ASSESSING THE PROVISION AND EQUITABILITY OF PRIMARY CARE IN A LOW-RESOURCE SETTING

by
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Abstract

Introduction: To inform policies to promote well-being and eliminate health inequities in all settings, this dissertation focuses on an often-cited necessity for population health and heath equity—primary care—by pursuing the following aims: 1) conducting a review of the literature on the impact of primary care features on health access inequities 2) investigating the association between primary care experience (PCE) and the likelihood of hospitalization for chronic ambulatory care sensitive conditions (ACSCs) & inequities in the likelihood of hospitalization for chronic ACSCs among adults in rural Bihar, one of India's socioeconomically backward states; and 3) investigating the association between the quality of local primary care—measured as average provider competence—and an individual's self-rated health (SRH) & inequities in SRH in rural Bihar, India.

Methods: The 1st aim uses the scoping review approach. The 2nd and 3rd aims analyze data collected through household and provider surveys conducted under a parent study set in Bihar, India, using logistic regressions to model the odds of hospitalization and poor SRH as a functions of PCE and average provider competence, respectively, including interactions with markers of inequity.

Results: Primary care interventions are largely associated with improvements along the health access continuum for disadvantaged and advantaged populations, oftentimes with greater improvements for disadvantaged populations. Better PCE is associated with reduced likelihood of hospitalization for chronic ACSCs among adults. Individuals in the poorest wealth quintile with better PCE experienced the largest drop in the likelihood of hospitalization, compared to higher wealth quintiles. Better quality of local primary care, beyond a threshold, is associated with better individual-level SRH, although improvements in SRH appear to inequitable by gender and age.

Conclusion: This dissertation provides support for the strengthening of primary care systems, particularly in LMICs to tackle the burden of chronic primary care sensitive conditions and health inequities. Findings also highlight the importance of ensuring that the local quality of primary care is of an adequate standard to promote population health. More studies are needed to evaluate the quality of primary care and the reasons behind inequities in access to primary care in lower income countries.

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Dedication

To my parents, Mr. Adetula and Mrs. Olabanji Abiodun, for your undying love and support. Thank you.

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Chapter 1: Introduction

Primary health care (PHC) is widely recognized as a concept that is essential to the promotion of health and well-being.[1] In 1978, the International Conference on PHC held in Almaty, Kazakhstan launched the global thrust for prioritization of PHC as "an integral part…of [a] country's health system…and of the overall social and economic development of [a] community…The first level of contact of individuals, the family and community with the national health system bringing health care as close as possible to where people live and work...".[2] The concept of PHC has, however, gone through several reinterpretations since the Declaration of Alma-Ata. To clarify this confusion and guide future implementation of PHC, the background paper for the Global Conference on PHC held in 2018 put forth a modern definition of PHC as a "whole-of-society approach" to health founded on 3 pillars: (1) delivery of health services to meet the health needs of individuals and families (2) multisectoral policy and action to address broader determinants of health, and, (3) empowered people and communities supported by the health system and other sectors to advocate for and co-develop needed health policies and services.[3,4] At the root of this approach is a commitment to “social justice, equity and participation”.[3] The first pillar of PHC includes the delivery of quality primary care.[4] The main features of primary care are: (i) first-contact access for each new health concern; (ii) continuity of care, i.e. using a particular source of care for most health needs over time; (iii) comprehensive care for most health needs; and (iv) coordinated care for instances when it must be sought elsewhere.[5] Primary care is oftentimes the means through which PHC is implemented in the health sector and is well-positioned for this role, as it is delivered by health providers who regularly engage with members of communities, and can identify applicable determinants of health and opportunities for intersectoral efforts to promote health.[1,6]

International evidence shows that quality primary care improves health outcomes and reduces health inequities.[4,5] A review of studies in the US found an association between

increased supply of primary care physicians and improved health outcomes, including reductions in all-cause mortality, cause-specific mortality (cancer, heart disease, stroke), infant mortality and low birth weight; higher life expectancy and self-rated health.[7] Interestingly, a study conducted in New York state found a positive association between the supply of primary care physician and hospitalization for ACSCs, possibly reflecting the inaccessibility of primary care physicians when they are present.[8] In Latin America and Asia, national primary care reforms have recorded reductions in mortality from primary care sensitive illnesses, such as childhood illnesses and infectious diseases. Efforts to strengthen primary care services likely played a major role in these positive trends.[9] In Benin, regular contact with a village health worker, which reflects the continuity feature of primary care, has been found to improve the likelihood of child survival.[10] Internationally, primary care reforms specifically aimed at disadvantaged populations have improved health equity. A study comparing England and Ontario found that England's prioritization of disadvantaged populations in its primary care investments may have contributed to a larger reduction of socioeconomic inequality in avoidable mortality between 2007 and 2011.[11] Another UK-based study found that each unit-increase in the supply of primary care providers was associated with a decrease in hospital admission rates for ACSCs, even after controlling for the degree of social deprivation in a population, among other confounders.[12] In Bolivia, Thailand and Bangladesh, evaluations of primary care programs targeting vulnerable groups have also recorded reductions in excess infant and child mortality, as compared to more advantaged groups.[13–15] Studies also point to the relationship that primary care can have with markers of inequity. For instance, an ecologic study of US metropolitan areas found that the inverse relationship between primary care physician supply and mortality lost its statistical significance among black Americans after controlling for the percentage of population with income below poverty level and other socioeconomic factors.[16] However, other US-based studies have found that an increased supply of primary care doctors and good primary care experience—in terms of accessibility, interpersonal relationship with the

provider, and continuity of care—are associated with good health and reductions in total mortality, infant mortality, and low birth weight, even in the presence of income inequality.[17–19]

The launch of the Sustainable Development Goals, founded on the principle of “leaving no one behind”, has renewed the call for the eradication of health inequity globally.[20] Health inequity is defined as “the [presence] of systematic and potentially remediable differences in one or more aspects of health across socially, demographically, or geographically defined populations or population subgroups (International Society for Equity in Health 2000).”[21] The WHO’s Commission on Social Determinants of Health (CSDH) conceptual framework captures the pathways through which mechanisms at different levels of society result in health inequities.[22] According to the framework, social, economic and political mechanisms determine an individual's level of privilege, also referred to as their socioeconomic position, which is often proxied by income, education, occupation, gender, race/ethnicity, or social class. Socioeconomic position influences one's experiences with intermediate determinants of health, which include living & working conditions, behavioral factors, psychosocial factors, and access to quality health care. Differential experiences with these determinants result in differences in exposure and vulnerability to health-compromising conditions. This ultimately leads to inequitable health outcomes. The framework also captures the "feedback" effect that illness can have on an individual's socioeconomic position, e.g. by reducing their ability to pursue employment opportunities, thereby worsening their socioeconomic position. Widespread illnesses can also influence the social, economic and political mechanisms that determine socioeconomic position. Additionally, the framework captures the role that the health system can play in reducing the negative effect of societal disparities on health by (1) reducing differences in exposure and vulnerability to health-compromising conditions through the provision of quality health care, and (2) promoting intersectoral action to improve health and reduce the negative impact of illness. The standards for quality primary care are

associated with better health, especially for disadvantaged groups, thus highlighting the essential role of primary care in positioning the health system to reduce health inequities.[5] The state of primary care in low- and middle-income countries (LMICs) is of particular concern, as these countries contend with the double of acute and chronic conditions that are amenable to quality primary care.[9] Health inequity also remains a major obstacle to improvements in health status.[23] Although several studies have found a positive association between primary care interventions and reductions in maternal, neonatal and child mortality in LMICs, there remains a dearth of evidence on the impact of primary care on adult health outcomes and health inequities in these settings.[4] Growing recognition of the critical role that primary care plays in the achievement of global development goals for health calls for more in-depth understanding of the association between primary care and health outcomes, and inequities in all settings to inform health reforms aimed at strengthening primary care systems. This dissertation, therefore, addresses this research gap by pursuing the following aims:

Aim 1: To conduct a scoping review of the international literature on the effect of primary care, as defined by its main and derivative features, on inequities in key dimensions of health care access (approachability, acceptability, availability, affordability, appropriateness). This scoping review will provide an updated synthesis of the literature on the impact of primary care on health inequities and identify focus areas for future research studies to enhance our understanding of the association between primary care and health equity in various settings.

Aim 2: To investigate the association between primary care experience—i.e. the reported experience of patients with their primary care provider—and the likelihood of hospitalization among adults with chronic ambulatory care sensitive conditions (ACSCs); and the association between primary care experience and inequities in the likelihood of hospitalization among adults with chronic (ACSCs) in rural Bihar, India. ACSCs are chronic or acute health conditions for which hospitalization can be prevented through quality primary

care. Primary care can provide early management for these conditions, thereby preventing complications. This aim seeks to remedy the dearth of evidence on the impact of primary care on adult health and health inequity by focusing on adult health outcomes in Bihar, one of India's socioeconomically backward states.

Aim 3: Investigate the association between the quality of local primary care and individual self-rated health (SRH); and the association between the quality of local primary care and inequities in SRH in rural Bihar, India. The quality of local primary care is measured as the average competence of primary care providers in an individual's village. This aim also seeks to remedy the dearth of evidence on the impact of primary care on adult health and health inequity by focusing on SRH, which is predictive of morbidity and mortality,[24] among different age groups in Bihar, India.

Organization of the dissertation

The subsequent chapters of this dissertation are organized as subsequently described. Chapter 2 provides an overview of the methods used to pursue each aim of this dissertation. Chapter 2 also provides a description of the context of Bihar, India—the setting for Aims 2 and 3—and a description of the parent study upon which the analyses for Aim 2 and 3 are based. Chapters 3, 4 and 5 present Aims 1, 2, and 3, respectively. Each aim is presented as follows: firstly, an introduction section provides a synthesis of findings from the extant literature that are relevant to the aim, as well as the gap in the literature that necessitates the pursuit of the aim; a methods section follows to provide an explanation of how the aim was pursued; a results section follows to present the findings of the aim; lastly, a discussion section follows to highlight key findings of the aim, in light of findings from previous and related studies, and to present limitations of the study, as well as implications of the findings of the aim. Chapter 6 serves as the concluding chapter of this dissertation, providing a summary of the findings of each aim, the ways through which future research can build on these findings, and the policy implications of these findings.

Chapter 2: Methods

The aims of this dissertation were pursued using the following methods. Details of the methods used for each aim are described in their respective chapters.

Aim 1: Conduct a scoping review of the international literature on the effect of primary care, as defined by its main and derivative functions, on inequities in key dimensions of health care access (approachability, acceptability, availability, affordability, appropriateness). A search strategy, which was developed around the two main terms of interest: “Primary health care” and “health equity”, was adapted and used in several databases. Relevant articles were selected based on criteria detailed in the Aim 1 chapter. Findings from this review are presented as a narrative synthesis and are organized by health access dimension. Under each health access dimension, equity effects of identified primary care interventions/reforms, as well as the primary care features enhanced by each intervention/reform are presented.

Aim 2: Investigate the association between primary care experience—i.e. the reported experience of patients with their primary care provider—and the likelihood of hospitalization among adults with chronic ambulatory care sensitive conditions (ACSCs); and the association between primary care experience and inequities in the likelihood of hospitalization among adults with chronic (ACSCs) in rural Bihar, India. This aim used data collected through the household survey conducted as part of a parent study (described under the “Parent study” section of this chapter), which conducted a situational analysis of the PHC system in Bihar, India (described in more detail under the “Context” section of this chapter). Specifically, survey responses pertaining to chronic illnesses experienced by adult household members (30 years old or older) were analyzed. Logistic regressions were used to model the odds of hospitalization as a function of primary care experience (PCE) score, and interactions between primary care experience and variables used to mark inequities (sex, caste, and wealth quintile; these variables are also referred to as ‘equity indicators’ in

this dissertation), adjusted for the type of chronic ACSC, and provider- and patient-level characteristics.

Aim 3: Investigate the association between the quality of local primary care and individual self-rated health (SRH); and the association between the quality of local primary care and inequities in SRH in rural Bihar, India. This aim used data collected through the household and clinical vignettes conducted as part of the same parent study that provided the data used in Aim 2. The quality of local primary care is measured as the average competence of primary care providers in an individual's village. Logistic regressions were used to model the odds of poor SRH—i.e. fair, poor or very poor SRH—as a function of a village's average provider competence, interactions between average provider competence score and variables used to mark inequities (sex, age, and wealth; these variables are also referred to as 'equity indicators' in this dissertation), adjusted for an individual- and household-level characteristics.

Context

Figure 2.1: Maps of India & Bihar (source: Google Maps)

With a population of 104.1 million, Bihar is the 3rd most populous state in India.[25,26]In addition to the pressures of having a large and growing population, Bihar is also one of India's Empowered Action Group (EAG) states, i.e. one of India's 8 socioeconomically backward

states.[26] Effects of the lack of resources can be seen in Bihar's health system, which is underperforming for several reasons, including underfunding, weak infrastructure and a shortage of human resources.[26] As a result, Bihar's population is yet to enjoy the benefits of a fully functional primary health care system. In fact, the five leading sources of disability-adjusted life year (DALY) loss in Bihar—(in order of magnitude) diarrhea, ischemic heart disease, lower respiratory infection, iron deficiency anemia, and chronic obstructive pulmonary disease (COPD)—can all be better managed with a strong primary health care system.[27] Beyond health, Bihar lags behind other Indian states in other aspects of development, evidenced by its bottom ranking in the list of Indian states on the Human Development Index.[28]

Bihar's population is almost 90% rural.[26] The government-funded portion of health system is organized according to the three-tiered system adopted for rural areas nationally. [29] The primary level consists of 2 kinds of facilities: sub-centers (SCs) and primary health centers.[29] According to government guidelines, SCs serve as the first point of contact between the primary health care system and the community (3,000 – 5,000 people), providing services related to behavior change, maternal and child health, family welfare, nutrition, immunization, diarrhea control and communicable disease control programs.[29] Primary health centers serve as referral units for SCs, and the point of contact between the larger village community (20,000 – 30,000 people) and a medical officer.[29] Primary health centers provide curative and preventive services.[29] However, health system realities do not always reflect government guidelines. For instance, centre:rural population ratios in Supaul, a district in Bihar, are 58% and 88% below recommended ratios.[28]

As part of a mixed health system, Bihar's public primary care providers coexist with private providers, who are either formally trained or informal. Data shows that private providers are the main source of curative care in Bihar, as 76% of curative care visits are made to a private provider, while public providers are usually sought for other services such as contraception.[30] Care seeking from private providers exposes many to the risk of financial

hardship due to out-of-pocket expenditure since health insurance coverage is low. Only 12% of households have a member who is covered by health insurance.[31] While there appears to be a division of labor between private and public primary care providers, the details of Bihar's primary care market are not clearly understood.

Parent study: Assessment of Primary Health Care in Bihar

The 2nd and 3rd aims of this dissertation are based on data collected as part of a parent study titled “Assessment of Primary Health Care in Bihar”, which conducted a situational analysis of the PHC system in Bihar, India to understand the extent to which the PHC system addresses population health needs.

The Assessment of Primary Health Care in Bihar Study was conducted under the Bihar Technical Support Program (BTSP), a partnership between CARE, an international nongovernmental organization (NGO), the Bill & Melinda Gates Foundation (BMGF) and the Government of Bihar.[32] Through the BTSP, Oxford Policy Management (OPM)—funded by BMGF—subcontracted Johns Hopkins University to design the Assessment of Primary Health Care in Bihar Study. OPM carried out the data collection while CARE India was a key stakeholder. The study was approved by the Johns Hopkins University Institutional Review Board and the Sigma Institutional Review Board in India for human subjects research. The principal investigator was Dr. Krishna Rao.

As part of primary data collection for the study, a cross-sectional survey of households in rural Bihar was conducted from November 2019 till March 2020. Households were sampled using stratified 3-stage probability proportional to size (PPS) sampling. In the 1st stage, 70 PHC catchment areas were sampled from the 9 divisions of Bihar using systematic random sampling. In the 2nd stage, 5 villages were selected within each selected PHC catchment area using systematic random sampling. In the 3rd stage, a listing of households was conducted in each selected village. Thirty households were selected from each village listing using systematic random sampling. A total of 8,365 households and 39,477 individuals were

sampled. The survey was first administered to an adult member of each sampled household, who was identified by the head of the household. This adult member identified members of the household. Household members or their mothers, if the household member was a child, then provided information on their health status, i.e. their self-reported health status at the time of the survey, acute illnesses experienced 30 days prior, most recent hospitalizations, chronic illnesses, in the case of adult household members, and providers that were sought for care. Information was also collected on care seeking related to pregnancy and childbirth, household socioeconomic status and other contextual measures.

Provider surveys were conducted with all PHCs identified for the household survey sampling and providers identified through the household survey who were within 5km of a sampled village. To survey providers identified through the household survey, 1 of the 5 villages, which were selected within each PHC catchment area for the household survey, was sampled using simple random sampling. Providers identified by household survey respondents were then located to participate in the provider surveys. Three types of provider surveys were administered: 1) facility-based assessments were used to measure the structural quality (i.e. condition of building, equipment, drugs and available, human resources present) of facilities, 2) clinical vignettes (further described in the Methods section of Chapter 5) were conducted with providers to assess their knowledge and 3) direct observations of provider-patient consultations were conducted to assess providers' practice. Surveys were conducted from February 2020 till March 2021, with a pause between March 2020 and February 2021 due to the COVID-19 pandemic. Direct observations did not resume after the pause due to concerns for the safety of survey enumerators during the COVID-19 pandemic. A total of 390 providers were surveyed—71 public providers and 319 private providers. Clinical vignettes and facility assessments were administered to all providers while direct observations were conducted with 110 providers.

To inform this study, the author of this dissertation worked as a research assistant with other members of the project team to analyze secondary data on the resources available to

Bihar's PHC system, coverage of primary care services, and the level and distribution of health status (morbidity and mortality), expenditures, and use of curative and preventive health services in Bihar. The author also helped to design surveys tools, which were used to collect primary data on the use of primary care among households and primary care provider practices, and consent forms. The author also supported cleaning of the household survey data after the survey was completed.

Chapter 3: A scoping review of reviews on the impact of primary care features on health access inequities

Introduction

Primary care is one of the pillars of primary health care (PHC), a key strategy to achieve universal health coverage and the United Nations Sustainable Development Goals.[4] Primary care is defined as the level of a health system that has the following set of unique features: first-contact access for each new health need, continuous person-focused care over time, comprehensive care for most health needs, and coordinated care when it must be sought elsewhere. These main features give rise to derivative features: family centeredness/orientation, i.e. the consideration of family context in the assessment of an individual's health needs; cultural competence, i.e. recognition of the needs of a subpopulation that are not mainstream; and community orientation, i.e. use of community or other epidemiological data in planning for and evaluating services to address a community's health needs.[33]International evidence shows that quality primary care improves health outcomes and reduces health inequities.[4,5] However, focused attention on the effect of primary care on health inequities is warranted given the renewed call in the global community to tackle lingering inequities.[20] A study on member countries of the Organization for Economic Cooperation and Development (OECD) found that access to primary care services is mostly evenly distributed, sometimes favoring the poor, while access to specialist care favors the wealthy.[34] Previous summaries of the literature also show that primary care interventions and stronger primary care systems are associated with reduced health inequities in high-income countries and LMICs.[4,35] Comprehensiveness of services, a main feature of primary care, has also been found to be associated with more equitable health care in countries of varying income levels.[35] In LMICs, primary care interventions and reforms targeted at disadvantaged populations, based on poverty and rurality, have also reduced health gaps between these groups and more advantaged populations.[9,36]

Across the literature, primary care is measured in various ways: a type of provider, a set of features (also called functions), and orientation of a health system.[4] However, it is the attainment of primary care's features that qualifies it as 'good'.[5] Various measures may refer to primary care features implicitly but explicit discussion is necessary to understand how features can be enhanced to ensure the delivery of quality primary care. Furthermore, while often-cited seminal reviews on the impact of primary care present key findings on health inequity alongside other outcomes, an updated synthesis of the literature that is focused solely on the impact of primary care on health inequity is needed to inform global efforts to eradicate lingering inequities. It is also important to understand the various points at which inequities manifest on the health access continuum—from needing a health service to receiving care that is appropriate for one's needs. These points are specified in a conceptual framework developed by Levesque et al. as the following sequence of five dimensions of health care access: 1) Approachability: awareness of the existence of needed health services, followed by 2) Acceptability: comfortability with the way a health service is provided, followed by 3) Availability and accommodation: level of ease with which care can be reached in a timely manner, followed by 4) Affordability: availability of financial resources to receive care, and finally followed by 5) Appropriateness: whether the health service adequately addresses the health need.[37] Quality primary care reduces health inequities by impacting a patient's experience with these dimensions.

To address the aforementioned research gap, this scoping review provides an updated synthesis of the literature on the impact of primary care on health equity. Specifically, this review synthesizes the effects of primary care interventions and reforms on the 5 dimension of health access conceptualized by Levesque et al (approachability, acceptability, availability and accommodation, affordability and appropriateness) for disadvantaged and advantaged populations, while highlighting the primary care features— first-contact access, continuity, comprehensiveness, coordination, family centeredness/orientation, cultural competence, and community orientation—enhanced by each primary care intervention/reform. This review

also identifies focus areas for future research studies to enhance our understanding of the association between primary care and health equity in various settings, and the ways through which primary care systems can be strengthened to mitigate health inequities. A scoping review is deemed as the best approach to synthesize the literature because the aims of this synthesis are to identify how research on the impact of primary care on health equity has been conducted thus far, and to identify knowledge gaps in the literature. These goals are in line with indications for a scoping review.[38] Compared to often-cited seminal reviews on the impact of primary care, this review is unique in its singular focus on health equity, and its application of the definition of primary care, as a set of features, and a conceptual framework of access to synthesize findings.

Methods

A search strategy was developed in consultation with an informationist around the two main terms of interest: “Primary health care” and “health equity”. The search terms used for “Primary health care” included words to capture features of primary care. Due to the extensive quantity of literature on the objective of this review, only review articles are included in this scoping review. As such, the search strategy included a filter for systematic and scoping reviews. The search strategy was adapted and used in the following databases: PubMed, Embase, Cochrane Reviews, Scopus and WHO Regional (numeric and text). The last search was run on January 5, 2022. Complete search strategies can be found in the appendix.

A scoping review on the impact of primary care on health inequity was published by the WHO in 2018.[4] This review thus builds on the findings of the previously done scoping review by only including articles published in 2018 and after. A review of reviews on strategies to reduce health inequalities was retrieved from the search conducted for this review.[39] Relevant reviews published in 2018 and after were selected from the retrieved review, based

on their titles and abstracts, to be screened. Additionally, other articles retrieved from the databases were included if they were:

- Reviews published in 2018 or after
- reviews with a description of their search strategy that includes a list of all databases and other sources searched, key terms/words used, and an explanation of restrictions, limits, filters and/or adapted search strategies applied to their search
- focused on health services provided at an individual's first point of contact with the health system, i.e. primary care services.
- discussed the impact of at least one of the main or derivative features of primary care, as per Starfield's definition of primary care[33], (or an intervention to improve a feature) on differences in at least one of the five dimensions of health care access specified in the access conceptual framework developed by Levesque et al [37] between advantaged and disadvantaged groups
- specified the indicator(s) used to distinguish between groups based on advantage—such as place of residence, race, occupation, gender, religion, education, or socioeconomic status

Reviews were excluded if they were published before 2018. Reviews were also excluded if they discussed primary care only in broad terms, such that the features addressed were not clear or if they discussed impacts on health equity only in broad terms, such that the affected health access dimensions and indicator(s) used to distinguish between groups based on advantage were not clear. Reviews were excluded if they discussed the impact of primary care on a health access dimension among disadvantaged groups without comparisons to advantaged groups.

The title/abstract of each article was screened independently by two reviewers. The author of this dissertation resolved conflicting votes. Each full text article was also screened independently by two reviewers, and the author of this dissertation resolved conflicting votes. Some articles were screened into the full text stage that did not clearly meet the objective of

the review. As such, if the abstract of an article was not clearly related to the impact of primary care/primary health care on health/health access or did not discuss effects on health inequities or disparities, reviewers would first read through the introduction, methods, discussion and conclusion sections. If relevant information was found, reviewers would read the results section for more details. If no relevant information was found, reviewers would exclude the article. An extensive report on health care quality, which was informed by a literature review, was also retrieved from the search conducted for this review. Since reading through the entire report was beyond the scope of this review, the summary chapter and sections with headings that included “primary care” or “equity” were reviewed to decide on the relevance of the report to this review. Articles were also excluded at the data abstraction stage after further reading revealed that they were not relevant to the objective of this scoping review.

The author of this dissertation abstracted the following information from articles included in this review: author, publication year, type and objective of the review, number and type of studies included that are relevant to this review, countries and populations covered by relevant studies, how primary care is described in each relevant study including the primary features addressed, the indicators used to distinguish between advantaged and disadvantaged population, and the impact of primary care on each mentioned health access dimension. The health equity impacts were categorized using terminology adapted from a review by Schleiff et al[40]:

- Pro–equity effect: outcomes improve more for disadvantaged groups than for advantaged groups.
- Equity effect: outcomes improve for disadvantaged and advantaged groups equivalently.
- Inequity effect: outcomes improve less for disadvantaged groups than for advantaged groups

Findings from this review are presented as a narrative synthesis and are organized by health access dimensions. Under each health access dimension, the results of pertinent studies identified in included reviews are presented. The primary care features enhanced by the interventions or reforms assessed in each study are also presented.

Results

Study characteristics

Of the 3,228 articles published in/after 2018 and screened, 11 reviews were included in this scoping review, consisting of 7[41–47] systematic and 4[48–51] non-systematic reviews. The article selection flow diagram, which specifies the number of articles retrieved from the database search, and the number of articles excluded at key points of the selection process can be found in the Appendix (Appendix Figure 3.1). This diagram was created using the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) figure template provided by Covidence, the software platfrom used to conduct this review[52]. The reviews covered a wide range of topics, including the national health reforms, health interventions targeted at marginalized groups, namely asylum seekers and culturally and linguistically diverse patients, interventions aimed at improving behavioral and mental health, especially among racial and ethnic minorities, vaccination coverage for children, community health worker (CHW) interventions for maternal and newborn health services, patient navigation for vulnerable populations and quality improvement interventions to reduce health inequities among people with diabetes in primary care. These reviews included a total of 27 studies that are relevant to this scoping review. These studies cover several countries—Thailand, China, USA, Australia, UK, Sweden, Australia, Belgium, India, Bangladesh, Nepal, Malawi, Kenya, —and various population groups—pregnant and post-partum women & newborns, children, asylum seekers, people with mild-to-moderate mental health problems, people with type-2 diabetes, adults, adolescents, and the general population. The indicators used to distinguish between advantaged and disadvantaged populations include wealth, nationality,

insurance coverage, race/ethnicity, age, and various socioeconomic characteristics (e.g. characteristics of the household head, literacy, caste). Types of studies include secondary data analyses (n=2), randomized control trials (RCTs) (n=8), a quasi-experimental study, cross-sectional studies (n=6), pre-post studies (n=7), a longitudinal study, and qualitative studies (n=2).

