreated or receive medications for their diabetes, they could alternatively develop related complications. The nature of diabetes is such that an individual may die due to complications induced by the symptoms or effects of diabetes. Eight complications related to diabetes were considered: (i) nephropathy, (ii) retinopathy, (iii) neuropathy, (iv) angina pectoris, (v) peripheral vascular disease (PVD), (vi) myocardial infarction (MI), (vii) stroke, and (viii) heart failure. These complications were selected as the main diabetes-related complications based on the published literature and past costing studies for diabetes focused on Cambodia [97, 133]. If not well-controlled, diabetes can cause blindness, kidney failure, lower limb amputation, and cardiovascular events [134–137]. Studies suggest that the prevalence of retinopathy among diabetics is 35% and may be higher among people of lower socioeconomic status [134, 138]. An estimated 80% of end-state renal disease cases are caused by diabetes and diabetes also increases the risk of lower extremity amputation due to neuropathy by 10 or 20 times compared to non-diabetic populations [134, 139, 140]. Lastly, adults with diabetes have a two to three times higher rate of cardiovascular disease (CVD) and an increased rate of CVD mortality by two- to four-fold, making it the leading cause of death among people with diabetes [134, 135, 141, 142]. We conservatively assume that complication-related states represent the most severe stages of a complication. Complication-specific costs were included based on the most common and/or feasible treatment in Cambodia.

HEF eligibility was assumed for individuals with an annual income of below approximately US\$377, which corresponds to the 20th percentile of Cambodia's estimated national income distribution [143]. Because the specific requirements for HEF eligibility are not released publicly, the exact eligibility threshold is not known. For this reason, the model was also run for an eligibility threshold at the 30th percentile of the estimated income distribution across the population for comparison. Upon seeking care at public facilities, about 88% of HEF beneficiaries claim their benefits under the scheme (see Chapter 3). The model assumed that changes in care seeking behavior would be driven by the knowledge of HEF coverage and of availability of diabetes-related services in public facilities. If individuals are compelled to be screened or treated for diabetes because of their coverage under HEF, it was assumed that they will claim HEF benefits upon receiving those services. Thus, it was assumed that all patients seeking care for diabetes-related services would claim their benefits under HEF. HEF entitlements are expected to provide full financial coverage for all of the

services listed in its benefit package. However, given the high costs generally associated with diabetes management, we considered two different scenarios of HEF coverage of direct medical costs associated with diabetes-related care to illustrate the range of potential impact of HEF strategies. In the first case, HEF is assumed to provide financial coverage for 80% of direct medical costs that would otherwise be paid out-of-pocket. In the second case, HEF coverage is assumed to cover 100% of those direct medical costs.

Six strategies involving changes to HEF coverage for diabetes care were compared to the current standard in which HEF beneficiaries do not receive any financial coverage for available diabetes-related services, which is primarily the case when seeking care for such services in the private sector (Table 4.1). These strategies were selected based on the cascade of care for diabetes and how service packages are defined in HEF (see Appendix C.1). Strategies varied in terms of which segments of the diabetes cascade of care would be covered: diagnostics, medications, and treatment of diabetes-related complications (Table 4.1). Evidence suggests that HEF reduces the probability of seeking care in the private sector and shows that public health services utilization increases among HEF beneficiaries compared to “near-poor” non-beneficiaries (i.e., individuals just above the threshold of HEF eligibility) [29, 68, 71, 72, 108, 121, 144, 145]. For scenarios in which the respective services for each particular strategy would be available in the public sector, we assumed that HEF coverage for services specified in each of the strategies will increase utilization of those services among HEF beneficiaries.

Strategies that included the coverage of diagnostic services were assumed to impact the probabilities of care seeking behavior for diabetes-related symptoms and subsequent diagnosis in the presence of disease. Strategies involving medications were assumed to impact the probabilities of drug adherence for diabetes and strategies related to complications of the disease were assumed to affect the probability of care seeking for complications. While coverage for diabetes-related complications may compel patients to seek care, there may be little capacity of facilities to provide curative care for severe acute conditions, such as myocardial infarction or stroke, and services may minimally reduce mortality. Additionally, there is little data available to inform how formal treatment of complications affect health outcomes in Cambodia. As a result, the potential effects of health care seeking and treatment for complication-related mortality was not accounted for in the model.

Table 4.1: Description of the strategies analyzed and their hypothetical impacts

Strategy	HEF coverage description	Description of impact
Current standard	No financial coverage for any diabetes-related services	Represents current situation
Diagnostics only	Diagnostic services for diabetes including screening and laboratory testing	Reduces barriers to care seeking, increasing probability of diagnosis (RR = 1.5) and care utilization (RR = 2.0)
Drug therapy only	Prescribed medication (i.e., oral-anti diabetic (OAD) medication and/or insulin)	Reduces barriers to access to medicines, increasing drug adherence ($p = 0.40$)
Complications only	Treatment for diabetes-related complications	Reduces barriers to care seeking, increasing probability of care utilization (RR = 2.0)
Diagnostics + Drug therapy	Diagnostic services and prescribed medication	Combined effect of strategies for diagnostics and drug therapy
Drug therapy + Complications	Prescribed medication and treatment for diabetes-related complications	Combined effect of strategies for diagnostics and complications
Diagnostics + Drug therapy + Complications	Diagnostic services, prescribed medication and treatment for diabetes-related complications	Combined effect of strategies for diagnostics, drug therapy, and complications

RR: relative risk; p indicates a probability value

Impacts described above were simulated in the model as relative risks or changes in probability to represent assumed behavior changes among HEF beneficiaries.

4.2.3 COMPUTING HEALTH GAINS, PUBLIC COSTS, AND FINANCIAL RISK PROTECTION

Disability-adjusted life-years (DALYs) were used to capture health impacts. DALYs were calculated as the sum of years of life lost (YLL) due to premature mortality and years of life lived with disability (YLD) among people living with diabetes and its consequences [146, 147]. YLLs were calculated using the life expectancy for Cambodia at the age at which death occurred. YLDs were estimated for each yearly iteration of the model as the number of individuals in each state multiplied by the corresponding disability weight for that state. The disability weight of 0.049 associated with uncomplicated diabetes was incurred upon being diagnosed with diabetes in the model. Also in line with GBD 2017, DALYs were not discounted over time [11, 148].

Costs in the model included those for screening, laboratory testing, OAD and insulin therapies, facility-based treatments for each complication, outpatient visits, and hospitalization with an average length of stay of 5 days for diabetes [132]. Whether an individual sought outpatient or inpatient care for a particular condition was randomly attributed based on probability of care seeking by HEF status. Costs related to diabetes man-

agement and health services for complications were included only if individuals sought health services, thus incurring facility-related costs and OOP expenditures in the form of direct medical and non-medical expenditures. Non-medical costs included transportation costs for travel to outpatient visits or for hospitalizations [29, 72]. Direct medical and non-medical costs that were not covered by HEF were considered to be paid out of pocket by the patient. All costs data used in the model were converted into 2019 USD and discounted using a 3% annual discount rate [149]. Non-discounted total costs were also computed (see Appendix C.4, Table C.4.1).

The extent of financial risk protection across the various HEF coverage scenarios was measured by individuals' incurred direct medical and non-medical costs, the incidence of catastrophic health expenditures (CHE), and the number of households pushed below the international poverty line as a result of OOP expenditures related to diabetes. A case of CHE would be incurred when OOP expenditures exceeded 40% of household income; thresholds of 10% and 25% were also examined [18, 150]. A household was considered to have been impoverished by health expenditures when OOP expenditures caused the household to fall below the international poverty line [151]. Thus, impoverishment outcomes were relevant only for households above the poverty line prior to any OOP expenditures. As much of the poorest 20% of the Cambodian population is already below the international poverty line, this means that this measure of financial risk protection was primarily relevant in the scenario in which the poorest 30% of the population was eligible to be enrolled in HEF coverage.

A population of 800,000 was simulated to represent the estimated 16 million people of Cambodia's population. Analyses were limited to only those individuals who would be considered eligible for HEF and thereby potentially receive the intervention. Thus, the model was implemented on the subsample of 160,000 individuals who were the poorest 20% and who were assumed to be eligible for HEF (240,000 individuals for poorest 30% eligible) per comparator strategy. The resulting costs, OOP expenditures, and financial risk protection estimates were then inflated to represent this subpopulation, about 3.2 million people likely eligible for HEF in Cambodia. Results are reported as incremental cost-effectiveness ratios (ICERs) in terms of cost per DALY averted and cost per CHE case averted. Results were also disaggregated by sex. Outcomes of interest were computed based only on utilization of services among diabetics. In other words, increases in utilization of services, such as diagnostics, for those without diabetes were not accounted for in the computation of outcomes

Table 4.2: Input parameters used in the economic evaluation of coverage of diabetes-related services under Health Equity Funds in Cambodia

Parameter	Description	Value	Probability Distribution	Source
Costs*				
Diagnostics	Unit cost of fasting plasma glucose (FPG) test	1.10	<i>Lognormal</i> (−0.232, 0.809)	[97]
Laboratory	Cost of laboratory services for diagnostic testing	1.41	<i>Lognormal</i> (−0.024, 0.857)	[97]
Oral anti-diabetic (OAD) therapy	Annual average cost of OAD per patient	27.86	<i>Lognormal</i> (3.245, 0.406)	[97]
Insulin	Annual average cost of insulin per patient	125.80	<i>Lognormal</i> (4.816, 0.195)	
Outpatient visits				
<i>Health center</i>	Cost of outpatient visit to health center	4.15	<i>Lognormal</i> (1.299, 0.496)	[132]
<i>CPA1 facility</i>	Cost of outpatient visit to CPA1 facility	10.32	<i>Lognormal</i> (2.298, 0.268)	[132]
<i>CPA2 facility</i>	Cost of outpatient visit to CPA2 facility	6.28	<i>Lognormal</i> (1.754, 0.408)	[132]
<i>CPA3 facility</i>	Cost of outpatient visit to CPA3 facility	44.40	<i>Lognormal</i> (3.791, 0.059)	[132]
Inpatient visits (per day)				
<i>Health center</i>	Cost of inpatient visit to health center	4.77	<i>Lognormal</i> (1.479, 0.408)	[132]
<i>CPA1 facility</i>	Cost of inpatient visit to CPA1 facility	59.73	<i>Lognormal</i> (4.083, 0.115)	[132]
<i>CPA2 facility</i>	Cost of inpatient visit to CPA2 facility	29.53	<i>Lognormal</i> (3.378, 0.115)	[132]
<i>CPA3 facility</i>	Cost of inpatient visit to CPA3 facility	40.85	<i>Lognormal</i> (3.703, 0.115)	[132]
Discount rate	Discount rate applied to public spending	0.03	-	Assumption
Individual expenditures*				
Transport costs				
<i>Outpatient care</i>	Average cost of transport for care seeking at a health center	0.92	<i>Lognormal</i> (−0.138, 0.330)	[72]
<i>Inpatient care</i>	Average cost of transport for care seeking at a public hospital	11.65	<i>Lognormal</i> (2.453, 0.068)	[72]
Population characteristics				
All-cause mortality	Age- and sex-adjusted all-cause mortality	0.046	-	[65]
Diabetes incidence (mean)	Age- and sex-adjusted annual diabetes incidence	0.001	-	[11]
Diabetes prevalence (mean)	Age- and sex-adjusted diabetes prevalence	0.062	-	[11]

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Table 4.2 – continued from previous page

Parameter	Description	Value	Distribution	Source
Diabetes-related mortality	Age- and sex-adjusted diabetes-related mortality	0.030	-	[11]
Income	Average annual household income (USD, 2017)	5,783	<i>Gamma</i> (0.5, 11566.32)	[143]
Diabetes-related complications				
Undiagnosed diabetes				
Disability weight	Disability weight for undiagnosed diabetes	0.049	-	[11]
Nephropathy				
Incidence	Annual incidence of nephropathy among diabetics	0.0100	-	[153]
Effectiveness of therapy	Effect of glucose-lowering agents on incidence of nephropathy (RR)	0.30	-	[154–156]
Disability weight	Disability weight for nephropathy (stage 5)	0.569	-	[11]
Case fatality rate	Nephropathy-related mortality among diabetics	0.311	-	[157]
Treatment cost	Annual cost of nephropathy treatment (outpatient, hemodialysis)	6,358	<i>Lognormal</i> (8.733, 0.219)	[158]
Retinopathy				
Incidence	Annual incidence of retinopathy among diabetics	0.0212	-	[159]
Effectiveness of therapy	Effect of glucose-lowering agents on incidence of retinopathy (RR)	0.68	-	[156]
Disability weight	Disability weight for retinopathy	0.184	-	[11]
Case fatality rate	Retinopathy-related mortality among diabetics	0	-	Assumption
Treatment cost	Annual cost (USD) of retinopathy treatment (outpatient, intravitreal injection)	330	<i>Lognormal</i> (5.792, 0.115)	[160]
Neuropathy				
Incidence	Annual incidence of neuropathy among diabetics	0.0466	-	[161]
Effectiveness of therapy	Effect of glucose-lowering agents on incidence of neuropathy (RR)	0.94	-	[162]
Disability weight	Disability weight for neuropathy	0.133	-	[11]
Case fatality rate	Neuropathy-related mortality among diabetics	0	-	Assumption
Treatment cost	Daily cost (USD) of acetylsalicylic acid (outpatient)	2.62	<i>Lognormal</i> (6.862, 0.029)	[163]

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Table 4.2 – continued from previous page

Parameter	Description	Value	Distribution	Source
Angina pectoris <i>Incidence</i>	Annual incidence of angina pectoris among diabetics	0.0067	-	[156]
<i>Effectiveness of therapy</i>	Effect of glucose-lowering agents on incidence of angina pectoris (RR)	0.68	-	[156]
<i>Disability weight</i>	Disability weight for angina pectoris (moderate)	0.080	-	[11]
<i>Case fatality rate</i>	Angina pectoris-related mortality among diabetics	0	-	Assumption
<i>Treatment cost</i>	Daily cost (USD) of beta blocker (outpatient)	7.07	Lognormal(7.855, 0.029)	[163]
Peripheral vascular disease (PVD) <i>Incidence</i>	Annual incidence of PVD among diabetics	0.0085	-	[164]
<i>Effectiveness of therapy</i>	Effect of glucose-lowering agents on incidence of PVD (RR)	0.74	-	[156]
<i>Disability weight</i>	Disability weight for PVD	0.014	-	[11]
<i>Case-fatality rate</i>	Probability of amputation due to PVD and subsequent death within one year among diabetics	0.002	-	[165]
<i>Treatment cost</i>	Daily cost (USD) of beta blocker (outpatient)	7.07	Lognormal(7.855, 0.029)	[163]
Myocardial infarction (MI) <i>Incidence</i>	Annual incidence of MI among diabetics	0.174	-	[156]
<i>Effectiveness of therapy</i>	Effect of glucose-lowering agents on incidence of MI (RR)	0.39	-	[154, 155]
<i>Disability weight</i>	Disability weight for MI	0.432	-	[11]
<i>Case fatality rate</i>	MI-related mortality among diabetics	0.707	-	[155]
<i>Treatment cost</i>	Daily cost (USD) of beta blocker (inpatient)	7.07	Lognormal(7.855, 0.029)	[163]
Stroke				

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Table 4.2 – continued from previous page

Parameter	Description	Value	Distribution	Source
<i>Incidence</i>	Annual incidence of stroke among diabetics	0.0033	-	[156]
<i>Effectiveness of therapy</i>	Effect of glucose-lowering agents on incidence of stroke (RR)	0.59	-	[156]
<i>Disability weight</i>	Disability weight for stroke (level 5)	0.588	-	[11]
<i>Case fatality rate</i>	Stroke-related mortality among diabetics	0.693	-	[166]
<i>Treatment cost</i>	Daily cost (USD) of acetylsalicylic acid (inpatient)	2.62	<i>Lognormal</i> (6.862, 0.029)	[163]
Heart failure	Annual incidence of heart failure among diabetics			
<i>Incidence</i>		0.0033	-	[156]
<i>Effectiveness of therapy</i>	Effect of glucose-lowering agents on incidence of heart failure (RR)	0.68	-	[156]
<i>Disability weight</i>	Disability weight for heart failure (severe)	0.179	-	[11]
<i>Case fatality rate</i>	Heart failure-related mortality among diabetics	0.639	-	[166]
<i>Treatment cost</i>	Daily cost (USD) of beta blocker (inpatient)	7.07	<i>Lognormal</i> (7.855, 0.029)	[163]
Care delivery & utilization				
Diagnosis	Percentage of diabetics with previous diagnosis by provider	0.370	<i>Beta</i> (8.241, 14.057)	[96]
Care seeking				
<i>Outpatient visit (non-HEF)</i>	Probability of outpatient care utilization (public) for diabetes complications	0.117	<i>Beta</i> (0.916, 4.412)	[71]
<i>Outpatient visit (HEF)</i>	Probability of outpatient care utilization (public) for diabetes complications	0.172	<i>Beta</i> (0.420, 3.171)	[71]
<i>Inpatient visit</i>	Probability of hospitalization (public) for diabetes complications	0.015	<i>Beta</i> (8.850, 581.150)	[71]
Provider choice			-	
<i>Health center</i>	Proportion seeking treatment from health center for most recent illness	0.114	<i>Beta</i> (9.755, 107.796)	[129]

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Table 4.2 – continued from previous page

Parameter	Description	Value	Distribution	Source
<i>CPA1 facility</i>	Proportion seeking treatment from CPA1 facility for most recent illness	0.025	<i>Beta</i> (10.943, 574.050)	[129]
<i>CPA2 facility</i>	Proportion seeking treatment from CPA2 facility for most recent illness	0.030	<i>Beta</i> (11.862, 557.843)	[129]
<i>CPA3 facility</i>	Proportion seeking treatment from CPA3 facility for most recent illness	0.042	<i>Beta</i> (7.304, 190.218)	[129]
Drug therapies				
<i>OAD</i>	Probability of receiving OAD prescription	0.224	-	[105]
<i>Insulin</i>	Probability of receiving insulin prescription	0.017	-	[106]
<i>Combination</i>	Probability of receiving OAD + insulin prescription	0.07	-	[106]
<i>OAD to insulin</i>	Probability of transitioning from OAD to insulin therapy	0.04	-	[167]
<i>Adherence</i>	Probability of adhering to prescribed therapy	0.125	-	Assumption, [97]
Health Equity Funds (HEF)				
Eligible	Income percentile eligible for HEF	0.20, 0.30	-	Assumption
Enrolled	Proportion of target population enrolled in HEF	0.75	-	[23]
Coverage benefits	Proportion of expenditures covered under HEF (subsidy rate)	0.80, 1.00	-	Assumption
Utilization	Proportion of beneficiaries using HEF at point-of-service	1.00	-	Assumption

*All monetary values were adjusted to 2019 USD [152]

All cost-related parameters describe the cost per instance (i.e., per visit, per use of transport, etc.) unless otherwise stated (e.g., annual costs of drug therapies). All disease-related parameters refer to annual estimates.

of interest.

A literature review was conducted to gather information for each input parameter included in the model. Whenever possible, parameters were specific to the Cambodian population and health system. When data for Cambodia were not available, any information available for countries in the region or LMIC settings was used. If these data were also not available, other global estimates were used or necessary assumptions were made (Table 4.2). To assess the robustness of our findings, probabilistic uncertainty analyses were conducted. Parameters for costs and effectiveness of strategies were varied to generate 50 distinct sets of parameters drawn from defined probability distributions. Lognormal distributions were applied to represent potential variability in costs and beta distributions to represent potential variability in probabilities used in the model. Effects of HEF strategies were expressed as relative risks in the model and varied according to a normal distribution (Table 4.1, $\sigma^2 = 0.1$).

The specifications of probability distributions for each input parameter were informed by the 95% confidence intervals of parameter estimates taken from the literature. The model was then implemented on the same population using each set of parameters. The model used a sample of 800,000 to represent 16 million, resulting in 160,000 individuals representing the poorest 20% of the population that may be eligible for HEF. To test the uncertainty of results based on sample characteristics, 40,000 individuals were sampled with replacement from the simulated population to generate 100 different populations. Outcomes of interest were computed for each of these 100 populations to gauge the range of possible results given the potential variability in parameters and population characteristics in Cambodia. All analyses were conducted in R (version 3.6.1).

4.3 RESULTS

4.3.1 STATE DURATION

Based on the input parameters, strategies affected the duration of time individuals spent in various model states that resulted in detected changes in health and financial risk protection impacts. Those strategies providing coverage for diagnostic services resulted in a greater number of diagnosed cases and, subsequently, more individuals receiving drug therapy options. Strategies with coverage of medications resulted in less time

spent in states of diabetes-related complications. This time instead was spent in states of diagnosed diabetes, either being prescribed diet and/or lifestyle advice or drug therapy (i.e., OAD or insulin regimens). Providing coverage for both diagnostic services and medications amplified these impacts, decreasing the level of undiagnosed diabetes and increasing the number individuals receiving drug therapies. Due to lack of data, we did not account for the potential impact of treatment of severe complications to prevent subsequent mortality. Thus, HEF coverage for complications did not result in any changes to the duration of time spent in disease states, mirroring the number of life-years spent in each state under the current standard of care in which no diabetes-related services were covered. Across strategies, women had more diabetes-related cardiovascular conditions than their male counterparts. In combination with higher diabetes mortality for women, this consistently drove a greater health impact among women compared to men.

4.3.2 COSTS ASSOCIATED WITH HEF COVERAGE OF DIABETES SERVICES

HEF coverage for the full continuum of care for diabetes resulted in the highest costs, while providing coverage for solely drug therapy resulted in the lowest costs per HEF beneficiary. Examination of incremental costs between HEF strategies and the current provision of care showed that coverage of drug therapies was cost-saving due to its prevention of high-cost severe complications. Treatment for diabetes-related complications consistently comprised the greatest proportion of costs. Reductions in the number of individuals and/or the duration of time spent in states representing diabetes-related complications drove reductions in costs. Since covering medication costs resulted in reduced complications, costs were reduced for this strategy, mitigating any initial cost increases due to increased coverage of other services. Nevertheless, the costs of treating diabetes-related complications as a result of increased care seeking for diabetes care persistently drove the incremental costs of HEF strategies by a significant proportion (Figure 4.2).

Without any intervention, direct medical costs for the simulated cohort would increase annually over the first seven years of the time horizon, followed by a decrease in annual costs that result in a leveling of cumulative total costs over the entire simulation period (see Appendix C.3, Figure C.3.2). The initial increase can be explained by increases in diabetes incidence and complications as more of the population cohort reaches ages for which the incidence of diabetes increases. The subsequent decreases in costs can be attributed to fewer individuals with complications remaining in the population, either as a result of diabetes-related or all-cause

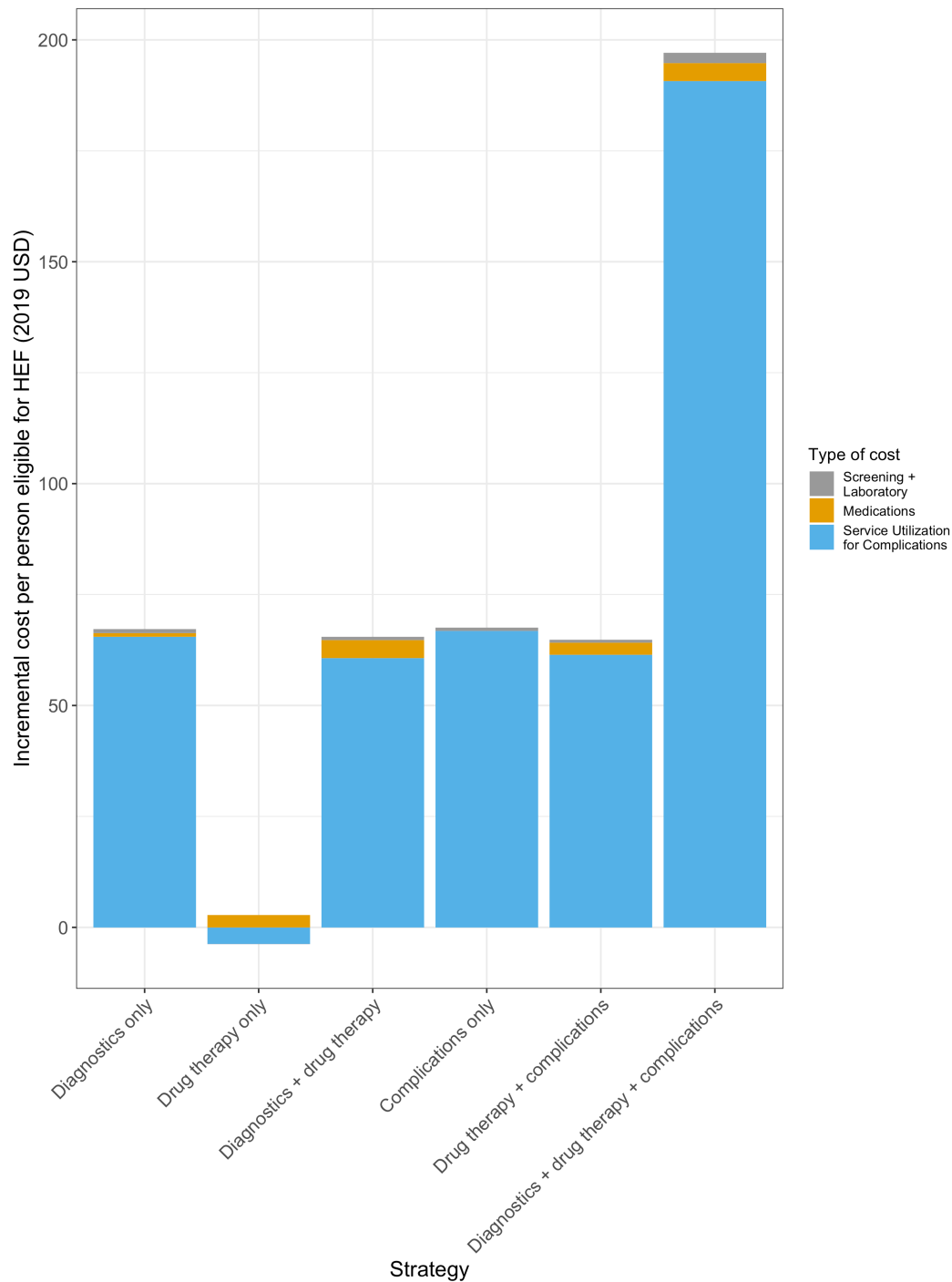


Figure 4.2: Incremental total costs per person eligible for HEF (poorest 20%) by type of cost

mortality during earlier years of the simulation. The mean annual direct medical cost without intervention was estimated to be about \$62 per diabetic patient. Comparing the cumulative direct medical costs over the 45 years of the model, results showed that any strategy would significantly reduce the direct medical costs

incurred by diabetic patients. This difference can be interpreted as the amount to be covered by HEF and paid for by the government, which would amount to between \$28 and \$58 per diabetic patient depending on the extent of coverage and services covered. The magnitude of total direct medical costs over time changes as a function of the number of individuals covered by HEF, as illustrated in Figure C.3.2 between different income thresholds for HEF eligibility.

4.3.3 HEALTH IMPACT

Compared to the current situation in Cambodia, in which HEF does not provide explicit coverage for diabetes-related services, strategies showed varied impacts on health. Namely, coverage for only diagnostic services resulted in increased DALYs in the population because diagnosed, uncomplicated diabetes (types 1 and 2) would incur disability (0.049) due to worry and minimal interference with daily activity [11]. Covering only diagnostic services was the only strategy that would result in high expenditures for DALYs incurred (see Appendix C.3, Table C.3.1). Without corresponding increases in appropriate care and management of the disease, there would be no means by which to prevent the development of later complications that would result in significant DALYs. On the other hand, treatment of diabetes through regular drug therapy would result in DALYs averted that can compensate for the DALYs incurred upon diagnosis of uncomplicated diabetes. Covering drug therapies under HEF would cost \$27 per DALY averted if the poorest 20% of the population were eligible for HEF, while adding HEF coverage for diagnostic services as well would cost an estimated \$2,468 per DALY averted. Providing coverage for drug therapies and treatment for diabetes-related complications together would cost about \$3,727 per DALY averted.

Examination of the states that drove DALYs averted upon coverage of diabetes medications revealed that about 36% of the DALYs averted would be due to prevention of diabetes-related death, while 9% would be due to prevention of neuropathy. The remaining DALYs averted upon appropriate care and management via drug therapies would be due to prevention of retinopathy (~3%), nephropathy (<1%), myocardial infarction (<1%), angina pectoris (<1%), and stroke (<1%). HEF coverage for both diagnostic services and drug therapies contributed to the greatest DALYs averted because more diabetes-related deaths were prevented as a result. Disaggregation of results by sex revealed distinct patterns in the way that strategies affected men and women in terms of health impact. With HEF coverage for medications, about 35% of DALYs averted

would be due to prevention of diabetes-related mortality. Approximately 9% of DALYs averted would be due to neuropathy prevention among women. Examination of impacts on men revealed similar trends: 38% of DALYs averted would be due to prevention of diabetes-related mortality and 8% would be due to prevention of neuropathy. Similarly, the costs of HEF strategies differed significantly by sex (Figure 4.3). Those strategies that had positive health impacts consistently drove more favorable ICER estimates among women compared to men.

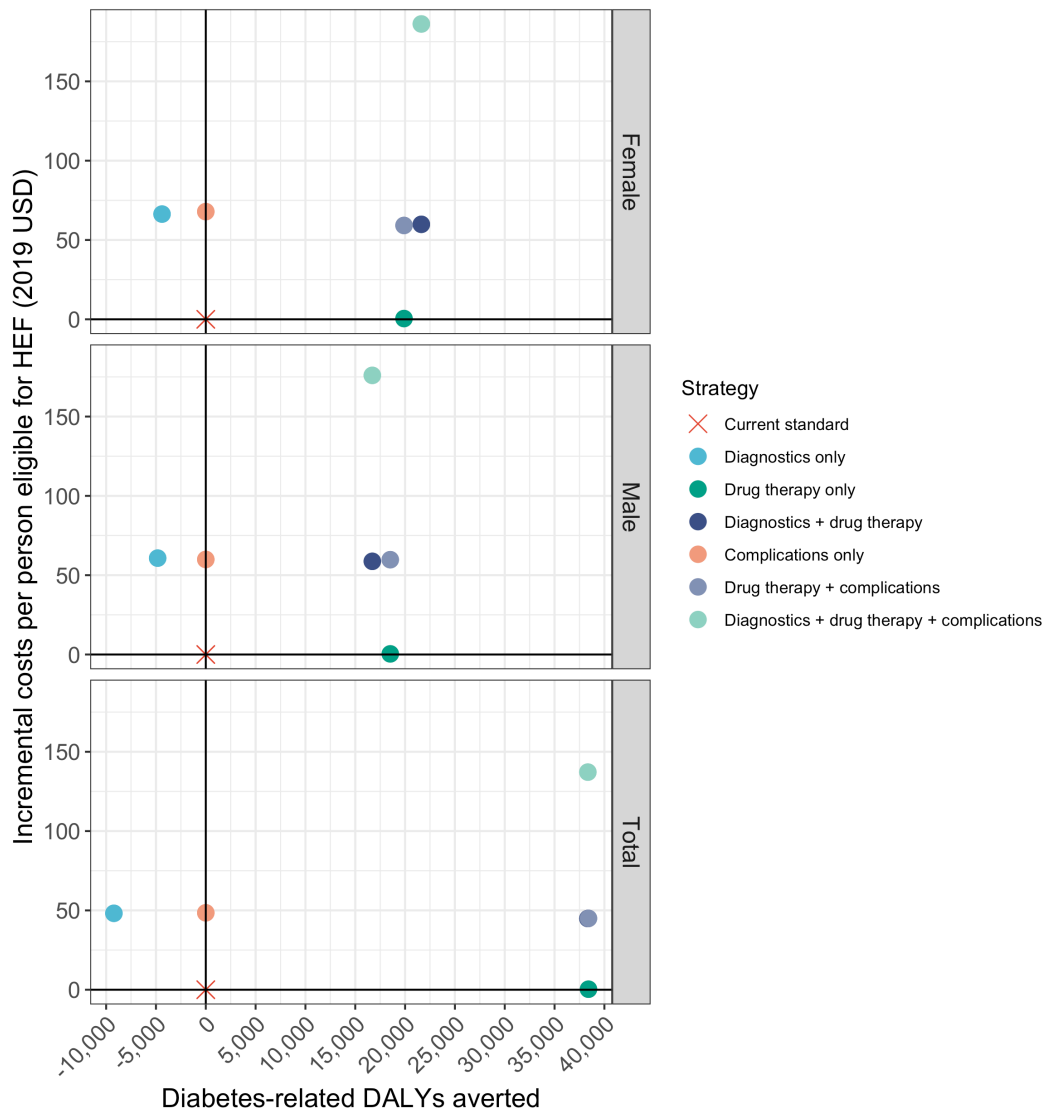


Figure 4.3: Incremental total costs per person eligible for HEF (poorest 20%) vs. diabetes-related DALYs averted by population group and strategy

Covering diagnostic services and drug therapies in the scenario in which 30% of the poorest would be eli-

gible for HEF demonstrated more favorable population-level benefits for men and women compared to the scenario in which only 20% of the population would be eligible. If the poorest 30% of the population were eligible for HEF, covering drug therapies could save \$32 per DALY averted and providing additional coverage for diagnostic services would cost \$3,696 per DALY averted. Analyzing the costs per diabetes-related DALY averted over time in the model revealed that cost savings associated with providing financial coverage for drug therapies could begin as early as the second year of coverage under this scenario (Figure C.3.1). For strategies that provide coverage for complications, model results showed that there would initially be decreases in costs per DALY averted, followed by increases in incremental costs in later years as individuals age, accruing disability from diabetes-related complications and mortality.

4.3.4 FINANCIAL RISK PROTECTION

Total estimated OOP health expenditures for diabetes were highest for HEF strategies that included coverage for diagnostic services and drug therapies. Thus, coverage for both diagnostic services and medications for drug therapies resulted in the most OOP expenditures averted. Given the significant burden of diabetes among women, women tended to benefit most from coverage of any diabetes-related services across the cascade of care in comparison to men. When considering the incremental cost per HEF beneficiary, covering OAD and insulin therapies was the most favorable option, contributing to the greatest number of cases of CHE averted and reducing costs (Figure 4.4). With financial coverage at 80% of direct medical costs, this strategy was estimated to cost \$2 per case of CHE averted with CHE measured as spending over 40% of a household's total income on health expenditures (see Appendix C.3, Table ??). Coverage for diagnostic services and drug therapies would cost an estimated \$1,220 per case of CHE averted under the same policy. Providing coverage for all diabetes-related services was the most expensive strategy for a similar number of cases of CHE averted. When HEF coverage was possible for the poorest 20% of the population, the overwhelming majority of those eligible for such coverage were below the international poverty line prior to the intervention. Yet, in a scenario in which HEF coverage may be offered to the poorest 30% in the population, cases of poverty may indeed be prevented.

The benefits of providing financial coverage for 100% rather than only 80% of direct medical costs were pronounced across the strategies. In the most extreme case in which all diabetes-related services across the

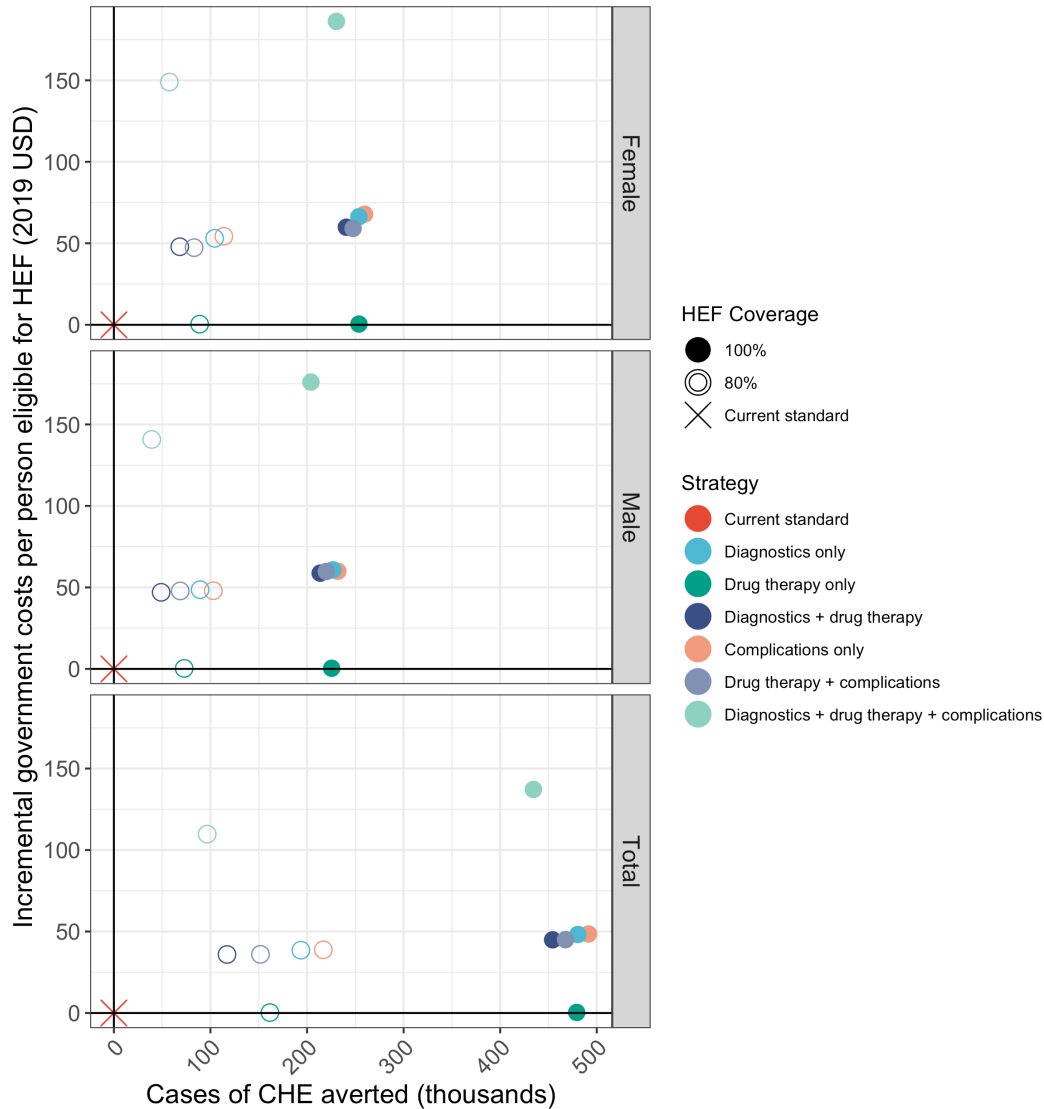


Figure 4.4: Incremental government costs per person eligible for HEF (poorest 20%) vs. financial risk protection measures by population group and strategy

continuum of care were covered for the poorest 20% of the population, \$790 in OOP spending could be averted per diabetic eligible for HEF over the 45-year time horizon under 100% coverage compared to \$572 OOP spending averted per diabetic eligible for HEF. Providing HEF coverage for 80% of the direct medical costs to patients for drug therapies would still cost only \$6 per case of CHE averted, while 100% coverage for diagnostics as well as drug therapies would cost \$315 per case of CHE averted. In a scenario in which 30% of the population would be eligible for HEF, the model showed that there would be savings between \$2 and \$7 per CHE case averted under strategies covering solely drug therapies and reduced costs for other strategies.

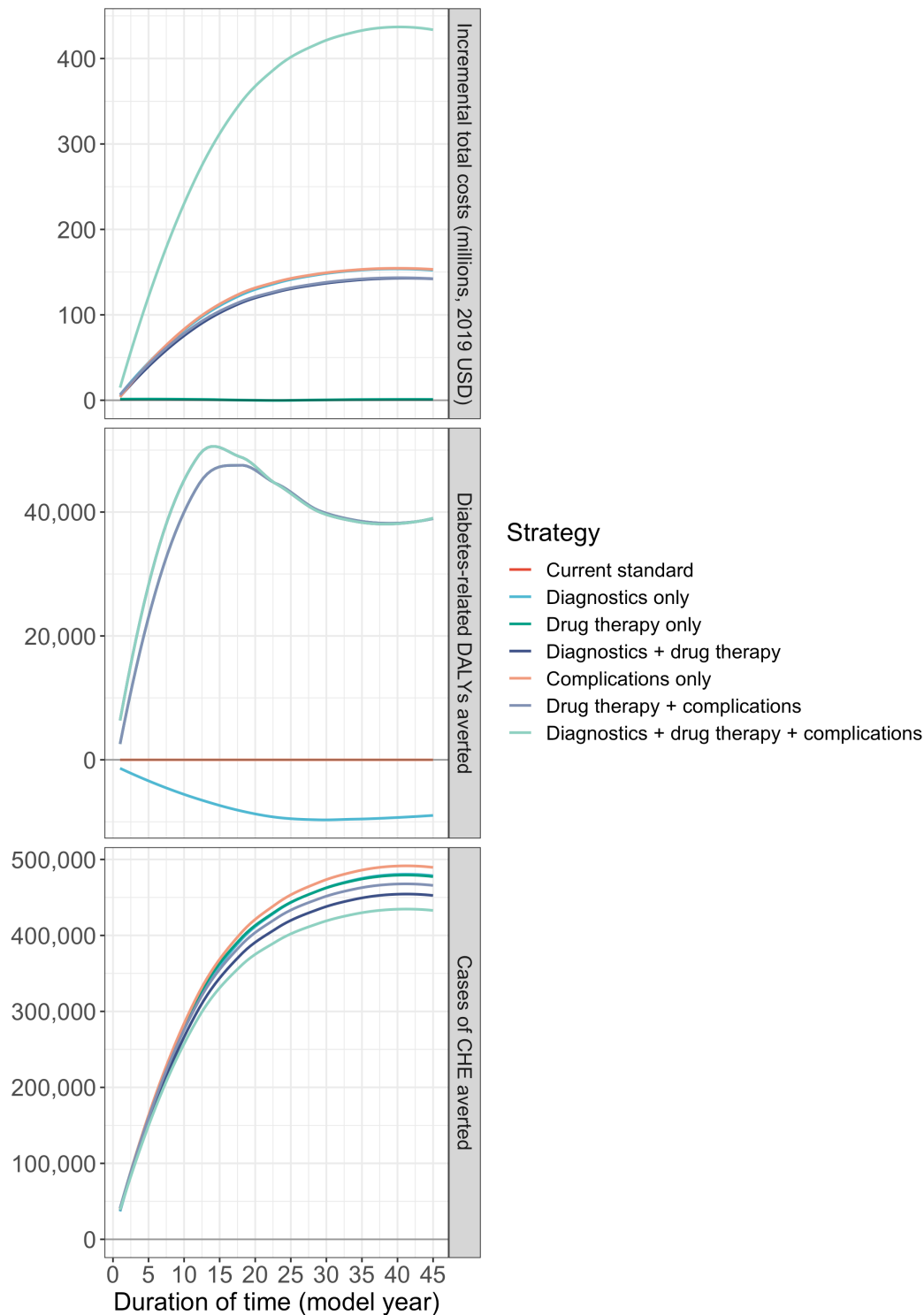


Figure 4.5: Incremental costs and impacts over time, HEF eligibility: 20%, OOP coverage: 100%

These savings could accrue as early as the first year of coverage (Appendix C.3, Figure C.3.4).

4.3.5 UNCERTAINTY ANALYSIS

For four of the six strategies examined, the 95% uncertainty ranges of estimates of health impacts included zero diabetes-related DALYs averted (Figure 4.6). This suggests that, despite the modeled mean outcomes reported above, there may be populations and/or scenarios under which the health impacts of these strategies are minimal. Examining uncertainty for a population in which the poorest 30% of the population would be eligible for HEF demonstrated parallel results in terms of uncertainty.

Examination of CHE cases averted showed that all of the strategies would reduce the number of CHE cases due to diabetes-related care. Providing coverage for diabetes-related complications consistently reduced the greatest number of CHE cases followed by coverage for diagnostic services and medications (Figure 4.6). Such results suggest that the value of coverage strategies under HEF may be seen in the prevention and/or reduction of CHE and, in some cases, impoverishment. These findings were consistent when analyzing uncertainty under both scenarios of HEF eligibility (20% and 30% of Cambodia's poorest) in the population.

4.4 DISCUSSION

4.4.1 SUMMARY OF KEY FINDINGS

We modeled the benefits of providing financial coverage for the costs of drug therapies for diabetes under HEF for a scenario in which they are indeed available in the public sector. This strategy would cost \$27 per diabetes-related DALY averted and \$2 per case of CHE averted over the 45-year time horizon. Coverage that included treatment for diabetes-related complications consistently drove up costs, but prevented considerable CHE cases, particularly among women. Including diagnostic services in HEF coverage increased negative health impacts as well as costs. Negative health impacts were attributable to the small, but notable, disability weight associated with the psychological worry of having the disease and being on daily medications. Thus, as more individuals are diagnosed with diabetes, more would incur this negative impact on health. However, a benefit package that provided financial coverage for both diagnostic services and diabetes medications would increase the number of individuals receiving appropriate care, thereby increasing positive health impacts, albeit for a cost of \$3,727 per DALY averted and \$315 per CHE case averted.