Equity impacts on heath access dimensions

The equity impacts of covered interventions are grouped and discussed based on related health access dimensions. The primary care features addressed by each intervention are also highlighted.

Approachability:

A review of the impact of community-based interventions on maternal and neonatal health outcomes in LMICs found 4 studies showing equity, pro-equity and inequity effects on the approachability of health services.[46] Two studies showed equity effects of interventions, which enhanced the first-contact and/or coordination features of primary care through home visits from CHWs and referral in the case of pregnancy complications[53] or newborn illness. In Malawi, the coverage of at least 1 ANC visit with skilled provider increased equitably among the poorest and richest households. In Kenya, a qualitative study found that protective homebased care practices improved across socioeconomic groups. Three studies showed pro-equity effects of interventions, which enhanced the first-contact and/or coordination features of primary care through home visits from CHWs, referral in the case of newborn illness and a mixed intervention, which trained community skilled birth attendants in basic skilled delivery care at home and linked them to referral health facilities. In Malawi, improvements in coverage of institutional delivery and knowledge of danger signs following the intervention favored the poorest households, compared to the richest (e.g. change in CoI for institutional delivery: -0.059 (95% CI: -0.098, -0.020)). In India, contact with a CHW increased the odds of at least four ANC visits and facility delivery among women in the lower

wealth group (OR: 2.11; 95% CI: 1.71, 2.60) but not among women in the higher wealth group; and it increased the odds of facility delivery among illiterate women (OR: 2.34; 95% CI: 1.83, 3.02) more than among literate women (OR: 1.33; 95% CI: 1.02, 1.71). In Bangladesh, low performing areas, based on baseline socio-economic status and skilled birth attendance, experienced greater increase in the proportion of women with at least four ANC visits (OR: 7.2 (95% CI 3.6 to 14.3) vs 1.9 (95% CI 1.1 to 3.3)) and skilled birth attendance (OR: 4.9 (95% CI 3.3 to 7.2) vs 1.7 (95% CI 1.3 to 2.3)) than high performing areas. However, in India, an intervention that enhanced the first-contact feature of primary care through home visits by CHWs had an inequity effect, such that the odds of at least 4 ANC visits increased among non-Muslim women (OR: 1.85; 95% CI: 1.33, 2.58) but not among Muslim women.

Availability and accommodation:

Nineteen studies discussed equity impacts related to availability and accommodation.

A benefit incidence analysis of Thailand's UHC reforms, which enhanced the first-contact access and comprehensiveness features of primary care, found that government spending through the country's Universal Coverage Scheme (UCS) was pro-poor since health service utilization over a 6-year period, especially at primary and secondary levels of care, was higher among members from the poorest quintile (26-29% of outpatient visits) than the richest quintile (7-11% of outpatient visits), when compared to their corresponding membership proportions (23-24% and 12-13% of UCS members were from the poorest and richest quintiles respectively).[49,54] Since the government's health reforms prioritized geographic accessibility of PHC services, it can be inferred that the results of the benefit analysis indicate a pro-equity effect on the availability of care.[49]

Community-based interventions on maternal and neonatal health outcomes in LMICs have been found to have equity, pro-equity and inequity effects on the availability of health services.[46] Five studies showed equity effects of interventions, which enhanced the first-contact and/or coordination features of primary care through home visits from CHWs,

community based skilled birth attendance, and referral in the case of pregnancy complications[53] or newborn illness. In Malawi, equitable coverage of antenatal home visits by trained community members was observed between the poorest and richest households. In Bihar, India, immunization by CHWs was not associated with household SES. The receipt of pregnancy or nutrition-related information from CHWs was also not associated with household or village characteristics. Additionally, contact with National Health Mission programme-trained CHWs (ASHAs) during pregnancy was equitable across socio-economic groups in Uttar Pradesh. In a rural block located in Uttar Pradesh, utilization of ASHA services did not differ significantly by caste (for birth registration), nor by socio-economic class, maternal education or caste (for ANC and PNC). In Kenya, a qualitative study found that skilled birth attendance improved across socioeconomic groups. Five studies showed pro-equity effects of interventions, which enhanced the first-contact and/or coordination features of primary care through home visits from CHWs and referral in the case of complications. In Uttar Pradesh, India, the coverage of antenatal and post-natal home visits improved to a greater extent among women from the poorest households, compared to the richest households, in the district where the intervention was implemented (Change in CoI for antenatal home visit: -0.172 (95% CI: -0.200, -0.143); change in CoI for postnatal home visit: -0.225 (95% CI: -0.289, -0.161)). In a rural block located in Uttar Pradesh, utilization of ASHA services for birth registration was higher among women of a lower socio-economic class (compared to higher socio-economic class, p-value=0.55), and who were illiterate (compared to those with a high school education, p-value=0.21), although the differences are not statistically significant. In Bihar, India, provision of food supplements by CHWs was greater among families in the lowest wealth quintile (compared to the wealthiest quintile: OR 0.87 (95% CI 0.79 to 0.96)) and with less educated household heads (compared to more educated: OR: 0.84; 95% CI: 0.63, 1.11). In Bangladesh, pro-poor improvements in the coverage of several indicators (at least 4 ANC visits, ANC by a trained provider, and PNC within 48 hours) were observed in the intervention areas, as indicated by negative and

statistically significant changes in concentration indexes. In Nepal, the coverage of uterotonic protection for vaginal deliveries increased the most among women from the two lowest wealth quintiles. Three studies showed in-equity effects of interventions, which enhanced the first-contact and/or coordination features of primary care through home visits from CHWs and referral in the case of newborn illness. In Malawi, coverage of antenatal home visits by CHWs was higher among women in richest quartile than in the poorest quartile (CoI for at least 1 antenatal home visit: 0.079 (95% CI 0.022 to 0.170)). In Bihar, India, the odds of immunization by CHWs was higher among households with a more educated household head (immunization OR: 1.39, 95% CI: 1.05, 1.82). In a rural district of Uttar Pradesh, India, utilization of ASHA services for birth registration was significantly higher among Hindu women compared to Muslim women (OR: 4.41, p=0.05).

A Nepal-based intervention, which enhanced the first-contact feature of primary care by using female community health volunteers (FCHVs) and CHWs as patient navigators for pregnant women, had a pro-equity effect on the availability of services, as women from the poorest quartiles were more likely to receive a home visit for their newborn from a navigator within 3 days of delivery than the richest quartile. As patient navigators, FCHVs and CHWs accompanied women to the health center and arranged for their free transportation.[48]

Studies also show the equity impacts of US-based interventions to enhance the comprehensiveness feature of primary care by incorporating mental and behavioral health services into primary care.[41,43] Ayalon et al. found that, when MH/SA services are provided in primary care clinics with communication between the MH/SA clinician and the primary care provider, the difference in the average number of MH/SA visits between African American and white elderly adults was not statistically significant (adjusted IRR: 0.58; CI:0.25–1.33, p=0.20).[55] On the other hand, when patients were referred to MH/SA services in a different location, the number of MH/SA visits was significantly smaller among African Americans than whites (adjusted incident rate ratio [IRR]: 2.87; CI: 1.06 –7.73, p=0.03).[55] The integrated model, therefore, had a pro-equity effect on the availability of care to African Americans,

compared to whites. Another intervention providing MH/SA services in primary care clinics (also called integrated care) had an equity effect on availability of mental health care among older adults in all ethnic groups (including Whites), except Asians.[43] The rate of mental health and substance abuse treatment increased for older adults receiving integrated care, compared to the referral model, except for Asian adults who had a lower odds of care access when receiving integrated care. [43] Differences in care access among ethnic groups were not statistically significant. [43] Another intervention enabling PCPs to provide mental health services, with a focus on youth, incorporated the coordination and cultural competence features of primary care, and had a potential pro-equity effect among black youth, compared to their white counterparts. The rate of specialty mental health care use at six-month follow up increased significantly among Black youth (OR: 9.37, 95% CI: 1.58–55.71) while the increase was weaker among white youth (OR: 3.09, 95% CI: .77–12.39).[56] A quality improvement (QI) collaborative care program for depression, which also enhanced the cultural competence feature, had a pro-equity effect on the availability of treatment among ethnic minorities (Latinos and African Americans), compared to whites. Among patients with baseline disorder, the QI program reduced unmet need for depression care among minorities to a greater extent than among whites.[57] Two other collaborative care programs for depression, targeting older adults, had equity effects on rates of depression care use. Results showed similar levels of improvement among ethnic minorities, compared to whites[58], and among African Americans (a potential equity effect in this case since the improvement in the intervention group do not appear to differ from the control group with statistical significance), also compared to whites [59] as evidenced by statistically insignificant interactions between ethnicity and intervention status.

A review of vaccination coverage among children at the national level found that the provision of vaccination through a special organization—known as well-baby clinics—within primary care, which enhanced first contact, continuity, comprehensiveness and coordination features of primary care, had potential equity effects on the availability of vaccines for

children in European countries.[45] Three included studies from Sweden, Australia and Belgium showed that uptake of MMR and/or DTP vaccines via well-baby clinics was not associated with parental income, area level SES or family income.[45] Maternal education was also not associated with MMR coverage in Belgium.[45] Although, a potential inequity effect was noted in Australia, based on maternal education, as the lowest educated group had a higher odds (1.63, 95% CI: 1.04-2.55) of being unvaccinated than the highest educated group.[45]

Affordability:

Two studies discussed equity impacts related to affordability. A secondary analysis of China's national survey data shows that health reforms, which enhanced the comprehensiveness feature of primary care by including supply subsidies for the delivery of primary care services, had a pro-equity effect on the affordability of health care. The rate of catastrophic health expenditure declined the most for households in the lowest income quartile (reduction between 2010 and 2016 (considering catastrophic health expenditure as out-of-pocket payments greater than 40% of households' total non-food consumption expenditure): –6·16% ($p < 0·01$), compared to reductions of 2·7% ($p < 0·01$), 1·4% ($p < 0·05$), and 2·7% ($p < 0·01$), for the second, third, and fourth quartiles, respectively) (Yip-2019).[50] In Australia, the Integrated Health-care pathway, which promoted the first-contact access and cultural competence features of primary care for asylum seekers, had an equity effect on affordability, as it ensured that asylum seekers had the same access to health services regardless of insurance coverage.[51,60]

One study based in Bangladesh showed potentially pro-equity effect of an intervention, which enhanced the first-contact feature of primary care through a voucher program that gave free access to various maternal health services.[46] CHWs recruited women to the program. The intervention's marginal effect was stronger among women in the poorest wealth quintile compared to the wealthier quintiles for ANC (43% (95% CI: 25-61%) vs 22%

(95% CI: 13-30%)), PNC (25% (95% CI: 13-38%) vs 17% (95% CI: 10-25%)) and delivery (68% (95% CI: 55-81%) vs 42% (95% CI: 33-50%)) with a skilled provider.[46]

Acceptability:

Two studies discussed equity impacts related to acceptability. A US-based intervention to encourage breastfeeding among Cambodian postpartum women enhanced the cultural competence feature of their primary care service by implementing a Cambodian menu for postpartum mothers, and demonstrated a pro-equity effect.[42] After implementation, breastfeeding initiation rates were no longer significantly different between Cambodian and non-Cambodian women (66.7% Cambodian vs.68.9% non-Cambodian p = .874), whereas rates had been significantly lower among Cambodian mothers before the intervention (16.7% Cambodian vs. 60.6% non-Cambodian p = .003).[42] Another US-based intervention enabling PCPs to provide mental health services to youth, which incorporated comprehensiveness, coordination and cultural competence features of primary care had a pro-equity effect on acceptability of care for Latino youth, compared to their white counterparts. Study results show that satisfaction with care was higher among Latino youth receiving the intervention, compared to those receiving usual care, with a statistically significant difference (p=.015), while the increase among white youth receiving the intervention was not statistically significant (p=.213).[56]

Appropriateness:

Five studies discussed equity impacts related to appropriateness. The studies assessed interventions targeting the provision of mental and behavioral health services within primary care,[43,44] quality improvement interventions for primary-level diabetes care[47], and patient navigation for maternity care[48].

Three of these studies assessed US-based interventions that enhanced the comprehensiveness feature of primary care by incorporating mental health services. A collaborative care program for depression, which also incorporated the cultural competence feature of primary care, had a pro-equity effect, as it resulted in greater improvement of

health outcomes, when compared to usual care, among Latinos and African Americans combined than among whites (p=.04 for intervention-ethnicity interaction for probable depressive disorder).[57] On the other hand, another collaborative care program for depression, had equity effects since it improved health outcomes similarly among older ethnic minorities and whites.[58] An intervention enabling PCPs to provide mental health services to youth—also incorporating the coordination and cultural competence features of primary care—had a pro-equity effect among black youth, whose depressive symptoms improved significantly at six-months follow-up (difference between intervention and usual care depression scale score: –7.55, 95% CI: –12.17 to –2.93), compared to their white counterparts, who experienced weaker improvements (difference between intervention and usual care depression scale score: –.16, 95% CI: –6.37 to 6.04).[56] A UK-based intervention concerned the coordination feature of primary care, as it focused on referrals from primary care providers to artist-facilitated groups, and was found to have a potentially pro-equity effect on mental health outcomes.[44] Black and ethnic minority participants jointly had a higher mental well-being score than White British participants, though the difference (3.3, 95% CI: -5.3, 11.9) was not statistically significant.[61]

A Nepal-based intervention, which enhanced the first-contact feature of primary care by using female community health volunteers (FCHVs) and CHWs as patient navigators for pregnant women, had an equity effect on the appropriateness of services, as facility delivery increased among women from all wealth quintiles following the intervention.[48]

Discussion

This scoping review of reviews sought to provide an updated synthesis of the evidence on the impact of primary care, as defined by its main and derivative features, on health access inequities. The interventions covered in the literature addressed the following features of primary care: first contact access, comprehensiveness, continuity, coordination, and cultural competence. Included studies assessed the impact of these interventions on health access

inequity, by highlighting the following health access dimensions: approachability, acceptability, availability and accommodation, affordability, and appropriateness. Only 5 of 27 studies discussed inequity effects of primary care interventions, which means that the clear majority (82%) of included studies point to pro-equity and equity effects of primary care interventions. This means that interventions mostly improved health access dimensions similarly for disadvantaged and advantaged groups, or to a larger extent for disadvantaged groups. The findings of this review also indicate that research studies on the equity impacts of primary care are lacking and that studies assessing such impacts are mostly (16 out of 27, 59%) set in high- and upper-middle income countries. Additionally, studies from lower income countries are focused on maternal and newborn health, while studies from higher income countries cover a wider variety of health services.

Although primary care is described in various ways in the literature (type of provider, features, and the orientation of a health system)[4], this review has categorized each primary care intervention and reform according to the corresponding feature of primary care since it is the fulfillment of key features that constitutes good quality primary care.[5] Evidence shows the different ways that these features can be enhanced for various population groups, through nationwide health reforms, interventions for specific groups (pregnant and post-partum women and newborns, children, asylum seekers, adults, adolescents), and specific services. Primary care features are also often enhanced in concert to mitigate health access inequities, as seen in examples such as Thailand's UHC reforms[49], which targeted first contact access and comprehensiveness; interventions to incorporate mental health into primary care,[41,43] which also addressed comprehensiveness, cultural competence and coordination; well-baby clinics providing vaccinations for children with a focus on first-contact access, and continuity , comprehensiveness and coordination[45]; and community based intervention for mothers and newborns which enhance first-contact access and coordination of care[46,48]. Coordination is often described as referrals from primary care to specialty care.[5] However, literature also highlights the important role that primary care plays in referring

patients to non-clinical services that can effectively address their mental health needs.[44] As such, the person-focused—as opposed to disease-focused—delivery of care engendered by primary care[5] can facilitate multi-sectorial collaborations to promote the well-being of individuals and communities.

As concerns the impact of primary care on health access inequities, evidence shows that efforts to improve primary care features are associated with impact along various points on the health access continuum. Studies have found mostly pro-equity or equity effects from the starting point of approachability of health services to the final point of appropriateness of care, as seen in improvements in health outcomes. Since this review includes qualitative studies, statistical significance could not be assessed for all reported equity impacts of primary care interventions. As such, the number of studies reporting pro-equity effects has not been distinguished from the number reporting equity effects. Notwithstanding, this review includes several examples of pro-equity effects of interventions that enhance features of primary care, thus confirming that good quality primary care is associated with reduced inequities in health access and outcomes, as noted in previous reviews (WHO-econ case, Starfield-2005, Shi-2012).[4,5,62] Pro-equity impacts of primary care on health access are oftentimes a result of interventions that are targeted towards disadvantaged populations. For instance, differences in breastfeeding initiation rates between Cambodian and non-Cambodian postpartum women in a US hospital were reduced through the introduction of Cambodian menu.[42] In Australia, a healthcare pathway was introduced specifically for asylum seekers and steps were taken to ensure that lack of Medicare entitlement did not impede access to health care.[51] In Bangladesh, poor pregnant women were supported financially to pay for transportation to facilities and medicines were supported, and were oftentimes accompanied by CHWs to health facilities.[4663]Additionally, US-based interventions to integrate mental health services into primary care included cultural sensitivity training for staff to alert them to the specific needs of ethnic minorities.[43] Similarly, a review (not included in this scoping review) of reimbursement systems for primary care and their

effect on health inequities did not find evidence of an impact but concluded that reimbursement systems could reduce health inequalities by directing resource allocations to disadvantaged populations.[64]

This scoping review has also highlighted the need for more studies that evaluate the impact of primary care on health access inequities. Although several reviews were found that discussed the impact of primary care on disadvantaged populations, many of them were excluded from this review because they did not explicitly compare health access dimensions between disadvantaged and advantaged groups. This component is essential to furthering our understanding of ways to reduce health inequities, which have been prioritized on the global health agenda. Additionally, most of the included studies are from higher income countries. Among studies set in LMICs, the majority (10 out of 12) focused on access to maternal and newborn health services. So, there appears to be a need for further research on the impact of primary care on health inequities in lower-income countries. Moreover, future studies are needed that are set in LMICs and investigate the equity impacts of primary care reforms and interventions on access to a wider variety of health services, such as services for mental health, chronic conditions and adult populations. This review covered a wide range of study types, which attests to the various forms that primary care interventions take and various methods through which equity impacts can be evaluated. When possible, future research studies should apply experimental or quasi-experimental longitudinal designs to capture the independent effect of primary care on health inequities. Qualitative study designs are also needed to understand the experiences of vulnerable populations with accessing primary care, which can inform interventions to reduce health access inequities through primary care. Studies should also specify the primary care features targeted by evaluated interventions so that evidence syntheses can readily identify commonalities among successful efforts to enhance certain features, as well as features that require further research. Notably, family centeredness and community orientation are features which were not highlighted among interventions identified in this review. As such, future studies can

inform ways to enhance primary care, so that care is adequately informed by an individual's familial and community context.

While this scoping review provides a needed synthesis of the literature, there are limitations. Firstly, only reviews published in English were considered. So finding from relevant reviews published in other languages were not accounted for in this synthesis. Additionally, this review only includes reviews with explicit discussions of the equity impacts of primary care, i.e. the health access dimension is identified, as well as the indicator(s) used to distinguish between groups based on advantage. As such, cursory mentions of equity effects of primary care were not included, which may have resulted in the omission of potentially relevant results. The few studies found to discuss an inequity effect of a primary care intervention may also indicate publication bias. Primary care features do not promote inequity in and of themselves but certain interventions could have such unintended consequences as a result of their design or implementation.

In summary, the evidence gathered through this scoping review shows that interventions to enhance primary care features are associated with improvements along the health access continuum for disadvantaged and advantaged populations, oftentimes in ways that reduce health access inequities. These interventions can take various forms—health reforms consisting of a large set of interventions and targeted programs for specific groups or health services—and can address several primary care features in concert. Notably, pro-equity effects are usually not happenstance, as they often involve efforts designed with disadvantaged populations in mind. To further the literature on the impact of primary care on health equity and support the application of research findings, further research is needed that evaluates the impact of primary care interventions on health access inequities and addresses a wider variety of health challenges in lower income countries.

Chapter 4: Investigating the association between primary care experience and hospitalization for chronic ambulatory care sensitive conditions among adults in rural Bihar, India

Introduction

Primary health care (PHC), which aims to bring health care as close as possible to where people live and work by being the first level of contact between a nation's health system and its inhabitants, is widely accepted as a key strategy for improving health outcomes and promoting health equity—two major objectives on the global development agenda.[1,2] One of the pillars of PHC is the delivery of quality primary care.[4] The main functions of primary care are: (i) first-contact access for each new health concern; (ii) continuity of care, i.e. using a particular source of care for most health needs over time; (iii) comprehensive care for most health needs; and (iv) coordinated care for instances when it must be sought elsewhere.[5] Using various measures of primary care, such as the supply of primary care providers, the receipt of primary care service, the strength of primary care systems, several studies have linked primary care availability and quality with improved health outcomes and reduced impact of poor economic conditions on health.[4]

A widely used and validated indicator of primary care quality is the occurrence of hospitalization due to ambulatory care sensitive conditions (ACSC). These are chronic or acute health conditions for which hospitalization can be prevented through quality primary care. Primary care can provide early management for these conditions, thereby preventing complications. It is therefore telling that the top 5 leading causes of death in LMICs include lower respiratory infection, diarrhea, ischemic heart disease—all of which are ACSCs.[65] Additionally, these countries are grappling with high levels of health inequity.[23] International evidence shows that quality primary care is essential to tacking these issues.[4,5] However, while there is extensive evidence of the positive impact of primary care on maternal, neonatal and child health in LMICs, there is need for further research on primary care as relates to adult health outcomes and health equity in these contexts.[4]

This study seeks to address this gap in the literature by investigating (a) the association between primary care experience—i.e. the reported experience of patients with their primary care provider—and the odds of hospitalization for chronic ACSCs (diabetes, asthma, lung disease, heart disease, hypertension), and (b) the association between primary care experience and inequities in hospitalization among adults (30 years old and above) in rural Bihar, India. Inequities in hospitalization will be considered by sex, socioeconomic status (SES; proxied by wealth quintile in this study) and caste since these are well-known markers of health inequity in the Indian context.[66] Good primary care experience, particularly in terms of provider's accessibility and relationship with the patient, has previously been found to be associated with better self-rated health and mental health.[19] Additionally, the experiences of patients with their providers has been connected to several key components of health care provision, including patients' adherence to providers' instructions and employee satisfaction.[67] Measuring patient experience in primary care is therefore essential to ensuring that services are responsive to patients' health needs.

This study focuses on Bihar, one of India's socioeconomically backward states. A more detailed description of Bihar's context is provided in the Methods chapter of this dissertation. As of 2016, the 5 leading sources of disability-adjusted life year (DALY) loss in Bihar, were ambulatory case sensitive conditions (ACSCs): diarrhea, ischemic heart disease, lower respiratory infection, iron deficiency anemia, and chronic obstructive pulmonary disease (COPD).[27]An assessment of public primary health centers found Bihar to be among India's poorest performing states.[68] Moreover, the quality of government funded primary care in much of India is below minimum standards.[68] This partly explains why outpatient care is mainly sought from India's largely unregulated private sector. Moreover, health inequities persist in India across socioeconomic status, caste, class, sex, and place of residence.[66] As such, this study will not only address a research gap but will also proffer policy implications for the strengthening for Bihar's and, by extension, India's primary care system.

Methods

Data collection

Data used in this study was collected via the household survey conducted as part of the parent study described in the "Methods" chapter of this dissertation. As concerns chronic illnesses experienced by adult household members (30 years old or older), the survey collected information on the type of ailment (asthma/ lung disease or condition , heart disease/condition , diabetes/high blood sugar, hypertension or high blood pressure, and/or other), when the individual was diagnosed, if they have ever been hospitalized for the condition, and questions related to care seeking, such as the number of visits made to a health provider for the condition in the past year, the type of provider usually sought to manage the condition, travel time to the provider from home, and level of satisfaction with their usual source of care (USC).

Data analysis

Analyses only included responses pertaining to chronic conditions that are ambulatory care sensitive conditions (ACSCs), i.e. asthma/ lung disease or condition, heart disease/condition, diabetes/high blood sugar, hypertension or high blood pressure. Since individuals could be diagnosed with 1 or more chronic ACSCs, the unit of data analysis is each instance of a chronic ACSC. Statistical analyses were conducted using Stata V. 13. To address the 1st objective of this study, which is to investigate the association between primary care experience and the odds of hospitalization for chronic ACSCs, logistic regressions were used to model the odds of hospitalization as a function of primary care experience (PCE) score, adjusted for the type of chronic ACSC, and provider and patient characteristics, pertaining to the individual and their household.

$$\text{logit}(P\_\text{hospitalization}_{ijk} = 1) = \beta_0 + \beta_1[\text{PCE score}]_{ijk} + \beta_2[\text{chronic ACSC type}]_{ijk} + \beta_3[\text{provider type}]_{ijk} + \beta_4[\text{patient's individual characteristics}]_{jk} + + \beta_5[\text{patient's household characteristics}]_{k};$$

for j = 1,…,n_k individuals in household *k*, and i = 1,…,n_{jk} chronic ACSCs reported for individual j_k

The main independent variable, primary care experience (PCE) score for a chronic ACSC instance, is calculated as a sum of the patient satisfaction score and the travel time score. Patient satisfaction is on a 4-point Likert scale in the household survey with the following options: very satisfied, somewhat satisfied, somewhat dissatisfied, very dissatisfied. However, the majority of the responses were either “somewhat satisfied” or “very satisfied”, so the patient satisfaction score was dichotomized into 2 categories: less than very satisfied and very satisfied. The travel time score was divided into quartiles 1 to 4—1 being the highest quartile for the time taken to visit a USC for a chronic ACSC, and 4 being the lowest quartile for the time taken to visit a USC. The PCE score was dichotomized with PCE scores ranging from 2 to 6 at the lower tier and higher scores, i.e. PCE scores of 7 or 8, set as the higher tier. The minimum PCE score (2) means that patient satisfaction and travel time received the lowest possible scores (1 each) resulting in a sum of 2, while the highest PCE score (8) means that patient satisfaction and travel time received the highest possible scores (4 each) resulting in a sum of 8. The correlation between patient satisfaction and travel time was also calculated using Kendall's rank correlation.

Previous studies show hospitalization for chronic ACSCs is a result of an interplay of factors, including provider characteristics, which determine the provision of care needed to prevent hospitalization, and patient characteristics, which predispose a patient to hospitalization and influence their ability to access needed care to prevent hospitalization.[69] To capture provider characteristics, the regressions were adjusted for the type of usual source of care (USC) that the patient sought for their chronic ACSC—whether a private or public provider. Predictors that capture patient characteristics include caste of the head of the patient’s household[1], sex and patient’s household’s wealth quintile, which is proxy for socioeconomic status. These

[1] Referred to as patient’s caste in subsequent sections of this paper

variables represent key markers of health outcome inequities in India—sex, caste, and socioeconomic status. [66] Religion of the head of the patient's household[2] was also included in the regressions since level of socioeconomic advantage has been found to differ based on religion in the Indian context.[70] Other predictors capturing patient characteristics include factors that are associated with hospitalization for chronic ACSCs: whether the patient had more than one chronic ACSC (proxy for comorbidity), age of the patient, patient's marital status (proxy for social support), level of education, employment status, smoking status, and whether the family is enrolled in a health insurance scheme.[69]The months since a patient's ACSC diagnosis was also adjusted for, seeing as this may affect recall of hospitalization for said condition.

Regarding USC type, analyses exclude individuals who used pharmacies as the USC for their chronic ACSC since pharmacists do not perform any type of examination on their patients. Of the 1,651 observations from adults with chronic ACSCs, who indicated whether they were ever hospitalized for their condition and had USCs other than pharmacies, 1,557 observations (94%) had responses to all considered predictors. Since this is greater than 90%, missingness was not imputed.

Households' wealth quintiles are based on an index, which was measured as a household wealth index, which was calculated via principal component analysis of household assets.[71] The validity of these quintiles and caste categories were assessed by testing their association with education, using Pearson's chi-squared tests corrected for stratification of the sample at district level (Appendix Table 4.1). Pearson's chi-squared tests were also used to test the association between the odds of hospitalization for a patient with chronic ACSC and each categorical predictor. For the continuous predictors, locally weighted regressions of the logit of the odds of hospitalization for a chronic ACSC against each predictor were performed to assess their functional form and check for splines. The statistical significance

[2] Referred to as patient's religion in subsequent sections of this paper

of potential splines was assessed using linear combinations of spline term coefficients in logistic regressions adjusted for clustering of the sample at the village level, with the odds of hospitalization for a chronic ACSC as the outcome. None of the splines were statistically significant so they were not included in subsequent analyses. T-tests, also corrected for stratification of the sample at district level, were used to compare the means of continuous predictors between chronic ACSC instances that resulted in hospitalization and those that did not result in hospitalization.

Aside from the PCE score, key predictors, i.e. independent variables that were included in all regressions, were USC type, chronic ACSC type, sex, wealth quintile and caste. Other predictors were considered as potential predictors to include in the regressions. To select from among the potential covariates, logistic regressions of the odds of hospitalization for a chronic ACSC were performed on key predictors, and every possible combination of the potential covariates. Akaike information criterion (AIC) and Bayesian information criterion (BIC) were calculated for each model. The logistic regression with the lowest AIC, adjusted for clustering at the village level, was considered as the final model. Three mixed effect logistic regressions, with random intercepts at household and village levels, using the same predictors at the final model, were performed to compare results with the logistic regressions—a) using only key predictors, b) using all predictors of the final model, and c) using key predictors and all potential covariates.

The goodness-of-fit of the final model was assessed using several measures. The variance inflation factor (VIF) was calculated to assess multicollinearity of predictors. An area under ROC curve (AUC) was calculated to measure the model's predictive ability. Pearson's and Hosmer-Lemeshow goodness-of-fit tests were also conducted. Standardized Pearson residuals were plotted against predicted probabilities to check for influential observations and assess the fit of the model. Finally, the average of chronic ACSC instances resulting in hospitalization was modeled as a function of predicted probabilities using a restricted cubic

spline, and compared to a y=x line in a plot to assess the model's goodness-of-fit. This plot is also referred to as the Weatherman plot.

To address the 2nd objective of this study, which is to investigate the interaction between primary care experience and inequities in the odds of hospitalization for chronic ACSCs, interactions between primary care experience and the equity indicators (sex, caste, and wealth quintile) were added to the logistic regressions used to address Objective 1. The same steps used for Objective 1 were followed to determine the final model that would be used to test the interactions except, in this instance, the interaction terms were also considered as key predictors. To further test for interactions between PCE score and the equity indicators, stratified regressions were conducted to adjust for correlations among interaction terms, which could dampen interaction effects in regressions when they exist. Logistic and mixed effect logistic regressions were stratified by PCE score categories, and each category of sex, wealth quintile, and caste, while adjusting for the other predictors of the final model.

The results of the final regression models for objectives 1&2 were also presented as marginal effects plots. Plots of the marginal effect of each predictor, excluding interactions, on the probability of hospitalization for a chronic ACSC are presented. The interactions between PCE score and the equity indicators are also presented as plots of marginal probabilities of each combination of PCE score and category of sex, wealth quintile, and caste.

Analyses for objectives 1&2 were repeated on a subset of the sample, i.e. individuals who had been diagnosed with a chronic ACSC for at least a year, to adjust for the number of visits paid to a health provider for a chronic ACSC in the past year. This variable served as a proxy for illness severity and proclivity for health service use. These variables may also be associated with hospitalization for chronic ACSCs, since more severe cases or a higher proclivity for health service use would typically result in more visits to a health provider over a given time period, and consequently a greater likelihood of being hospitalized for the

chronic ACSC. Individuals who had been aware of their illness for less than a year were excluded because their number of visits to health provider during the past year does not capture their health service use if they had been aware of their chronic ACSC diagnosis for the entire year. The analyses repeated for this subgroup were bivariate analyses, logistic and mixed effect logistic regressions with & without interactions, stratified logistic regressions, goodness-of-fit tests, and plots of marginal effects and probabilities.

Results

The study sample consists of 1,643 chronic ACSC instances from 1,391 individuals had responses to questions for the dependent variable (ever hospitalization for a chronic ACSC) and the main independent variable (Primary care experience (PCE) score). A total of 1,642 chronic ACSC instances from 1,390 individuals were included in the final regression models (Table 4.2 Model 2 & Table 4.3 Model 2) subsequently described.

As compared to chronic ACSC instances that did not result in hospitalization, those that did were experienced by people who were slightly older on average (59 years vs. 57 years), and had been diagnosed with the ailment for a longer period of time (~6 years vs. ~5 years). Bivariate analyses (Table 4.1) also show that a higher percentage of chronic ACSC instances with lower PCE scores (2-6) resulted in hospitalization than those with a higher PCE score of 7 or 8 (15.8% vs. 9.4%). Interestingly, chronic ACSC instances among people who were very satisfied with their USC had a higher chance of resulting in hospitalization than those among people who were less than very satisfied with their USC (14.7% vs 8.3%). With respect to travel time to a USC, the percentage of chronic ACSC instances resulting in hospitalization increases as the travel time to USC (grouped into quartiles) increases. Kendall's rank correlation coefficients for correlation between travel time quartiles and patient satisfaction (tau-b= -.069, p-value= .002) show that both measures are correlated. Chronic ACSCs managed by a public USC were slightly more likely to result in hospitalization than those managed by a private USC (15.9% vs 13%), though this is not

statistically significant. Results also show that the likelihood of hospitalization significantly differs by type of chronic ACSC, with instances of CHD most likely to result in hospitalization, at 29%, followed by ASTH/COPD, at 14.5%. Chronic ACSCs experienced by men were also more likely to result in hospitalization than those experienced by women (14.3% vs. 12.5%), though this is also not statistically significant. With respect to SES, hospitalization does not appear to follow an SES gradient and differences among quintiles are not statistically significant. Among castes, chronic ACSC experienced by individuals in the SC/ST category were the most likely to result in hospitalization, but only by a few percentage points. Hospitalization also does not appear to follow a caste gradient and differences among caste categories are also not statistically significant. Chronic ACSCs experienced by individuals who are unmarried/previously married (vs. married), without formal education (vs. with at least primary education), unemployed/retired (vs. employed), do not currently smoke tobacco (vs. currently smoke tobacco), are Hindu (vs. non-Hindu), and are part of families who are enrolled in health expense support (vs. without health expense support) were slightly more likely to result in hospitalization. None of these differences are statistically significant. However, chronic ACSCs experienced by individuals with more than one chronic ACSC were more likely to result in hospitalization than those with only one chronic ACSC (17.% vs 11.8%).

Logistic regressions (without interactions)

Modeling the odds of ever being hospitalized for a chronic ACSC as a function of PCE score using logistic regressions shows that higher PCE score (7/8) is associated with lower odds of hospitalization, after adjusting for key variables and other covariates. Chronic ACSC instances managed by USCs with higher PCE scores had 0.67 (95% CI: 0.48-0.93) times lower odds of resulting in hospitalization than instances managed by USCs with lower PCE scores (2-6), adjusting for other variables in the model ($p<0.05$, Table 4.2-Model 2). This association remains largely similar after adjusting for only key variables (Table 4.2, Model 1),

and after adjusting for key variables and all considered covariates (Appendix Table 4.2, Model 1). Among all combinations of considered covariates, the age of a patient and whether they had more than 1 chronic ACSC resulted in the logistic regression with the lowest AIC (Table 4.2-Model 2). Better PCE scores remain associated with lower odds of ever being hospitalized for a chronic ACSC when modeled using mixed effects logistic regressions (Appendix Table 4.3, Models 1-3). Looking at the equity indicators (sex, SES, and caste), results from logistic and mixed effect logistic regressions (Table 4.2 & Appendix Table 4.2) show no statistically significant association between the odds of ever being hospitalized for a chronic ACSC and any of these variables, after adjusting for key variables and other covariates. Results of the logistic regression with the lowest AIC (Table 4.2-Model 2) show that chronic ACSCs experienced by men had a 1.12 (95% CI: 0.83 – 1.52) times higher odds of resulting in hospitalization than those experienced by women. The odds of hospitalization does not follow a gradient by wealth quintile or caste. Chronic ACSCs experienced by individuals from the 2nd poorest wealth quintile (20% - 40%) had the highest odds of resulting in hospitalization—1.51 times (95% CI: 0.88-2.58) higher than those of the reference group (poorest wealth quintile (< 20%)). Among caste categories, chronic ACSCs experienced by individuals from the SC/ST (reference group) had the highest odds of resulting in hospitalization.

Logistic regressions (with interactions)

To test whether the association between the odds of ever being hospitalized for a chronic ACSC and the equity indicators (sex, SES, and caste) differs at higher and lower PCE scores, interactions between PCE score and each equity indicator were added to the logistic (Table 4.3) and mixed effect logistic regressions. However, the associations do not differ with statistical significance. At higher PCE scores, the odds ratios of ever hospitalization increased between men and women (reference group), and among wealth quintiles (as compared to the poorest quintile (reference group)), while it decreased among caste

categories (as compared to SC/ST (reference group)), adjusting for key variables and other covariates (Table 4.3, Model 2). The interactions are also not statistically significant when included in the logistic regression adjusting for all considered covariates (Appendix Table 4.2 Model 2) or when included in mixed effect logistic regressions (Appendix Table 4.3 Models 4-6).

Stratified logistic regressions

Since correlation among interaction terms can dampen interaction effects when they exist, stratified logistic regressions were conducted to adjust for those correlations. The first stratification was done by PCE score. At lower and higher PCE scores, the association between the odds of ever being hospitalized for a chronic ACSC does not differ by sex, SES, or caste with statistical significance. As seen in the logistic regressions with interaction terms, the odds ratios of ever hospitalization between men and women (reference group), and among wealth quintiles (as compared to the poorest quintile (reference group)) are higher at higher PCE scores, while the odds ratios among caste categories (as compared to the SC/ST category (reference group)) are lower at higher PCE scores, adjusting for key variables and other covariates with logistic regressions (Table 4.4) and mixed effect logistic regressions (Appendix Table 4.4).

Next, logistic regressions were stratified by caste. Results show that higher PCE scores are associated with lower odds of hospitalization for a chronic ACSC in all three caste categories—0.82 times lower in the SC/ST category, 0.62 times lower in the OBC category, and 0.65 times lower in the General caste category—while adjusting for key variables and other covariates (Table 4.5). This association was only statistically significant in the OBC category in logistic (Table 4.5) and mixed effect logistic regressions (Appendix Table 4.5).

Logistic regressions were then stratified by sex. Results show that higher PCE scores are associated with lower odds of hospitalization for a chronic ACSC among men and women—0.62 times lower among women and 0.73 times lower among men—while adjusting for key

variables and other covariates (Table 4.6). However, this association is not statistically significant among men or women in logistic (Table 4.6) and mixed effect logistic regressions (Appendix Table 4.6).

Finally, logistic regressions were stratified by wealth quintile. Results also show that higher PCE scores (7/8) are associated with lower odds of hospitalization for a chronic ACSC across quintiles—0.35 times lower in the poorest quintile, 0.58 times lower in the 20-40 quintile, 0.88 times lower in the 40-60 quintile, 0.61 times lower in the 60-80 quintile, 0.95 times lower in the richest quintile—while adjusting for key variables and other covariates (Table 4.7). This association was only statistically significant in the poorest quintile, as modeled by the logistic regression. Stratification was not done using mixed effects logistic regression because the model could not converge at all quintile strata.

Marginal effects plots

Figure 4.1 shows the marginal effect of each variable on the probability of hospitalization for a chronic ACSC based on the final model (Table 4.2, Model 2). Higher PCE scores are associated with a decrease of 0.042 (95% CI: -.076 - -.0089) in the probability of hospitalization for a chronic ACSC, adjusting for key variables and other covariates.

Figures 4.2-4.4 show the marginal probabilities of hospitalization for a chronic ACSC for each combination of PCE score and equity indicator based on the logistic regression with the lowest AIC, including interactions (Table 4.3, Model 2). At lower and higher PCE scores, the 95% CIs for men and women overlap, showing that the differences are not statistically significant. The marginal probability of hospitalization is, however, higher among chronic ACSC instances experienced by men than by women at lower and higher PCE scores. As concerns caste, the 95% CIs also overlap at lower and higher PCE scores. The marginal probability of hospitalization is highest among chronic ACSC instances experienced by SC/ST caste at lower and higher PCE scores, and even more so at higher PCE scores. As concerns SES, the 95% CIs also overlap at lower and higher PCE scores. While the

marginal probability of hospitalization drops for each wealth quintile at higher PCE scores, the drop is notably steepest for the poorest quintile.

Goodness of fit

Considering the logistic regression with the lowest AIC and without interactions as the final model of the association between the odds of hospitalization for a chronic ACSC and PCE score, several measures were calculated to assess the fit of the model. The variance inflation factor (VIF) was calculated to assess multicollinearity. A VIF of 1.59 shows that multicollinearity is at an acceptable level. An area under ROC curve (AUC) is 0.67, which is also the probability with which predicted probability of hospitalization for a randomly selected chronic ACSC instance that resulted in hospitalization exceeds that of randomly selected chronic ACSC instance that did not result in hospitalization. Results of the Pearson's and Hosmer-Lemeshow goodness-of-fit tests show that the null hypothesis cannot be rejected, which means that the model fits reasonably well.

Standardized pearson residuals were plotted against predicted probabilities to assess the fit of the model and check for influential observations. The plot (Appendix Figure 4.8) does not indicate any potentially influential observations since there are no points that are notably far away from other points. The locally weighted regression of the residuals against predicted probabilities also shows the residuals are close to 0 on average, which indicates a good model fit. Additionally, the average number of cases (i.e. chronic ACSC instances resulting in hospitalization) in each bin of predicted probability was plotted (Appendix Figure 4.9). The average of chronic ACSC instances resulting in hospitalization was modeled and plotted as a function of predicted probabilities using a restricted cubic spline. The plot shows that the y=x fit is within the 95% CI of this function, which indicates that the predicted probabilities are within an acceptable range of observed probabilities. This further supports that the final model has a good fit.

Subanalysis results

To test whether analysis results would change when illness severity or proclivity for health service use is adjusted for, analyses were conducted on a subset of the data—among individuals who had been diagnosed with a chronic ACSC for at least a year—to adjust for the number of visits paid to a health provider for a chronic ACSC in the past year in the regressions. The subanalysis sample consisted of 1,495 of chronic ACSC instances from 1,276 individuals had responses to the dependent variable (ever hospitalization for a chronic ACSC) and the main independent variable (PCE score). A total of 1494 chronic ACSC instances from 1,273 individuals were included in the final regression models (Appendix Table 4.8: Models 2 & 5). The subanalysis results are similar to results from the full dataset. A detailed description of these results is provided in the appendix.

Discussion

The main objectives of this study were to investigate (a) the association between primary care experience and the odds of hospitalization for chronic ACSCs (diabetes, asthma, lung disease, heart disease, hypertension), and (b) the association between primary care experience and inequities, by sex, socioeconomic status (proxied by wealth quintile) and caste, in the odds of hospitalization for chronic ACSCs among adults in rural Bihar, India. As concerns the 1st objective, findings show that better primary care experience, in terms of physical accessibility of and patient satisfaction with a usual source of care, is associated with lower likelihood of hospitalization for a chronic ACSC among adults 30 years and older in rural Bihar, India, even after adjusting for demographic factors and recognized predictors of hospitalization for chronic ACSCs in various contexts. Interestingly, when the components of primary care experience are considered separately, higher patient satisfaction is associated with a higher likelihood of hospitalization, while higher physical accessibility is associated with a lower likelihood of hospitalization for a chronic ACSC. As concerns the 2nd objective, findings show that, while the interactions between primary care experience and the 3 equity indicators (sex, caste, wealth quintile) were not statistically significant,

stratification by wealth quintile showed that the poorest quintile experienced the largest drop in the likelihood of hospitalization for a chronic ACSC when exposed to better primary care experience, compared to higher wealth quintiles. Results of this study, therefore, indicate that a better primary care experience may hold the greatest benefit for individuals from the poorest wealth quintile.

This study adds to the body of evidence that shows that better primary care—specifically better accessibility and interpersonal relationship between a patient and their provider—is associated with better health outcomes. Specifically, this study measured primary care experience as a composite score of the time taken to see a USC for a chronic ACSC and patient satisfaction with the USC, and found better primary care experience to be associated with a lower likelihood of hospitalization for a chronic ACSC, adjusting for several patient characteristics. In a US-based study, Shi et. al found that, among individuals who had a primary care physician as their usual source of care, those who reported a better experience, in terms of accessibility and interpersonal relationship, also reported better general and mental health.[19] This study also contributes to the larger body of literature which has shown across various contexts that stronger primary care systems are associated with improved health outcomes, including reduced hospitalization for ACSCs.[4,62] Additionally, findings also show that heart disease clearly had the highest odds of hospitalization among all chronic ACSCs included in this study. This result is in line with national and state level studies, which have found cardiovascular disease to be one of the leading causes of premature death in all parts of India, including poorer states, like Bihar, and rural areas.[72,73] However, even when adjusted for the presence of heart disease, this study still found that the odds of hospitalization drops with improvement in primary care experience, thus providing further support for the importance of good quality primary care in preventing complications resulting from ACSCs, such as heart disease.[74]

While this study did not find statistically significant association between the equity indicators (sex, SES, and caste) and the odds of hospitalization for a chronic ACSC, results show

interesting comparisons to those of other studies. Chronic ACSCs among men were more likely to result in hospitalization than among women. Another study using a nationally representative sample of India's population also found that males spent 24% more on hospitalization than females.[75] However, lower spending and service use among women may reflect poorer access to care rather than less need for care. A study among India's elderly found that women are hospitalized less frequently than men despite having poorer self-rated health, which implies limited access to health services.[76] With regards to SES, the odds of hospitalization does not appear to follow a gradient in this study. On the other hand, a review of studies from high income countries found a gradient relationship such that the risk of hospitalization for chronic ACSCs increased as income earned or socioeconomic status dropped, possibly due to higher risk factors and lower cardiovascular disease knowledge among those with low socioeconomic status.[69] Among caste categories, this study found the highest odds of hospitalization in the SC/ST category. Interestingly, among India's elderly (ages 60 years and above), ST and SC categories had lower rates of NCD-related hospitalizations than OBC and General caste categories.[77] Another study comparing data on India's elderly from 1995 and 2014 found that, while SC/STs had lower odds of hospitalization for any ailment than non-SC/STs in 2014, they had a higher odds in 1995, though the 1995 odds ratio was not statistically significant.[78] As concerns the impact of primary care on inequities in the odds of hospitalization for a chronic ACSC, stratified analysis shows that the poorest quintile experienced the largest drop in the likelihood of hospitalization for a chronic ACSC when exposed to better primary care experience. This result is in line with findings from other studies in higher income settings, which show less advantaged groups benefiting more from primary care than more advantaged groups.[5] For instance, a US-based state-level study found that an increase of one primary care doctor was associated with 2.5 times greater drop in deaths per 10,000 population among African Americans than among white Americans.[79] Another municipality-level study in Brazil also showed that the expansion of the nation's community-based primary healthcare (PHC)

programme, which is based on a scaled-up comprehensive primary care system[80], was associated with 2.3 times greater drop in ACSC mortality in the black/pardo population than in the white population.[81] These studies postulate that primary care favors disadvantaged groups through the prevention and early detection of diseases caused by stressors that are associated with disadvantage (e.g. poverty). While these are ecological studies, this study further supports their findings using individual-level analyses.

Findings from this study have several policy implications. The association between better primary care experience and reduced likelihood of hospitalization for chronic ACSCs among adults in Bihar, India provides further support for the strengthening of Bihar's—and more widely, India's—primary care system, especially as the country grapples with the increasing burden of chronic conditions. The Indian government recently launched health and wellness centers, which aim to bring a wide range of primary care services, including the control of chronic conditions, closer to communities.[82] The government will need to ensure adequate implementation of these centers across the country and that services are easily accessible to all individuals, regardless of social strata, so that the pro-equity benefits of quality primary care can be realized. Coordination with the private sector is also critical to the success of the primary care system, since it is the main provider of curative primary care in the country[83], as exemplified by the study sample, which predominantly sought care from private providers.

This study also provided evidence for the particularly adverse outcomes resulting from heart disease, and the positive role that better primary care experience can play in the lives of people who suffer from this condition by potentially reducing the likelihood of complications that will lead to hospitalization. As such, investment in primary care can be seen as a strategy to curb one of the leading causes of premature mortality in India. Additionally, hospitalization for heart diseases and chronic ailments often calls for catastrophic health expenditure, impoverishing households across the country.[75] By averting avoidable hospitalizations, a strong primary care system will also protect many from financial hardship.

Inevitably, this study has limitations that should be acknowledged. The moderate size of the sample limits the detectability of interaction effects in multivariate regressions. Stratified regressions were conducted to make up for this limitation. There is also a risk of recall bias since variables are based on individuals' responses. Additionally, the cross-sectional nature of the data means that it is not possible to establish a causal relationship between primary care experience and the likelihood of hospitalization for chronic ACSCs using the results of this study. However, since the number of visits to health provider in the past year, which serves as a proxy for illness severity and proclivity for health service use, was adjusted for in the subanalyses, it is less likely that the observed association between primary care experience and the likelihood of hospitalization for a chronic ACSC is due to individuals who are less likely to be hospitalized, i.e. those with less severe ailments or who are less likely to seek health care, seeking out better primary care experience. Additionally, the components included in the primary care experience measure are limited to those that were available in the household survey. As such, other features of primary care—comprehensiveness, coordination, family centeredness, cultural competence, and community orientation[33]—were not included. Findings may thus underestimate the potential impact of high-quality primary care on the likelihood of hospitalization for chronic ACSCs. It is also important to note that the household survey does not distinguish between primary care providers and specialists among the usual sources of care mentioned for chronic ACSCs. So, some of the providers may be specialists. However, specialists performing chronic care management serve many primary care functions, so the experience of their patients in this case can be accurately viewed as primary care experience.

This study adds to the body of evidence on primary care, as it relates to adult health outcomes and health inequity, in LMICs, where much of the literature has so far focused on the link between primary care delivery and maternal, neonatal and child health.[4] Findings contribute to the growing evidence of the association between primary care and improved health outcomes by showing that better primary care experience, in terms of accessibility

and patient satisfaction, is associated with a lower likelihood of hospitalization among adults with chronic ACSC in a resource limited setting. This study also provides an additional example of a less advantaged group—in this case, the poorest wealth quintile—potentially benefitting more from accessible primary care than more advantaged groups, thereby contributing to the literature on primary care's pro-equity effects. Results of this study highlight the importance of efforts to strengthen Bihar's and India's primary care system, which are critical to reducing the high burden of several ACSCs, such as heart disease, and protecting individuals from financial hardship resulting from avoidable hospitalization. To build on study findings, further research is needed that incorporates all features of primary care into the measure of primary care experience and uses longitudinal, experimental/quasi-experimental study designs to establish causal effects of quality primary care on health outcomes and health inequities.

Tables for Chapter 4

Table 4.1: Bivariate analysis

Have you ever been hospitalized for your ACSC?				
	No	**Yes**	**N**	**P-value**
	%	%		
PCE score				<.001
2-6	84.2	15.8	1,018	
7/8	90.6	9.4	625	
Patient satisfaction				0.004
Less than very satisfied	91.7	8.3	336	
Very satisfied	85.3	14.7	1,308	
Travel time to USC (score)				<.001
1 (2.17h - 48.03h)	79	21	271	
2 (0.77h - 2h)	82.9	17.1	551	
3 (0.27h - 0.75h)	89.1	10.9	396	
4 (0h - 0.25h)	94	6	430	
USC type				0.319
Public	84.1	15.9	164	
Private	87	13	1,487	
Chronic ACSC				<.001
ASTH/COPD	85.5	14.5	227	
CHD	70.7	29.3	256	
DM	89.5	10.5	392	
HTN	90.9	9.1	776	
Sex				0.279
Female	87.5	12.5	904	
Male	85.7	14.3	747	
Wealth quintiles				0.352
Less than 20	88.4	11.6	310	
20-40	83.5	16.5	310	
40-60	88.5	11.5	347	
60-80	87.5	12.5	265	
Greater than 80	85.6	14.4	417	
Caste				0.374
SC/ST	84.2	15.8	297	
OBC	87.6	12.4	1,013	
General	86.1	13.9	339	
Marital Status				0.314
Unmarried/Previously Married	84.9	15.1	318	
Married	87.1	12.9	1,333	
Education level				0.892
No schooling/Urdu class	86.6	13.4	871	
Completed at least Primary	86.8	13.2	780	

Employment status				0.686
Unemployed/Retired	86.4	13.6	1,038	
Employed	87.1	12.9	613	
Currently smokes tobacco				0.608
No	86.3	13.7	1,062	
Yes	87.2	12.8	588	
Religion				0.257
Non-Hindu	89.3	10.7	206	
Hindu	86.3	13.7	1,443	
Has another chronic ACSC				0.009
No	88.2	11.8	1,162	
Yes	83	17	489	
Family enrolled in health expense support				0.153
No	87.5	12.5	1,220	
Yes	84.6	15.4	344	
	Mean (SE)	**Mean (SE)**		
Age	57.1 (.41)	59.1 (.91)		0.031
Months since chronic ACSC diagnosis	64.4 (2.03)	74.2 (4.51)		0.048

Table 4.2: Ever Hospitalized vs Primary Care Experience – Logistic Regression, without interactions (Odds Ratios)

	(1)			(2)		
-Log Likelihood	-569.25			-565.81		
AIC	1164.51			1161.62		
BIC	1234.07			1241.88		
	Odds Ratio	***95% CI***	***p***	***Odds Ratio***	***95% CI***	***p***
PCE score (ref: 2-6)						
7/8	0.66*	[0.47,0.92]		0.67*	[0.48,0.93]	
USC type (ref: Public)						
Private	0.99	[0.62,1.59]		0.97	[0.60,1.57]	
Chronic ACSC (ref: ASTH/COPD)						
CHD	2.32***	[1.52,3.54]		2.29***	[1.49,3.53]	
DM	0.66	[0.41,1.06]		0.65	[0.40,1.05]	
HTN	0.61*	[0.40,0.93]		0.60*	[0.39,0.92]	
Sex (ref: Female)			**0.20**[2]			**0.45**[2]
Male	1.21	[0.90,1.63]		1.12	[0.83,1.52]	
Wealth quintile (ref: Less than 20)			**0.40**[2]			**0.51**[2]
20-40	1.53	[0.90,2.61]		1.51	[0.88,2.58]	
40-60	1.00	[0.59,1.70]		1.03	[0.62,1.73]	
60-80	1.22	[0.72,2.05]		1.22	[0.73,2.05]	
Greater than 80	1.36	[0.81,2.29]		1.32	[0.78,2.21]	
Caste (ref: SC/ST)			**0.37**			**0.33**[2]
OBC	0.75	[0.51,1.11]		0.74	[0.50,1.11]	
General	0.79	[0.47,1.32]		0.75	[0.45,1.25]	
Has another chronic ACSC (ref: No)						
Yes				1.24	[0.89,1.74]	
Age (centered)				1.01*	[1.00,1.02]	
Observations	1642			1642		

[1]P-value assuming null hypothesis of dummy variables for categorical coefficients jointly equating 0

Model (1) is logistic regression with only key covariates, excluding interactions. Model (2) is logistic regression with the lowest AIC, excluding interactions.