Disaggregated results by sex highlighted critical differences in experiences of the disease across men and

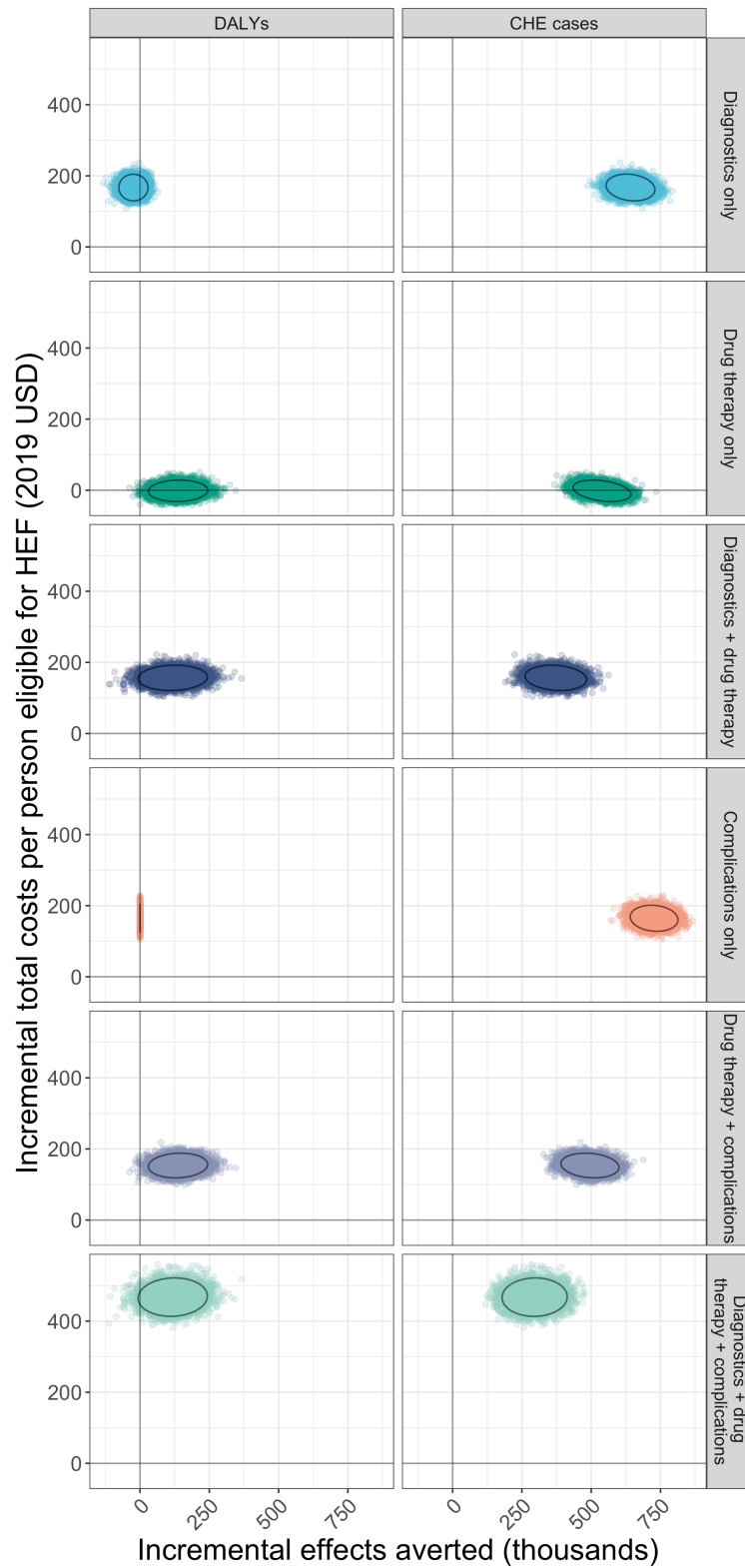


Figure 4.6: Results of probabilistic uncertainty analysis (HEF eligibility: 20%)

Ellipses indicate 95% uncertainty range of estimates.

women. Based on the existing literature, women have a slightly higher incidence of diabetes in Cambodia and higher mortality as a result of the condition and its related complications, particularly from cardiovascular events [168, 169]. These key differences drove the differences in findings by sex, as women were more likely to have diabetes complications compared to men and subsequently die of those complications. Women experienced particular benefits in terms of health gains and financial risk protection, suggesting that targeted interventions such as those described in this paper could considerably alleviate the disproportionate burden of diabetes among women. The increased probability for complications among women also points to the reason for why women appear to benefit so significantly from strategies that include financial support for treatment of complications. Notably, the model assumes similar behaviors among men and women with respect to care seeking and willingness to pay for formal health care. Studies on care seeking behavior for diabetes in other LMIC settings demonstrated that women more often appropriately sought care for their condition, however, suggesting that the impact estimates of this model may be conservative for women and overestimated among men [29, 170–172].

This study adopted a societal perspective and, thus, diverged from previous costing analyses conducted for type 2 diabetes in Cambodia in 2014, which estimated costs and health impacts from a government perspective for the country's entire population [97]. Flessa and Zembok estimated \$11 million (2013 USD) in costs to the government if diabetes treatment were to be provided to all diabetics in the country [97]. In our model, estimated annual costs reached a peak of approximately \$4.1 million and a mean of \$2.4 million (2019 USD) over the 45-year time horizon for only 20% of the population with consideration of care seeking behaviors of this population. The higher cost estimates can largely be explained by differences in the epidemiological and cost input parameters used. Focusing only on type 2 diabetes, Flessa and Zembok (2014) calibrated the demographic and epidemiological development of diabetes from European studies to fit the statistics of the Cambodian population. In contrast, our study used diabetes prevalence, incidence, and mortality estimates from GBD 2017, which were generally higher estimates of diabetes epidemiological measures in the country.

Flessa and Zembok (2014) applied a flat annual average cost for inpatient and outpatient treatment, while our model considered the differential costs of care seeking at different levels of care as well as the average length of stay for hospitalization due to diabetes-related issues. Similar to our findings, Flessa and Zembok

(2014) highlighted that chronic complications associated with diabetes were the main cost driver in their model, estimating additional treatment for these complications would double estimated total costs by 2028. Our model distinguishes costs associated with each particular complication included in the model - accounting for, for example, the different annual costs of treatment for nephropathy versus retinopathy. This modeling decision was made because of the considerable differences between costs of certain complications, particularly the high costs associated with nephropathy. As a result, these critical differences in inputs and model design may have led to different estimates between these analyses.

Study findings also align with other costing and cost-effectiveness analyses of diabetes management conducted in LMICs, though there remains wide variation in results across country studies depending on approaches and perspectives [100]. Multiple studies similarly highlight that the most expensive complications were cardiovascular conditions and events, contributing to high annual inpatient costs [100, 173]. In Cambodia, the price for metformin, the type of OAD considered in our model, was reported to be approximately \$25 per patient per year [97, 100]. A study conducted in 2008 estimated that the average cost of illness of diabetic patients was \$881 in Thailand, notably higher than the estimates presented here. However, this study also accounted for economic losses in productivity among patients and associated with informal caregiving, which comprised about 28% of those costs [173]. Another study identified retinopathy screening and glycemic control as priority interventions as among the most cost-effective options, aligning with our findings that prevention of severe complications through appropriate drug therapies can favorably contribute to health and financial benefits [174]. Intensive glycemic control was reported to be highly cost-effective for the sub-Saharan Africa and Southeast Asia regions in this study. Authors also noted varying impacts within patient subgroups, such as among men versus women, as in our study [174]. These parallel findings emphasize that policy design and adoption should carefully weigh the nuanced differential health and financial impacts of interventions over the course of the diabetes trajectory with respect to such population subgroups.

4.4.2 FINANCIAL RISK PROTECTION AND HEALTH SYSTEMS STRENGTHENING FOR DIABETES

The complexity of diabetes with its high costs, many complications, and complicated treatment regimens make the diabetes burden difficult to tackle for both individual patients and governments. Bigdeli *et al.* highlighted the tendency of NCD patients in Cambodia to seek some form of social protection to cover their

medical needs through enrollment in voluntary community-based health insurance schemes [29]. However, access to such coverage, for which beneficiaries make regular payments for membership in the risk pool, likely remains out of reach for the poorest. Providing appropriate financial and service coverage through HEF could alternatively alleviate the health and cost burden of diabetes in this population. Simulation of disease states alongside care delivery pathways provided a means to measure the outcomes driven by complex relationships as a patient navigates their disease and the health care system in Cambodia. The findings of this study point to opportunities to incur cost savings and health gains in the effort to control the growing diabetes problem. Simulations also highlight the burden of diabetes faced by women that extends throughout their lifetimes with the compounding effects of the disease on health and financial security through HEF coverage. The differential impacts by sex illustrated by the model correspond to existing literature highlighting sex differences in the trajectory of diabetes and the development of cardiovascular conditions [29, 168, 169]. Significant impacts for women point to the relevance of targeted interventions for the disease.

Interventions to provide financial coverage for services across the cascade of care for diabetes prompt a parallel focus on improved availability and infrastructure for such services. As is the case in many LMIC settings, Cambodia has not yet established practice guidelines for diabetes and it remains unclear how the disease should be managed in the public health care system [175]. Interventions at the level of primary care, the level at which diabetes would ideally be diagnosed and regularly managed, have the potential for far-reaching improvements in regular care and management of diabetes as well as for overall health system strengthening. Because of the complexity of diabetes, a multi-pronged approach that integrates prevention strategies with health system strengthening focused on primary care may be most effective in terms of health gains and costs saved. Indeed, while the focus of this study was on the treatment and management of diabetes, various efforts to prevent diabetes have consistently been shown to be cost-effective. Evidence from this study does not preclude policies for the prevention of diabetes, but rather emphasizes the importance of tackling all steps of the disease trajectory. Prevention may contribute to greater benefits when combined with interventions at primary facilities for diabetes management and support. Providing sufficient service coverage and financial risk protection for diabetes-related services delivered through primary care remains only one major objective of health systems that has been examined in this study.

4.4.3 LIMITATIONS AND PROPOSED IMPROVEMENTS TO THE MODEL

Upon systematic review of type 1 diabetes cost-effectiveness models, Henriksson *et al.* reported that ‘best in class’ diabetes models employ microsimulation methods to simulate both microvascular and macrovascular complications, adverse events, costs, quality-adjusted life-years (QALYs) over a lifetime time horizon, accounting for parameter uncertainty [176]. The model presented here was a microsimulation that implemented each of these features, with the exception of measuring health impacts using QALYs. Instead, DALYs were computed, as is often the case when assessing cost-effectiveness of interventions in LMIC settings and computed as outcomes for other cost-effectiveness studies in Cambodia [177–179]. Similar to the majority of existing models for diabetes, the microsimulation used a Markov approach and was implemented at the patient level [176]. Also like several other models, many parameter estimates used in our model were based on the United Kingdom Prospective Diabetes Study (UKPDS), which began tracking a cohort of diabetic individuals in 1977 [155, 156]. However, this cohort may not be representative of the course of diabetes in Cambodia and any limitations of the UKPDS data may be relevant here as well.

Opportunities to improve the model would require enhanced data sources, particularly sources relevant to Cambodia or similar settings. Many have called for efforts to standardize or harmonize the collection and reporting of cost data for diabetes [100]. Currently, multiple parameters are informed by literature rooted in studies based in high-income settings or assumed when sufficient data do not exist. The model could be strengthened by including more specific data on the characteristics of HEF as well as patterns of health care utilization in Cambodia. The current range of information available over time makes these parameters more difficult to specify and provides a wide range of possible values that can only be tested in sensitivity analyses. The model does not take into account the potential evolution of the diabetes burden in terms of incidence or mortality over the course of the 45-year time horizon. However, it is possible that advances in health care and technology for diabetes management may induce changes in the trajectory of the disease over individuals’ lifetimes. Similarly, changes in drug adherence could also impact disease trajectory. The model also does not replenish the population over the course of the model, failing to account for demographic transitions and population aging over time. Yet, aging of the population may have considerable impacts on the epidemiological outcomes for diabetes into the future.

Data currently available provide little insight into the impact of outpatient visits and/or hospitalization

for diabetes-related complications, such as neuropathy, nephropathy, and cardiovascular conditions. The impacts of formal health care treatment on such complications may be attributable to a complex combination of availability of technology, human resources, health literacy, and quality of care that remains difficult to reliably predict in the Cambodian setting. For this reason, the model did not take into account the potential effects of formal treatment for diabetes-related complications on disability or mortality. However, it may be the case that increasing access to formal treatment for severe complications contributes to benefits beyond financial risk protection towards population health gains. Additionally, the model does not distinguish between type 1 and type 2 diabetes in the population due to lack of data; many of the resources reporting on diabetes in Cambodia describe general diabetes information. However, studies on diabetes in other settings suggest differences in health effects between the two types. Future iterations of this model could be improved by incorporating data to inform such impacts of the health system.

The model in this paper does not consider any startup costs related to the rollout of sufficient service availability for diabetes. Such a model could consider the costs of additional training of human resources, distribution of screening, testing supplies, and drug therapies to primary care facilities, and any additional infrastructure or equipment necessary for the screening and treatment of diabetes and its complications. Similarly, increasing the capacity for relevant and feasible diabetes care and management services in the country may have spillover effects beyond the populations targeted by interventions. In the case of HEF strategies and social health protection schemes more generally, the poorest in Cambodia are targeted. However, the increased awareness of diabetes and greater availability of diabetes-related services in public facilities may have broader impacts on the population. The model does not account for increased utilization of services among those who do not have diabetes. As a result, it is possible that the model underestimates the costs associated with diagnostic services for diabetes. To date, however, there is little information available regarding how often diabetes screening and other diagnostic services are conducted when individuals seek care in Cambodia.

Researchers currently have a limited understanding of the potential impacts of benefit design on health-related behaviors, particularly with respect to care seeking patterns and drug adherence. This results in uncertainty surrounding the magnitude of effects of changes in HEF coverage on patient behaviors, such as care seeking and utilization for diagnostic services and/or treatment for severe complications and drug adherence to OAD and insulin therapies. It is also possible that household dynamics influence the probability of care

seeking and is worth noting that, while diabetes costs and health impacts were computed by individual patients, income and CHE was measured at the household level in the model. Further research in these areas would contribute to a more nuanced and precise estimate of costs, health gains, and impacts on financial risk protection. Applying economic evaluation methods to assess the impact of interventions on different population groups was inspired by extended cost-effectiveness analysis (ECEA) methods [180]. A full ECEA in which parameters input into the model are disaggregated by population subgroups of interest, such as income quintile or sex, was not possible based on existing data. Future modeling to estimate the impact of diabetes coverage policies would benefit from disaggregated data by population subgroups to understand differential impacts across the population and improve equity in access to diabetes-related services.

4.4.4 IMPLICATIONS FOR POLICY

Study findings highlight the multifaceted benefits of providing financial coverage for diabetes care and management, especially for medications for glycemic control. The true benefit of such policies would lie in increased financial risk protection and reduced CHE due to diabetes. Encouraging appropriate adherence to medication for diabetic patients could lead to reductions in complications to ultimately reduce the economic burden of disease. Alongside its positive impacts on household financial security, this study supports making at least diabetes medications available through HEF in Cambodia. Additional benefits for health and financial risk protection could be gained by providing financial support for care seeking for complications, particularly among women, who generally have greater risk of developing CVD as a result of their condition.

The increase in health and financial risk protection benefits derived from increases in the proportion of direct medical OOP expenditures covered by HEF suggest that policies to provide coverage for diabetes-related services should cover all of individuals' OOP costs to achieve the greatest gains (e.g., 100% rather than 80%). Similarly, examination of scenarios in which either 20% or 30% of the poorest in the population are eligible for such financial support demonstrated that increasing the population eligible for HEF benefits increased the return on investments when providing coverage for diabetes medications. The direct medical costs that would hypothetically be covered under HEF would amount to a cost of \$28 to \$58 per diabetic patient eligible for the scheme depending on the benefit package and level of coverage for diabetes care and management in Cambodia. This study largely analyzed costs and impacts from a societal perspective. Providing 100% coverage of

direct medical costs across diagnostic services, drug therapies, and treatment for complications would cost \$58 per diabetic patient.

Equity considerations are important when making decisions on how to design benefit packages for social health protection schemes. In this paper, covering drug therapies and treatments for complications was analyzed to understand the relationship between these stages of care with respect to costs and health and financial risk protection impacts. Nevertheless, such a strategy could drive further inequities since receiving appropriate diagnostic services could remain a barrier to accessing financial coverage for appropriate treatment. Considering health, financial risk protection, and equity impact together points to outlining a benefit package that, at the very least, provides financial coverage for and availability of diagnostics and medications in a diabetes coverage policy. Adding diagnostic services to the benefit package would cost \$50 at the 100% coverage level. These costs per diabetic HEF enrollee correspond to \$0.20 to \$1.41 per capita, which may be reasonable increases in public health spending given that most recent estimates put government health expenditures at only 6% of GDP [67].

Efforts focused on the availability of diabetes-related services under HEF coverage should be informed by detailed information on the costs of medications that the Cambodian public sector would procure for services under the scheme. Similarly, cost estimates would be improved for diagnostic services and treatment for complications if specific unit cost estimates for Cambodia were to become available. This would provide more accurate cost estimations and support informed decision-making with consideration of the burden of diabetes in the long term. Future research should focus on the collection of context-specific data to inform the parameter inputs of simulation models such as the model of this study and, in so doing, inform appropriate strategic planning and management of diabetes for the Cambodian health system.

4.5 CONCLUSIONS

Though HEF coverage purports to include screening, testing, and treatment for diabetes, the scheme was ultimately not designed to address the needs of patients with NCDs and assessments have shown that these services remain inaccessible, especially for the poor [29]. Based on the findings of this analysis, efforts to improve service coverage, and subsequently, financial coverage for diabetes diagnostic and treatment therapies for the poor in Cambodia would be highly cost-effective in terms of health and financial risk protection ben-

efits. Women would particularly benefit from availability of and financial risk protection for diabetes-related services under HEF. To improve estimates of costs, health impacts, and financial implications, future models will need more data on care seeking behavior for diabetes as well as the costs of that care seeking, diagnostic and treatment services, and diabetes-related complications. Further research could also explore the impact of improved service and financial coverage for diabetes to the entire Cambodian population.

5

Conclusion

5.1 KEY FINDINGS & POLICY IMPLICATIONS

This dissertation examined different avenues by which national health systems could be improved to equitably increase access to health services: through enhanced organization and management of service delivery, strategic engagement of users towards appropriate utilization, and cost-effective coverage of services to tackle burdens of disease. Together, they may support strategic design and implementation of interventions to strengthen health systems and achieve UHC.

5.1.1 STRATEGIZING HEALTH SYSTEM ORGANIZATION AND COMMUNICATION OUTREACH

Health programs could work towards optimizing their impact by considering how to design organizational structures in decentralized settings with respect to decision space, capacity, and accountability. Paper 1, like previous studies, supported the conclusion that changes in decision space alone fail to achieve the objectives of the health system to improve population health or achieve other health system objectives. Rather, corresponding adjustments in institutional capacity and accountability structures are likely to be necessary to bring about positive changes [34]. This means that deconcentration of powers across levels of the health system or a health program should ensure that each level or role have the training and experience necessary to carry out expected functions. It also means that accountability should be balanced to ensure appropriate priorities and focuses across levels as well as continued motivation to achieve health system goals. Improved planning was particularly important in improving access as measured by the number of immunized children. Impacts of interventions likely depend significantly on context. The relationships detected for IMI in India highlighted important phenomena influencing the program's effectiveness in particular areas, such as infrastructural challenges and movement of human resources. However, such relationships may not be relevant for other settings where community conflict and resistance to health services may not be contributing factors. This makes strategic design and implementation of health programs and the consideration of decision space, capacity, and accountability ever more relevant to address context-specific needs and challenges.

The modeling approach and findings of Paper 1 could reasonably be extended to system-wide interventions, where complex interrelationships between organizational structures make tracking their impacts challenging. Strategic planning for broader health system strengthening efforts should, therefore, carefully consider how health officials make decisions for service delivery and provide them with the tools and structure to successfully carry out their roles and responsibilities. For example, Paper 2 suggests that investments in efforts to inform beneficiaries of social health protection schemes of their entitlements can contribute to only very slight increases in appropriate utilization of care and promote greater financial risk protection. However, the findings of Paper 1 emphasize that, in the face of increased utilization, public facilities will need to have parallel improvements in institutional capacity and accountability to adequately serve more patients. Similarly, interventions to tackle NCDs through health services will call for increased institutional capacity through provider education and knowledge as well as availability of supplies and infrastructure for such

services. Indeed, it is likely that improvements in institutional capacity and accountability will further support appropriate utilization of health services by promoting positive changes in care seeking behavior from high-cost, private providers to the public sector. Thus, without the appropriate changes in decision space, capacity, and accountability to effectively respond to local needs, achieving sufficient health services utilization in the public sector will remain challenging. With careful consideration of how decision space, capacity, and accountability operate together within organizational structures, strategically designed interventions can optimize health system performance for greater access to appropriate services.

5.1.2 OPTIMIZING FINANCIAL RISK PROTECTION TO PROMOTE ACCESS TO HEALTH SERVICES

Achieving financial risk protection requires engagement of both beneficiaries and payers to act and respond appropriately to health care seeking and provision. To realize financial risk protection in the face of the need for health services, beneficiaries must understand their entitlements, perceive that such services will address their health needs, and know how to access them. The evidence of Paper 2 suggests that the majority of beneficiaries know about their entitlements and that they are accessed at public providers. However, persistently low utilization of them suggests that other factors may be at play. That microsimulation of interventions to further increase awareness of HEF would increase health services utilization by only 2% bolster such conclusions. In this setting, building trust of public providers and improved perceptions of quality of care may be alternative approaches to improve financial risk protection.

Paper 3 examines an additional approach to improving financial risk protection: to improve service and financial coverage for NCDs, such as diabetes, whose increasing burden nearly guarantees that such services will be in demand as countries continue to develop. Lower-middle income countries are already facing the burden of such NCDs, but many do not have access to treat and manage their conditions. Not precluding the importance of interventions for prevention of these diseases, governments can alleviate their health and economic impacts on the most vulnerable groups with strategic policy outlining sufficient social protections. Nevertheless, the success of such policies again depend on the capacity of public health services to serve the care and management needs of NCDs.