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

Table 4.3: Ever Hospitalized vs Primary Care Experience – Logistic Regression, with interactions (Odds Ratios[1])

	(1)			(2)		
-Log Likelihood	-567.95			-564.37		
AIC	1175.90			1172.74		
BIC	1282.91			1290.45		
	Odds Ratio	***95% CI***	***p***	***Odds Ratio***	***95% CI***	***p***
PCE score (ref: 2-6)						
7/8	0.43	[0.15,1.17]		0.42	[0.15,1.14]	
USC type (ref: Public)						
Private	0.97	[0.61,1.55]		0.95	[0.59,1.53]	
Chronic ACSC (ref: ASTH/COPD)						
CHD	2.35***	[1.54,3.58]		2.31***	[1.50,3.55]	
DM	0.67	[0.42,1.09]		0.66	[0.41,1.08]	
HTN	0.62*	[0.40,0.94]		0.61*	[0.40,0.93]	
Sex (ref: Female)			**0.86**[3]			**0.82**[3]
Male	1.19	[0.83,1.72]		1.10	[0.75,1.60]	
7/8 X Male	1.07	[0.52,2.20]		1.09	[0.52,2.26]	
Wealth quintile (ref: Less than 20)			**0.58**[3]			**0.54**[3]
20-40	1.28	[0.69,2.38]		1.24	[0.67,2.31]	
7/8 X 20-40	1.93	[0.69,5.41]		2.06	[0.73,5.80]	
40-60	0.79	[0.43,1.45]		0.81	[0.44,1.47]	
7/8 X 40-60	2.49	[0.80,7.70]		2.52	[0.82,7.74]	
60-80	1.08	[0.59,1.98]		1.07	[0.58,1.97]	
7/8 X 60-80	1.63	[0.51,5.16]		1.68	[0.53,5.29]	
Greater than 80	1.11	[0.60,2.05]		1.06	[0.58,1.95]	
7/8 X Greater than 80	2.13	[0.71,6.37]		2.20	[0.74,6.52]	
Caste (ref: SC/ST)			**0.79**[3]			**0.78**[3]
OBC	0.82	[0.51,1.33]		0.81	[0.50,1.32]	
7/8 X OBC	0.76	[0.35,1.66]		0.76	[0.35,1.65]	
General	0.85	[0.46,1.57]		0.81	[0.44,1.49]	
7/8 X General	0.83	[0.29,2.42]		0.84	[0.29,2.45]	
Has another chronic ACSC (ref: No)						
Yes				1.25	[0.89,1.75]	
Age (centered)				1.01*	[1.00,1.02]	
Observations	1642			1642		

[1]Except highlighted interaction terms, which are quotients of odds ratios
[2]P-value assuming null hypothesis of interaction coefficients jointly equating 0
Model (1) is logistic regression with only key covariates, including interaction terms of interest.
Model (2) is logistic regression with lowest AIC, including interaction terms of interest.

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

Table 4.4: Ever Hospitalized (stratified by PCE score), Logistic Regression (Odds Ratios (OR))

	(1)		(2)	
	OR$_{(se)}$	*p*	**OR $_{(se)}$**	*p*
USC type (ref: Public)				
Private	0.92$_{(0.25)}$		1.01$_{(0.69)}$	
Chronic ACSC (ref: ASTH/COPD)				
CHD	2.37$_{(0.65)}$**		2.27$_{(0.96)}$	
DM	0.77$_{(0.24)}$		0.40$_{(0.20)}$	
HTN	0.57$_{(0.17)}$		0.63$_{(0.25)}$	
Sex (ref: Female)		0.80		0.32
Male	1.05$_{(0.20)}$		1.34$_{(0.40)}$	
Wealth quintile (ref: Less than 20)		0.78		0.37
20-40	1.22$_{(0.39)}$		2.41$_{(1.12)}$	
40-60	0.81$_{(0.25)}$		1.95$_{(0.98)}$	
60-80	1.06$_{(0.33)}$		1.84$_{(0.94)}$	
Greater than 80	1.03$_{(0.32)}$		2.40$_{(1.16)}$	
Caste (ref: SC/ST)		0.67		0.39
OBC	0.81$_{(0.20)}$		0.63$_{(0.21)}$	
General	0.79$_{(0.25)}$		0.71$_{(0.34)}$	
Has another chronic ACSC (ref: No)				
Yes	1.33$_{(0.25)}$		1.02$_{(0.38)}$	
Age (centered)	1.02$_{(0.0075)}$*		1.00$_{(0.011)}$	
Observations	1017		625	

Models (1)-(2) are logistic regressions using key covariates and potential confounders included in full logistic regression with lowest AIC. Model (1) only includes observations with PCE score 2- 6. Model (2) only includes observations with PCE score 7/8; se = standard error

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

Table 4.5: Ever Hospitalized (stratified by Caste), Logistic regression (Odds Ratios (OR))

	(1)	(2)	(3)
	OR $_{(se)}$	**OR $_{(se)}$**	**OR $_{(se)}$**
PCE score (ref: 2-6)			
7/8	0.82$_{(0.28)}$	0.62$_{(0.13)}$*	0.65$_{(0.31)}$
USC type (ref: Public)			
Private	1.78$_{(1.18)}$	0.79$_{(0.24)}$	0.81$_{(0.49)}$
Chronic ACSC (ref: ASTH/COPD)			
CHD	2.82$_{(1.38)}$*	2.11$_{(0.65)}$*	2.03$_{(1.12)}$
DM	0.26$_{(0.16)}$*	0.97$_{(0.33)}$	0.33$_{(0.20)}$
HTN	0.43$_{(0.19)}$	0.76$_{(0.22)}$	0.34$_{(0.20)}$
Sex (ref: Female)			
Male	1.05$_{(0.40)}$	1.51$_{(0.29)}$*	0.53$_{(0.20)}$
Wealth quintile (ref: Less than 20)			
20-40	1.56$_{(0.84)}$	1.74$_{(0.57)}$	0.64$_{(0.50)}$
40-60	1.19$_{(0.58)}$	0.95$_{(0.33)}$	1.17$_{(0.71)}$
60-80	2.51$_{(1.30)}$	1.15$_{(0.40)}$	0.47$_{(0.36)}$
Greater than 80	0.60$_{(0.50)}$	1.22$_{(0.42)}$	1.50$_{(0.83)}$
Has another chronic ACSC (ref: No)			
Yes	1.56$_{(0.66)}$	1.22$_{(0.28)}$	1.10$_{(0.46)}$
Age (centered)	1.03$_{(0.016)}$	1.00$_{(0.0071)}$	1.05$_{(0.020)}$**
Observations	297	1008	337

Models (1)-(3) are logistic regressions using key covariates and potential confounders included in full logistic regression with the lowest AIC. Model (1) only includes observations in the SC/ST caste. Model (2) only includes observations in the OBC caste. Model (3) only includes observations in the General caste; se = standard error

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

Table 4.6: Ever Hospitalized (stratified by Sex), Logistic regression (Odds Ratios (OR))

	(1)	(2)
	OR$_{(se)}$	**OR $_{(se)}$**
PCE score (ref: 2-6)		
7/8	0.62$_{(0.15)}$	0.73$_{(0.19)}$
USC type (ref: Public)		
Private	1.45$_{(0.66)}$	0.74$_{(0.22)}$
Chronic ACSC (ref: ASTH/COPD)		
CHD	2.11$_{(0.68)}^{*}$	2.45$_{(0.77)}^{**}$
DM	0.76$_{(0.28)}$	0.56$_{(0.18)}$
HTN	0.65$_{(0.21)}$	0.54$_{(0.17)}^{*}$
Wealth quintile (ref: Less than 20)		
20-40	1.66$_{(0.57)}$	1.25$_{(0.51)}$
40-60	0.99$_{(0.38)}$	0.98$_{(0.37)}$
60-80	1.05$_{(0.37)}$	1.43$_{(0.58)}$
Greater than 80	1.26$_{(0.45)}$	1.27$_{(0.49)}$
Caste (ref: SC/ST)		
OBC	0.63$_{(0.17)}$	0.94$_{(0.28)}$
General	0.96$_{(0.32)}$	0.62$_{(0.25)}$
Has another chronic ACSC (ref: No)		
Yes	1.29$_{(0.29)}$	1.23$_{(0.31)}$
Age (centered)	1.01$_{(0.0082)}$	1.02$_{(0.0097)}$
Observations	902	740

Models (1)&(2) are logistic regressions using key covariates and potential confounders included in full logistic regression with the lowest AIC. Model (1) only includes observations from women. Model (2) only includes observations from men; se = standard error

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

Table 4.7: Ever Hospitalized (stratified by SES), Logistic regression (Odds Ratio (OR))

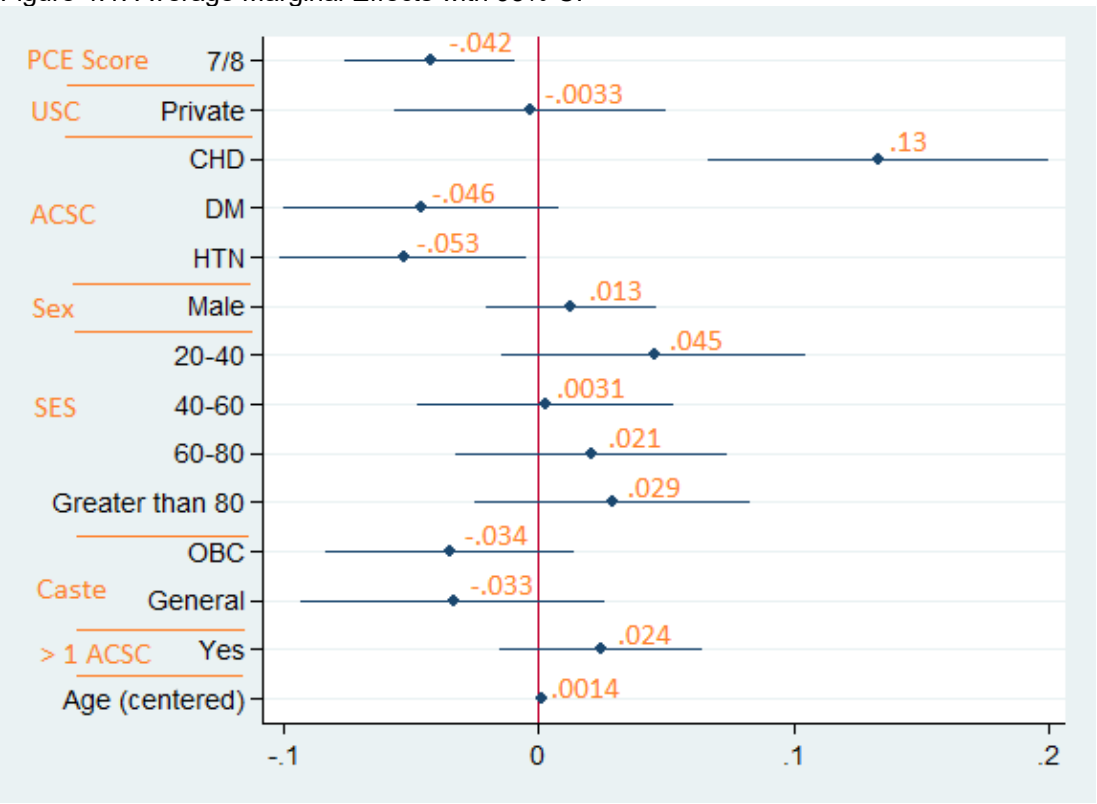
	(1)	(2)	(3)	(4)	(5)
	OR$_{(se)}$	**OR$_{(se)}$**	**OR$_{(se)}$**	**OR$_{(se)}$**	**OR$_{(se)}$**
PCE score (ref: 2-6)					
7/8	0.35$_{(0.15)}^{*}$	0.58$_{(0.19)}$	0.88$_{(0.34)}$	0.61$_{(0.26)}$	0.95$_{(0.36)}$
USC type (ref: Public)					
Private	1.29$_{(0.76)}$	4.87$_{(3.65)}^{*}$	0.58$_{(0.28)}$	0.74$_{(0.40)}$	0.42$_{(0.18)}^{*}$
Chronic ACSC (ref: ASTH/COPD)					
CHD	2.22$_{(1.11)}$	3.72$_{(1.91)}^{*}$	1.12$_{(0.57)}$	0.85$_{(0.54)}$	4.88$_{(3.50)}^{*}$
DM	0.83$_{(0.48)}$	0.90$_{(0.46)}$	0.82$_{(0.40)}$	0.36$_{(0.24)}$	0.62$_{(0.42)}$
HTN	0.48$_{(0.26)}$	0.80$_{(0.36)}$	0.40$_{(0.21)}$	0.48$_{(0.25)}$	0.93$_{(0.63)}$
Sex (ref: Female)					
Male	1.00$_{(0.41)}$	1.07$_{(0.36)}$	1.06$_{(0.40)}$	1.67$_{(0.72)}$	1.07$_{(0.38)}$
Caste (ref: SC/ST)					
OBC	0.67$_{(0.29)}$	0.84$_{(0.34)}$	0.71$_{(0.33)}$	0.39$_{(0.15)}^{*}$	1.58$_{(1.21)}$
General	0.89$_{(0.55)}$	0.47$_{(0.30)}$	0.93$_{(0.50)}$	0.22$_{(0.12)}^{**}$	2.18$_{(1.67)}$
Has another chronic ACSC (ref: No)					
Yes	1.48$_{(0.68)}$	0.85$_{(0.35)}$	1.23$_{(0.41)}$	1.71$_{(0.69)}$	1.69$_{(0.55)}$
Age (centered)	1.03$_{(0.015)}^{*}$	1.01$_{(0.013)}$	1.02$_{(0.016)}$	0.99$_{(0.017)}$	1.01$_{(0.014)}$
Observations	306	310	347	264	415

Models (1)-(5) are logistic regressions using key covariates and potential confounders included in full logistic regression with the lowest AIC. Model (1) only includes observations in < 20% wealth quintile. Model (2) only includes observations in 20%-40% wealth quintile. Model (3) only includes observations in 40%-60% wealth quintile. Model (4) only includes observations in 60%-80% wealth quintile. Model (4) only includes observations in > 80% wealth quintile; se = standard error

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

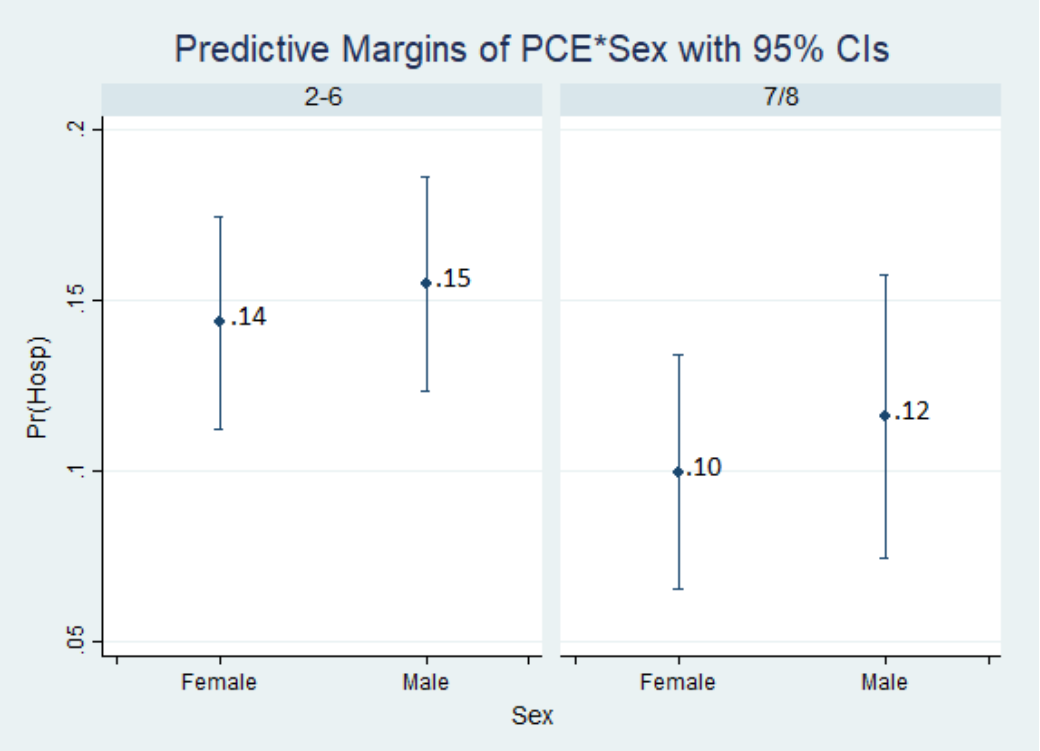
Figures for Chapter 4

Figure 4.1: Average Marginal Effects with 95% CI



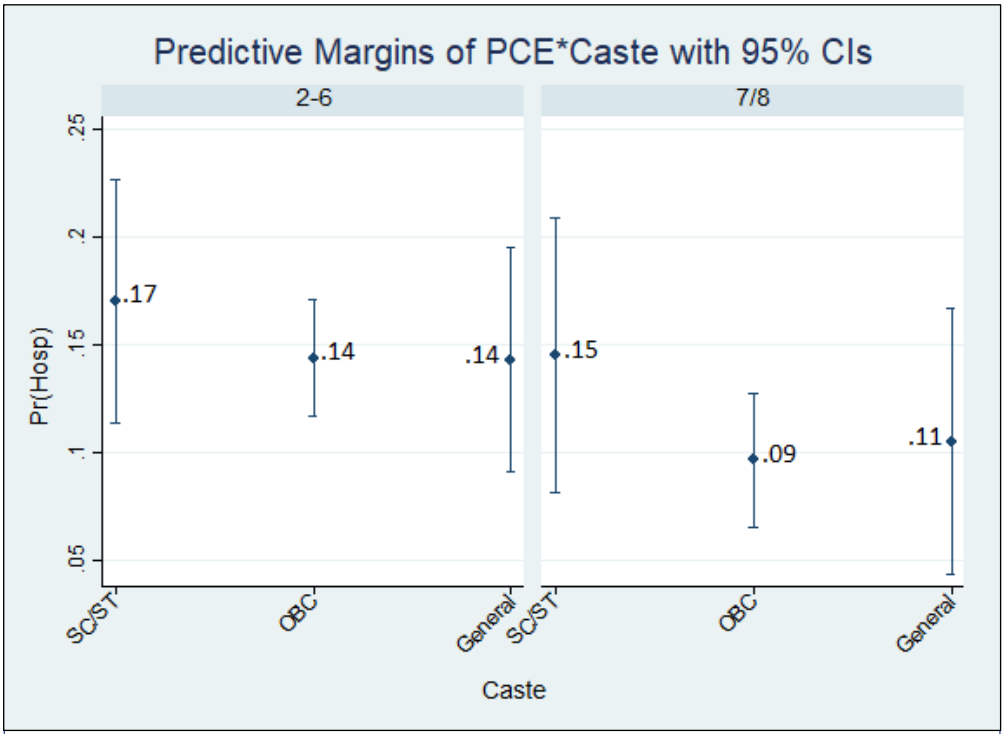
Note: Marginal effect of each variable on the probability of hospitalization for a chronic ACSC. For categorical variables, each category is compared to the reference category (each reference category is noted in Table 4.2). Calculations are based on logistic regression using key variables and other covariates with the lowest AIC, without interactions, i.e. Table 4.2 Model 2.

Figure 4.2: Predictive Margins of PCE*Sex



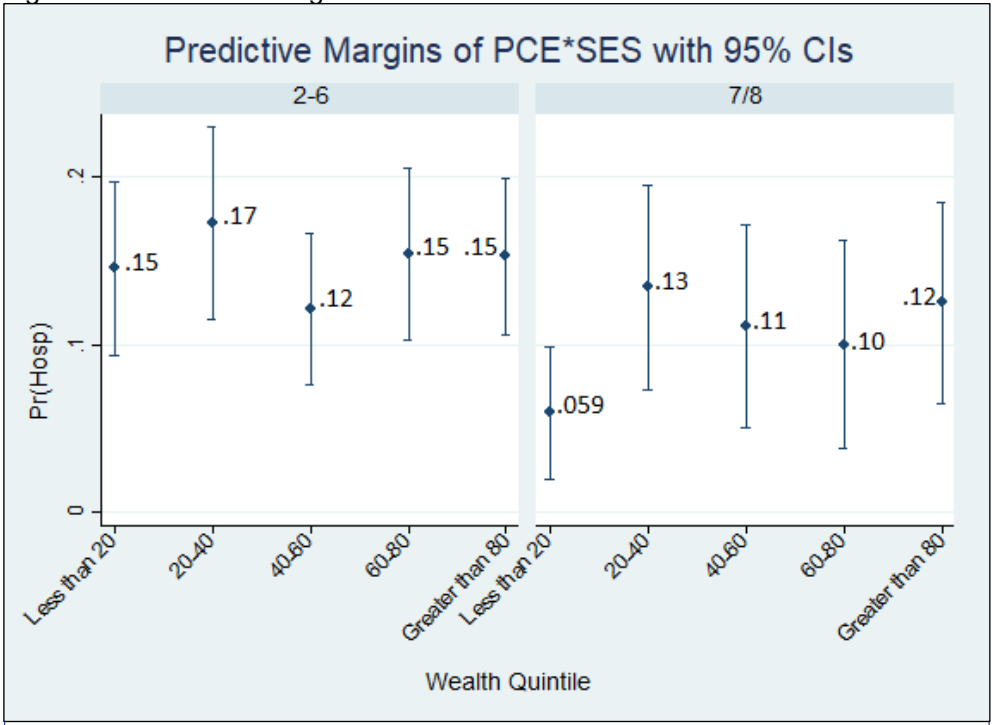
Note: Marginal probabilities of hospitalization for a chronic ACSC for each combination of PCE score and sex. Calculations are based on logistic regression using key variables and other covariates with the lowest AIC, with interactions, i.e. Table 4.3, Model 2.

Figure 4.3: Predictive Margins of PCE*Caste



Note: Marginal probabilities of hospitalization for a chronic ACSC for each combination of PCE score and caste. Calculations are based on logistic regression using key variables and other covariates with the lowest AIC, with interactions, i.e. Table 4.3, Model 2.

Figure 4.4: Predictive Margins of PCE*SES



Note: Marginal probabilities of hospitalization for a chronic ACSC for each combination of PCE score and wealth quintile (proxy for socioeconomic status (SES)). Calculations are based on logistic regression using key variables and other covariates with the lowest AIC, with interactions, i.e. Table 4.3, Model 2.

Chapter 5: Investigating the association between the quality of local primary care and an individual's self-rated health in rural Bihar, India

Introduction

Several studies have found primary care to be associated with improvements in health outcomes.[4,5,62] Among these studies are ecological studies that show an association between the increased supply of primary care providers and improvements in various measures of population health, including reductions in all-cause, cause-specific mortality (cancer, heart disease, stroke), and infant mortality; low birth weight; higher life expectancy; self-rated health; and hospital admissions in high-income settings.[7,84] Ecological studies also bring attention to the need for research on accessibility or structure of primary care. In England, for instance, the supply of primary care providers was not associated with mortality after adjusting for the structure of primary care services among other covariates.[85] In New York state, a positive association was found between the supply of primary care physicians and the rate of hospitalization for ambulatory care sensitive conditions (ACSCs) thus highlighting the need to investigate the accessibility of primary care physicians where they are present.[8] Moreover, ecological studies provide evidence for the association between primary care and reduced health inequities. A study assessing 21 OECD countries found that access to primary care services is mostly evenly distributed or favors the poor while access to specialist care favors the wealthy.[34] In the US, an increase of one primary care doctor was associated with 2.5 times greater drop in deaths per 10,000 population among African Americans than among white Americans.[79] Studies can also highlight intricacies in the relationship between primary care and markers of inequity, such as race. For instance, an ecologic study of US metropolitan areas found that primary care physician supply was not associated with mortality among black Americans in areas with high income inequality, hinting at potentially limited access to primary care services.[16]

While ecological studies of the supply of primary care physicians and services have so far provided insight into the impact of primary care on health and health inequities, measures of supply are limited because they do not capture the quality of care supplied. Additionally, it is important to investigate the association between population-level measures of primary care and individual-level outcomes to ensure that health improvements observed at the population-level are in fact a reflection of desired improvements in the health of individuals. To address these research gaps, this study aims to investigate: 1) the association between the quality of local primary care—measured by the average competence of primary care providers in an individual's village—and an individual's self-rated health (SRH), and 2) the association between the quality of local primary care and inequities in SRH, based on sex, wealth, and age, in rural Bihar, India. India is one of many LMICs, where the quality of primary care is variable and health inequity remains a major obstacle to improvements in health status.[9,23] This study will thus help to remedy the dearth of literature on primary care, as relates to health equity, in LMICs, and build the body of evidence on population-level measures of primary care.

SRH is a useful indicator to measure the impact of population-level quality of primary care because it is a simple and direct measurement of one's perceived well-being, and is predictive of morbidity and mortality.[86,87] SRH has been found to be associated with several biological and social determinants of health, including age, sex, social capital and community-level characteristics.[88] Studies have also found the individual-level measure of a patient's experience with their primary provider and the population-level measure of the ratio of primary care physician-to-population to be positively associated with good individual-level SRH.[19,89] Although, increased supply of primary care providers may not be sufficient to improve SRH among the elderly, potentially due to additional health needs that come with aging.[90] These associations are reflective of the WHO's conceptual framework for the social determinants of health, which captures the pathways through which societies stratify population groups, thereby impacting health outcomes.[22] As such, an individual's health is

determined by their socioeconomic position, which can be proxied by their sex, wealth, occupation, and level of education. Socioeconomic position influences one's experience of several intermediary determinants, including the social support (e.g. being married), biological factors (e.g. health impacts associated with aging), and the health system (e.g. accessibility of health services), which ultimately impact health outcomes. The framework also captures the role that the health system can play in mitigating health inequities through the provision of equitable, quality health services. The study focuses on the role of primary care.

Methods

Data collection

Data used in this study was collected via the household and provider clinical vignettes conducted as part of the parent study described in the "Methods" chapter of this dissertation. To assess the quality of local primary care, clinical vignettes were used to measure providers' competence with managing the following cases: diarrhea and pneumonia in children, and hypertension and angina in adults. Clinical vignettes were conducted with the primary provider or an available provider at the location where health services are provided. For each case, providers were assessed on their knowledge of the following core areas: patient history evaluation, patient examinations, diagnostics, diagnosis, prescriptions, and home care recommendations. These areas of assessment were developed based on standard treatment guidelines and consultations with primary care practitioners. To conduct a clinical vignette with a provider, one survey enumerator acted as the patient (or the patient's mother) and answered questions from the provider about their condition while another enumerator recorded the provider's stated actions for each area of assessment. For each provider, a competence score was calculated by first calculating the proportion of correct actions taken for each assessment area of a case, summing these proportions to

calculate the score for each case and, finally, summing scores across cases to calculate the provider's total score. Providers' scores were scaled to range from 0 to 100.

The household survey dataset was linked with the provider survey dataset, using unique identifiers for each provider, so that each surveyed individual who sought care for their ailment was linked the provider(s) practicing at the location that they sought care from if those providers were contacted for the provider survey. This data merging made it possible to calculate, for each village included in the household survey and among individuals who reported seeking care for an illness in the 30 days prior, the percentage of individuals who sought care from a location with a provider, with whom clinical vignettes were conducted. Only villages, where over 40% of surveyed individuals who reported seeking care for an illness sought care from a location with a surveyed provider, were included in this study. This amounted to 50 villages, consisting of 5,858 individuals. Medical shops were not considered among providers since they do not typically perform examinations. The data merge also allowed for linking responses to questions of interest in the household survey from individuals in a village to the average provider competence score for that village. Responses to all individual- and household-related variables were collected using the household survey, included the outcome variable of interest, self-rated health.

Data analysis

For each included village, the average competence of providers was calculated as an average of competence scores of all surveyed providers from that village. All individuals who participated in the household survey from each village were included in the analysis for a total of 5,858 individuals. Of these 5,858 individuals, 5,683 individuals (97%) responded to all variables of interest, except level of education, which was only asked of individuals who were at least 4 years old. Of the 5337 individuals eligible to respond to all variables of interest, 5180 (97%) responded to all variables of interest. Since these percentages are greater than 90%, missingness was not imputed.

To address the 1st objective of this study, which is to investigate the association between the quality of local PHC and individual self-rated health (SRH), mixed effect logistic regressions were used to model the odds of poor SRH—i.e. responding to the question, "In general, how would you rate your health today (options: excellent, good, fair, poor or very poor)?" with fair, poor or very poor—as a function of a village's average provider competence, individual and household characteristics, adjusted for random effects at household and village levels:

$$\text{logit}(P\_srh_{ijk} = 1) = \beta_0 + \beta_1[\text{Average provider competence}]_k + \beta_2[\text{Individual characteristics}]_{ijk} + \beta_3[\text{Household characteristics}]_{jk} + u_{jk} + u_k ;$$

for k = 1,…,50 villages, with j = 1,…,n_k households in village *k*, and i = 1,…,n_{jk} individuals in household j_k

An individual's characteristics include variables used to mark inequities (sex, age, and household wealth), which are also referred to as equity indicators in this paper, and sociodemographic variables. The sociodemographic variables considered were perceived accessibility of health care, marital status, employment status, level of education, and household enrollment in health insurance. Previous studies have found sex, age, education, employment status, family income, and health insurance to be associated with self-rated health.[19,91]

Exploratory analyses were carried out using Pearson's chi-squared tests, locally weighted regressions and t-tests. Pearson's chi-squared tests were also used to test the association between the probability of poor SRH and each categorical predictor. For continuous predictors (average provider competence score, age, wealth), locally weighted regressions of the log of the odds of poor SRH were performed against each predictor to assess their functional form. Average provider competence score was included in the regression as a linear spline, as the plot of the locally weighted regression of the log of the odds of poor SRH revealed a spline at a score of 45. To explore alternative coding for the average provider competence score, the association between the odds of poor SRH and a binary version of the average provider competence score was also assessed, considering only the highest

and lowest quartiles of the average provider competence score. Individuals from the villages with average provider competence scores in the highest quartile had 0.65 (95% CI: 0.35-1.24) times lower odds of poor SRH than those from villages in the lowest quartile, without adjusting for any other covariates, although this difference was not statistically significant. Age was divided by 10 so that every unit equates a 10-yr change, i.e. a decade, and included the regressions as a quadratic variable. Household wealth was calculated as an index via principal component analysis of household assets[71]. Wealth index values were also multiplied by 10 since the wealth index values ranged from 0 to 1, so a unit change in wealth index, using the original scale, would only capture variations between the minimum and maximum values. Wealth was included in the regressions as a linear variable. All continuous variables were centered at their means. T-tests, corrected for stratification of the sample at district level, were also used to compare the means of continuous predictors between those with good/excellent SRH and those with poor SRH. To select the sociodemographic variables to include in the mixed effect logistic regression, logistic regressions of the odds of poor SRH were performed on the core predictors (average provider competence score, sex, age, and wealth), and every possible combination of sociodemographic variables. Akaike information criterion (AIC) was calculated for each model. Variables resulting in the lowest AIC were selected for the final model. The fit of the final model was assessed using the variance inflation factor to check for multicollinearity, and measures of potentially influential observations to assess sensitivity to these observations. Potentially influential observations were identified as outliers using measures of leverage, standardized Pearson's residuals, deviance residuals, difference of chi-squares, and Pregibon’s dbeta. These measures were calculated using logistic regression adjusted for clustering of the sample at the village level. The outlying observations were omitted from the regressions to check the sensitivity of the regression results. None of the observations substantially altered the results.

To address the 2nd objective of this study, the association between the quality of local primary care and inequities in SRH, based on sex, wealth, and age, interactions between

average provider competence score and the equity indicators (sex, age, and wealth) were added to the mixed effect logistic regressions used to address Objective 1. To select the sociodemographic variables to be included in this set of regressions, logistic regressions of the odds of poor SRH were performed on an updated set of core predictors—now including interactions terms—and every possible combination of sociodemographic variables considered for Objective 1. Variables resulting in the lowest AIC were selected for the final model. The fit of the final model was assessed using the same methods as with Objective 1. The regression results are presented using categorized versions of age (< 15 years, 15-39 years, 40-59years, 60 years and above) and wealth (by tertile) in the interaction terms with average provider competence score. Marginal effect plots derived from the final model, using categorized versions of age and wealth to model their main effects and interactions, were also plotted to visualize the interactions, keeping other predictors at their means.

Results

The study sample consists of 5,858 individuals from 50 villages. Bivariate analyses (Table 5.1) show that individuals with poor SRH live in villages with a slightly lower average provider competence score (37.8 vs 38.5), though this difference is not statistically significant. They are also generally older (31.4 years vs 24.0, $p < 0.001$) and come from slightly poorer households, based on their wealth index. However, the difference in wealth index is not statistically significant. Women, those who are married and those who haven't had formal schooling are also more likely to have poor SRH. Additionally, those who perceive care to not always be available when needed, are employed, and are part of households enrolled in health expense support are slightly more likely to have poor SRH, although these differences are not statistically significant.

Table 5.2 presents the odds ratios for reporting poor SRH, as a function of average provider competence, and other covariates. When average provider competence score is less than

45, a unit increase in competence score is not associated with a change in the odds of poor SRH. This lack of association holds when adjusted for equity indicators, i.e. sex, age and wealth. When further adjusted for sociodemographic variables, i.e. employment status, marital status, and perceived accessibility of care, a unit increase in competence score—when less than 45—is associated with 1.01 times (95% CI: 0.95-1.07) higher odds of poor SRH, though not statistically significant (Table 5.2 Model 3). When average provider competence score is above 45, a unit increase in competence score is associated with .87 times (95% CI: 0.75-1.00, $p<0.05$) lower odds of poor SRH (Table 5.2 Model 1). This association becomes marginally insignificant (p-value =.06) when adjusted for equity indicators and sociodemographic variables (Table 5.2 Models 2 & 3). Males also have a lower odds (adjusted OR: 0.74, 95% CI: 0.64-0.87) of poor SRH than women. This association weakens to 0.84 times lower odds and becomes marginally insignificant (p=.08) when further adjusted for sociodemographic variables. As age increases, poor SRH becomes increasingly more likely. Wealth, on the other hand, is negatively associated with the odds of poor SRH since a unit increase in the scaled wealth index measure is associated with .93 times (95% CI: 0.86-1.00, p=.053 (Table 5.2 Model 2)) lower odds of poor SRH, although this is marginally statistically insignificant. These associations remain even after further adjustment for all other considered sociodemographic variables (Appendix Table 5.1).

Table 5.3 presents the odds ratios for reporting poor SRH, as a function of average provider competence, sex, age and wealth, including interactions between average competence score and sex, age and wealth. Model 1 presents regression results excluding other sociodemographic variables, while Model 2 adjusts for employment status and marital status. When average provider competence score is less than 45, the association between average provider competence score and the likelihood of poor SRH does not differ by sex, age or wealth with statistical significance. When average provider competence score is greater than 45, the association between average provider competence score and the

likelihood of poor SRH differs by sex (p= .04 (Table 5.3 Model 1), p =.05 (Table 5.3 Model 2)) and age (p =.01 (Table 5.3 Model 1 & 2)). The association does not differ by wealth with a notable level of statistical significance (p=.63 (Table 5.3 Model 1), p=.59 Table 5.3 Model 2). When further adjusted for all considered covariates (Appendix Table 5.2 Model 2), the association between average provider competence score greater than 45 and the likelihood of poor SRH only differs notably by age (p=.05), possibly due to the drop in sample size since 8% of the sample were ineligible to provide a response on their level of education due to their age (education level was not asked of children younger than 4 years old). When level of education is excluded from the regression (Appendix Table 5.2 Model 1), the association between average provider competence score greater than 45 and the likelihood of poor SRH differs by age with statistical significance (p=.01) and by sex with marginal insignificance (p=.07).

Figures 5.1-5.3 present these interactions as marginal effect plots based on the regression model that uses categorial versions of age, sex, and wealth to model their main effects and interactions with average provider competence scre, adjusted for other sociodemographic variables, i.e. employment status and marital status. Figure 5.1 shows that males consistently have lower probability of poor SRH than females, and this probability drops as average provider competence score increases beyond 45 for both sexes. However, the drop is steeper for males. Figure 5.2 shows that older individuals generally have a higher probability of poor SRH. Although the probability of poor SRH drops as average provider competence score increases beyond 45 for all age groups, the steepness of the drop is noticeable lowest in the oldest age group (60 – 95 yrs). Figure 5.3 shows the individuals from poorer households have a higher probability of poor SRH. The probability of poor SRH drops as average provider competence score increases beyond 45 for all wealth groups; the rate of change is not markedly different among groups.

Discussion

The main objectives of this study were to investigate the association between the quality of local primary care—measured by the average competence of primary care providers in an individual's village—and individual self-rated health (SRH) and, the association between the quality of local primary care and inequities in SRH, based on sex, wealth, and age. Findings show that, when the average competence score of providers in a village is greater than 45 (on the scale of 0 to 100), a unit increase in score associated with .87 times lower odds of poor SRH (p-value =.06) for an individual in that village, adjusted for individual and household characteristics. Inequities and inequalities in SRH were also observed, as results show higher odds of poor SRH among women, individuals from poorer households and older adults, as compared to men, individuals from wealthier households, and younger adults, respectively. Findings also indicate that there are interactions between the competence of nearby providers—i.e. providers in the village where an individual resides—and inequities in SRH, such that, although SRH improves for every unit increase in average competence score above 45, the rate of improvement is slower for women than men, and for older individuals than younger individuals. This implies that, in communities where the quality of local primary care is beyond a certain threshold (average provider competence score=45), SRH improves more for men and younger people than for women and older people, respectively. Findings do not indicate notable differences in improvements in SRH by household wealth.

As concerns the association between primary care, at an ecological level, and health outcomes, the literature often measures primary care in terms of the supply of primary care providers in a given area.[4,89] Looking at the association between supply of primary care and self-rated health, previous studies have found mixed results. A US-based study found that individuals living in states with a higher ratio of primary care physician-to-population had higher odds of reporting good/excellent health than those living in states with a lower ratio.[89]

A UK-based study investigating the association between primary care availability and SRH among older adults found no association. This lack of association may indicate that the primary care system is not well suited to the unique health needs of older adults.[90] This study goes beyond looking at the presence of primary care providers to assess the quality of care provided, as measured by the competence of providers. This is particularly important in the LMIC context where health systems tend to consist of a large and inadequately regulated private sector[83], so measures of supply will not adequately capture the variability in quality of care received. Results from this study further support the global literature on the association between primary care and health outcomes by showing that primary care provision, in terms of quality and beyond a certain threshold, is associated with better SRH. For increased supply of providers to positively impact health, the providers must be capable of providing quality care. Interestingly, findings also show that the average competence of providers may need to surpass a certain level before improvements in SRH can be observed. This is understandable since an improvement in average provider competence would not be expected to improve patient outcomes if what the providers know to do is still largely incorrect.

The results of this study also indicate potential inequities and inequalities in SRH, which have been observed in other studies. Adjusting for average provider competence, and individual and household characteristics, the odds of poor SRH is higher among women, older adults, and individuals from poorer households, as compared to men, younger adults, and individuals from wealthier households, respectively. Previous studies on SRH also found that women were more likely to report poorer SRH than men.[91] Health inequality between younger and older adults is well established in the literature. Older adults are more likely to experience pain and other chronic ailments.[92] In India, a nationally representative survey found that older individuals were more likely to report instances of morbidity.[93] Other studies have also found lower family income to be associated with poorer SRH.[19,89]

Interestingly, findings from this study show that, while the odds of poor SRH drops as average competence of primary care providers in a village improves beyond the threshold, the odds do not drop at the same rate among groups. The odds of poor SRH drop at a slower rate for women and older adults, as compared to men and younger adults, respectively. These results point to potential inequities in accessibility of care, putting women and older adults at disadvantage. Previous studies attest to this inference. For instance, elderly Indian women reported poorer health status than elderly men but were hospitalized less frequently than men, indicating poorer access to care potentially stemming from a need for financial empowerment.[76] Similarly, women in several resource limited settings tend to occupy a disadvantaged position due to the economic structure of their households resulting in limited access to care.[94] As concerns older adults, India's elderly have been found to avoid seeking medical treatment despite having a greater need for care because they view their morbidities as age-related.[93] This might explain why SRH improvements were observed to be slower among older individuals than younger individuals for each unit increase in average provider competence beyond a score of 45. This study found no interaction between wealth and average provider competence for the odds of poor SRH. In other words, there were no statistically significant differences in SRH between poorer and wealthier individuals for different levels of average provider competence. A previous study, using India's national level data, found that wealthier individuals are more like to use outpatient care than poorer individuals, and poorer individuals are more likely to report untreated ailments than wealthier individuals.[93] So, an interaction may exist between wealth and average provider competence at the national level.

Findings from this study hold several policy implications. It is evident that the competence of primary care providers needs to be at an adequate level to promote the wellbeing of individuals who seek care from them. Since rural India's primary care market is largely private and informal[95], steps need to be taken to improve the competence of formal and informal providers alike. However, efforts to train informal providers will need to address the

concerns of likely opposers, such as the Indian Medical Association.[96] Interventions from the policy level are also needed to support women in health care seeking and sensitize members of their households to the challenges they may face with accessing care that is commensurate to their health needs. As concerns older adults, India has taken a positive step by initiating the National Programme for the Healthcare of Elderly, which provides services at primary and higher levels of care to promote healthy ageing among the elderly.[97] Active outreach to older adults is also important to encourage them to seek care, and to encourage members of their household to support them in timely care seeking. Finally, multisectoral efforts will be needed to address other social determinants of health beyond the health sector to further narrow gaps in SRH among groups.

Inevitably, this study has limitations that should be acknowledged. The cross-sectional nature of the data means that it is not possible to establish a causal relationship between self-rated health and average competence of providers in a village. Additionally, not all providers who were sought for treatment in the villages included in this study could be traced. However, the benchmark used for each included village—at least 40% of care seekers sought care from a location with surveyed provider—means that the average provider competence score gives insight into the competence of providers that serve the inhabitants of each village. This study has also measured average provider quality in terms of competence, which is different from practice. However, since providers cannot practice beyond what they know, the competence score captures, on average, the highest level of care quality that patients can receive.

This study contributes to the literature on primary care by showing that, beyond the supply of primary care providers, the quality of local providers—measured by average competence of primary care providers in one's village—is also associated with individual-level SRH, even when adjusted for known health outcome predictors. But for pro-health benefits of primary care to be realized, the competence of primary care providers must be at an adequate standard and access to primary care must be equitable. The findings of this study indicate

potential inequities in health access by sex and age. To ensure the effectiveness of interventions to address these inequities, further research is needed on the cause of existing access inequities to inform efforts to resolve them.

Tables for Chapter 5

Table 5.1: Bivariate analysis

In general, would you rate your health today as fair, poor or very poor?					
	No	**Yes**	**Overall**	**N**	**P-value**
	Mean (SE)	**Mean (SE)**	**Mean (SE)**		
Average provider competence score	38.5 (.97)	37.8 (.85)	38.3 (.91)		0.26
Age, years	24.0 (.35)	31.4 (.83)	26.1 (.34)		<0.001
Wealth Index	4.83 (.088)	4.76 (.14)	4.81 (.088)		0.58
	%	**%**	**%**		
Sex					0.009
Female	69.9	30.1	52.0	3,051	
Male	73.1	26.9	47.9	2,807	
Age					<0.001
Less than 15 years	76.3	23.9	36.8	2,158	
15-39 years	75.0	25.0	37.2	2,176	
40-59 years	63.9	36.1	15.6	912	
60 years and above	52.7	47.3	10.4	611	
Marital Status					<0.001
Unmarried/Previously Married	75.4	24.6	55.8	3,268	
Married	66.5	33.5	44.2	2,590	
Education					<0.001
No schooling/Urdu class	66.0	34.0	36.1	1,927	
Completed at least Primary	75.0	25.0	63.9	3,410	
How often care could be received if needed					0.41
Not always	69.4	30.6	32.6	1,909	
Always	72.4	27.6	67.4	3,949	
Employment status					0.24
Unemployed/Retired	71.9	28.1	77.3	4,526	
Employed	69.8	30.2	22.7	1,332	
Family enrolled in health expense support					0.69
No	72.3	27.7	75.8	4,306	
Yes	71.3	28.7	24.2	1,378	
Note: SE = Standard Error					

Table 5.2: Odds Ratio for Reporting Fair/Poor Self-Rated Health (No Interactions)

	Model 1		***Model 2***		***Model 3[3]***	
	Odds Ratio [95% CI]		*Odds Ratio [95% CI]*		*Odds Ratio [95% CI]*	
Average Competence Score < 45	1.00	[0.95,1.06]	1.00	[0.95,1.07]	1.01	[0.95,1.07]
Average Competence Score > 45	0.87*	[0.75,1.00]	0.86	[0.74,1.01]	0.86	[0.74,1.01]
Sex (ref: Female)						
Male			0.74***	[0.64,0.87]	0.84	[0.70,1.02]
Age (decades)			1.15***	[1.07,1.23]	1.09	[0.97,1.23]
Age (decades) ^2			1.06***	[1.04,1.08]	1.07***	[1.04,1.09]
Wealth index X 10			0.93	[0.86,1.00]	0.93	[0.86,1.00]
Employment status (ref: Unemployed/Retired)						
Employed					0.74*	[0.58,0.96]
Marital status (ref: Not married)						
Married					1.36*	[1.03,1.79]
How often care could be received if needed (ref: Not Always)						
Always					0.94	[0.75,1.17]
Observations	5858		5857		5857	

Model 1 provides the unadjusted odds ratio of reporting fair/poor SRH for a unit increase in average competence score. Model 2 provides the odds ratio of reporting fair/poor SRH for a unit increase in average competence score, adjusted for equity indicators, i.e. sex, age and wealth index. Model 3 provides the odds ratio of reporting fair/poor SRH for a unit increase in average competence score, adjusted for equity indicators and sociodemographic variables, i.e. employment status, marital status and perceived accessibility of care.

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

Table 5.3: Odds Ratio[a] for Reporting Fair/Poor Self-Rated Health (Including Interactions)

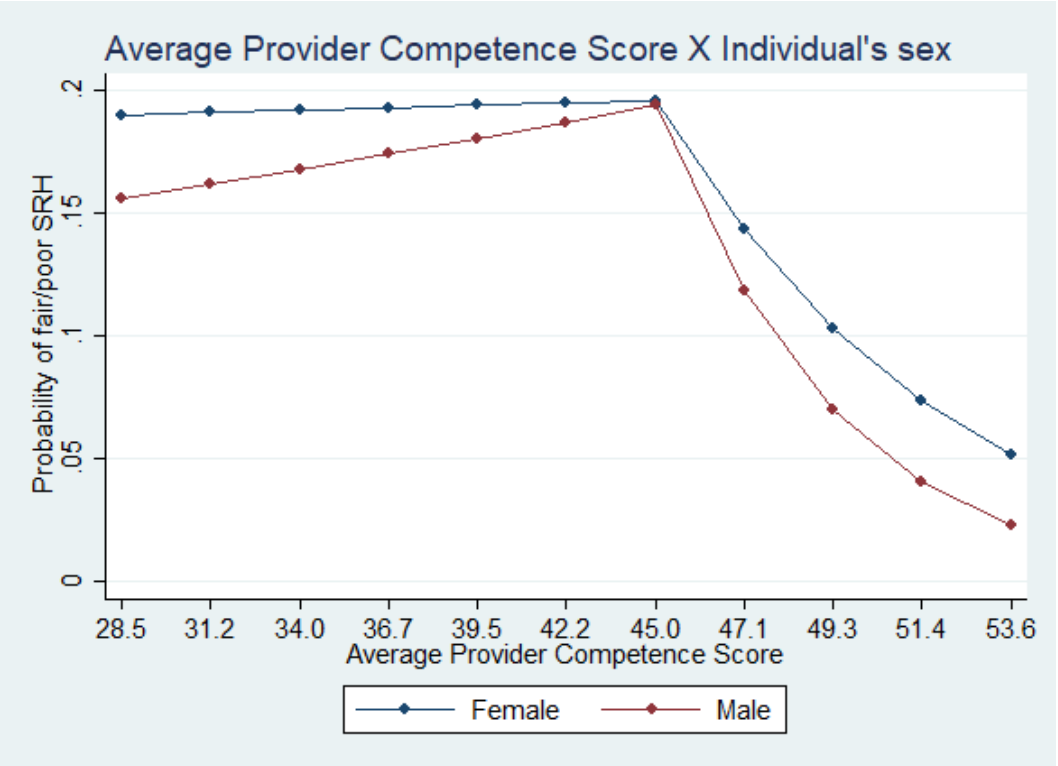
	Model 1[1]		***Model2[1]***	
Independent Variables	*Odds Ratio[a] [95% CI]*		*Odds Ratio[a] [95% CI]*	
Average Competence Score < 45	1.00	[0.93,1.08]	1.00	[0.93,1.08]
Average Competence Score > 45	0.73*	[0.56,0.94]	0.72*	[0.56,0.93]
Sex (ref: Female)				
Male	0.78**	[0.66,0.92]	0.87	[0.72,1.06]
Average Competence Score < 45 X Male	1.01	[0.98,1.05]	1.01	[0.98,1.05]
Average Competence Score > 45 X Male	0.89*	[0.81,0.99]	0.90	[0.81,1.00]
Age (decades)	1.12**	[1.04,1.20]	1.06	[0.94,1.19]
Age (decades) ^2	1.06***	[1.04,1.08]	1.07***	[1.04,1.10]
Average Competence Score < 45 X Age quartiles (ref: <= 15 yrs)				
Average Competence Score < 45 X [15 yrs - 39 yrs]	0.98	[0.94,1.02]	0.98	[0.94,1.02]
Average Competence Score > 45 X [15 yrs - 39 yrs]	1.18	[1.00,1.39]	1.17	[0.99,1.37]
Average Competence Score < 45 X [40 yrs – 59 yrs]	0.96	[0.91,1.01]	0.96	[0.91,1.01]
Average Competence Score > 45 X [40 yrs – 59 yrs]	1.29**	[1.07,1.55]	1.28**	[1.07,1.54]
Average Competence Score < 45 X [60 yrs - 95 yrs]	0.95	[0.89,1.01]	0.95	[0.89,1.01]
Average Competence Score > 45 X [60 yrs - 95 yrs]	1.38**	[1.13,1.68]	1.38**	[1.13,1.68]
Wealth index X 10	0.93	[0.86,1.01]	0.93	[0.86,1.01]
Average Competence Score < 45 X Wealth Index tertiles (ref: Wealth index X 10: 0-4)				
Average Competence Score < 45 X Wealth Index *10: 5	1.03	[0.95,1.11]	1.03	[0.95,1.11]
Average Competence Score > 45 X Wealth Index *10: 5	0.98	[0.79,1.22]	0.99	[0.79,1.23]
Average Competence Score < 45 X Wealth Index *10: 6-10	1.05	[0.98,1.13]	1.05	[0.98,1.13]
Average Competence Score > 45 X Wealth Index *10: 6-10	1.07	[0.88,1.31]	1.08	[0.88,1.32]
Marital status (ref: Not married)				
Married			1.38*	[1.05,1.83]
Employment status (ref: Unemployed/Retired)				
Employed			0.77*	[0.59,0.99]
Observations	5857		5857	

[a]Except highlighted interaction terms. [1]Model 1 includes interactions between average competence score and equity indicators, i.e. sex, age and wealth index. [2]Model 2 includes interactions between average competence score and equity indicators, adjusted for sociodemographic variables, i.e. employment status, marital status.