In 2016, total health expenditure per capita was US\$63 and US\$78 in India and Cambodia, respectively, remaining below the US\$ 79 average among lower-middle income countries and far below the US\$ 255

among middle-income countries [181, 182]. Study findings suggest that coverage of diagnostic services and medications would increase spending per capita by only US\$1 to US\$2 and considerably improve financial risk protection among the poorest NCD patients. Such strategic increases in spending through cost-effective investments could further optimize the design of health systems to tackle population health challenges [183]. Such interventions would require considerable political will and commitment to significant investments in primary health care and health systems more broadly. Yet, in anticipating current and future health needs, such health system investments would support countries in their endeavor to achieve and maintain UHC in the years to come.

5.2 FUTURE RESEARCH

Research to support policies improving access to health care focus on data and information about how humans interact within a complex social and economic system. This system is characterized by diverse, and at times, competing needs among both patients and providers, intricate human behaviors and perspectives, and complex organizational structures. This dissertation attempted to reveal the benefits of new approaches and perspectives in studying access to health care in LMICs. With study results suggesting different factors to consider in the measurement of decision space and institutional capacity, Paper 1 pointed to questions on how to appropriately measure decision space, and decentralization more broadly, in diverse contexts as well as future questions on how best to integrate decision space and institutional capacity in program planning and implementation. Paper 2 suggested that focuses on interventions to increase care seeking in the public sector in general may do more to improve desired objectives. Paper 3 emphasized the need for a clear plan on what chronic care and management of NCDs, such as diabetes, should look like in resource-constrained settings as well as highlighted the need for country-specific data to provide more exact cost and outcome estimates.

For each of these specific areas aiming to improve access to health services, future research would benefit from improved data sources. Improvements to the data could include improvements in routine record keeping, strategic design of data collection activities to address questions relevant to access, and access to more varied datasets that provide multiple perspectives of the problem. Continuing to ensure high-quality data collection will also be important to gathering evidence for appropriate priority setting and effective policymaking. Promoting greater use and contribution to open data and data sharing platforms may enhance possibilities of

additional findings in this area.

For the studies included in this dissertation, it was not possible to make conclusions about causal relationships due to the nature of the study design and contexts driving available data. Nevertheless, the conclusions drawn concerning existing synergies associated with performance as well as effectiveness of interventions make significant contributions to the literature and address the needs of health systems in lower-middle income countries. Future research should include efforts to design studies that allow for causal inference. The challenges associated with collecting such data encourage greater openness to innovative approaches to this area of research. Innovations could include new approaches to data collection as well as methods not yet applied to these types of research questions.



Paper 1: Supplementary materials

A.1 CONCEPTUALIZATION OF DECENTRALIZATION

Decentralization can be broadly defined as the process of transferring responsibilities and resources from the central government to subnational government entities and is typically classified into four types: (1) deconcentration, (2) delegation, (3) devolution, and (4) privatization (see Box A.1) [26, 184]. Each of these forms of decentralization can result in different effects on the functionalities, responsibilities, and authority of actors across levels of the health system. By the mid-1990s, at least 80% of the world's countries had implemented some form of decentralization with donors' active support [185–187].

Box A.1: Typology of different forms of decentralization.

Deconcentration	Delegation	Devolution	Privatization
Shifting power from the central offices to peripheral offices of the same administrative structure	Shifting responsibility and authority to semi-autonomous agencies	Shifting responsibility and authority from the central offices to separate administrative structures within the public administration	Transferring operational responsibilities or ownership to private providers

Source: Bossert, 1998 [26]

The public administration approach emphasizes public participation and accountability, contending that decentralized health systems can ensure the responsiveness and flexibility of management to meet local needs and better align with key principles of health service provision [30, 184, 187–189]. Local fiscal theory suggests that, with decentralization, subnational governments will be empowered to provide optimal levels of public goods and services, achieving efficiency and quality objectives [26, 190]. The social capital perspective asserts that decentralized health systems encourage citizen participation in the planning and provision of health services [191]. Each of these perspectives promotes underlying themes of strengthened governance through increased civil participation and accountability that can be achieved through some combination of political, administrative, and/or fiscal decentralization (Figure A.1).

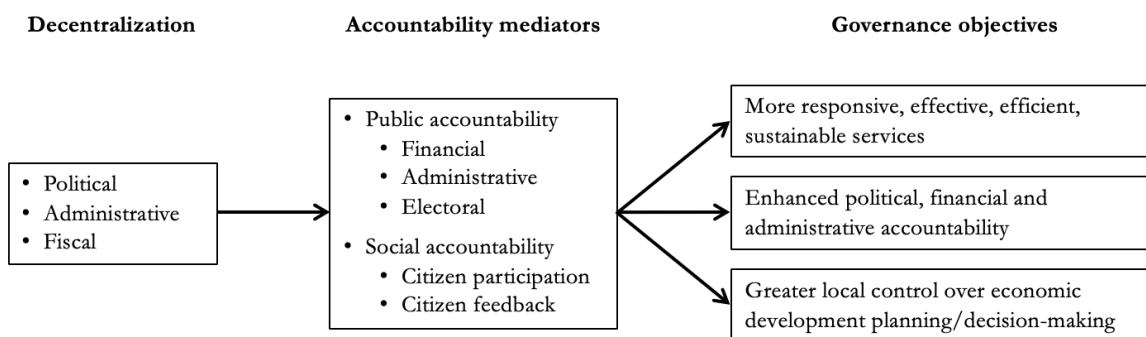


Figure A.1: Decentralization from a governance perspective

Source: Mitchell & Bossert, 2010; adapted from Yilmaz et al., 2008 [33, 192]

A.1.1 DECISION SPACE APPROACH

Rooted in the principal-agent approach, the decision space framework positions a central authority as a principal with specific objectives and lower level authorities as agents who are given resources towards achieving those objectives. These characteristics can also be found in the implementation of a vertical health program, whereby a principal defines the program objective and agents implement features of the program toward this narrow objective.

Decision space can be formally defined by laws and regulations (*de jure*) or informally, that resulting from lack of enforcement of formal definitions or gray areas in authority (*de facto*). An advantage of using this approach is the specificity and nuance with which decentralization can be defined for the health sector. Decision space may be defined for various health functions and activities of local authorities (Table A.1).

Table A.1: Selection of health sector functions and decision space

Function	Key determinants of local-level decision space
<i>Financial management</i>	
Expenditures	Ability to determine budgetary allocations (e.g., planning, budgeting, and execution)
Sources of revenue	Availability of/authority to use funds raised from all levels of the system (e.g., intergovernmental transfers, own-source revenues, income from user fees and contracts, borrowing)
<i>Human resources management</i>	
Civil service	Ability to decide compensation package, terms of employment
Contracting (with individuals) and provider payment mechanisms	Range of permissible contracting options of health workers, provider payment mechanisms
<i>Service organization</i>	
Required programs	Ability to modify implementation of national programs
Hospital autonomy	Ability of hospitals to be independently managed (incl. discretion over all health sector functions within hospitals)
Insurance plans	Ability to create, manage, and/or regulate local insurance mechanisms (e.g., determine service coverage or minimum packages, introduce community-based health insurance)
Contracting (with organizations)	Ability to enter into contracts with organizations to deliver specified services
Continued on next page	

Table A.1 – continued from previous page

Function	Key determinants of local-level decision space
Procurement of goods	Ability to procure locally goods and services
Source: Mitchell & Bossert, 2010; adapted from Bossert, 1998 [26, 33]	

Rather than conceptualizing decentralization as a single transfer of a block of authority and responsibility, the various health functions of actors can be disaggregated and degree of choice within each function detailed. These health functions may include (i) strategic and operational planning, (ii) financial management or budgeting, (iii) human resources management, (iv) service organization and delivery, (v) access rules, and (vi) governance rules. Decision space can, therefore, be mapped across a spectrum of narrow to wide for each health function (see example Table A.2).

Table A.2: Map of decision space

Functions	Range of choice		
	<i>narrow</i>	<i>moderate</i>	<i>wide</i>
Finance			
Sources of revenue	→	→	→
Allocation of expenditures	→	→	→
Income from fees and contracts	→	→	→
Service organization			
Hospital autonomy	→	→	→
Insurance plans	→	→	→
Payment mechanisms	→	→	→
Contracts with private providers	→	→	→
Required programs/norms	→	→	→
Human resources			
Salaries	→	→	→
Contracts	→	→	→
Civil service	→	→	→
Access rules			
Targeting	→	→	→
Governance rules			
Facility boards	→	→	→
Health offices	→	→	→
Community participation	→	→	→
Source: Bossert, 1998 [26]			

Bossert and Mitchell (2011) expand upon the decision space approach to argue that it is the interaction of decision space, institutional capacities, and accountability that produces improved system outcomes (Figure

2.1) [34]. Assessment of institutional capacities focuses on individual level attributes of local health systems. In the context of a health program, capacities may be measured by the level of education and/or training of health workers, the availability of funds, the adequacy of infrastructure, or the ability to conduct monitoring and evaluation activities. Measures of accountability consider the initiative of actors in decision-making processes and actors' involvement in supervision.

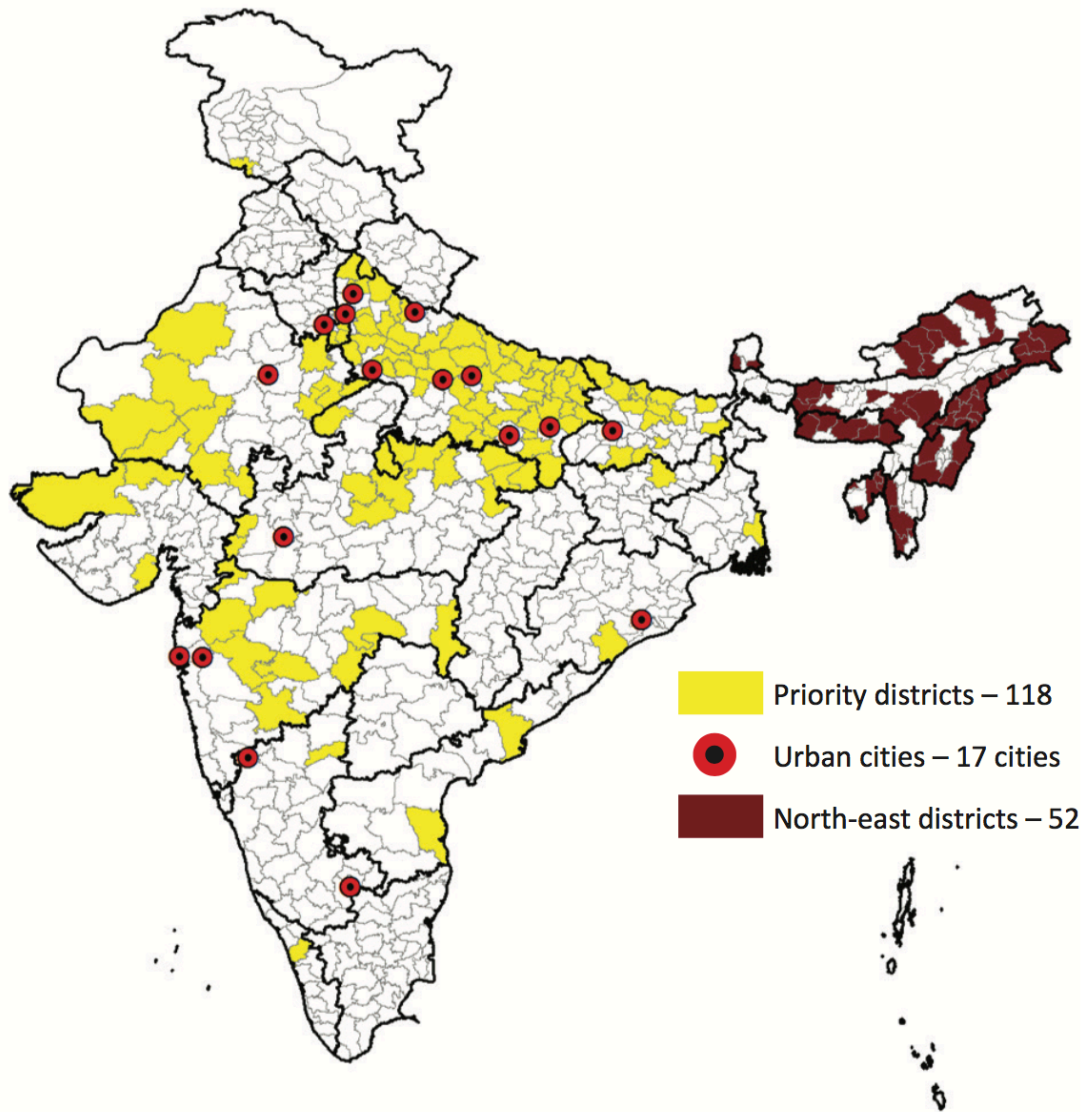


Figure A.2: Districts and urban areas selected for IMI implementation
Source: IMI Program Documents, Government of India

A.2 IMPLEMENTATION OF INTENSIFIED MISSION INDRADHANUSH (IMI)

IMI is a program of periodic intensification of routine immunization (RI) implemented by the Government of India in low-coverage districts across India [15]. The aim of the program is to cover all children missed by the UIP and MI initiatives in select districts and urban cities to achieve 90% coverage by December 2018. These locations are recorded to have low immunization coverage at the time of IMI implementation under the following criteria: (i) estimated number of children who missed DTP₃/Pentavalent₃ > 13,000, or (ii) DTP₃/Pentavalent₃ < 70%. Districts and urban cities were selected through the triangulation of available datasets, such as national surveys, HMIS data, and WHO monitoring data. Analyses of these data identified 170 districts and 17 urban cities. Additional districts were included in the initiative based on states' requests.

Management of the program was decentralized to district and sub-district (i.e., block) levels [15]. Within each selected district or city, a process of microplanning was carried out to identify children with missing doses and outreach to communities to deliver immunization in the community at temporary vaccination sites during one week of each month for four consecutive months. IMI planning was steered based on information provided by gap assessments, supervision by the government, concurrent monitoring by partners (i.e., WHO, UNICEF, UNDP, etc.), and endline surveys. IMI consisted of four rounds of immunization conducted between October 2017 and January 2018. Each immunization drive was spread over seven working days with the exception of holidays, Sundays, and routine immunization days already planned. After the completion of these rounds, states were expected to undertake measures to sustain the gains achieved, thereby strengthening the routine immunization system.

Microplanning involved stakeholders at the district, block, and subcenter levels. Auxiliary Nurse Midwives (ANMs) posted at subcenters prepare a list of areas within their subcenter catchment area requiring additional sessions under IMI and revise this list as needed in consultation with the block medical officer in-charge (MOIC). This list was then reviewed and finalized at the district level by the District Immunization Officer (DIO). Led by the national government, a monitoring framework replicating the polio accountability system was established to oversee IMI activities at the state, district, and block levels. Task forces for immunization at the state, district, and block levels were formed for regular planning and review of the routine immunization program, also tasked with oversight of IMI. Monitoring data was intended to be fed back to block, district,

and state task forces for immediate corrective action and to guide programmatic decision making.

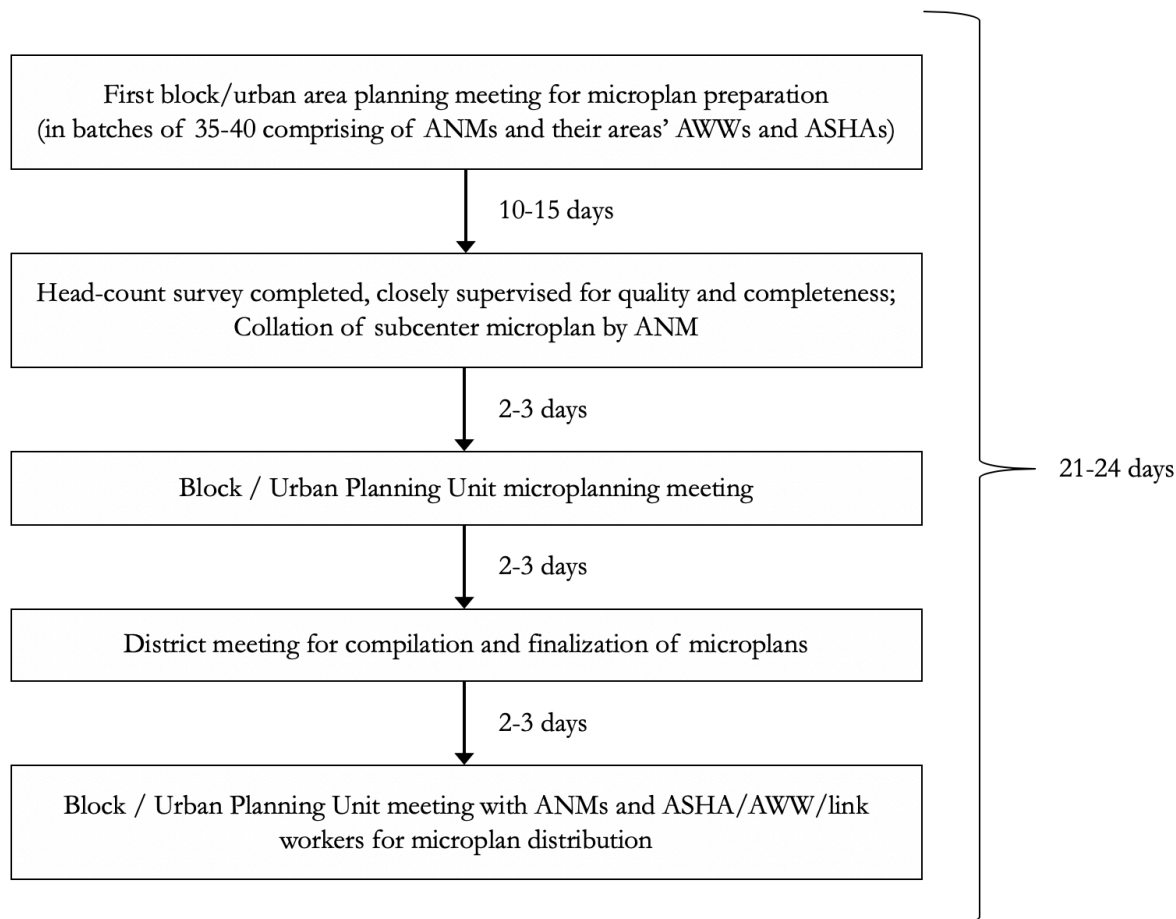


Figure A.3: Sequence of the IMI microplanning process

Source: IMI Program Documents, Government of India

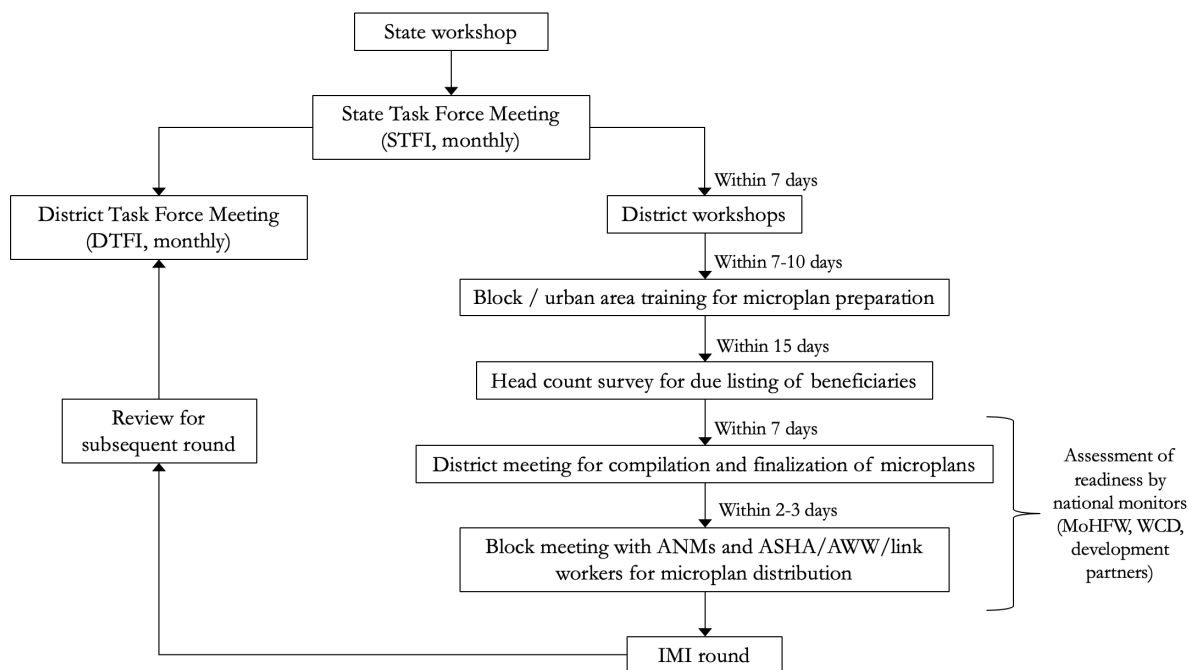


Figure A.4: Steps for rollout of training and implementation of IMI

Source: IMI Program Documents, Government of India

A.3 STUDY INSTRUMENTS

Study instruments were developed based on past questionnaires used in studies examining decision space in India [51]. They were further adapted to context and the IMI program based on discussions throughout the training of the locally-based research team and pilot testing of the tools. These instruments made up the final section of a larger questionnaire collecting data on IMI from retrospective review of facility records and key informant interviews.