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

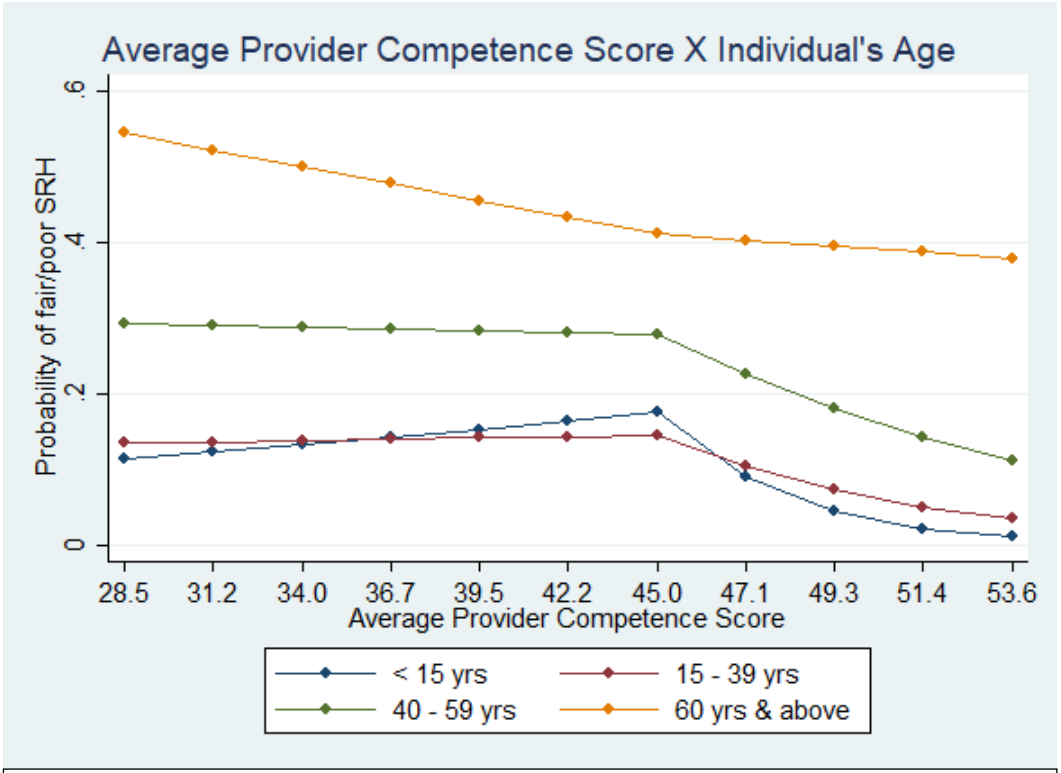
Figures for Chapter 5

Figure 5.1: Predictive Margins of Average vignette score X Sex



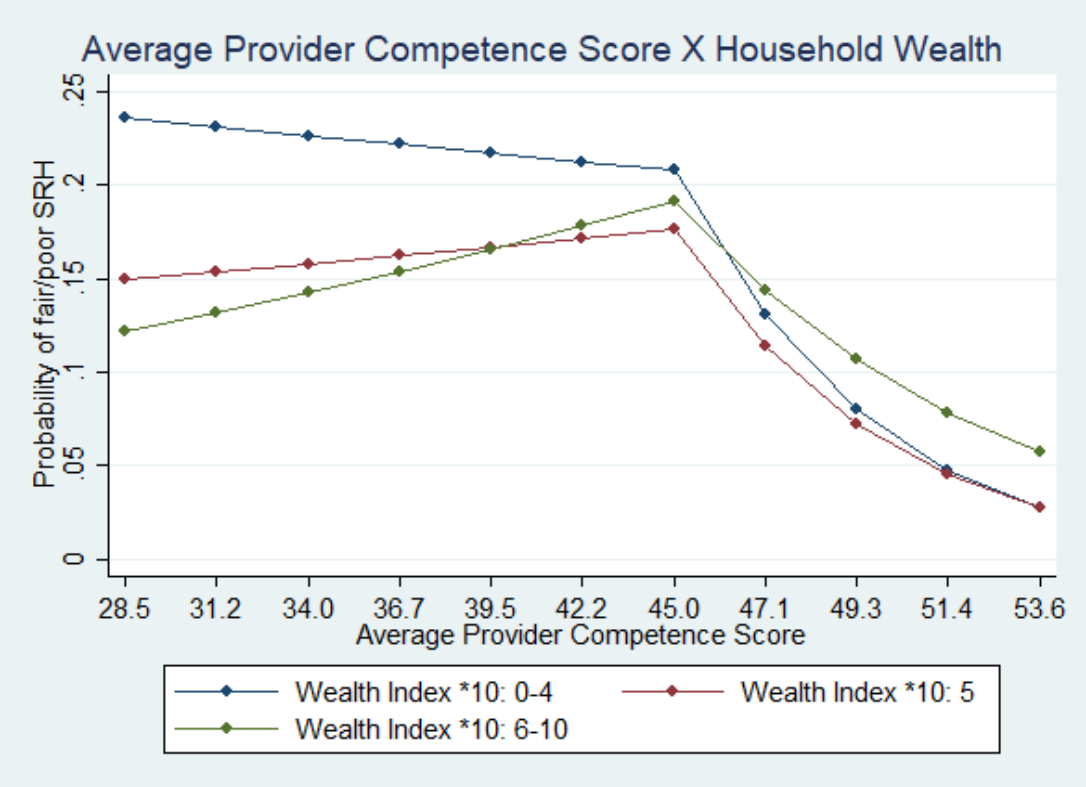
Note: Marginal effect plot based on mixed effects logistic regression modeling odds of poor SRH as function of average provider competence score, categorized versions of all equity indicators (sex, age and wealth), interactions between average provider competence score and equity indicators, marital status and employment status.

Figure 5.2: Predictive Margins of Average vignette score X Age



Note: Marginal effect plot based on mixed effects logistic regression modeling odds of poor SRH as function of average provider competence score, categorized versions of all equity indicators (sex, age and wealth), interactions between average provider competence score and equity indicators, marital status and employment status.

Figure 5.3: Predictive Margins of Average vignette score X Wealth



Note: Marginal effect plot based on mixed effects logistic regression modeling odds of poor SRH as function of average provider competence score, categorized versions of all equity indicators (sex, age and wealth), interactions between average provider competence score and equity indicators, marital status and employment status.

Chapter 6: Conclusion

To inform policies and reforms seeking to promote well-being and eliminate health inequities in all contexts, this dissertation focused on an often-cited necessity for population health and heath equity—primary care—by pursuing the following aims: 1) to conduct a scoping review that provides an updated synthesis of the literature on the impact of primary care features on health access inequities 2) to investigate (a) the association between primary care experience—i.e. the reported experience of patients with their primary care provider—and hospitalization for chronic ambulatory care sensitive conditions (ACSCs), and (b) the association between primary care experience and inequities in hospitalization for ACSCs among adults in rural Bihar, India; and 3) to investigate (a) the association between the association between the quality of local primary care—measured by the average competence of primary care providers in an individual's village—and an individual's self-rated health, and (b) the association between the quality of local primary care and potential inequities in SRH in rural Bihar, India.

The 1st aim was pursued by using the scoping review approach to synthesize the effects of primary care interventions and reforms on disadvantaged and advantaged populations on the 5 dimension of health access (approachability, acceptability, availability and accommodation, affordability and appropriateness), while highlighting the primary care features— first-contact access, continuity, comprehensiveness, coordination, family centeredness/orientation, cultural competence, and community orientation—enhanced by each primary care intervention and reform. Evidence gathered through the scoping review showed that interventions to enhance primary care features, for which there is evidence of their equity effects, target a wide variety of population groups from several countries of varying income levels, although the majority (59%) of interventions were from high- and upper middle-income countries. Additionally, interventions set in higher income countries cover a wider range of health services than those set in lower income countries, which were

solely focused on maternal and newborn health. Various study designs were used to evaluate equity effects of primary care intervention, including quantitative (experimental, quasi-experimental, and non-experimental) and qualitative studies. Interventions are largely associated improvements along the health access continuum for disadvantaged populations, oftentimes in ways that reduce health access inequities. Moreover, pro-equity effects often involve efforts that are targeted at disadvantaged populations. The review also highlighted a lingering need for more research on the impact of primary care on health equity and the impact of primary care on a wider variety of health challenges in lower income countries. The 2nd and 3rd aims sought to address research gaps identified by the scoping review by investigating the association between primary care experience and quality of local primary care—measured by the competence of primary care providers in a village—on chronic ACSCs and SRH, respectively, among residents of rural Bihar, India. These aims resulted in findings that speak to previous literature from even higher income settings. To address the 2nd aim, logistic regressions were used to model the odds of hospitalization as a function of primary care experience (PCE) score, adjusted for provider and patient characteristics, among adults with chronic ACSCs. Findings from the 2nd aim show that better primary care experience—in terms timeliness of access and a patient's satisfaction with their provider—is associated with reduced likelihood of hospitalization for chronic ACSCs among adults in rural Bihar, India. Additionally, individuals in the poorest quintile with better primary experience experienced the largest drop in the likelihood of hospitalization for a chronic ACSC, compared to higher wealth quintiles. This finding further supports the inference made in previous studies that quality primary care favors disadvantaged groups through the prevention and early detection of diseases caused by stressors that are associated with disadvantage. To address the 3rd aim, logistic regressions were used to model the odds of poor SRH—i.e. fair, poor or very poor SRH—as a function of a village's average provider competence and patient characteristics. Average provider competence was assessed using clinical vignettes, which evaluated a provider's competence with managing diarrhea and

pneumonia in children, and hypertension and angina in adults. Findings from the 3rd aim show the potential impact of limited access to quality primary care for disadvantaged groups. The study found that higher competence of nearby primary care providers is associated with better individual-level SRH but improvements in SRH are unevenly spread among groups. Women and older adults experience less improvement in SRH for every unit increase in average competence score above 45 (the observed threshold for average provider competence, after which SRH improvement are observed with every unit increase in competence) than men and younger individuals, respectively. This indicates possible limitations in access to care for these groups.

The findings from this dissertation have several policy implications. The association between better primary care experience and reduced likelihood of hospitalization for chronic ACSCs among adults in Bihar, India provides further support for the strengthening of Bihar's—and more widely, India's—primary care system, especially as the country grapples with the increasing burden of chronic conditions, like many other LMICs. The positive association between the average competence of nearby providers and good SRH after average provider competence attains a certain level also points to the importance of ensuring that primary care providers—public and private—can provide care at an adequate standard to promote the wellbeing of their patients. Since rural India's primary care market is largely private and informal, concerted effort to ensure the quality of formal and informal providers is critical. Additionally, findings, which indicate potential inequities in access by sex and age, highlight the need for further investigation into these inequities to inform health reforms to address them. Although this dissertation adds to the literature on primary care, as relates to health equity, in lower income countries, more of such studies are needed to evaluate the quality of primary care in these settings and to inform efforts to ensure that the benefits of good quality primary care are realized more widely.

To build on the findings of this dissertation, future studies can address certain limitations. Patient surveys that capture at least the four main features of primary care (first-contact

access, continuity, comprehensiveness, coordination) can be used to provide a more comprehensive measure of an individual's primary care experience. To further investigate the association between primary care experience and hospitalization for ACSCs, hospital records, where available, should be used to confirm reported hospitalization, rather than solely relying on a patient's recall. Additionally, evaluations of the effect of population-level measures of primary care quality can move beyond the realm of average provide competence to capture the practice of nearby providers using patient observations or standardized patients. Studies can also administer provider surveys that measure the performance of primary care attributes, in addition to management of commonly encountered diseases. To make causal inferences, Cohort studies can be used to evaluate primary care systems, comparing health outcomes among individuals who are exposed to varying levels of primary care quality. However, the feasibility of cohort studies relies on the availability of records needed to establish temporality. Such records may not be available in settings with poorly regulated health systems. Studies can also apply qualitative designs to further investigate the experiences of vulnerable populations with accessing primary care and to understand how and why certain vulnerable populations benefit more from quality primary care services as compared to more advantaged populations in resource-limited setting like Bihar, India.

References

1. Hone T, Macinko J, Millett C. Revisiting Alma-Ata: what is the role of primary health care in achieving the Sustainable Development Goals? *The Lancet*. 2018;392(10156):1461-1472. doi:10.1016/S0140-6736(18)31829-4
2. Declaration of Alma-Ata, International Conference on Primary Health Care, Alma-Ata, USSR, 6-12 September 1978. Published online 1978.
3. World Health Organization and the United Nations Children's Fund (UNICEF). *A Vision for Primary Health Care in the 21st Century: Towards Universal Health Coverage and the Sustainable Development*.; 2018.
4. World Health Organization. Building the economic case for primary health care: a scoping review. Published online 2018:28. https://www.who.int/docs/default-source/primary-health-care-conference/phc---economic-case.pdf?sfvrsn=8d0105b8_2
5. Starfield B, Shi L, Macinko J. Contribution of primary care to health systems and health. *Milbank Quarterly*. 2005;83(3):457-502. doi:10.1111/j.1468-0009.2005.00409.x
6. Andermann A. Taking action on the social determinants of health in clinical practice: A framework for health professionals. *CMAJ*. 2016;188(17-18):E474-E483. doi:10.1503/cmaj.160177
7. Macinko J, Starfield B, Shi L. Quantifying the health benefits of primary care physician supply in the United States. *International Journal of Health Services*. 2007;37(1):111-126. doi:10.2190/3431-G6T7-37M8-P224
8. Schreiber S, Zielinski T. The meaning of ambulatory care sensitive admissions: Urban and rural perspectives. *Journal of Rural Health*. 1997;13(4):276. doi:10.1111/j.1748-0361.1997.tb00970.x
9. Kruk ME, Porignon D, Rockers PC, Van Lerberghe W. The contribution of primary care to health and health systems in low- and middle-income countries: A critical review of major primary care initiatives. *Soc Sci Med*. 2010;70(6):904-911. doi:10.1016/j.socscimed.2009.11.025
10. Velema JP, Alihonou EM, Gandaho T, Hounye FH. Childhood mortality among users and non-users of primary health care in a rural West African community. *Int J Epidemiol*. 1991;20(2):474-479. doi:10.1093/ije/20.2.474
11. Cookson R, Mondor L, Asaria M, Kringos DS, Klazinga NS, Wodchis WP. Primary care and health inequality: Difference-in-difference study comparing England and Ontario. *PLoS One*. 2017;12(11). doi:10.1371/journal.pone.0188560
12. Gulliford MC. Availability of primary care doctors and population health in England: Is there an association? *J Public Health Med*. 2002;24(4):252-254. doi:10.1093/pubmed/24.4.252
13. Perry H, Robison N, Chavez D, et al. The census-based, impact-oriented approach: Its effectiveness in promoting child health in Bolivia. *Health Policy Plan*. 1998;13(2):140-151. doi:10.1093/heapol/13.2.140
14. Vapattanawong P, Hogan MC, Hanvoravongchai P, et al. Reductions in child mortality levels and inequalities in Thailand: analysis of two censuses. *Lancet*. 2007;369(9564):850-855. doi:10.1016/S0140-6736(07)60413-9
15. Mercer A, Khan MH, Daulatuzzaman M, Reid J. Effectiveness of an NGO primary health care programme in rural Bangladesh: Evidence from the management information system. *Health Policy Plan*. 2004;19(4):187-198. doi:10.1093/heapol/czh024

16. Shi L, Starfield B. The effect of primary care physician supply and income inequality on mortality among Blacks and Whites in US metropolitan areas. *Am J Public Health*. 2001;91(8):1246-1250. doi:10.2105/AJPH.91.8.1246
17. Shi L, Macinko J, Starfield B, et al. Primary care, infant mortality, and low birth weight in the states of the USA. *J Epidemiol Community Health (1978)*. 2004;58(5):374-380. doi:10.1136/jech.2003.013078
18. Shi L, Starfield B, Kennedy B, Kawachi I. Income Inequality, Primary Care, and Health Indicators. 1999;48(4).
19. Shi L, Starfield B, Politzer R, Regan J. Primary care, self-rated health, and reductions in social disparities in health. *Health Serv Res*. 2002;37(3):529-550. doi:10.1111/1475-6773.t01-1-00036
20. Marmot M, Bell R. The Sustainable Development Goals and Health Equity. *Epidemiology*. 2018;29(1):5-7. doi:10.1097/EDE.0000000000000773
21. Starfield B. State of the Art in Research on Equity in Health. *J Health Polit Policy Law*. 2006;31(1). https://read.dukeupress.edu/jhppl/article-pdf/31/1/11/358931/JHPPL031-01_04_StarfielFpp.pdf?casa_token=3zrYvExgRe8AAAAA:4Y3YeVyC1BnGFYoj2
22. Solar O, Irwin A. *A Conceptual Framework for Action on the Social Determinants of Health. Social Determinants of Health Discussion 2 (Policy and Practice)*.; 2010. http://apps.who.int/iris/bitstream/10665/44489/1/9789241500852_eng.pdf?ua=1&ua=1
23. Amouzou A, Kozuki N, Gwatkin DR. Where is the gap?: The contribution of disparities within developing countries to global inequalities in under-five mortality. *BMC Public Health*. 2014;14(1):1-5. doi:10.1186/1471-2458-14-216
24. Idler EL, Benyamini Y. Self-Rated Health and Mortality: A Review of Twenty-Seven Community Studies. *J Health Soc Behav*. 1997;38(1):21-37.
25. Government of India Ministry of Home Affairs. *Census*.; 2011.
26. Berman P, Bhawalkar M, Jha R. *Tracking Financial Resources for Primary Health Care in Bihar, India*.; 2017.
27. Dandona L, Dandona R, Kumar GA, et al. Nations within a nation: variations in epidemiological transition across the states of India, 1990–2016 in the Global Burden of Disease Study. *The Lancet*. 2017;390(10111):2437-2460. doi:10.1016/S0140-6736(17)32804-0
28. Kamath S, Kamath R, D'Souza B. An assessment of the public healthcare infrastructure deficiency in a district of Bihar state of India. *Postgrad Med J*. 2017;93(1105):710-711. doi:10.1136/postgradmedj-2017-135065
29. Chokshi M, Patil B, Khanna R, et al. Health systems in India. *Journal of Perinatology*. 2016;36(s3):S9-S12. doi:10.1038/jp.2016.184
30. International Institute for Population Sciences (IIPS) and ICF. *National Family Health Survey (NFHS-4), 2015-16: India*.; 2017. http://rchiips.org/NFHS/NFHS-4Reports/India.pdf
31. International Institute for Population Sciences (IIPS) and ICF. *National Family Health Survey (NFHS-4), India, 2015-16: Bihar*.; 2017. http://rchiips.org/nfhs/NFHS-4Reports/Bihar.pdf
32. CARE. Bihar Technical Support Program. Accessed August 18, 2023. https://www.care.org/our-work/health/strengthening-healthcare/bihar-technical-support-program/
33. Starfield B. *Primary Care: Balancing Health Needs, Services, and Technology* . Oxford University Press; 1998.

34. Van Doorslaer E, Masseria C, Koolman X. Inequalities in access to medical care by income in developed countries. *Cmaj*. 2006;174(2):177-183. doi:10.1503/cmaj.050584
35. Starfield B. Primary care: An increasingly important contributor to effectiveness, equity, and efficiency of health services. SESPAS report 2012. *Gac Sanit*. 2012;26(SUPPL.1):20-26. doi:10.1016/j.gaceta.2011.10.009
36. MacInko J, Starfield B, Erinosho T. The impact of primary healthcare on population health in low- and middle-income countries. *Journal of Ambulatory Care Management*. 2009;32(2):150-171. doi:10.1097/JAC.0b013e3181994221
37. Levesque JF, Harris M, Russell G. Patient-centred access to health care. *Int J Equity Health*. 2013;12(18):1-9.
38. Munn Z, Peters MDJ, Stern C, Tufanaru C, McArthur A, Aromataris E. Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Med Res Methodol*. 2018;18(1). doi:10.1186/s12874-018-0611-x
39. Garzón-Orjuela N, Samacá-Samacá DF, Luque Angulo SC, Mendes Abdala CV, Reveiz L, Eslava-Schmalbach J. An overview of reviews on strategies to reduce health inequalities. *Int J Equity Health*. 2020;19(1):1-11. doi:10.1186/s12939-020-01299-w
40. Schleiff M, Kumapley R, Freeman PA, Gupta S, Rassekh BM, Perry HB. Comprehensive review of the evidence regarding the effectiveness of community-based primary health care in improving maternal, neonatal and child health: 5. equity effects for neonates and children. *J Glob Health*. 2017;7(1). doi:10.7189/jogh.07.010905
41. Martinez LS, Lundgren L, Walter AW, et al. Behavioral health, primary care integration, and social work's role in improving health outcomes in communities of color: A systematic review. *J Soc Social Work Res*. 2019;10(3):441-457. doi:10.1086/704070
42. Handtke O, Schilgen B, Mösko M. Culturally competent healthcare – A scoping review of strategies implemented in healthcare organizations and a model of culturally competent healthcare provision. *PLoS One*. 2019;14(7). doi:10.1371/journal.pone.0219971
43. Lee-Tauler SY, Eun J, Corbett D, Collins PY. A systematic review of interventions to improve initiation of mental health care among racial-ethnic minority groups. *Psychiatric Services*. 2018;69(6):628-647. doi:10.1176/appi.ps.201700382
44. Costa A, Sousa CJ, Seabra PRC, et al. Effectiveness of social prescribing programs in the primary health-care context: A systematic literature review. *Sustainability (Switzerland)*. 2021;13(5):1-21. doi:10.3390/su13052731
45. Arat A, Burström B, Östberg V, Hjern A. Social inequities in vaccination coverage among infants and pre-school children in Europe and Australia - A systematic review. *BMC Public Health*. 2019;19(1). doi:10.1186/s12889-019-6597-4
46. Blanchard AK, Prost A, Houweling TAJ. Effects of community health worker interventions on socioeconomic inequities in maternal and newborn health in low-income and middle-income countries: A mixed-methods systematic review. *BMJ Glob Health*. 2019;4(3). doi:10.1136/bmjgh-2018-001308
47. Terens N, Vecchi S, Bargagli AM, et al. Quality improvement strategies at primary care level to reduce inequalities in diabetes care: An equity-oriented systematic review. *BMC Endocr Disord*. 2018;18(1). doi:10.1186/s12902-018-0260-4

48. Louart S, Bonnet E, Ridde V. Is patient navigation a solution to the problem of "leaving no one behind"? A scoping review of evidence from low-income countries. *Health Policy Plan*. 2021;36(1):101-116. doi:10.1093/heapol/czaa093
49. Tangcharoensathien V, Witthayapipopsakul W, Panichkriangkrai W, Patcharanarumol W, Mills A. Health systems development in Thailand: a solid platform for successful implementation of universal health coverage. *The Lancet*. 2018;391(10126):1205-1223. doi:10.1016/S0140-6736(18)30198-3
50. Yip W, Fu H, Chen AT, et al. 10 years of health-care reform in China: progress and gaps in Universal Health Coverage. *The Lancet*. 2019;394(10204):1192-1204. doi:10.1016/S0140-6736(19)32136-1
51. Nkhoma G, Lim CX, Kennedy G, Stupans I. Policies and initiatives/programs that promote health and self-care in asylum seekers living in high income countries: a narrative review. *Int J Hum Rights Healthc*. Published online 2021. doi:10.1108/IJHRH-09-2021-0165
52. Veritas Health Innovation. Covidence systematic review software.
53. Mannah MT, Warren C, Kuria S, Adegoke AA. Opportunities and challenges in implementing community based skilled birth attendance strategy in Kenya. *BMC Pregnancy Childbirth*. 2014;14(1). doi:10.1186/1471-2393-14-279
54. Limwattananon S, Tangcharoensathien V, Tisayaticom K, Boonyapaisarncharoen T, Prakongsai P. Why has the universal coverage scheme in Thailand achieved a pro-poor public subsidy for health care? In: *BMC Public Health*. Vol 12. ; 2012. doi:10.1186/1471-2458-12-S1-S6
55. Ayalon L, Areá PA, Linkins K, Lynch M, Estes CL. *Integration of Mental Health Services Into Primary Care Overcomes Ethnic Disparities in Access to Mental Health Services Between Black and White Elderly*.; 2007.
56. Ngo VK, Asarnow JR, Lange J, et al. Outcomes for Youths From Racial-Ethnic Minority Groups in a Quality Improvement Intervention for Depression Treatment. *PSYCHIATRIC SERVICES*. 2009;60(10).
57. Wells K, Sherbourne C, Schoenbaum M, et al. *Five-Year Impact of Quality Improvement for Depression Results of a Group-Level Randomized Controlled Trial*.
58. Areán PA, Ayalon L, Hunkeler E, et al. *Improving Depression Care for Older, Minority Patients in Primary Care*. Vol 43.; 2005.
59. Joo JH, Morales KH, De Vries HF, Gallo JJ. Disparity in use of psychotherapy offered in primary care between older African-American and white adults: Results from a practice-based depression intervention trial. *J Am Geriatr Soc*. 2010;58(1):154-160. doi:10.1111/j.1532-5415.2009.02623.x
60. Cheng IH, McBride J, Decker M, Watson T, Jakubenko H, Russo A. The Asylum Seeker Integrated Healthcare Pathway: A collaborative approach to improving access to primary health care in South Eastern Melbourne, Victoria, Australia. *Aust J Prim Health*. 2019;25(1):6-12. doi:10.1071/PY18028
61. Van De Venter E, Buller AM. Arts on referral interventions: A mixed-methods study investigating factors associated with differential changes in mental well-being. *Journal of Public Health (United Kingdom)*. 2015;37(1):143-150. doi:10.1093/pubmed/fdu028
62. Shi L. The Impact of Primary Care: A Focused Review. *Scientifica (Cairo)*. 2012;2012:1-22. doi:10.6064/2012/432892
63. Quayyum Z, Khan MNU, Quayyum T, Nasreen HE, Chowdhury M, Ensor T. "Can community level interventions have an impact on equity and utilization of maternal health care" - Evidence from rural Bangladesh. *Int J Equity Health*. 2013;12(1). doi:10.1186/1475-9276-12-22