State: _____ Data collector: _____
District: _____ Date: _____

code

Section 5 of 5: Decision capacity

Respondent profile

D5.01	Age (years) :													
D5.02	Sex : ☐ Male ☐ Female													
D5.03	Years in government service :													
D5.04	Length of time (years) in present district :													
D5.05	Current position : ☐ DIO ☐ Other, specify: _____													
D5.06	Were you involved in IMI in any role? ☐ YES ☐ NO, END INTERVIEW													
D5.07	Position during IMI : ☐ DIO ☐ Other, specify: _____													
D5.08	Were you based in this district during IMI? ☐ YES ☐ NO, specify location: _____													
D5.09	Educational qualifications (list highest degree)													
D5.10	Have you received any additional formal management training related to your work in the past 2 years <table border="1"> <thead> <tr> <th>No</th> <th>Title of training</th> <th>Duration (specify # days/weeks/months)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td></td> <td></td> </tr> <tr> <td>2</td> <td></td> <td></td> </tr> <tr> <td>3</td> <td></td> <td></td> </tr> </tbody> </table>		No	Title of training	Duration (specify # days/weeks/months)	1			2			3		
No	Title of training	Duration (specify # days/weeks/months)												
1														
2														
3														

General Overview

	I am going to ask you some questions about the Routine Immunization program (RI) in your district.										
D5.11	In your district, has there been progress toward immunization coverage goals in the past 2 years?										
D5.12	What are the main challenges of implementing RI in your district? Encourage free response; note free responses here or use tick boxes if applicable: <table border="0"> <tr> <td>☐ Staffing / Vacancies</td> <td>☐ Funding</td> </tr> <tr> <td>☐ Inefficient operations</td> <td>☐ Vaccine Supply Issues</td> </tr> <tr> <td>☐ Patients lack awareness</td> <td>☐ Patients hesitancy</td> </tr> <tr> <td>☐ Target population hard to reach</td> <td>☐ Social media rumors</td> </tr> <tr> <td>☐ Staff motivation</td> <td>☐ Record-keeping issues</td> </tr> </table>	☐ Staffing / Vacancies	☐ Funding	☐ Inefficient operations	☐ Vaccine Supply Issues	☐ Patients lack awareness	☐ Patients hesitancy	☐ Target population hard to reach	☐ Social media rumors	☐ Staff motivation	☐ Record-keeping issues
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☐ Inefficient operations	☐ Vaccine Supply Issues										
☐ Patients lack awareness	☐ Patients hesitancy										
☐ Target population hard to reach	☐ Social media rumors										
☐ Staff motivation	☐ Record-keeping issues										
D5.13	How effective has IMI been as a supplement to RI? ☐ NOT AT ALL EFFECTIVE ☐ SOMEWHAT EFFECTIVE ☐ EFFECTIVE ☐ VERY EFFECTIVE										



Strategic and operational planning

D5.14	What are the top three challenges that you have experienced implementing IMI? (List in order of importance) 1. 2. 3.
D5.15	What is your role / what specific actions do you take in the development of the final plan of IMI?

D5.16	Did you participate in IMI review meetings during IMI rounds? ☐ YES ☐ NO, skip to D5.19
D5.17	What is the process for making decisions during IMI review meetings?
D5.18	What changes were made to IMI implementation following the IMI review meetings, if any?



Financial Management

D5.19	Were funds allocated to your district specifically for IMI? ☐ YES ☐ NO
D5.20	Did your district have sufficient funds to implement IMI as planned? ☐ YES ☐ NO

Human resources

D5.21	Describe the training that you received to implement IMI. (check all that apply) ☐ IMI communication session ☐ BRIDGE IPC Skills training ☐ AEFI protocol training ☐ CSO orientation on communication plan and use of monitoring tools ☐ Media spokespersons training ☐ IMI microplanning & reporting workshop (district-level) ☐ Health workers training (ANMs, LHVs, health supervisors) ☐ Mobilizers training (ASHAs, AWWs) ☐ Other, specify: _____
D5.22	Did you use this training to solve any problems with IMI planning or implementation in the last year? ☐ YES ☐ NO
D5.23	Do you feel that this training was sufficient given your responsibilities under the program? ☐ YES, skip to D5.25 ☐ NO

D5.24	In what way was the training not sufficient? What additional training would have helped you?
D5.25	Has your experience with the implementation of IMI led you to make any changes to the RI plan or the way RI is implemented? ☐ YES ☐ NO, skip to D5.27
D5.26	If yes, how?
D5.27	Do you think there will be a need for additional rounds of IMI in your district in the future? Why or why not?



Governance and local participation

D5.28	Do you have a direct supervisor for your IMI activities? ☐ YES ☐ NO, skip to D5.31
D5.29	How frequently did your supervisor communicate with you about IMI on a regular basis during IMI rounds? ☐ Almost Daily ☐ 2-4 times per week ☐ About once a week ☐ 1-2 times per month ☐ Less than 1 time per month
D5.30	What actions does your direct supervisor take to supervise your IMI activities?
D5.31	What actions do you take to supervise the IMI activities of those under your supervision? (block)

D5.32	Did you make changes to IMI planning or implementation based on the feedback from your supervisor or someone you supervise? ☐ YES ☐ NO
D5.33	Why or why not?
D5.34	Has community participation (feedback/ concerns/ rumors/ resistance) from the community, affected how IMI was implemented in this district? ☐ YES ☐ NO, skip to D5.36
D5.35	If yes, how so?



Service organization and delivery

D5.36	If IMI were to be implemented again, what would you do differently?
D5.37	If you had the freedom to do <i>anything</i> , what would you do to improve the efficiency of IMI?

Adoption of technology

D5.38	To what extent has your district implemented electronic recording of RCH registers? ☐ Have not started ☐ Began implementation (date/time period: _____) ☐ Fully implemented (date/time period: _____)
-------	--

Future priorities

(PRESENT TO INTERVIEWEE)

D5.57	To improve your own/district performance, which of the following functions is most important, in your view, to have more freedom about: <i>Rank in order of importance; 1 being the most important and 7 being the least important.</i> ☐ Increase the amount of the budget you are allowed without higher approval ☐ Ability to plan and budget with more flexibility ☐ Ability to spend with more flexibility ☐ Ability to select senior staff ☐ Ability to hire and fire staff ☐ Ability to set local priorities that override central priorities ☐ Ability to generate additional local funds ☐ Other, specify: _____
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State: _____ Data collector: _____
District: _____ Date: _____
Block: _____

code

Section 5 of 5: Decision capacity

Respondent profile

B5.01	Age (years) :													
B5.02	Sex : ☐ Male ☐ Female													
B5.03	Years in government service :													
B5.04	Length of time (years) in present block:													
B5.05	Current position : ☐ MO ☐ Other, specify: _____													
B5.06	Were you involved in IMI in any role? ☐ YES ☐ NO, END INTERVIEW													
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B5.08	Were you based in the present block during IMI? ☐ YES ☐ NO, specify location: _____													
B5.09	Educational qualifications (list highest degree)													
B5.10	Additional management training related to your work received in the past 2 years (please specify) <table border="1"> <thead> <tr> <th>No</th> <th>Title of training</th> <th>Duration (specify days/weeks/months)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td></td> <td></td> </tr> <tr> <td>2</td> <td></td> <td></td> </tr> <tr> <td>3</td> <td></td> <td></td> </tr> </tbody> </table>		No	Title of training	Duration (specify days/weeks/months)	1			2			3		
No	Title of training	Duration (specify days/weeks/months)												
1														
2														
3														

General Overview

	I am going to ask you some questions about the Routine Immunization program (RI) in this Block.
B5.11	In this block, has there been progress toward immunization coverage goals in the past 2 years?
B5.12	What are the main challenges of implementing RI in this block? Encourage free response; note free responses here or use tick boxes if applicable: ☐ Staffing / Vacancies ☐ Inefficient operations ☐ Patients lack awareness ☐ Target population hard to reach ☐ Staff motivation ☐ Funding ☐ Vaccine Supply Issues ☐ Patients hesitancy ☐ Social media rumors ☐ Record-keeping issues
B5.13	How effective has IMI been as a supplement to RI? ☐ NOT AT ALL EFFECTIVE ☐ SOMEWHAT EFFECTIVE ☐ EFFECTIVE ☐ VERY EFFECTIVE



Strategic and operational planning

B5.14	What are the top three challenges that you have experienced implementing IMI? (List in order of importance) 1. 2. 3.
B5.15	What is your role / what specific actions do you take in the development of the final plan of IMI?

B5.16	Did you participate in IMI review meetings during IMI rounds? ☐ YES ☐ NO, skip to D5.19
B5.17	What is the process for making decisions during IMI review meetings?
B5.18	What changes were made to IMI implementation following the IMI review meetings, if any?



Financial Management

B5.19	Were any funds allocated to your block specifically for IMI? ☐ YES ☐ NO
B5.20	Did your block have sufficient funds to implement IMI as planned? ☐ YES ☐ NO

Human resources

B5.21	Describe the training that you received to implement IMI. (check all that apply) ☐ IMI communication session ☐ BRIDGE IPC Skills training ☐ AEFI protocol training ☐ CSO orientation on communication plan and use of monitoring tools ☐ Media spokespersons training ☐ IMI microplanning & reporting workshop (district-level) ☐ Health workers training (ANMs, LHVs, health supervisors) ☐ Mobilizers training (ASHAs, AWWs) ☐ Other, specify: _____
B5.22	Did you use this training to solve any problems with IMI planning or implementation in the last year? ☐ YES ☐ NO
B5.23	Do you feel that this training was sufficient given your responsibilities under the program? ☐ YES, skip to B5.25 ☐ NO

B5.24	In what ways was the training not sufficient? What additional training would have helped you?
B5.25	Has your experience with the implementation of IMI led you to make any changes to the RI plan or the way RI is implemented? ☐ YES ☐ NO, skip to B5.27
B5.26	If yes, how?
D5.27	Do you think there will be a need for additional rounds of IMI in this block in the future? Why or why not?



Governance and local participation

B5.28	Do you have a direct supervisor for your IMI activities? ☐ YES ☐ NO, skip to B5.31
B5.29	How frequently did your supervisor communicate with you about IMI on a regular basis during IMI rounds? ☐ Almost Daily ☐ 2-4 times per week ☐ About once a week ☐ 1-2 times per month ☐ Less than 1 time per month
B5.30	What actions does your direct supervisor take to supervise your IMI activities?
B5.31	What actions do you take to supervise the IMI activities of those under your supervision? (subcentre)

B5.32	Did you make changes to IMI planning or implementation based on feedback from your supervisor or someone you supervise? ☐ YES ☐ NO
B5.33	Why or why not?
B5.34	Has community participation (feedback/ concerns/ rumors/ resistance) from the community, affected how IMI was implemented in this block? ☐ YES ☐ NO, skip to B5.36
B5.35	If yes, how so?



Service organization and delivery

B5.36	If IMI were to be implemented again, what would you do differently?
B5.37	If you had the freedom to do <i>anything</i> , what would you do to improve the efficiency of IMI?

Adoption of technology

B5.38	To what extent has this block implemented electronic recording of RCH registers? ☐ Have not started ☐ Began implementation (date/time period: _____) ☐ Fully implemented (date/time period: _____)
-------	---

Future priorities

(PRESENT TO INTERVIEWEE)

B5.57	To improve your own/block performance, which of the following functions is most important, in your view, to have more freedom about: <i>Rank in order of importance; 1 being the most important and 7 being the least important.</i> ☐ Increase the amount of the budget you are allowed without higher approval ☐ Ability to plan and budget with more flexibility ☐ Ability to spend with more flexibility ☐ Ability to select senior staff ☐ Ability to hire and fire staff ☐ Ability to set local priorities that override central priorities ☐ Ability to generate additional local funds ☐ Other, specify: _____
-------	--



District: _____ Data Collector: _____
Block: _____ Date: _____
Sub-centre: _____

code

Section 5 of 5: Decision capacity

Respondent profile

S5.01	Age :													
S5.02	Sex : ☐ Male ☐ Female													
S5.03	Years in government service :													
S5.04	Length of time (<i>years</i>) in present sub-centre:													
S5.05	Current position : ☐ ANM ☐ Other, specify: _____													
S5.06	Were you involved in IMI in any role? ☐ YES ☐ NO, END INTERVIEW													
S5.07	Position during IMI : ☐ ANM ☐ Other, specify: _____													
S5.08	Were you based in the present district during IMI? ☐ YES ☐ NO, specify location: _____													
S5.09	Educational qualifications (list highest degree)													
S5.10	Additional management training related to your work received in the past 2 years (please specify) <table border="1"> <thead> <tr> <th>No</th> <th>Title of training</th> <th>Duration (specify days/weeks/months)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td></td> <td></td> </tr> <tr> <td>2</td> <td></td> <td></td> </tr> <tr> <td>3</td> <td></td> <td></td> </tr> </tbody> </table>		No	Title of training	Duration (specify days/weeks/months)	1			2			3		
No	Title of training	Duration (specify days/weeks/months)												
1														
2														
3														

General Overview

S5.11	For interviewer: Is other staff present during the interview? ☐ YES ☐ NO
S5.12	What are the challenges of implementing routine immunization program (RI) in this sub-centre? Encourage free response; write down responses here and/or use tick boxes if applicable: ☐ Staffing / Vacancies ☐ Funding ☐ Inefficient operations ☐ Vaccine Supply Issues ☐ Patients lack awareness ☐ Patients hesitancy ☐ Target population hard to reach ☐ Social media rumors ☐ Staff motivation ☐ Record-keeping issues
S5.13	How effective has IMI been as a supplement to RI? ☐ NOT AT ALL EFFECTIVE ☐ SOMEWHAT EFFECTIVE ☐ EFFECTIVE ☐ VERY EFFECTIVE



Strategic and operational planning

S5.14	What are the top three challenges that you have experienced implementing IMI? (List in order of importance) 1. 2. 3.
S5.15	What is your role / what specific actions do you take in the development of the final plan of IMI?

Human resources

S5.16	Describe the training that you received to implement IMI. (check all that apply) ☐ IMI communication session ☐ BRIDGE IPC Skills training ☐ AEFI protocol training ☐ CSO orientation on communication plan and use of monitoring tools ☐ Media spokespersons training ☐ IMI microplanning & reporting workshop (district-level) ☐ Health workers training (ANMs, LHVs, health supervisors) ☐ Mobilizers training (ASHAs, AWWs) ☐ Other, specify: _____
S5.17	Do you remember what was talked about in the training? ☐ YES ☐ NO, skip to S5.20
S5.18	Do you feel that this training was sufficient given your responsibilities under the program? ☐ YES ☐ NO
S5.19	Why or why not?



S5.20	Has your experience with IMI led you to make any changes to the RI plan or the way RI is implemented? ☐ YES ☐ NO, skip to B5.22
S5.21	If yes, how?

Governance and local participation

S5.22	Do you have a direct supervisor for your IMI activities? ☐ YES ☐ NO, skip to S5.25
S5.23	How frequently did your supervisor communicate with you about IMI on a regular basis during IMI rounds? ☐ Almost Daily ☐ 2-4 times per week ☐ About once a week ☐ 1-2 times per month ☐ Less than 1 time per month
S5.24	What actions does your direct supervisor take to supervise your IMI activities?

S5.25	Has community participation (feedback/ concerns/ rumors/ resistance) from the community, affected how you implement IMI activities? ☐ YES ☐ NO, skip to S5.27
S5.26	If yes, how so?

Service organization and delivery

S5.27	If IMI were to be implemented again, what would you do differently?
-------	---



S5.28	If you had the freedom to do <i>anything</i> , what would you do to improve the efficiency of IMI?
-------	--

**Availability of infrastructure
(OBSERVE, IF POSSIBLE)**

S5.29	Subcentre has the following infrastructure (check all that apply) : ☐ Electricity ☐ Running water ☐ Flush or pour toilet ☐ Pit latrine ☐ Separate room for ANC check up ☐ Stand-alone building (i.e. building consists of subcentre only)
S5.30	Type of building : ☐ Government building ☐ Private building (i.e. house, barn, etc.)
S5.31	Building ownership : ☐ Owned ☐ Rented
S5.32	Are toilet facilities usable? ☐ YES ☐ NO, specify reason: _____ ☐ No toilet facilities available

A.4 SUPPLEMENTARY FIGURES

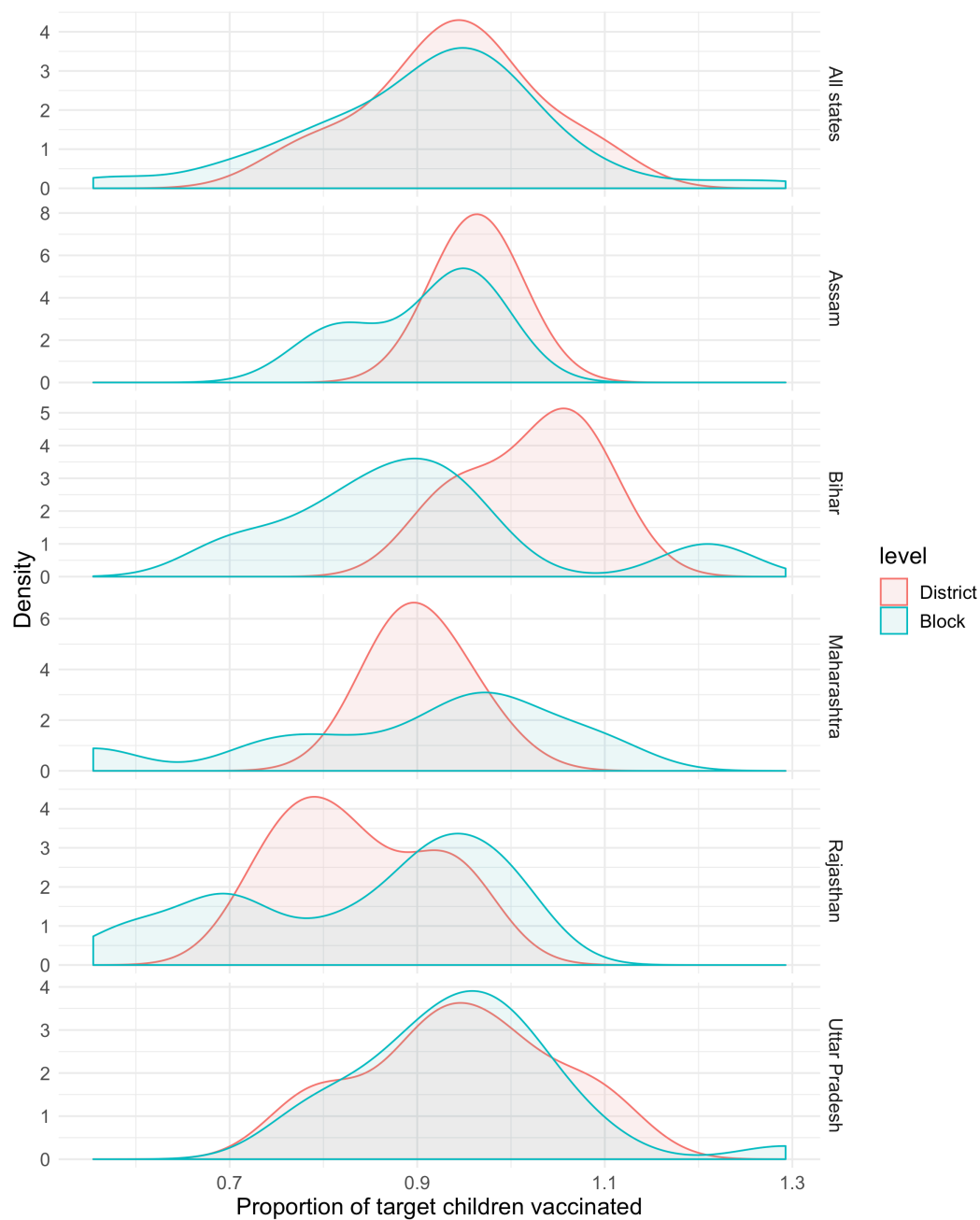


Figure A.4.1: Density plot of the proportion of target children vaccinated during IMI by state and level

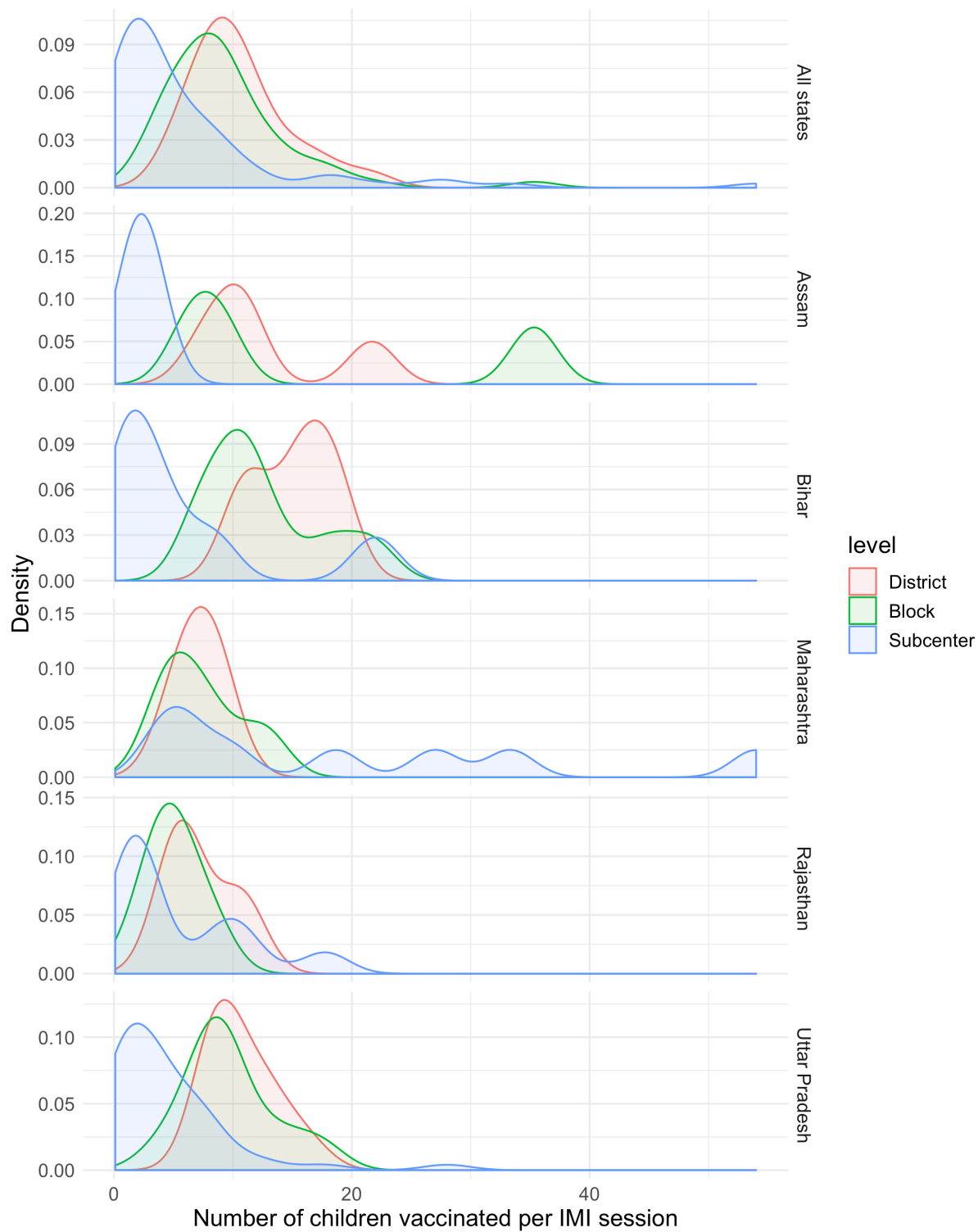


Figure A.4.2: Density plot of the number of children vaccinated per IMI session by state and level

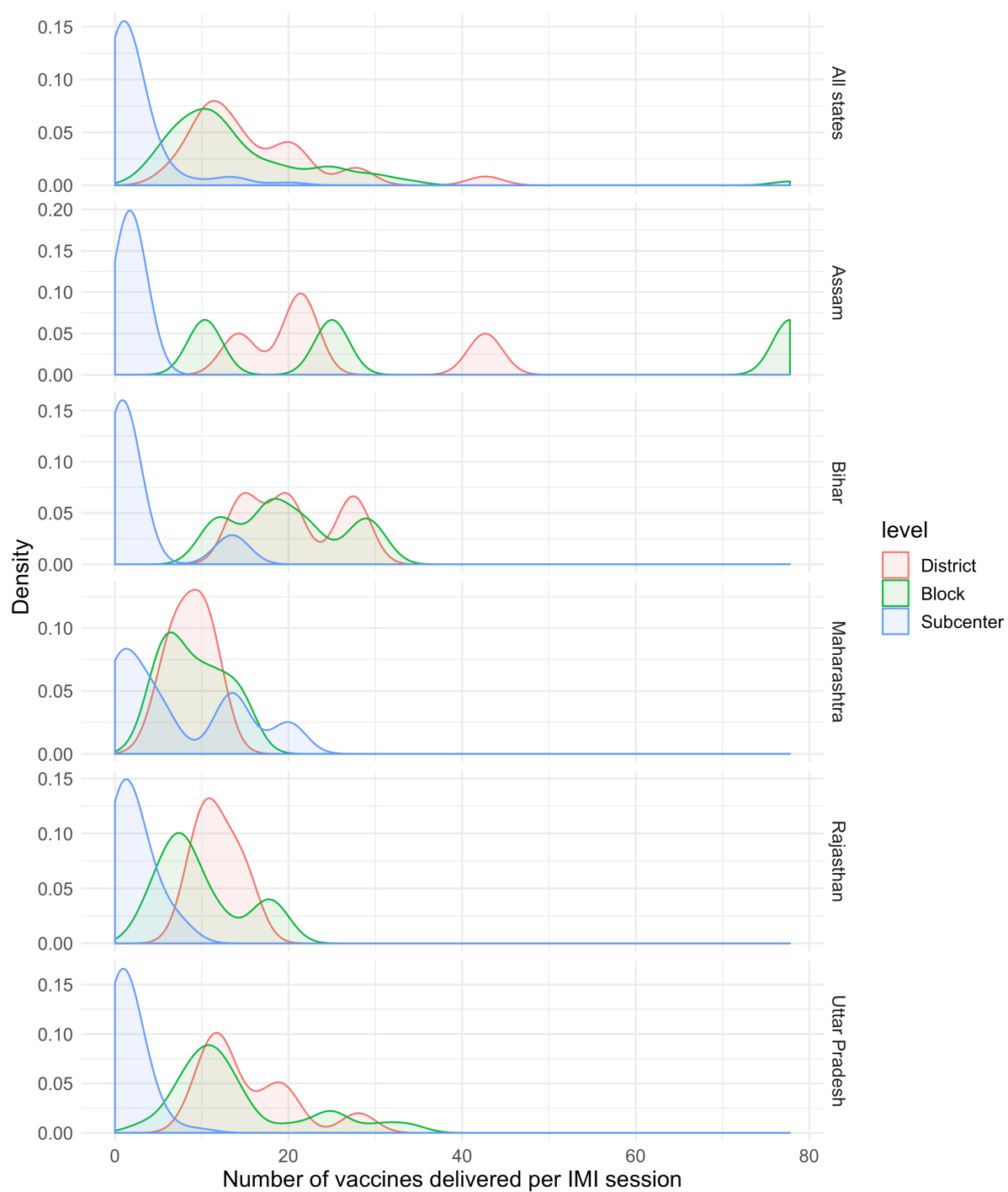


Figure A.4.3: Density plot of the number of vaccine doses delivered per IMI session by state and level

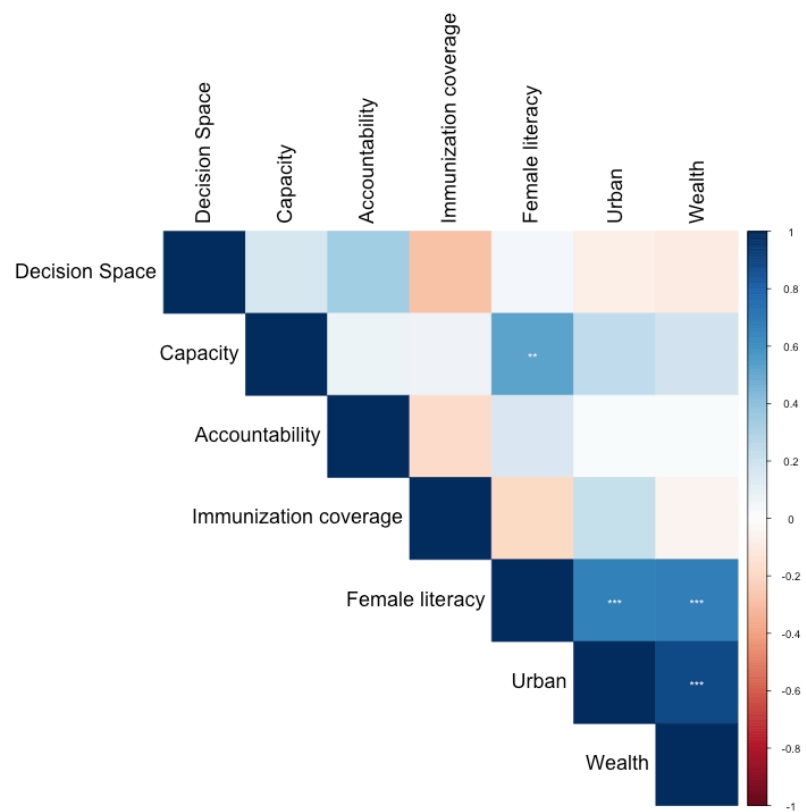


Figure A.4.4: Correlation plot between state-level characteristics and district-level dimensions

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

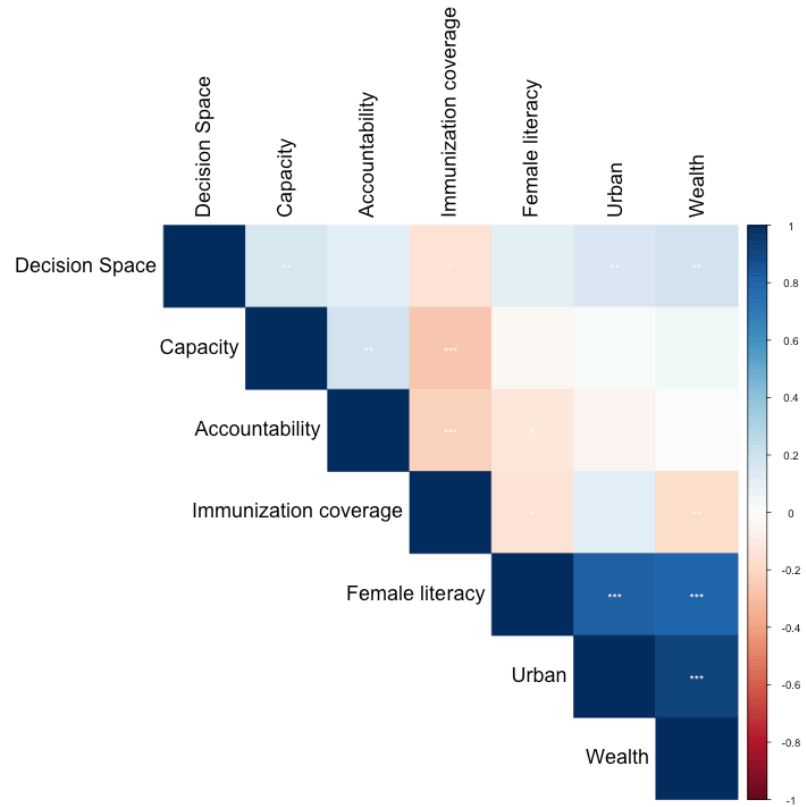


Figure A.4.5: Correlation plot between state-level characteristics and subcenter-level dimensions
 $*p < 0.05$; $**p < 0.01$; $***p < 0.001$

Figure A.4.6: Path diagram for structural equation model, model A
 B=Block-level indicators; S=Subcenter-level indicators.

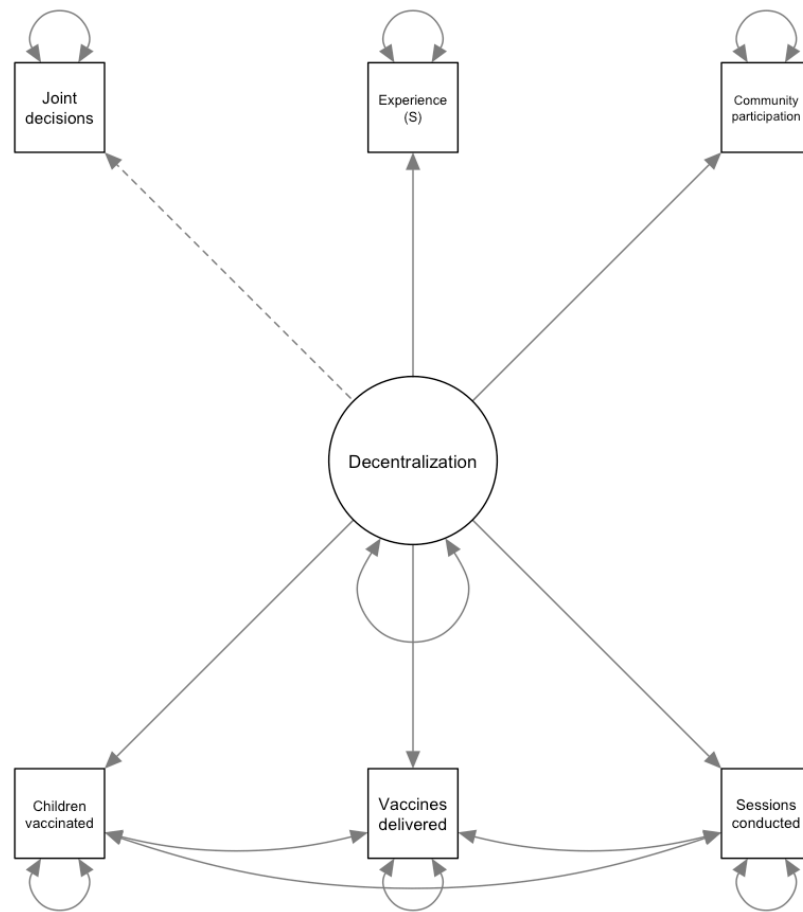


Figure A.4.7: Path diagram for structural equation model, model B

Specification: Latent construct decentralization generated by a measurement model with one item from each framework dimension (Decision Space, Institutional Capacity, Accountability) to result in a one-factor model to predict performance outcomes.

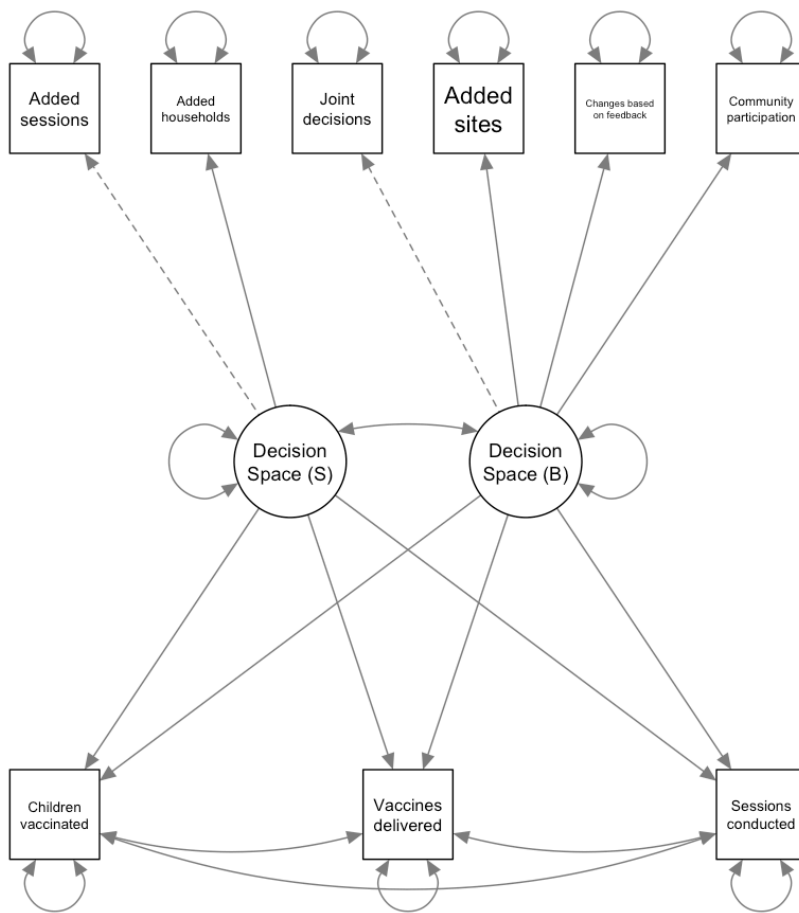


Figure A.4.8: Path diagram for structural equation model, model C
 Specification: Decision space measured at block and subcenter levels both directly predict performance outcomes. B=Block-level indicators; S=Subcenter-level indicators.

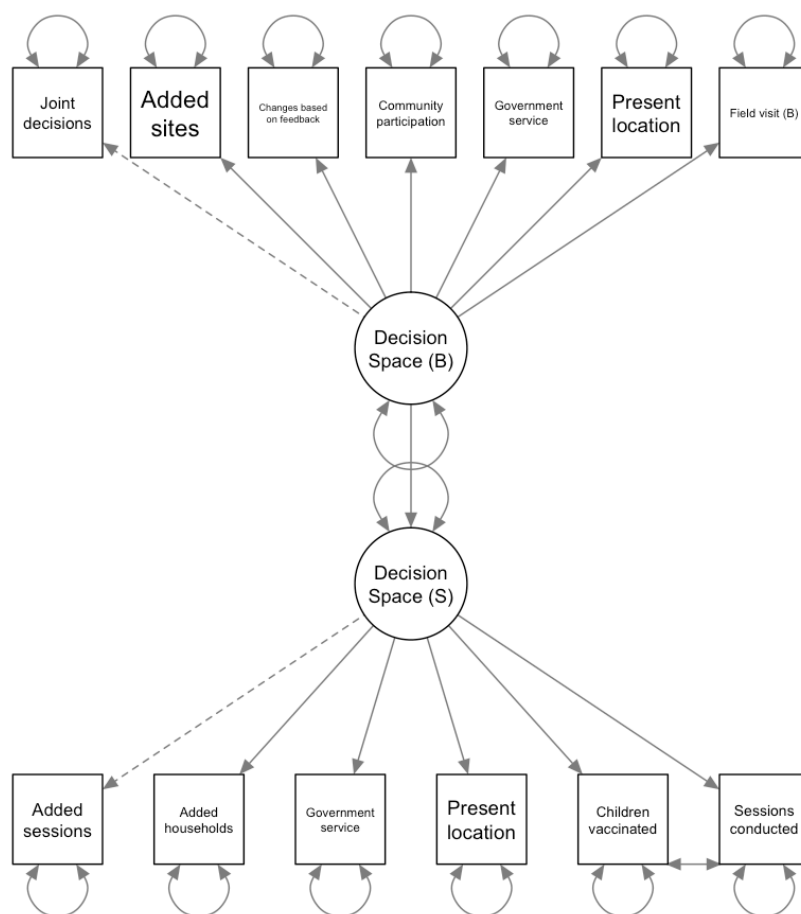


Figure A.4.9: Path diagram for structural equation model, model D

Specification: Block-level decision space predicts subcenter-level decision space, which subsequently predicts performance outcomes. Only two performance measures presented here. B=Block-level indicators; S=Subcenter-level indicators.

A.5 SUPPLEMENTARY TABLES

Table A.5.1: Correlations between heuristic composite scores and performance measures

Dimension / Domain	Children vaccinated per session	Vaccines delivered per session	Proportion of target children vaccinated	Proportion of sessions per microplan
District, n	24	24	24	-
<i>Decision Space</i>	-0.02	0.00	0.04	-
Strategic and operational planning	0.10	0.15	-0.20	-
Human resources management	-0.15	-0.18	-0.09	-
Service delivery and organization	-0.05	-0.07	0.16	-
Governance and local participation	0.08	0.12	0.22	-
<i>Institutional Capacity</i>	0.12	0.18	-0.14	-
Education	0.50*	0.31	0.29	-
Experience in government service	0.49*	0.54**	0.36	-
Duration in present location	-0.20	-0.09	-0.11	-
Additional training	0.24	0.32	-0.17	-
Funding	-0.31	-0.19	-0.21	-
Adoption of technology	0.02	0.00	0.02	-
<i>Accountability</i>	0.11	0.12	0.27	-
Supervision presence	0.27	0.29	0.15	-
Supervisory actions	0.10	0.13	0.19	-
Community participation	-0.08	-0.10	0.22	-
Block, n	55	55	55	-
<i>Decision Space</i>	0.36**	0.34*	-0.16	-
Strategic and operational planning	0.29*	0.28*	-0.05	-
Human resources management	0.21	0.18	0.03	-
Service delivery and organization	0.28*	0.25	-0.14	-
Governance and local participation	-0.01	0.03	-0.19	-
<i>Institutional Capacity</i>	0.18	0.34	-0.21	-

Continued on next page

Table A.5.1 – continued from previous page

Dimension / Domain	Children vaccinated per session	Vaccines delivered per session	Proportion of target children vaccinated	Proportion of sessions per microplan
Education	-0.02	-0.06	0.08	-
Experience in government service	0.29*	0.36**	-0.31*	-
Duration in present location	0.12	0.11	-0.05	-
Additional training	0.01	-0.06	-0.16	-
Funding	0.01	0.01	-0.08	-
Adoption of technology	-0.05	0.00	0.08	-
<i>Accountability</i>	0.20	0.14	0.13	-
Supervision presence	0.29*	0.19	0.14	-
Supervisory actions	-0.16	-0.12	-0.06	-
Community participation	0.14	0.11	0.11	-
Subcenter, n	78	78	-	275
<i>Decision Space</i>	-0.02	0.03	-	0.16**
Strategic and operational planning	0.04	0.12	-	-0.17**
Service delivery and organization	-0.04	-0.01	-	0.33***
Governance and local participation	-0.06	-0.09	-	0.22**
<i>Institutional Capacity</i>	-0.01	-0.03	-	0.30***
Education	0.15	0.15	-	0.18**
Experience in government service	-0.09	-0.06	-	0.20*
Duration in present location	-0.06	-0.08	-	0.15
Additional training	-0.14	-0.12	-	0.20**
Infrastructure	0.04	-0.04	-	-0.02
<i>Accountability</i>	-0.14	-0.09	-	0.32***
Supervision presence	0.05	0.10	-	0.20***
Supervisory actions	0.08	0.15	-	-0.11
Community participation	-0.24*	-0.248	-	0.39***
				* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

A.6 INPUTS FOR CFA AND SEM ANALYSES

Table A.6.1: Variance-covariance matrix used in CFA and SEM analyses for models (unadjusted)

	Reported changes to RI Sessions added	Add'l households	Government service (ANM)	Present location (ANM)	Experience (ANM)	Supervisory field visit (SC)	Community participation (SC)
Sessions added	0.1944						
Additional households	-0.1280	0.2517					
Government service (ANM)	-0.8339	0.3150	115.6010				
Present location (ANM)	-0.4664	0.3387	46.1629	55.8808			
Experience (ANM)	-0.0300	0.0202	4.1783	5.0041	0.5579		
Supervisory field visit (SC)	0.0060	-0.0201	0.1415	-0.1815	-0.0281	0.1529	
Community participation (SC)	-0.0435	0.0612	0.9402	0.6273	0.0556	-0.0096	0.1503
Joint decision making	0.0650	-0.0488	-1.9504	-1.1870	-0.1245	-0.0134	-0.0886
Added site to RI	0.0645	-0.0592	0.0347	-0.6964	-0.0476	-0.0060	-0.0868
Changes based on feedback	-0.0338	0.0357	0.3029	0.2860	0.0386	0.0189	0.0275
Community participation (Block)	-0.0103	0.0238	0.2306	0.1216	0.0165	0.0114	0.0412
Government service (MOIC)	0.0763	-0.7989	-13.5053	-7.3496	-0.8561	0.5697	-1.3693
Present location (MOIC)	-0.2177	-0.4839	-1.8254	-0.8527	-0.0837	0.1408	-0.4541
Supervisory field visit (Block)	0.0075	-0.0060	0.2011	-1.0295	-0.0578	0.0029	-0.0643
House to house verification (Block)	0.0160	-0.0298	0.3327	0.3615	0.0457	-0.0090	-0.0006
Children vaccinated per session	-0.2048	-0.4086	-7.8769	1.4117	-0.4421	0.5904	-0.8491
Vaccines delivered per session	-0.0406	-0.1867	-1.5225	0.4428	-0.2391	0.2763	-0.3450
Proportion of sessions conducted	-0.0365	0.0550	0.4411	0.5577	0.0416	-0.0096	0.0550

	Joint decision making	Added site to RI	Changes based on feedback	Community participation (Block)	Government service (MOIC)	Present location (MOIC)	Supervisory field visit (Block)
Joint decision making	0.2451						
Added site to RI	0.1222	0.2414					
Changes based on feedback	-0.0482	-0.0457	0.1733				
Community participation (Block)	-0.0735	-0.0275	0.0401	0.1174			
Government service (MOIC)	1.9755	1.5461	-0.4061	-1.1763	78.0829		
Present location (MOIC)	1.1012	0.5421	-0.2102	-0.3997	19.9190	24.6440	
Supervisory field visit (Block)	0.0472	0.1074	-0.0491	-0.0492	1.2880	0.7982	0.2510
House to house verification (Block)	-0.0161	0.0256	-0.0257	0.0104	0.1289	-0.1126	0.0269
Children vaccinated per session	2.6385	1.9958	-0.2471	-0.3430	16.3138	4.4137	0.3317
Vaccines delivered per session	1.3695	1.0621	0.0970	-0.1303	8.6647	1.4345	0.3390
Proportion of sessions conducted	-0.1059	-0.0708	0.0341	0.0604	-1.8225	-0.6229	-0.0684