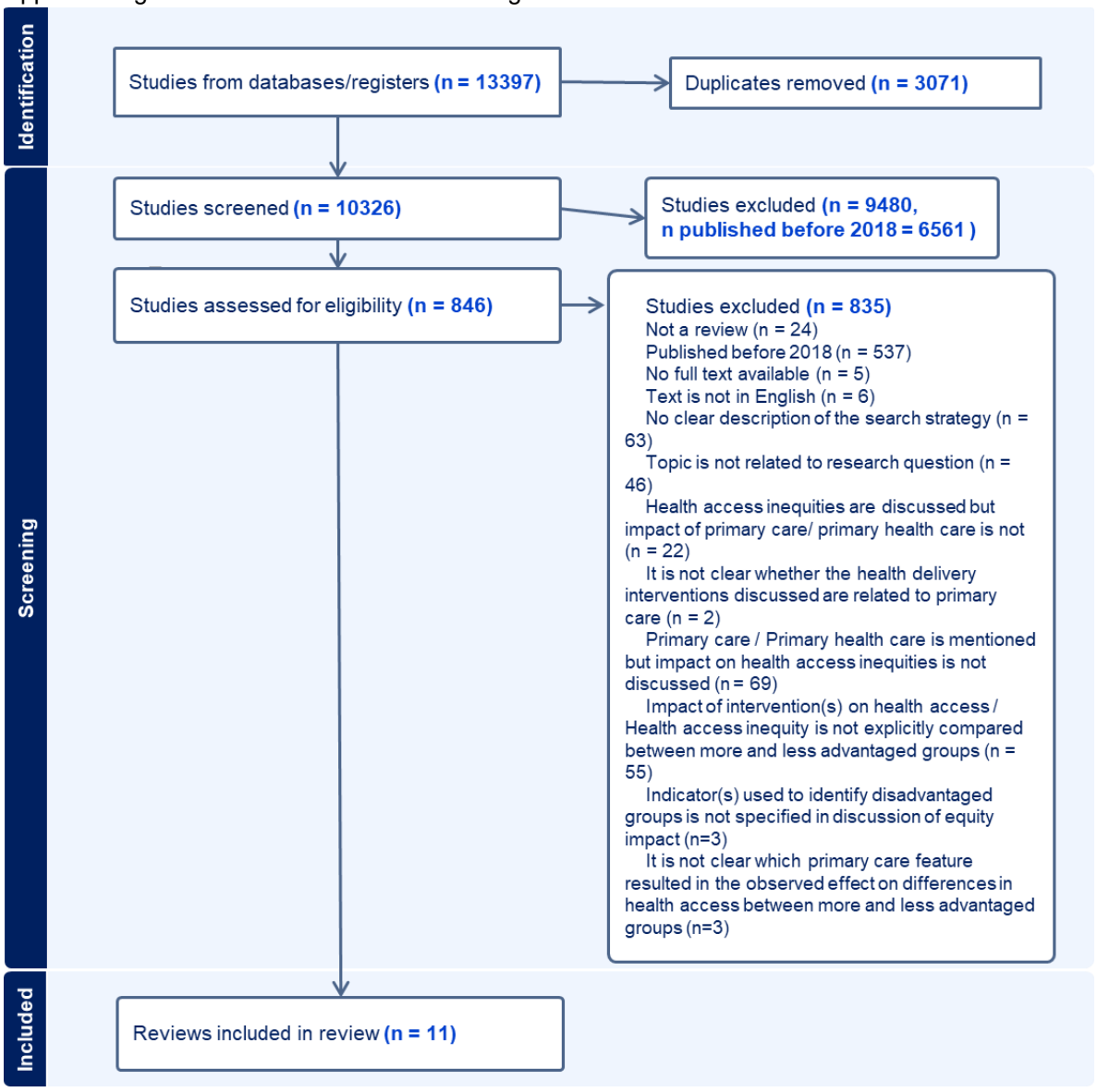
64. Tao W, Agerholm J, Burström B. The impact of reimbursement systems on equity in access and quality of primary care: A systematic literature review. *BMC Health Serv Res*. 2016;16(1):1-10. doi:10.1186/s12913-016-1805-8
65. World Health Organization. The top 10 causes of death. World Health Organization. Published December 9, 2020. https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death
66. Patel V, Parikh R, Nandraj S, et al. Assuring health coverage for all in India. *The Lancet*. 2015;386(10011):2422-2435. doi:10.1016/S0140-6736(15)00955-1
67. Browne K, Roseman D, Shaller D, Edgman-Levitan S. Analysis & commentary: Measuring patient experience as a strategy for improving primary care. *Health Aff*. 2010;29(5):921-925. doi:10.1377/hlthaff.2010.0238
68. Powell-Jackson T, Acharya A, Mills A. *An Assessment of the Quality of Primary Health Care in India*. Vol 48.; 2013.
69. Muenchberger H, Kendall E. *Determinants of Avoidable Hospitalization in Chronic Disease: Development of a Predictor Matrix*.; 2008.
70. Singh L, Goel R, Rai RK, Singh PK. Socioeconomic inequality in functional deficiencies and chronic diseases among older Indian adults: A sex-stratified cross-sectional decomposition analysis. *BMJ Open*. 2019;9(2):1-9. doi:10.1136/bmjopen-2018-022787
71. Hjelm L, Mathiassen A, Miller D, Wadhwa A. *VAM Guidance Paper: Creation of a Wealth Index*.; 2017.
72. Prabhakaran D, Jeemon P, Roy A. Cardiovascular Diseases in India: Current Epidemiology and Future Directions. *Circulation*. 2016;133(16):1605-1620. doi:10.1161/CIRCULATIONAHA.114.008729
73. Indian Council of Medical Research PHF of I and I for HM and E. *India: Health of the Nation's States: The India State-Level Disease Burden Initiative*.; 2017.
74. Rosano A, Loha CA, Falvo R, et al. The relationship between avoidable hospitalization and accessibility to primary care : a systematic review. 2012;23(3):356-360. doi:10.1093/eurpub/cks053
75. Kastor A, Mohanty SK. Disease-specific out-of-pocket and catastrophic health expenditure on hospitalization in India: Do Indian households face distress health financing? *PLoS One*. 2018;13(5). doi:10.1371/journal.pone.0196106
76. Roy K, Chaudhuri A. Influence of socioeconomic status, wealth and financial empowerment on gender differences in health and healthcare utilization in later life: evidence from India. *Soc Sci Med*. 2008;66(9):1951-1962. doi:10.1016/j.socscimed.2008.01.015
77. Akhtar SN, Saikia N. Differentials and predictors of hospitalisation among the elderly people in India: evidence from 75th round of National Sample Survey (2017-2018). *Working with Older People*. 2022;26(4):325-341. doi:10.1108/WWOP-11-2021-0055
78. Pandey A, Ploubidis GB, Clarke L, Dandona L. Hospitalisation trends in India from serial cross-sectional nationwide surveys: 1995 to 2014. *BMJ Open*. 2017;7(12). doi:10.1136/bmjopen-2016-014188
79. Shi L, Macinko J, Starfield B, Politzer R, Xu J. Primary care, race, and mortality in US states. *Soc Sci Med*. 2005;61(1):65-75. doi:10.1016/j.socscimed.2004.11.056
80. Harris M, Haines A. Brazil's Family Health Programme. *BMJ (Online)*. 2010;341(7784):1171. doi:10.1136/bmj.c4945
81. Hone T, Rasella D, Barreto ML, Majeed A, Millett C. Association between expansion of primary healthcare and racial inequalities in mortality amenable to primary care in

Brazil: A national longitudinal analysis. *PLoS Med*. 2017;14(5). doi:10.1371/journal.pmed.1002306
82. Ministry of Health and Family Welfare (MoHFW) and National Health Mission G of I. Ayushman Bharat - Health and Wellness Centre. https://ab-hwc.nhp.gov.in/
83. Kane S, Joshi M, Desai S, Mahal A, McPake B. People's care seeking journey for a chronic illness in rural India: Implications for policy and practice. *Soc Sci Med*. 2022;312. doi:10.1016/j.socscimed.2022.115390
84. Gulliford MC. Availability of primary care doctors and population health in England: is there an association? *J Public Health Med*. 2002;24(4):252-254.
85. Gulliford MC, Jack RH, Adams G, Ukoumunne OC. Availability and structure of primary medical care services and population health and health care indicators in England. *BMC Health Serv Res*. 2004;4:1-8. doi:10.1186/1472-6963-4-12
86. Idler EL, Kasp S V. *Self-Ratings of Health: Do They Also Predict Change in Functional Ability?* Vol 50.; 1995. https://academic.oup.com/psychsocgerontology/article/50B/6/S344/603904
87. Idler EL, Benyamini Y. *Self-Rated Health and Mortality: A Review of Twenty-Seven Community Studies*. Vol 38.; 1997.
88. Moss JL, Roy S, Clebak KT, et al. Area- and Individual-Level Correlates of Self-Rated Health: Implications for Geographic Health Disparities. *J Prim Care Community Health*. 2021;12. doi:10.1177/21501327211039715
89. Shi L, Starfield B. Primary care, income inequality, and self-rated health in the United States: A mixed-level analysis. *International Journal of Health Services*. 2000;30(3):541-555. doi:10.2190/N4M8-303M-72UA-P1K1
90. Wu YT, Prina M, Matthews F. The availability of local primary care services, satisfaction with health services and self-rated health in older English adults: A population-based study. *Prev Med Rep*. 2022;27. doi:10.1016/j.pmedr.2022.101786
91. Idler EL. *Discussion: Gender Differences in Self-Rated Health, in Mortality, and in the Relationship Between the Two*. Vol 43.; 2003. https://academic.oup.com/gerontologist/article/43/3/372/901179
92. Reyes-Gibby CC, Aday L, Cleeland C. *Impact of Pain on Self-Rated Health in the Community-Dwelling Older Adults*. www.elsevier.com/locate/pain
93. Pandey A, Ploubidis GB, Clarke L, Dandona L. Horizontal inequity in outpatient care use and untreated morbidity: Evidence from nationwide surveys in India between 1995 and 2014. *Health Policy Plan*. 2017;32(7):969-979. doi:10.1093/heapol/czx016
94. Santow G. *SOCIAL ROLES AND PHYSICAL HEALTH: THE CASE OF FEMALE DISADVANTAGE IN POOR COUNTRIES*. Vol 40.; 1995.
95. Das J, Daniels B, Ashok M, Shim EY, Muralidharan K. Two Indias: The structure of primary health care markets in rural Indian villages with implications for policy. *Soc Sci Med*. 2020;(June):112799. doi:10.1016/j.socscimed.2020.112799
96. Pulla P. India is Training 'Quacks' to Do Real Medicine. This is Why. *WIRE*. Published online November 3, 2015. https://thewire.in/government/india-is-training-quacks-to-do-real-medicine-this-is-why
97. Vaishnav LM, Joshi SH, Joshi AU, Mehendale AM. The National Programme for Health Care of the Elderly: A Review of its Achievements and Challenges in India. *Ann Geriatr Med Res*. 2022;26(3):183-195. doi:10.4235/agmr.22.0062

Appendix

Appendix for Chapter 3 (Aim 1)

Appendix Figure 3.1 : Article selection flow diagram



Search strategies

PubMed:

((((Primary Health Care[mesh] OR Primary Healthcare[tiab] OR Primary Health care[tiab] OR Primary Care[tiab] OR Family Practice[Mesh] OR Family Practice*[tiab] OR Family Practitioner*[tiab] OR General Practice[Mesh] OR "physicians, primary care"[MeSH] OR "General Practitioners" [Mesh] OR General Practice*[tiab] OR General Practitioner*[tiab] OR Family Medicine[tiab] OR Family Doctor*[tiab] OR Family Physician*[tiab] OR "continuity of patient care"[MeSH] OR "continuity of patient care"[tiab] OR continuity of care[tiab] OR continuity of healthcare[tiab] OR continuity of health care[tiab] OR "comprehensive health Care"[MeSH] OR ((first contact*[tiab] OR comprehensive*[tiab] OR coordinat*[tiab] OR co-ordinat*[tiab]) AND (care[tiab] OR healthcare[tiab] OR health care[tiab])))) OR ("Cultural Competency"[Mesh] OR "cultural competen*"[tiab] OR "culturally competen*"[tiab] OR "family center*"[tiab] OR "family centr*"[tiab] OR (family[tiab] AND orient*[tiab]) OR (community[tiab] AND orient*[tiab])))
AND
((Health Equity[mesh] OR ((health[tiab] OR healthcare[tiab]) AND Equit*[tiab]) OR health care inequit*[tiab] OR healthcare inequity*[tiab] OR health inequit*[tiab] OR "Healthcare Disparities"[Mesh] OR healthcare disparit*[tiab] OR health care disparit*[tiab] OR "Health Services Accessibility"[Mesh:NoExp] OR “Health Services Accessibility” [tiab] OR Access to Health Care[tiab] OR Health Services Availability[tiab])))
AND
(Cochrane Database Syst Rev[Ta] OR Search*[tiab] OR Meta-Analysis[Pt] OR Medline[tiab] OR evidence[tiab] OR Review[tiab] OR systematic[sb] OR scoping[ti])

Embase

#9. #7 AND #8
#8. [review]/lim OR [cochrane review]/lim OR [systematic review]/lim OR [meta analysis]/lim OR search*:ti,ab OR medline:ti,ab OR evidence:ti,ab OR review:ti,ab OR scoping:ti
#7. #3 AND #6
#6. #4 OR #5
#5. 'health care access'/de OR 'health services accessibility':ti,ab OR 'access to health care':ti,ab OR 'health services availability':ti,ab
#4. 'health equity'/exp OR 'health care disparity'/exp OR ((health OR healthcare OR 'health care') NEAR/5 equit*) OR 'health care inequit*':ti,ab,kw OR 'healthcare inequit*':ti,ab,kw OR 'health inequit*':ti,ab,kw OR 'healthcare disparit*':ti,ab,kw OR 'health care disparit*':ti,ab,kw
#3. #1 OR #2
#2. 'cultural competence'/exp OR 'cultural competen*':ti,ab OR 'culturally competen*':ti,ab OR 'family center*':ti,ab OR 'family centr*':ti,ab OR (family NEAR/3 orient*) OR (community NEAR/3 orient*)
#1. 'primary health care'/exp OR 'general practice'/exp OR 'primary healthcare':ti,ab,kw OR 'primary health care':ti,ab,kw OR 'primary care':ti,ab,kw OR 'family practice*':ti,ab,kw OR 'family practitioner*':ti,ab,kw OR 'general practice*':ti,ab,kw OR 'general practitioner*':ti,ab,kw OR 'family medicine':ti,ab,kw OR 'family doctor*':ti,ab,kw OR 'family physician*':ti,ab,kw OR 'continuity of care':ti,ab,kw OR 'continuity of healthcare':ti,ab,kw OR 'continuity of health care':ti,ab,kw OR (('first contact*' OR comprehensiv* OR coordinat* OR 'co ordinat*') NEAR/3 (care OR healthcare OR 'health care'))

Cochrane:

#1 MeSH descriptor: [Primary Health Care] explode all trees
#2 ("Primary Healthcare" OR "Primary Health care" OR "Primary Care"):ti,ab,kw
#3 MeSH descriptor: [Family Practice] explode all trees
#4 ("Family Practice*" OR "Family Practitioner*"):ti,ab,kw
#5 MeSH descriptor: [General Practice] explode all trees
#6 MeSH descriptor: [General Practitioners] explode all trees
#7 MeSH descriptor: [Physicians, Primary Care] explode all trees
#8 ("General Practice*" OR "General Practitioner*" OR "Family Medicine" OR "Family Doctor*" OR "Family Physician*"):ti,ab,kw
#9 MeSH descriptor: [Continuity of Patient Care] explode all trees
#10 ("continuity of patient care" OR "continuity of care" OR "continuity of healthcare" OR "continuity of health care"):ti,ab,kw
#11 MeSH descriptor: [Comprehensive Health Care] explode all trees
#12 ((("first contact*" OR comprehensive* OR coordinat* OR co-ordinat*) AND (care OR healthcare OR "health care"))):ti,ab,kw
#13 MeSH descriptor: [Cultural Competency] explode all trees
#14 ("cultural competen*" OR "culturally competen*" OR "family center*" OR "family centr*" OR (family AND orient*) OR (community AND orient*)):ti,ab,kw
#15 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14
#16 MeSH descriptor: [Health Equity] explode all trees
#17 (((health OR healthcare) AND Equit*) OR "health care inequit*" OR "healthcare inequit*" OR "health inequit*"):ti,ab,kw
#18 MeSH descriptor: [Healthcare Disparities] explode all trees
#19 ("healthcare disparit*" OR "health care disparit*"):ti,ab,kw
#20 MeSH descriptor: [Health Services Accessibility] this term only
#21 (“Health Services Accessibility” OR "Access to Health Care" OR "Health Services Availability"):ti,ab,kw
#22 #16 OR #17 OR #18 OR #19 OR #20 OR #21
#23 #15 AND #22

Scopus:

((((TITLE-ABS-KEY ("primary health care" OR "primary healthcare" OR "primary care" OR "family practice*" OR "family practitioner*" OR "general practice*" OR "general practitioner*" OR "family medicine" OR "family doctor*" OR "family physician*" OR "continuity of care" OR "continuity of healthcare" OR "continuity of health care")) OR (TITLE-ABS-KEY (("first contact*" W/5 care) OR (comprehensiv* W/5 care) OR (coordinat* W/5 care) OR ("co ordinat*" W/5 care) OR ("first contact*" W/5 healthcare) OR (comprehensiv* W/5 healthcare) OR (coordinat* W/5 healthcare) OR ("co ordinat*" W/5 healthcare) OR ("first contact*" W/5 "health care") OR (comprehensiv* W/5 "health care") OR (coordinat* W/5 "health care") OR ("co ordinat*" W/5 "health care"))) OR (TITLE-ABS-KEY (("cultural competen*" OR "culturally competen*" OR "family center*" OR "family centr*" OR (family W/5 orient*) OR (community W/5 orient*))))))
AND
((TITLE-ABS-KEY ("health equity" OR "health care disparity" OR "health care inequit*" OR "healthcare inequit*" OR "health inequit*" OR "healthcare disparit*" OR "health care disparit*")) OR (TITLE-ABS-KEY ((health W/5 equit*) OR (healthcare W/5 equit*)

OR ("health care" W/5 equit*))) OR (TITLE-ABS-KEY ("Health Services Accessibility" OR "Access to Health Care" OR "Health Services Availability"))))
AND
((SRCTITLE ("Cochrane Database of Systematic Reviews")) OR (TITLE-ABS (search* OR meta-analysis OR medline OR evidence OR review OR systematic OR scoping)))

WHO Regional:
620 English hits from Numeric search string, searched in Subject descriptor:
N04.590.233.727$ OR SP2.001.002$ OR SP2.122.107$ OR SP4.002.130$ OR H02.403.340.500$ OR H02.403.340 OR M01.526.485.810.800$ OR N02.360.810.795$ OR E02.760.169$ OR N02.421.585.169$ OR N04.590.233.727.210$ OR N04.590.233$ OR SP2.122$ OR SP9.160.030.010.010.020$ OR I01.880.853.100.364$
AND
N04.590.374.350.500$ OR N05.300.430.383$ OR SP1.001.042$ OR SP9.020.010.005.020$ OR N04.590.374.380$ OR N05.300.493$ OR N04.590.374.350$ OR N05.300.430$ OR SP1.001.032$ OR SP9.020.010.005$
11 English Text string, searched in “title, abstract, subject”:
"primary health care" OR "primary healthcare" OR "primary care" OR "family practice" OR "family practices" OR "family practitioner" OR "family practitioners" OR "general practice" OR "general practices" OR "general practitioner" OR "general practitioners" OR "family medicine" OR "family doctor" OR "family doctors" OR "family physician" OR "family physicians" OR "continuity of care" OR "continuity of healthcare" OR "continuity of health care" OR "first contact" OR “coordination of care” OR co-ordination of care” OR “comprehensive healthcare” OR “coordination of healthcare” OR “co-ordination of healthcare” OR “comprehensive health care" OR “coordination of health care" OR "co-ordination of health care" OR "cultural competency" OR "cultural competencies" OR "culturally competent" OR "family centered" OR "family centred" OR “family oriented” OR “community oriented”
AND
"health equity" OR "health care disparity" OR "health care inequity" OR "health care inequities" OR "healthcare inequity" OR "healthcare inequities" OR "health inequity" OR "health inequities" OR "healthcare disparity" OR "healthcare disparities" OR "health care disparity" OR "health care disparities" OR "Health Services Accessibility" OR "Access to Health Care" OR "Health Services Availability"
Numeric descriptors and their English Equivalents, by concept:
Primary Health Care
N04.590.233.727$ OR
SP2.001.002$ OR
SP2.122.107$ OR
SP4.002.130$ OR
Family Practice
H02.403.340.500$ OR
General Practice
H02.403.340
Physicians, primary care
M01.526.485.810.800
N02.360.810.795
General Practitioners

M01.526.485.810.485
N02.360.810.485
Continuity of patient care
E02.760.169
N02.421.585.169
N04.590.233.727.210
Comprehensive health care
N04.590.233
SP2.122
SP9.160.030.010.010.020
Cultural competency
I01.880.853.100.364

Second concept
Health Equity
N04.590.374.350.500
N05.300.430.383
SP1.001.042
SP9.020.010.005.020
Healthcare Disparities
N04.590.374.380
N05.300.493
Health Services Accessibility (no explode)
N04.590.374.350
N05.300.430
SP1.001.032
SP9.020.010.005

Appendix for Chapter 4 (Aim 2)

Full data analysis results (Supplementary tables)

Appendix Table 4.1: SES and Caste validation

	Education level			
	No schooling/ Urdu class	**Completed at least Primary**	**N**	**P-value**
	%	%		
Total	52.9	47.1	1,681	
Wealth quintiles				<.001
Less than 20	71.6	28.4	317	
20-40	60.7	39.3	318	
40-60	53.6	46.4	358	
60-80	55.8	44.2	269	
Greater than 80	30.5	69.5	419	
Caste				<.001
SC/ST	68	32	303	
OBC	58.1	41.9	1,034	
General	24.1	75.9	344	

Appendix Table 4.2: Ever Hospitalized vs Primary Care Experience, Logistic Regression (Odds Ratio (OR)[1])

	(1)	(2)
-LL	-562.41	-561.05
AIC	1168.82	1180.10
BIC	1286.53	1335.27
Observations	1557	1557
	OR$_{(se)}$	**OR$_{(se)}$**
PCE score (ref: 2-6)		
7/8	0.64$_{(0.12)}$*	0.47$_{(0.25)}$
USC type (ref: Public)		
Private	1.01$_{(0.25)}$	0.99$_{(0.25)}$
Chronic ACSC (ref: ASTH/COPD)		
CHD	2.45$_{(0.56)}$***	2.48$_{(0.56)}$***
DM	0.68$_{(0.18)}$	0.70$_{(0.18)}$
HTN	0.63$_{(0.14)}$*	0.64$_{(0.15)}$*
Sex (ref: Female)		
Male	1.47$_{(0.31)}$	1.43$_{(0.35)}$
7/8 X Male		1.08$_{(0.43)}$
Wealth quintile (ref: Less than 20)		
20-40	1.42$_{(0.41)}$	1.19$_{(0.39)}$
7/8 X 20-40		1.90$_{(1.00)}$
40-60	0.89$_{(0.25)}$	0.75$_{(0.25)}$
7/8 X 40-60		1.93$_{(1.23)}$
60-80	1.26$_{(0.35)}$	1.18$_{(0.38)}$
7/8 X 60-80		1.31$_{(0.79)}$
Greater than 80	1.40$_{(0.41)}$	1.16$_{(0.40)}$
7/8 X Greater than 80		1.96$_{(1.12)}$
Caste (ref: SC/ST)		
OBC	0.76$_{(0.16)}$	0.84$_{(0.22)}$
7/8 X OBC		0.73$_{(0.31)}$
General	0.84$_{(0.23)}$	0.90$_{(0.30)}$
7/8 X General		0.88$_{(0.51)}$
Has another chronic ACSC (ref: No)		
Yes	1.35$_{(0.24)}$	1.35$_{(0.24)}$
Age (centered)	1.01$_{(0.0070)}$	1.01$_{(0.0070)}$
Marital status (ref: Unmarried/Previously Married)		
Married	0.85$_{(0.18)}$	0.87$_{(0.19)}$
Education level (ref: None/Urdu class)		
Completed at least Primary	0.81$_{(0.15)}$	0.80$_{(0.15)}$
Employment status (ref: Unemployed/Retired)		
Employed	0.96$_{(0.19)}$	0.95$_{(0.19)}$
Currently smokes tobacco (ref: No)		
Yes	0.81$_{(0.15)}$	0.81$_{(0.16)}$
Religion (ref: Non-Hindu)		
Hindu	1.29$_{(0.35)}$	1.30$_{(0.35)}$
Family enrolled in health expense support scheme (ref: No)		
Yes	1.28$_{(0.23)}$	1.27$_{(0.23)}$
Months since ACSC diagnosis	1.00$_{(0.0011)}$	1.00$_{(0.0011)}$

[1]Except highlighted interaction terms, which are quotients of odds ratios
se = standard error

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

Appendix Table 4.3: Ever Hospitalized vs Primary Care Experience, Mixed Effect Logistic Regression (Odds Ratio (OR)[1])

	(1)	(2)	(3)	(4)	(5)	(6)
Observations	1642	1642	1557	1642	1642	1557
	OR(se)	**OR(se)**	**OR(se)**	**OR(se)**	**OR(se)**	**OR(se)**
PCE score (ref: 2-6)						
7/8	0.62(0.13)*	0.64(0.13)*	0.60(0.13)*	0.39(0.24)	0.37(0.23)	0.43(0.28)
USC type (ref: Public)						
Private	1.06(0.31)	1.04(0.31)	1.09(0.34)	1.04(0.31)	1.02(0.31)	1.07(0.33)
Chronic ACSC (ref: ASTH/COPD)						
CHD	2.87(0.87)***	2.80(0.86)***	3.09(0.99)***	2.93(0.89)***	2.86(0.88)***	3.16(1.03)***
DM	0.62(0.18)	0.60(0.18)	0.65(0.20)	0.63(0.19)	0.61(0.19)	0.66(0.21)
HTN	0.56(0.15)*	0.55(0.15)*	0.59(0.17)	0.56(0.15)*	0.56(0.15)*	0.60(0.17)
Sex (ref: Female)						
Male	1.24(0.22)	1.14(0.21)	1.58(0.46)	1.23(0.27)	1.12(0.25)	1.55(0.49)
7/8 X Male				1.05(0.41)	1.09(0.43)	1.10(0.46)
Wealth quintile (ref: Less than 20)						
20-40	1.75(0.52)	1.73(0.52)	1.61(0.50)	1.45(0.51)	1.40(0.50)	1.34(0.49)
7/8 X 20-40				1.94(1.29)	2.09(1.40)	1.91(1.31)
40-60	1.05(0.32)	1.09(0.33)	0.92(0.30)	0.77(0.28)	0.79(0.29)	0.74(0.28)
7/8 X 40-60				2.94(2.00)	3.00(2.05)	2.23(1.60)
60-80	1.32(0.43)	1.33(0.43)	1.38(0.47)	1.12(0.43)	1.11(0.43)	1.26(0.51)
7/8 X 60-80				1.84(1.32)	1.91(1.37)	1.43(1.05)
Greater than 80	1.45(0.43)	1.41(0.42)	1.51(0.48)	1.09(0.38)	1.04(0.37)	1.17(0.44)
7/8 X Greater than 80				2.66(1.77)	2.83(1.90)	2.43(1.66)
Caste (ref: SC/ST)						
OBC	0.73(0.18)	0.72(0.17)	0.75(0.19)	0.82(0.25)	0.81(0.25)	0.87(0.28)
7/8 X OBC				0.71(0.35)	0.71(0.35)	0.66(0.34)
General	0.75(0.23)	0.70(0.21)	0.83(0.27)	0.84(0.31)	0.78(0.29)	0.93(0.37)
7/8 X General				0.74(0.48)	0.74(0.49)	0.76(0.52)
Has another chronic ACSC (ref: No)						
Yes		1.32(0.27)	1.45(0.31)		1.33(0.28)	1.46(0.32)
Age (centered)		1.01(0.0074)	1.01(0.0086)		1.01(0.0074)*	1.01(0.0087)
Marital status (ref: Unmarried/Previously Married**)**						
Married			0.81(0.21)			0.82(0.21)
Education level (ref: None/Urdu class)						
Completed at least Primary			0.77(0.18)			0.76(0.18)
Employment status (ref: Unemployed/Retired)						
Employed			0.96(0.24)			0.95(0.24)
Currently smokes tobacco (ref: No)						
Yes			0.77(0.19)			0.77(0.19)
Religion (ref: Non-Hindu)						
Hindu			1.36(0.43)			1.37(0.44)
Family enrolled in health expense support scheme (ref: No)						
Yes			1.39(0.32)			1.38(0.32)
Months since ACSC diagnosis			1.00(0.0013)			1.00(0.0013)