	House to house verification (Block)	Children vaccinated per session	Vaccines delivered per session	Proportion of sessions conducted
House to house verification (Block)	0.1019			
Children vaccinated per session	-0.7876	73.6463		
Vaccines delivered per session	-0.2816	28.8867	12.4162	
Proportion of sessions conducted	0.0068	-1.6113	-0.6553	0.1342

Table A.6.2: Variance-covariance matrix used in CFA and SEM analyses for models (adjusted)

	Sessions added	Reported changes to RI Add'l households	Government service (ANM)	Present location (ANM)	Experience (ANM)	Supervisory field visit (SC)	Community participation (SC)
Sessions added	0.1977						
Additional households	-0.1261	0.2528					
Government service (ANM)	-0.8340	0.3149	115.6010				
Present location (ANM)	-0.4671	0.3383	46.1629	55.8809			
Experience (ANM)	-0.0264	0.0223	4.1782	5.0033	0.5618		
Supervisory field visit (SC)	0.0029	-0.0220	0.1415	-0.1808	-0.0315	0.1559	
Community participation (SC)	-0.0458	0.0598	0.9403	0.6278	0.0530	-0.0074	0.1521
Joint decision making	0.0501	-0.0577	-1.9500	-1.1837	-0.1409	0.0009	-0.0776
Added site to RI	0.0573	-0.0634	0.0349	-0.6949	-0.0554	0.0009	-0.0816
Changes based on feedback	-0.0406	0.0317	0.3031	0.2875	0.0311	0.0254	0.0324
Community participation (Block)	-0.0131	0.0222	0.2307	0.1222	0.0135	0.0140	0.0432
Government service (MOIC)	0.0761	-0.7991	-13.5053	-7.3495	-0.8563	0.5698	-1.3692
Present location (MOIC)	-0.2167	-0.4833	-1.8254	-0.8529	-0.0826	0.1398	-0.4549
Supervisory field visit (Block)	0.0018	-0.0094	0.2013	-1.0283	-0.0641	0.0084	-0.0601
House to house verification (Block)	0.0182	-0.0284	0.3327	0.3610	0.0481	-0.0112	-0.0023
Children vaccinated per session	-0.2073	-0.4101	-7.8769	1.4122	-0.4449	0.5928	-0.8472
Vaccines delivered per session	-0.0322	-0.1817	-1.5228	0.4409	-0.2299	0.2683	-0.3511
Proportion of sessions conducted	-0.0362	0.0551	0.4411	0.5577	0.0419	-0.0098	0.0548

	Joint decision making	Added site to RI	Changes based on feedback	Community participation (Block)	Government service (MOIC)	Present location (MOIC)	Supervisory field visit (Block)
Joint decision making	0.3143						
Added site to RI	0.1551	0.2571					
Changes based on feedback	-0.0168	-0.0307	0.1875				
Community participation (Block)	-0.0608	-0.0215	0.0459	0.1197			
Government service (MOIC)	1.9763	1.5465	-0.4058	-1.1761	78.0829		
Present location (MOIC)	1.0963	0.5398	-0.2124	-0.4006	19.9190	24.6443	
Supervisory field visit (Block)	0.0739	0.1201	-0.0370	-0.0443	1.2883	0.7964	0.2612
House to house verification (Block)	-0.0265	0.0206	-0.0304	0.0085	0.1288	-0.1118	0.0229
Children vaccinated per session	2.6502	2.0013	-0.2418	-0.3408	16.3139	4.4129	0.3362
Vaccines delivered per session	1.3307	1.0435	0.0794	-0.1374	8.6643	1.4372	0.3241
Proportion of sessions conducted	-0.1070	-0.0713	0.0336	0.0602	-1.8226	-0.6228	-0.0688

	House to house verification (Block)	Children vaccinated per session	Vaccines delivered per session	Proportion of sessions conducted
House to house verification (Block)	0.1035			
Children vaccinated per session	-0.7893	73.6483		
Vaccines delivered per session	-0.2758	28.8802	12.4380	
Proportion of sessions conducted	0.0070	-1.6115	-0.6547	0.1342

B

Paper 2: Supplementary materials

B.1 SURVEY QUESTIONS ON AWARENESS OF HEF BENEFITS

1. Does the closest public health center in your area provide free services for you with your HEF card?
2. Does the closest public hospital provide free services for you with your HEF card?
3. Can you get free delivery at government health facilities with your HEF card?
4. Can you get free medicines at government health facilities with your HEF card?
5. Can you get transportation costs reimbursed for delivery at government health facilities with your HEF card?

6. Can you get transportation costs reimbursed for hospitalization at government health facilities with your HEF card?
7. Can you get money for meals for a caregiver with a hospitalized patient at government health facilities with your HEF card?
8. Can you use your ID poor card or post ID card at public health facilities outside of your district?

B.2 DEFINITIONS OF OUTCOMES OF INTEREST

A series of questions were asked to obtain detailed information that was triangulated for each outcome of interest. Analyses of these questions to define each outcome are outlined below.

- **Sought health care:** Respondents were identified to have sought care in cases in which question 1 below was greater than zero and non-equivalent to question 2.
 1. How many times have you been ill / injured in the last 12 months?
 2. How many of these illnesses / injuries did you NOT seek treatment for?
- **Ever visited public provider:** Respondents were identified to have visited a public provider at least once if they reported having sought treatment for greater than zero illnesses or injuries and reported seeking treatment from a private provider fewer times than that value.
 1. How many of these illnesses / injuries did you seek outpatient / inpatient treatment for?
 2. How many of these outpatient / inpatient treatments were from a private provider?
- **Always visited public provider:** Respondents were identified to have visited a public provider for all illness /injuries if they reported having sought treatment for greater than zero illnesses or injuries and reported never seeking treatment from a private provider.
 1. How many of these illnesses / injuries did you seek outpatient / inpatient treatment for?
 2. How many of these outpatient / inpatient treatments were from a private provider?

- **Ever used HEF card:** Respondents were identified to have used their HEF card at least once if they reported having sought treatment for greater than zero illnesses or injuries and reported using a card for free health care at least once.
 1. How many of these illnesses / injuries did you seek outpatient / inpatient treatment for?
 2. How many of these outpatient / inpatient treatments did they use a card for free health care?
- **Always used HEF card:** Respondents were identified to have used their HEF card for all care seeking episodes if they reported having sought treatment for greater than zero illnesses or injuries and reported using a card for free health care for all the times they sought treatment.
 1. How many of these illnesses / injuries did you seek outpatient / inpatient treatment for?
 2. How many of these outpatient / inpatient treatments did they use a card for free health care?

B.3 MULTIPLE LOGISTIC REGRESSION MODEL SUMMARY TABLES

Table B.3.1: Odds ratios for predictors of care seeking

	<i>Dependent variable: Sought health care</i>
Age	1.000 (0.992, 1.008)
Sex	
Male	<i>Reference</i>
Female	0.978 (0.714, 1.340)
Education	
Never attended	<i>Reference</i>
Primary school	1.559* (1.108, 2.194)
Secondary school	0.974 (0.582, 1.631)
Ethnicity	

Continued on next page

Table B.3.1 – continued from previous page

	<i>Dependent variable: Sought health care</i>
Khmer	<i>Reference</i>
Non-Khmer	0.652 (0.237,1.795)
Income quintile	
Poorest	<i>Reference</i>
Poorer	1.292 (0.676,2.469)
Middle	1.424 (0.761,2.665)
Wealthier	1.355 (0.568,3.232)
Wealthiest	1.938 (0.788,4.765)
Awareness	
Health center services	0.287 (0.027,3.107)
Hospital services	1.452 (0.150,14.089)
Delivery	1.219 (0.359,4.135)
Medicines	0.327 (0.087,1.235)
Transport for delivery	1.687 (0.669,4.254)
Transport for hospitalization	0.923 (0.333,2.560)
Caregiver meals	1.476 (0.711,3.067)
Constant	60.577*** (17.854,205.533)
Observations	1,877
Log Likelihood	-496.308
Continued on next page	

Table B.3.1 – continued from previous page

<i>Dependent variable:</i>	
<i>Sought health care</i>	
Akaike Inf. Crit.	1,164.615
Prediction Accuracy	0.9032
<i>Note:</i>	*p<0.05; **p<0.01; ***p<0.001

Table B.3.2: Odds ratios for predictors of public provision and HEF claims for outpatient care

	<i>Dependent variable: Outpatient care</i>			
	Ever visited public provider (1)	Always visited public provider (2)	Ever used HEF card (3)	Always used HEF card (4)
Age				
	0.999 (0.993,1.006)	0.989* (0.980,0.998)	1.016 (0.991,1.041)	0.982* (0.966,0.997)
Sex				
Male				
			<i>Reference</i>	
Female	1.498*** (1.255,1.790)	1.648*** (1.262,2.152)	1.400 (0.679,2.887)	1.594 (0.986,2.579)
Education				
Never attended				
			<i>Reference</i>	
Primary school	0.852 (0.622,1.169)	0.776 (0.538,1.118)	1.311 (0.542,3.168)	1.236 (0.532,2.867)
Secondary school	0.788 (0.485,1.279)	0.870 (0.486,1.557)	0.550 (0.166,1.825)	1.064 (0.340,3.324)
Ethnicity				
Khmer				
			<i>Reference</i>	
Non-Khmer	0.272*** (0.128,0.577)	0.157** (0.042,0.582)	0.465 (0.020,10.908)	0.188 (0.026,1.336)
Income quintile				
Poorest				
			<i>Reference</i>	
Poorer	2.036**	2.004*	1.923	1.834

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Table B.3.2 – continued from previous page

	<i>Dependent variable: Outpatient care</i>			
	Ever visited public provider (1)	Always visited public provider (2)	Ever used HEF card (3)	Always used HEF card (4)
Middle	(1.277, 3.248) 1.631 (0.927, 2.872)	(1.102, 3.645) 2.541** (1.359, 4.753)	(0.381, 9.700) 1.798 (0.208, 15.525)	(0.641, 5.249) 2.802 (0.734, 10.701)
Wealthier	1.400 (0.819, 2.396)	1.020 (0.465, 2.239)	5.686 (0.432, 74.788)	3.295 (0.826, 13.150)
Wealthiest	1.115 (0.604, 2.055)	1.285 (0.607, 2.720)	7.062 (0.961, 51.873)	1.601 (0.491, 5.219)
Awareness				
Health center services	2.088* (1.086, 4.014)	1.814 (0.769, 4.283)	0.173 (0.00001, 3.073.535)	1.022 (0.040, 25.975)
Hospital services	0.341* (0.148, 0.788)	0.319* (0.130, 0.783)	0.219 (0.00002, 2.508.104)	0.098 (0.002, 4.433)
Delivery	0.540 (0.212, 1.376)	0.705 (0.274, 1.812)	0.717 (0.027, 18.753)	1.343 (0.119, 15.184)
Medicines	2.780 (0.852, 9.077)	3.458* (1.095, 10.917)		2.550 (0.190, 34.270)
Transport for delivery	1.460 (0.670, 3.182)	1.262 (0.624, 2.550)	0.592 (0.114, 3.070)	1.354 (0.423, 4.337)
Transport for hospitalization	0.689 (0.287, 1.658)	0.814 (0.383, 1.730)	4.052 (0.646, 25.393)	1.695 (0.413, 6.950)

Continued on next page

Table B.3.2 – continued from previous page

<i>Dependent variable: Outpatient care</i>				
	Ever visited public provider (1)	Always visited public provider (2)	Ever used HEF card (3)	Always used HEF card (4)
Caregiver meals	1.305 (0.744, 2.291)	1.031 (0.566, 1.877)	0.375 (0.123, 1.146)	0.332* (0.137, 0.805)
Constant	2.157 (1.000, 4.656)	0.473 (0.198, 1.131)	$1.4 \times 10^{10***}$ (4.6×10^8 , 4.9×10^{11})	$3.7 \times 10^{8***}$ (2.1×10^7 , 6.8×10^9)
Observations	1,555	1,555	588	609
Log Likelihood	-863.512	-649.248	-106.496	-205.815
Akaike Inf. Crit.	1,897.023	1,468.497	370.992	571.630
Prediction Accuracy	0.6711	0.7938	0.8793	0.7882
<i>Note:</i>	*p<0.05; **p<0.01; ***p<0.001			

Table B.3.3: Odds ratios for predictors of public provision and HEF claims for inpatient care

<i>Dependent variable: Inpatient care</i>				
	Ever visited public provider (1)	Always visited public provider (2)	Ever used HEF card (3)	Always used HEF card (4)
Age	1.018 (0.986, 1.051)	1.004 (0.976, 1.032)	1.005 (0.982, 1.030)	1.005 (0.973, 1.038)
Sex	<i>Reference</i>			
Male				
Female	0.658 (0.214, 2.030)	1.123 (0.319, 3.950)	0.456 (0.148, 1.407)	0.409 (0.110, 1.521)
Education	Continued on next page			

Table B.3.3 – continued from previous page

	<i>Dependent variable: Inpatient care</i>			
	Ever visited public provider (1)	Always visited public provider (2)	Ever used HEF card (3)	Always used HEF card (4)
Never attended				
Primary school	0.309 (0.085, 1.119)	0.315 (0.084, 1.185)		0.595 (0.166, 2.140)
Secondary school	1.307 (0.140, 12.251)	1.027 (0.092, 11.451)		15.146 (0.009, 26,850.970)
Income quintile				
Poorest			<i>Reference</i>	
Poorer	2.826 (0.465, 17.177)	3.852 (0.490, 30.305)		2.602 (0.414, 16.341)
Middle	3.016 (0.721, 12.614)	3.401 (0.556, 20.815)		1.421 (0.306, 6.598)
Wealthier	0.507 (0.089, 2.893)	0.967 (0.125, 7.514)		0.896 (0.139, 5.756)
Wealthiest	0.425 (0.027, 6.579)	2.233 (0.193, 25.831)		2.557 (0.161, 40.616)
Awareness				
Health center services	1.424 (0.114, 17.715)	0.323 (0.056, 1.859)	0.932 (0.133, 6.510)	0.543 (0.037, 8.049)
Hospital services	8.023 (0.343, 187.813)	38.071** (3.571, 405.913)		

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Table B.3.3 – continued from previous page

	<i>Dependent variable: Inpatient care</i>			
	Ever visited public provider (1)	Always visited public provider (2)	Ever used HEF card (3)	Always used HEF card (4)
Delivery	2.243 (0.119,42.322)	6.834 (0.091,514.574)	35.312 (0.074,16,959.370)	6.935 (0.102,472.070)
Medicines	0.165 (0.012,2.289)	0.056 (0.001,3.214)	0.038 (0.001,2.805)	0.029* (0.001,0.912)
Transport for delivery	1.779 (0.170,18.587)	0.726 (0.065,8.129)	1.021 (0.259,4.034)	0.058 (0.003,1.194)
Transport for hospitalization	0.598 (0.071,5.045)	1.110 (0.106,11.675)		66.333 (0.760,5,792.215)
Caregiver meals	4.858 (0.907,26.012)	5.494 (0.752,40.140)	0.670 (0.192,2.333)	0.244 (0.054,1.105)
Constant	0.434 (0.038,4.888)	0.285 (0.020,4.062)	10.547 (0.867,128.319)	266.639* (2.747,25,884.010)
Observations	248	248	256	186
Log Likelihood	-80.875	-70.656	-77.277	-59.454
Akaike Inf. Crit.	323.750	303.312	290.554	258.909
Prediction Accuracy	0.6412	0.7118	0.6829	0.6129
<i>Note:</i>	* p<0.05; ** p<0.01; *** p<0.001			

Table B.3.4: Odds ratios predictors of out-of-pocket expenditure in the past two weeks

	<i>Dependent variable: Paid out-of-pocket</i>
Age	1.008 (0.987,1.030)
Sex	
Male	<i>Reference</i>
Female	1.649 (0.918,2.962)
Education	
Never attended	<i>Reference</i>
Primary school	1.416 (0.551,3.639)
Secondary school	0.626 (0.223,1.758)
Income quintile	
Poorest	<i>Reference</i>
Poorer	0.834 (0.285,2.442)
Middle	0.701 (0.228,2.155)
Wealthier	0.797 (0.229,2.775)
Wealthiest	1.058 (0.225,4.974)
Awareness	
Health center services	0.784 (0.071,8.629)
Hospital services	17.755 (0.202,1,557.488)
Delivery	0.265 (0.008,8.720)
Medicines	0.467 (0.058,3.777)
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Table B.3.4 – continued from previous page	
	<i>Dependent variable:</i>
	<i>Paid out-of-pocket</i>
Transport for delivery	1.112 (0.314,3.932)
Transport for hospitalization	0.834 (0.171,4.063)
Caregiver meals	0.700 (0.261,1.880)
Constant	0.199 (0.011,3.749)
Observations	293
Log Likelihood	-145.854
Akaike Inf. Crit.	443.707
Prediction Accuracy	0.5404
<i>Note:</i>	*p<0.05; **p<0.01; ***p<0.001

B.4 DETAILED FIGURES OF UNCERTAINTY ANALYSIS

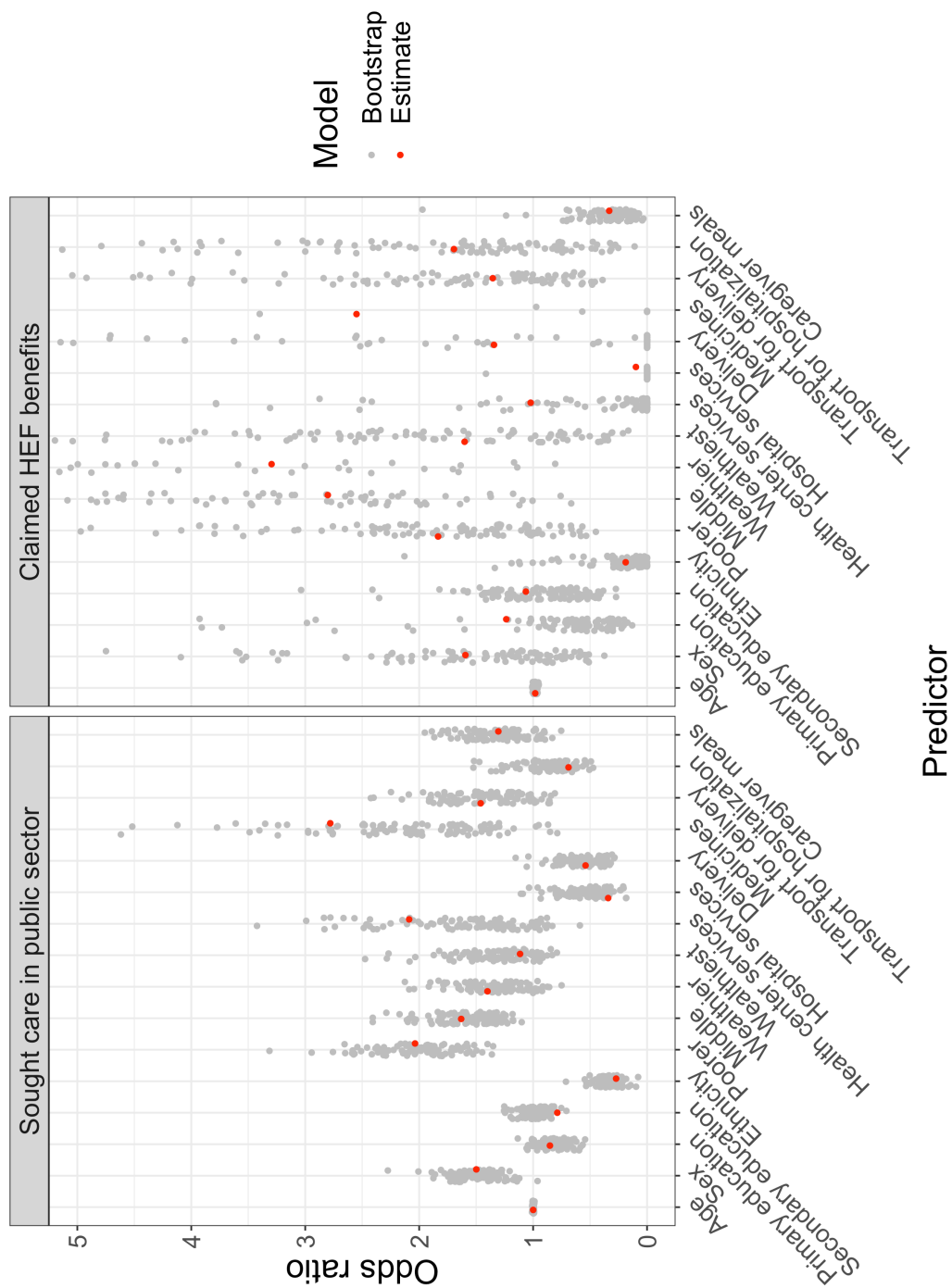


Figure B.4.1: Odds ratios of models fit on survey dataset and bootstrapped samples



Paper 3: Supplementary materials

C.1 DIABETES-RELATED SERVICE PACKAGES UNDER THE HEALTH EQUITY FUNDS

C.1.1 SERVICE PACKAGE 11: DIABETES SCREENING AT HEALTH CENTERS

Clinical Indications: This specific service package covers all services involved with screening and counseling persons for and about diabetes of persons with one or more risk factors (frequent urinating during the night, polydipsia, aged ≥ 40 years, overweight, tuberculosis, sudden weight loss, melioidosis, hypertension, history of stroke or ischemic heart disease).

Services covered:

- I. Consultation
 - History taking

- Vital information like blood pressure, height, weight, waist circumference
 - Fasting blood glucose
2. Medication
 - Referral to higher-level hospital if necessary
 3. Counseling
 - If present in the operational district: local Peer Educator Group
 - Blood sugar and blood pressure targets bodyweight
 - Behavioral changes regarding diet, exercise, smoking, alcohol
 - Risk factors for diabetic complications and means to prevent these
 4. Non-Medical Benefits
 - Self-management booklet with health education for record keeping
 - A3-Diabetes Pyramid Poster

Source: Guidelines for the Benefit Package and Provider Payment of the Health Equity Fund for the Poor [28]

C.1.2 SERVICE PACKAGE 12: DIABETES TREATMENT AND FOLLOW-UP AT HEALTH CENTERS

Clinical Indications: This service package covers the treatment and follow-up of people diagnosed with diabetes mellitus. It is intended to be used for quarterly follow-up consultations to monitor clinical progress once stable. If more or less frequent consultations are needed, use Service Package 11.

Services Covered:

1. Consultation
 - History since last consultation, including self-management, symptoms, treatment adherence and side effects, diet, exercise, smoking, alcohol
 - Any glucose or HbA_{1c} results since last consultation
 - Examination for blood pressure, height, weight, waist circumference
2. Investigations
 - Fasting blood glucose
3. Medication
 - Medication as indicated by the Clinical Practice Guidelines
 - Insulin syringes

4. Counseling

- Encourage diabetes patient to have contact with other diabetes patients in the village and peers
- Behavioral changes regarding diet, exercise, smoking, alcohol
- Risk factors for diabetic complications and means to prevent these
- Adherence with and understanding of requirements for treatment
- Check ability of self-monitoring, ask to see the patient self-management book and discuss the records and progress towards targets

Required Documentation: Letter from referral hospital to continue for treatment and follow up

Source: Guidelines for the Benefit Package and Provider Payment of the Health Equity Fund for the Poor [28]

C.1.3 SERVICE PACKAGE 30: DIABETES SCREENING AT REFERRAL HOSPITALS

Clinical Indications: This specific service package covers all services involved with screening and counseling persons for and about diabetes of persons with one or more risk factors (frequent urinating during the night, polydipsia, aged ≥ 40 years, overweight, tuberculosis, sudden weight loss, melioidosis, hypertension, history of stroke or ischemic heart disease).

Services covered:

1. Consultation

- History taking
- Vital information like blood pressure, height, weight, waist circumference
- Fasting blood glucose
- HbA_{1c}, creatin + urine albumin/protein + lipid profile + at least K⁺ electrolyte

2. Medication

- Medication as indicated by the Clinical Practice Guidelines
- Insulin syringes

3. Counseling

- If present in the operational district: local Peer Educator Group
- Blood sugar and blood pressure targets bodyweight
- Behavioral changes regarding diet, exercise, smoking, alcohol
- Risk factors for diabetic complications and means to prevent these

4. Non-Medical Benefits

- Self-management booklet with health education for record keeping
- A3-Diabetes Pyramid Poster

Required Documentation:

- Standard Patient Dossier Medical Records
- Hospital HEF Summary of Treatment Form
- Referral letter to higher-level hospital if necessary

Source: Guidelines for the Benefit Package and Provider Payment of the Health Equity Fund for the Poor [28]

C.1.4 SERVICE PACKAGE 31: DIABETES TREATMENT AND FOLLOW-UP AT REFERRAL HOSPITALS

Clinical Indications: This service package covers the treatment and follow-up of people diagnosed with diabetes mellitus. It is intended to be used for quarterly follow-up consultations to monitor clinical progress once stable. If more or less frequent consultations are needed, use Service Package 32.

Services Covered:

1. Consultation

- History since last consultation, including self-management, symptoms, treatment adherence and side effects, diet, exercise, smoking, alcohol
- Any glucose or HbA1c results since last consultation
- Examination for blood pressure, height, weight, waist circumference

2. Investigations

- Fasting blood glucose or RBG (+/- HbA1c one time per year), urine protein, creatin, lipids, hepatitis C

3. Medication

- Medication as indicated by the Clinical Practice Guidelines
- Insulin syringes

4. Counseling

- Encourage diabetes patient to have contact with other diabetes patients in the village and peers
- Behavioral changes regarding diet, exercise, smoking, alcohol
- Risk factors for diabetic complications and means to prevent these
- Adherence with and understanding of requirements for treatment

- Check ability of self-monitoring, ask to see the patient self-management book and discuss the records and progress towards targets

Required Documentation:

- Standard Patient Dossier Medical Records
- Hospital HEF Summary of Treatment Form
- Referral letter to higher-level hospital if necessary

Source: Guidelines for the Benefit Package and Provider Payment of the Health Equity Fund for the Poor [28]

C.1.5 SERVICE PACKAGE 32: UNCONTROLLED DIABETES CONSULTATION AT REFERRAL HOSPITALS

Clinical Indications: This service package is to be used for diabetes-related consultations that are not covered by Service Package 31.

Services Covered:

1. Consultation
 - History since last consultation, including self-management, symptoms, treatment adherence and side effects, diet, exercise, smoking, alcohol
 - Any glucose or HbA_{1c} results since last consultation
 - Examination for blood pressure, height, weight, waist circumference
2. Investigations
 - Fasting blood glucose or RBG (+/- HbA_{1c} one time per year), urine protein, creatin, lipids, hepatitis C
3. Medication
 - Medication as indicated by the Clinical Practice Guidelines
 - Insulin syringes
4. Counseling
 - Encourage diabetes patient to have contact with other diabetes patients in the village and peers
 - Behavioral changes regarding diet, exercise, smoking, alcohol
 - Risk factors for diabetic complications and means to prevent these
 - Adherence with and understanding of requirements for treatment

- Check ability of self-monitoring, ask to see the patient self-management book and discuss the records and progress towards targets

Required Documentation:

- Standard Patient Dossier Medical Records
- Hospital HEF Summary of Treatment Form
- Referral letter to higher-level hospital if necessary

Source: Guidelines for the Benefit Package and Provider Payment of the Health Equity Fund for the Poor [28]

C.2 SIMULATED POPULATION CHARACTERISTICS

Table C.2.1: Profile of simulated population by HEF eligibility (N = 800,000)

Characteristic	HEF Eligibility Poorest 20% (n = 160,000)	HEF Eligibility Poorest 30% (n = 240,000)
Age (at year 0)		
26-30 years	34,503 (22%)	51,823 (22%)
31-35 years	28,334 (18%)	42,479 (18%)
36-40 years	15,900 (10%)	23,819 (10%)
41-45 years	20,009 (13%)	29,896 (12%)
46-50 years	16,807 (11%)	25,166 (10%)
51-55 years	17,406 (11%)	26,377 (11%)
61-65 years	9,674 (6%)	14,428 (6%)
66-70 years	5,247 (3%)	7,806 (3%)
Sex		
Male	76,809 (48%)	115,204 (48%)
Female	83,191 (52%)	124,796 (52%)
Initial state		
Healthy	146,595 (92%)	219,936 (92%)
Undiagnosed diabetes	8,317 (5%)	12,509 (5%)
Diet/lifestyle consultation (no prescribed treatment)	3,749 (2%)	5,576 (2%)
Oral anti-diabetic therapy	1,083 (1%)	1,600 (1%)
Insulin therapy	86 (0.1%)	123 (0.1%)
Neuropathy	117 (0.1%)	173 (0.1%)
Retinopathy	29 (0.02%)	42 (0.02%)
Nephropathy	24 (0.01%)	41 (0.02%)
Enrolled in HEF	120,431 (75%)	180,312 (75%)

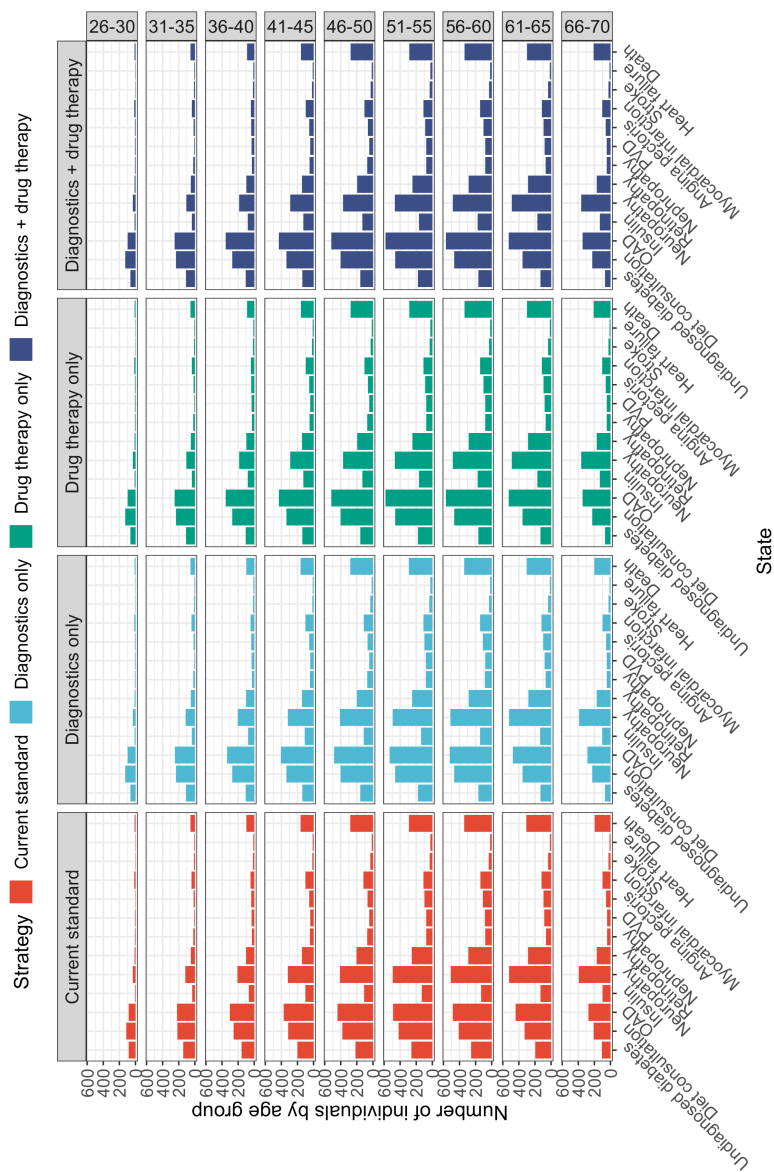
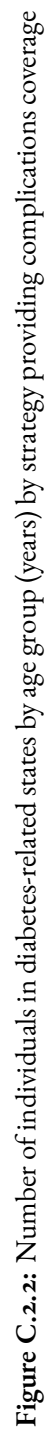


Figure C.2.1: Number of individuals in diabetes-related states by age group (years) by strategy providing coverage for diagnostics and drug therapies



C.3 INCREMENTAL COSTS AND IMPACTS

Table C.3.1: Incremental costs and health impact by strategy and HEF coverage scenario

Strategy	HEF Eligibility	OOP Coverage	Total Costs	Incremental Costs	DALYs	Incremental DALYs	ICER (\$/DALY averted)
Current standard	20%	100%	222,241,881	-	2,685,856	-	-
		80%					
	30%	100%	309,847,914	-	4,001,523	-	-
		80%					
Diagnostics only	20%	100%	375,570,938	153,329,057	2,695,079	9,222	-
		80%					
	30%	100%	462,913,640	153,065,726	4,010,745	9,222	-
		80%					
Drug therapy only	20%	100%	223,283,447	1,041,566	2,647,453	-38,404	27
		80%					
	30%	100%	308,635,759	-1,212,155	3,963,119	-38,404	-32
		80%					
Complications only	20%	100%	376,546,924	154,305,043	2,685,856	0	-
		80%					
	30%	100%	465,388,656	155,540,742	4,001,523	0	-
		80%					
Diagnostics + Drug therapy	20%	100%	365,140,541	142,898,661	2,647,515	-38,341	3,727
		80%					
	30%	100%	451,558,506	141,710,592	3,963,181	-38,341	3,696
		80%					
Drug therapy + Complications	20%	100%	365,438,949	143,197,068	2,647,453	-38,403	3,729
		80%					
	30%	100%	451,167,284	141,319,370	3,963,119	-38,404	3,680
		80%					
Continued on next page							

Table C.3.1 – continued from previous page

Strategy	HEF Eligibility	OOP Coverage	Total Costs	Incremental Costs	DALYs	Incremental DALYs	ICER (\$/DALY averted)
Diagnostics + Drug therapy + Complications	20%	100%	658,879,070	436,637,189	2,647,515	-38,341	11,388
		80%					
	30%	100%	747,217,986	437,370,072	3,963,181	-38,341	11,407
		80%					

HEF: Health Equity Funds; OOP: out-of-pocket expenditures; DALY: disability-adjusted life-year; ICER: incremental cost-effectiveness ratio
Note: Incremental values have been computed for each strategy compared to the current standard.

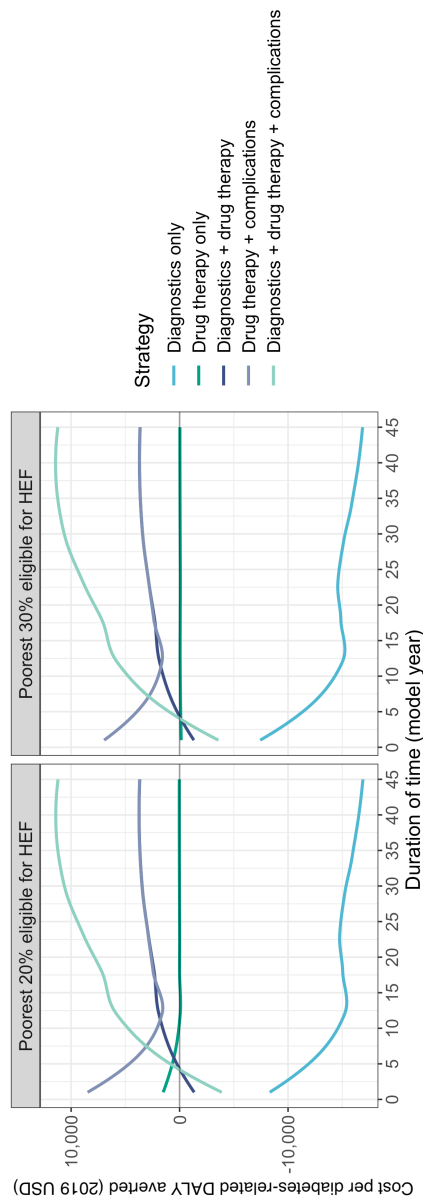


Figure C.3.1: Cost per diabetes-related DALY averted over time under 100% HEF coverage by strategy

Note: Based on model design, coverage for treatment for diabetes-related complications had no additional impact on health and are not included in figures.

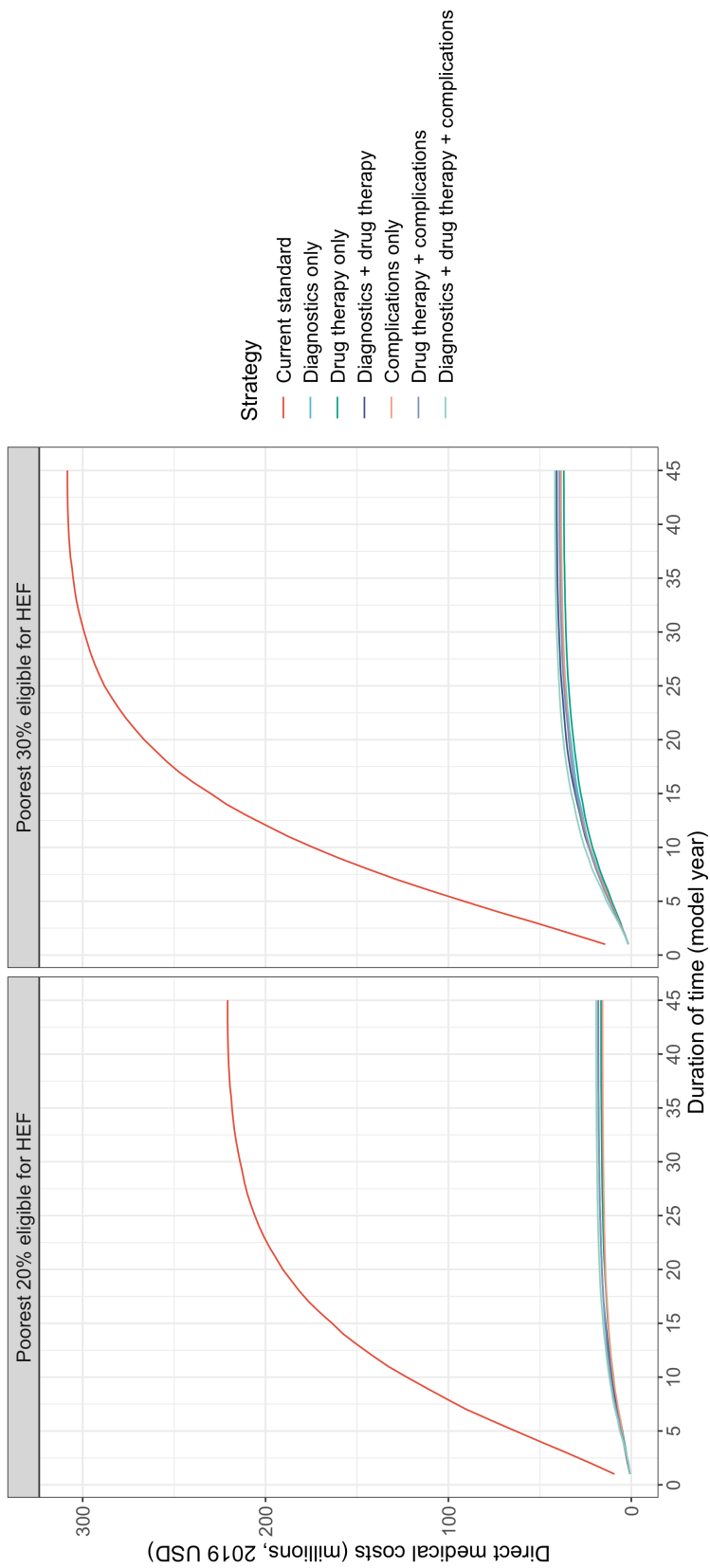


Figure C.3.2: Cumulative direct medical costs incurred over the time horizon of the model under 100% HEF coverage by strategy

Figure C.3.3: Incremental costs per person eligible for HEF vs. OOP expenditures averted by population group and strategy

Table C.3.2: Incremental costs and financial risk protection impact by strategy and HIEF coverage scenario

Strategy	HIEF Eligibility	OOP Coverage	Total Costs	Incremental Costs	CHE	Incremental CHE	ICER \$/CHE averted
Current standard	20%	100%	222,241,881	-	676,340	-	-
	80%	80%					
	100%	100%					
	30%	80%	309,847,914	-	746,840	-	-
Diagnostics only	20%	100%	375,570,938	153,329,057	195,860	-480,480	319
	80%	80%			482,720	-193,620	792
	100%	100%			214,020	-532,820	287
	30%	80%	462,913,640	153,065,726	553,100	-193,740	790
Drug therapy only	20%	100%	223,283,447	1,041,566	197,080	-479,260	2
	80%	80%			514,760	-161,580	6
	100%	100%			213,980	-532,860	-2
	30%	80%	308,635,759	-1,212,155	583,720	-163,120	-7
Complications only	20%	100%	376,546,924	154,305,043	184,900	-491,440	314
	80%	80%			459,460	-216,880	711
	100%	100%			203,440	-543,400	286
	30%	80%	465,388,656	155,540,742	529,880	-216,960	717
Diagnostics + Drug therapy	20%	100%	365,140,541	142,898,661	222,020	-454,320	315
	80%	80%			559,200	-117,140	1,220
	100%	100%			240,300	-506,540	280
	30%	80%	451,558,506	141,710,592	628,380	-118,460	1,196
Drug therapy + Complications	20%	100%	365,438,949	143,197,068	208,700	-467,640	306
	80%	80%			524,560	-151,780	943
	100%	100%			226,200	-520,640	271
	30%	80%	451,167,284	141,319,370	594,520	-152,320	928
Diagnostics + Drug therapy + Complications	20%	100%	658,879,070	436,637,189	241,880	-434,460	1,005
	80%	80%			579,720	-96,620	4,519
	100%	100%			259,640	-487,200	898
	30%	80%	747,217,986	437,370,072	649,720	-97,120	4,503
Continued on next page							

Table C.3.2 – continued from previous page

Strategy	HEF Eligibility	OOP Coverage	Total Costs	Incremental Costs	CHE	Incremental CHE	ICER \$/CHE averted
HEF: Health Equity Funds; OOP: out-of-pocket expenditures; CHE: catastrophic health expenditures; ICER: incremental cost-effectiveness ratio							
<i>Note: Incremental values have been computed for each strategy compared to the current standard. CHE reported above was measured at the 40% threshold.</i>							

Figure C.3.4: Cost per diabetes-related case of CHE averted over time under 100% HEF coverage by strategy

Figure C.3.5: Incremental costs per person eligible for HEF (poorest 30%) vs. cases of poverty averted by population group and strategy

C.4 RESULTS UNDER ALTERNATIVE DEFINITIONS OF MEASURES

Table C.4.1: Total and incremental (non-discounted) costs by strategy and HEF eligibility threshold

Strategy	HEF Eligibility	Total Costs	Incremental Costs
Current standard	20%	322,549,110	-
	30%	450,225,333	-
Diagnostics only	20%	536,610,639	214,061,528
	30%	665,908,790	215,683,457
Drug therapy only	20%	319,321,923	-3,227,187
	30%	446,552,844	-3,672,489
Complications only	20%	537,607,523	215,058,412
	30%	662,172,080	211,946,747
Diagnostics + drug therapy	20%	531,099,985	208,550,875
	30%	655,079,325	204,853,992
Drug therapy + complications	20%	528,887,847	206,338,737
	30%	653,067,179	202,841,846
Diagnostics + drug therapy + complications	20%	949,872,127	627,323,016
	30%	1,077,192,285	626,966,952

Table C.4.2: Cases of catastrophic health expenditure averted by threshold and strategy

Strategy	HEF Eligibility	OOP Coverage	Incremental CHE ₁₀	Incremental CHE ₂₅	Incremental CHE ₄₀
Current standard	20%	100%	-	-	-
		80%	-	-	-
	30%	100%	-	-	-
		80%	-	-	-
Diagnostics only	20%	100%	664,700	545,380	480,480
		80%	202,720	197,760	193,620
	30%	100%	799,860	610,580	532,820
		80%	202,680	197,360	193,740
Drug therapy only	20%	100%	589,040	501,680	444,800
		80%	139,120	151,520	162,400
	30%	100%	775,360	601,440	528,000
		80%	230,080	244,640	245,600
Complications only	20%	100%	684,900	559,060	491,440
		80%	242,720	226,600	216,880
	30%	100%	819,960	624,180	543,400
		80%	242,640	226,160	216,960
Diagnostics + drug therapy	20%	100%	618,100	512,340	454,320
		80%	66,540	101,120	117,140
	30%	100%	753,040	577,500	506,540
		80%	68,040	102,280	118,460
Drug therapy + complications	20%	100%	642,920	530,160	467,640
		80%	124,340	144,620	151,780
	30%	100%	778,380	595,660	520,640
		80%	124,800	144,480	152,320
Diagnostics + drug therapy + complications	20%	100%	665,200	544,380	479,260
		80%	144,800	156,940	161,580
	30%	100%	800,960	610,540	532,860
		80%	145,120	157,040	163,120

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