[1]Except highlighted interaction terms, which are quotients of odds ratios
se = standard error

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

Appendix Table 4.4: Ever Hospitalized (stratified by PCE score), Mixed Effects Logistic Regression (Odds Ratio (OR))

	(1)	*p*	(2)	*p*
	OR$_{(se)}$		**OR$_{(se)}$**	
USC type (ref: Public)				
Private	0.94$_{(0.33)}$		0.99$_{(0.76)}$	
Chronic ACSC (ref: ASTH/COPD)				
CHD	3.25$_{(1.30)}$**		2.62$_{(1.57)}$	
DM	0.72$_{(0.27)}$		0.31$_{(0.21)}$	
HTN	0.50$_{(0.18)}$		0.58$_{(0.27)}$	
Sex (ref: Female)		0.77		0.30
Male	1.07$_{(0.25)}$		1.45$_{(0.52)}$	
Wealth quintile (ref: Less than 20)		0.64		0.47
20-40	1.44$_{(0.55)}$		2.75$_{(1.67)}$	
40-60	0.79$_{(0.31)}$		2.37$_{(1.49)}$	
60-80	1.13$_{(0.46)}$		2.13$_{(1.38)}$	
Greater than 80	1.00$_{(0.38)}$		2.94$_{(1.82)}$	
Caste (ref: SC/ST)		0.79		0.43
OBC	0.80$_{(0.26)}$		0.59$_{(0.25)}$	
General	0.80$_{(0.32)}$		0.58$_{(0.35)}$	
Has another chronic ACSC (ref: No)				
Yes	1.46$_{(0.38)}$		1.06$_{(0.45)}$	
Age (centered)	1.02$_{(0.0098)}$*		1.00$_{(0.014)}$	
Observations	1017		625	

Model (1) includes only observations with PCE score 2- 6. Model (2) includes only observations with PCE score 7/8; se = standard error

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

Appendix Table 4.5: Ever Hospitalized (stratified by Caste), Mixed effects Logistic Regression (Odds Ratio (OR))

	(1)	(2)	(3)
	OR$_{(se)}$	**OR$_{(se)}$**	**OR$_{(se)}$**
PCE score (ref: 2-6)			
7/8	0.82$_{(0.30)}$	0.59$_{(0.15)}$*	0.57$_{(0.30)}$
USC type (ref: Public)			
Private	1.78$_{(1.12)}$	0.77$_{(0.27)}$	1.49$_{(1.35)}$
Chronic ACSC (ref: ASTH/COPD)			
CHD	2.82$_{(1.47)}$*	2.49$_{(1.03)}$*	2.66$_{(2.02)}$
DM	0.26$_{(0.18)}$	1.00$_{(0.38)}$	0.25$_{(0.20)}$
HTN	0.43$_{(0.22)}$	0.73$_{(0.26)}$	0.31$_{(0.21)}$
Sex (ref: Female)			
Male	1.05$_{(0.40)}$	1.58$_{(0.37)}$	0.53$_{(0.23)}$
Wealth quintile (ref: Less than 20)			
20-40	1.56$_{(0.84)}$	1.93$_{(0.73)}$	0.75$_{(0.73)}$
40-60	1.19$_{(0.62)}$	0.97$_{(0.38)}$	1.32$_{(1.13)}$
60-80	2.51$_{(1.50)}$	1.18$_{(0.49)}$	0.48$_{(0.45)}$
Greater than 80	0.60$_{(0.46)}$	1.24$_{(0.47)}$	1.83$_{(1.35)}$
Has another chronic ACSC (ref: No)			
Yes	1.56$_{(0.62)}$	1.27$_{(0.34)}$	1.08$_{(0.50)}$
Age (centered)	1.03$_{(0.017)}$	1.00$_{(0.0087)}$	1.06$_{(0.021)}$**
Observations	297	1008	337

Model (1) only includes observations in the SC/ST caste. Model (2) only includes observations in the OBC caste. Model (3) only includes observations in the General caste. se = standard error

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

Appendix Table 4.6: Ever Hospitalized (stratified by Sex), Mixed effects Logistic Regression (Odds Ratio (OR))

	(1)	(2)
	OR$_{(se)}$	**OR$_{(se)}$**
PCE score (ref: 2-6)		
7/8	0.54$_{(0.18)}$	0.68$_{(0.22)}$
USC type (ref: Public)		
Private	1.59$_{(0.88)}$	0.71$_{(0.30)}$
Chronic ACSC (ref: ASTH/COPD)		
CHD	2.79$_{(1.41)}$*	3.71$_{(2.01)}$*
DM	0.66$_{(0.34)}$	0.47$_{(0.22)}$
HTN	0.54$_{(0.25)}$	0.46$_{(0.20)}$
Wealth quintile (ref: Less than 20)		
20-40	2.20$_{(1.06)}$	1.39$_{(0.71)}$
40-60	1.04$_{(0.50)}$	1.04$_{(0.51)}$
60-80	1.14$_{(0.58)}$	1.64$_{(0.87)}$
Greater than 80	1.44$_{(0.69)}$	1.31$_{(0.63)}$
Caste (ref: SC/ST)		
OBC	0.54$_{(0.21)}$	0.94$_{(0.39)}$
General	0.84$_{(0.40)}$	0.55$_{(0.28)}$
Has another chronic ACSC (ref: No)		
Yes	1.38$_{(0.47)}$	1.28$_{(0.42)}$
Age (centered)	1.01$_{(0.012)}$	1.02$_{(0.012)}$
Observations	902	740

Model (1) only includes observations from women. Model (2) only includes observations from men. se = standard error

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

Subanalysis results

Bivariate analyses (Appendix Table 4.7) show that this subgroup retained many of the characteristics of the full sample, as expected since only 9% of the full sample was excluded from the subanalysis. On average, chronic ACSC instances resulting in hospitalization were linked with more visits to a health provider in the past year than those that didn't result in hospitalization (5 visits vs. 4 visits, p=0.027). Like the full sample, chronic ACSC instances resulting in hospitalization were also experienced by a slightly older group (59 years vs. 57 years) and by people who had been diagnosed for a longer period of time (6.6 years vs. 5.9 years), though these differences lost their statistical significance. Unlike the full same, the likelihood of hospitalization is equivalent among instances experienced by people with and without formal education. Other characteristics of this subgroup are the same as the full sample, in terms of comparison between and among sub-categories and statistical significance.

Logistic regressions (without interaction)

Modeling the odds of ever being hospitalized for a chronic ACSC as a function of PCE score using logistic regressions shows that a higher PCE score (7/8) is still associated with a lower odds of hospitalization, after adjusting for key variables and potential confounders, including the number of visits to a health provider in the past year. Chronic ACSC instances managed by USCs with a higher PCE score had 0.68 (95% CI: 0.48-0.96) times lower odds of resulting in hospitalization than those managed by USCs with a lower PCE score (2-6), adjusting for USC type, type of chronic ACSC, sex, wealth quintile, caste, whether the patient had more than 1 chronic ACSC, patient's religion and age, and the number of visits to a health provider for the chronic ACSC in the past year ($p<0.05$, Appendix Table 4.8 Model 2). This association remains largely similar after adjusting for only key variables (Appendix Table 4.8 Model 1), and after adjusting for key variables and all potential confounders that were considered (Appendix Table 4.8 Model 3). Among all combinations of

potential confounders, patient's religion and age, whether the patient had more than 1 chronic ACSC and the number of visits to a health provider for the chronic ACSC in the past year resulted in the logistic regression with the lowest AIC. The association between PCE score and the odds of ever being hospitalized for a chronic ACSC also remain largely similar when modeled using mixed effects logistic regressions (Appendix Table 4.9, Models 1-3). Considering the equity indicators, results from logistic and mixed effect logistic regressions (Appendix Tables 4.8 & 4.9) still show no statistically significant association between the odds of ever being hospitalized for a chronic ACSC and any of these variables, after adjusting for key variables and potential confounders. Results of the logistic regression with the lowest AIC (Appendix Table 4.8 Model 2) show that chronic ACSCs experienced by men have 1.14 (95% CI: 0.83 – 1.58) times higher odds of resulting in hospitalization than those experienced by women. The odds of hospitalization still does not appear to follow a gradient by wealth quintile or caste. Chronic ACSCs experienced by individuals from the 2nd poorest wealth quintile (20% - 40%) still had the highest odds of resulting in hospitalization—1.52 times (95% CI: 0.87-2.66) higher than those of the reference group (poorest wealth quintile)—followed by those experienced by the richest quintile, which had 1.29 times (95% CI: 0.74-2.26) higher odds of resulting in hospitalization than the reference group. Among caste categories, chronic ACSCs experienced by individuals from the SC/ST (reference group) still had the highest odds of resulting in hospitalization, but now followed by those of the OBC caste, which had 0.81 times (95% CI: 0.54-1.24) lower odds of resulting in hospitalization than the reference group.

Logistic regressions (with interactions)

As with the full sample, none of the interaction terms between PCE score and the equity indicators were statistically significant in the logistic and mixed effect logistic regressions (Appendix Table 4.8, Models 4-6 & 4.9, Models 4-6). At higher PCE scores (7 or 8), the odds ratios of ever hospitalization decreased slightly (0.99 (95% CI: 0.46-2.14) times lower) between men and women (reference group)—unlike in the full sample analyses where the

odds ratio increased—adjusting for USC type, type of chronic ACSC, wealth quintile, caste, whether the patient had more than 1 chronic ACSC, patient's religion and age, and the number of visits to a health provider for the chronic ACSC in the past year (Appendix Table 4.8, Model 5). As in the full sample analysis, the odds ratios of ever hospitalization decreased among caste categories (as compared to SC/ST (reference group)) while they increased among wealth quintiles (as compared to the poorest quintile (reference group)), while adjusting for the same set of predictors mentioned previously.

Stratified logistic regressions

As with the full sample, stratified logistic regressions were carried out for each level of PCE score and equity indicator, while adjusting for other key predictors and potential confounders included in the logistic regression with the lowest AIC.

Considering stratification by PCE score (Appendix Table 4.10), the association between the odds of ever being hospitalized for a chronic ACSC and all 3 equity indicators is still not statistically significant at lower or higher PCE scores, adjusting for USC type, type of chronic ACSC, whether the patient had more than 1 chronic ACSC, patient's religion and age, and the number of visits to a health provider for the chronic ACSC in the past year. As seen in stratified logistic regressions with the full sample, odds ratios of ever hospitalization between men and women (reference group), and among wealth quintiles (as compared to the poorest quintile (reference group)) are higher at higher PCE scores, while odds ratios among caste categories (as compared to SC/ST (reference group)) are lower at higher PCE scores.

When stratified by caste (Appendix Table 4.11), results are similar to those of the full sample. At higher PCE scores, there is also a lower odds of hospitalization for a chronic ACSC in all three caste categories—0.90 times lower in the SC/ST category, 0.60 times lower in the OBC category, and 0.64 times lower in the General caste category—while adjusting for USC type, chronic ACSC type, sex, wealth quintile, whether the patient had more than 1 chronic ACSC, patient's religion and age, and the number of visits to a health

provider for the chronic ACSC in the past year. This association was also only statistically significant in the OBC category, as with the full sample.

When stratified by sex (Appendix Table 4.12), results also show that a higher PCE score is associated with lower odds of hospitalization for a chronic ACSC among men and women—0.67 times lower among women and 0.70 times lower among men—while adjusting for USC type, chronic ACSC type, wealth quintile, caste, whether the patient had more than 1 chronic ACSC, patient's religion and age, and the number of visits to a health provider for the chronic ACSC in the past year. However, as with the full sample, this association is not statistically significant among men or women.

When stratified by wealth quintile (Appendix Table 4.12), results also show that a higher PCE score is associated with lower odds of hospitalization for a chronic ACSC across quintiles—0.43 times lower in the poorest quintile, 0.64 times lower in the 20-40 quintile, 0.81 times lower in the 40-60 quintile, 0.63 times lower in the 60-80 quintile, and 0.88 times lower in the richest quintile—while adjusting for USC type, chronic ACSC type, sex, caste, whether the patient had more than 1 chronic ACSC, patient's religion and age, and the number of visits to a health provider for the chronic ACSC in the past year. As with the full sample, this association was only statistically significant in the poorest quintile.

Marginal effects plots

Looking at the marginal effects of each predictor on the probability of hospitalization (Appendix Figure 4.1), results show that higher PCE scores are associated with a decrease of 0.041 (95% CI: -.076 - -.0053) in the probability of hospitalization for a chronic ACSC, adjusting for USC type, chronic ACSC type, sex, wealth quintile, caste, whether the patient had more than 1 chronic ACSC, patient's religion and age, and the number of visits to a health provider for the chronic ACSC in the past year. This is almost the same as the marginal effect found in the full sample analysis—a decrease of 0.042 (95% CI: -.076 - -.0089) in the probability of hospitalization at higher PCE scores.

Considering the marginal probabilities of hospitalization for a chronic ACSC for each combination of PCE score and equity indicator (sex, caste, SES) based on the logistic regression with the lowest AIC including interactions (Appendix Figures 4.2 – 4.4), results are almost identical with those of the full sample analysis, with differences of a few hundredths between some marginal probabilities.

Goodness of fit

As with the full sample, the logistic regression with the lowest AIC and without interactions was considered as the final model of the association between the odds of hospitalization for a chronic ACSC and PCE score. The measures of goodness-of-fit for this model were very similar to those of the model derived from the full sample. With a VIF of 1.52, multicollinearity of the model's predictors is at an acceptable level. The predicted probability for a randomly selected chronic ACSC instance resulting in hospitalization exceeds that of a randomly selected chronic ACSC instance that did not result in hospitalization with a probability of 0.68, which is the model's AUC. Results of the Pearson's and Hosmer-Lemeshow goodness-of-fit tests also show that the null hypothesis cannot be rejected, indicating a good model fit.

A plot of standardized Pearson's residuals against predicted probabilities (Appendix Figure 4.5) does not show any points that are notably far away from others, i.e. no influential points. The locally weighted regression of the residuals against predicted probabilities also shows the residuals are close to 0 on average—even more so than the full sample model—which indicates a good model fit. Additionally, a plot (Appendix Figure 4.6) of the average of chronic ACSC instances resulting in hospitalization, modeled as a function of predicted probabilities using a restricted cubic spline, shows that the y=x fits well within the 95% CI of this function.

Tables for Subanalysis

Appendix Table 4.7: Bivariate table (Subanalysis)

Have you ever been hospitalized for your ACSC?				
	No	**Yes**	**N**	**P-value**
	%	%		
PCE score				0.001
2-6	83.7	16.3	933	
7/8	90.2	9.8	562	
Patient satisfaction				0.009
Less than very satisfied	91.1	8.9	302	
Very satisfied	84.9	15.1	1,194	
Travel time to USC (score)				<.001
1 (2.17h - 48.03h)	78.7	21.3	254	
2 (0.77 - 2h)	82.4	17.6	501	
3 (0.27h - 0.75h)	89	11	362	
4 (0 - 0.25h)	93.5	6.5	382	
USC type				0.207
Public	82.9	17.1	146	
Private	86.6	13.4	1,356	
Chronic ACSC				<.001
ASTH/COPD	85.1	14.9	222	
CHD	69.7	30.3	231	
DM	89.3	10.7	345	
HTN	90.5	9.5	704	
Sex				0.305
Female	87.1	12.9	820	
Male	85.2	14.8	682	
Wealth quintiles				0.332
Less than 20	87.8	12.2	278	
20-40	82.3	17.7	277	
40-60	87.9	12.1	315	
60-80	87.3	12.7	245	
Greater than 80	85.7	14.3	385	
Caste				0.351
SC/ST	83.2	16.8	268	
OBC	87.1	12.9	922	
General	86.1	13.9	310	
Marital Status				0.384
Unmarried/Previously Married	84.6	15.4	292	
Married	86.6	13.4	1,210	
Education level				0.981
No schooling/Urdu class	86.2	13.8	797	
Completed at least Primary	86.2	13.8	705	
Employment status				0.851

Unemployed/Retired	86.1	13.9	949	
Employed	86.4	13.6	553	
Currently smokes tobacco				0.753
No	86	14	964	
Yes	86.6	13.4	537	
Religion				0.139
Non-Hindu	89.9	10.1	188	
Hindu	85.7	14.3	1,312	
Has another chronic ACSC				0.012
No	87.8	12.2	1,048	
Yes	82.6	17.4	454	
Family enrolled in health expense support				0.176
No	87	13	1,117	
Yes	84.1	15.9	308	
	Mean (SE)	**Mean(SE)**		
Age	57.4(0.43)	59.2(0.93)		0.073
Months since chronic ACSC diagnosis	70.6(2.12)	78.6(4.73)		0.13
Visits to HW for chronic ACSC in past year	4.38(0.17)	5.28(0.39)		0.027

Appendix Table 4.8: Ever Hospitalized vs Primary Care Experience, Logistic Regression - Subanalysis (Odds Ratio (OR)[1])

	(1)	(2)	(3)	(4)	(5)	(6)
-Log Likelihood	-528.21	-521.06	-519.51	-526.87	-519.61	-518.10
AIC	1082.42	1076.11	1085.03	1093.75	1087.23	1096.19
BIC	1150.77	1165.50	1205.95	1198.90	1213.41	1253.92
Observations	1494	1494	1419	1494	1494	1419
	OR$_{(se)}$	**OR$_{(se)}$**	**OR$_{(se)}$**	**OR$_{(se)}$**	**OR$_{(se)}$**	**OR$_{(se)}$**
PCE score (ref: 2-6)						
7/8	0.66$_{(0.11)}$*	0.68$_{(0.12)}$*	0.65$_{(0.12)}$*	0.54$_{(0.28)}$	0.57$_{(0.30)}$	0.67$_{(0.37)}$
USC type (ref: Public)						
Private	0.93$_{(0.23)}$	0.89$_{(0.22)}$	0.88$_{(0.23)}$	0.92$_{(0.22)}$	0.87$_{(0.22)}$	0.85$_{(0.22)}$
Chronic ACSC (ref: ASTH/COPD)						
CHD	2.39$_{(0.51)}$***	2.39$_{(0.52)}$***	2.53$_{(0.58)}$***	2.43$_{(0.52)}$***	2.41$_{(0.52)}$***	2.56$_{(0.58)}$***
DM	0.67$_{(0.17)}$	0.65$_{(0.16)}$	0.66$_{(0.17)}$	0.68$_{(0.17)}$	0.66$_{(0.17)}$	0.68$_{(0.18)}$
HTM	0.63$_{(0.14)}$*	0.61$_{(0.13)}$*	0.62$_{(0.15)}$*	0.63$_{(0.14)}$*	0.62$_{(0.14)}$*	0.64$_{(0.15)}$
Sex (ref: Female)						
Male	1.21$_{(0.20)}$	1.14$_{(0.19)}$	1.35$_{(0.30)}$	1.22$_{(0.24)}$	1.15$_{(0.23)}$	1.33$_{(0.33)}$
7/8 X Male				0.98$_{(0.38)}$	0.99$_{(0.39)}$	1.00$_{(0.42)}$
Wealth quintile (ref: Less than 20)						
20-40	1.57$_{(0.44)}$	1.52$_{(0.43)}$	1.42$_{(0.42)}$	1.31$_{(0.43)}$	1.24$_{(0.41)}$	1.20$_{(0.41)}$
7/8 X 20-40				1.89$_{(1.00)}$	2.00$_{(1.07)}$	1.83$_{(0.99)}$
40-60	1.01$_{(0.28)}$	1.07$_{(0.29)}$	0.95$_{(0.28)}$	0.85$_{(0.27)}$	0.91$_{(0.29)}$	0.89$_{(0.30)}$
7/8 X 40-60				1.93$_{(1.14)}$	1.84$_{(1.07)}$	1.28$_{(0.86)}$
60-80	1.23$_{(0.34)}$	1.24$_{(0.34)}$	1.26$_{(0.36)}$	1.13$_{(0.37)}$	1.14$_{(0.38)}$	1.23$_{(0.42)}$
7/8 X 60-80				1.43$_{(0.86)}$	1.39$_{(0.83)}$	1.15$_{(0.71)}$
Greater than 80	1.29$_{(0.36)}$	1.29$_{(0.37)}$	1.40$_{(0.42)}$	1.08$_{(0.36)}$	1.09$_{(0.37)}$	1.23$_{(0.44)}$
7/8 X Greater than 80				1.92$_{(1.10)}$	1.81$_{(1.03)}$	1.60$_{(0.94)}$
Caste (ref: SC/ST)						
OBC	0.76$_{(0.16)}$	0.81$_{(0.17)}$	0.81$_{(0.18)}$	0.87$_{(0.23)}$	0.95$_{(0.24)}$	0.98$_{(0.26)}$
7/8 X OBC				0.66$_{(0.27)}$	0.65$_{(0.27)}$	0.58$_{(0.26)}$
General	0.78$_{(0.22)}$	0.77$_{(0.22)}$	0.85$_{(0.26)}$	0.89$_{(0.30)}$	0.88$_{(0.29)}$	0.99$_{(0.35)}$
7/8 X General				0.71$_{(0.40)}$	0.74$_{(0.43)}$	0.73$_{(0.44)}$
Has another chronic ACSC (ref: No)						
Yes		1.28$_{(0.23)}$	1.39$_{(0.25)}$		1.28$_{(0.23)}$	1.39$_{(0.25)}$
Religion (ref: Non-Hindu)						
Hindu		1.55$_{(0.44)}$	1.55$_{(0.46)}$		1.56$_{(0.45)}$	1.57$_{(0.47)}$
Age (centered)		1.01$_{(0.0063)}$	1.01$_{(0.0075)}$		1.01$_{(0.0063)}$	1.01$_{(0.0075)}$
Health worker visits for chronic ACSC in past year		1.04$_{(0.018)}$*	1.04$_{(0.019)}$		1.04$_{(0.018)}$*	1.04$_{(0.019)}$*
Marital status (ref: Unmarried/Previously Married**)**						
Married			0.82$_{(0.19)}$			0.84$_{(0.19)}$
Education level (ref: None/Urdu class)						
Completed at least Primary			0.84$_{(0.16)}$			0.82$_{(0.16)}$
Employment status (ref: Unemployed/Retired)						
Employed			0.98$_{(0.20)}$			0.97$_{(0.20)}$
Currently smokes tobacco (ref: No)						
Yes			0.89$_{(0.17)}$			0.91$_{(0.18)}$
Family enrolled in health expense support scheme (ref: No)						
Yes			1.19$_{(0.22)}$			1.20$_{(0.23)}$
Months since diagnosis			1.00$_{(0.0012)}$			1.00$_{(0.0011)}$

[1]Except highlighted interaction terms, which are quotients of odds ratios.
Model (1) includes only key covariates. Model (2) includes key covariates and potential confounders producing logistic regression with lowest AIC. Model (3) includes key covariates and all potential confounders. Models (4) – (6) include same variables as Models (1) – (3) respectively, with interactions of interest; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; se = standard error

Appendix Table 4.9: Ever Hospitalized vs Primary Care Experience, Multi-level model Subanalysis-Odds Ratio (OR)[1]

	(1)	(2)	(3)	(4)	(5)	(6)
Observations	1494	1494	1419	1494	1494	1419
	OR(se)	**OR(se)**	**OR(se)**	**OR(se)**	**OR(se)**	**OR(se)**
PCE score (ref: 2-6)						
7/8	0.61(0.13)*	0.64(0.14)*	0.60(0.13)*	0.51(0.33)	0.55(0.35)	0.67(0.44)
USC type (ref: Public)						
Private	0.98(0.30)	0.93(0.29)	0.91(0.29)	0.97(0.30)	0.92(0.29)	0.89(0.29)
Chronic ACSC (ref: ASTH/COPD)						
CHD	3.00(0.93)***	2.93(0.91)***	3.19(1.04)***	3.07(0.96)***	2.99(0.94)***	3.26(1.07)***
DM	0.63(0.20)	0.61(0.19)	0.62(0.20)	0.64(0.20)	0.62(0.19)	0.64(0.21)
HTN	0.58(0.16)*	0.57(0.16)*	0.59(0.17)	0.59(0.16)	0.58(0.16)*	0.60(0.17)
Sex (ref: Female)						
Male	1.25(0.24)	1.17(0.22)	1.44(0.43)	1.28(0.29)	1.19(0.27)	1.44(0.47)
7/8 X Male				0.93(0.39)	0.94(0.39)	0.97(0.42)
Wealth quintile (ref: Less than 20)						
20-40	1.79(0.56)	1.73(0.54)	1.60(0.52)	1.46(0.54)	1.38(0.51)	1.33(0.51)
7/8 X 20-40				1.96(1.34)	2.08(1.42)	1.84(1.29)
40-60	1.03(0.33)	1.10(0.35)	0.96(0.32)	0.81(0.31)	0.88(0.33)	0.87(0.34)
7/8 X 40-60				2.27(1.61)	2.15(1.51)	1.41(1.06)
60-80	1.31(0.44)	1.32(0.44)	1.35(0.48)	1.14(0.46)	1.15(0.46)	1.27(0.53)
7/8 X 60-80				1.65(1.21)	1.59(1.16)	1.26(0.95)
Greater than 80	1.35(0.42)	1.35(0.42)	1.49(0.49)	1.03(0.38)	1.05(0.38)	1.22(0.47)
7/8 X Greater than 80				2.39(1.65)	2.30(1.58)	1.91(1.35)
Caste (ref: SC/ST)						
OBC	0.74(0.19)	0.80(0.20)	0.80(0.21)	0.90(0.29)	0.98(0.32)	1.04(0.35)
7/8 X OBC				0.58(0.30)	0.58(0.30)	0.49(0.27)
General	0.75(0.24)	0.73(0.24)	0.84(0.29)	0.91(0.36)	0.89(0.35)	1.06(0.45)
7/8 X General				0.60(0.41)	0.62(0.42)	0.60(0.42)
Has another chronic ACSC (ref: No)						
Yes		1.36(0.29)	1.50(0.33)		1.36(0.29)	1.50(0.33)
Religion (ref: Non-Hindu)						
Hindu		1.68(0.56)	1.70(0.59)		1.67(0.56)	1.70(0.60)
Age (centered)		1.01(0.0077)	1.01(0.0090)		1.01(0.0077)	1.01(0.0090)
Health worker visits for chronic ACSC in past year		1.04(0.020)*	1.04(0.021)*		1.04(0.020)*	1.04(0.021)*
Marital status (ref: Unmarried/Previously Married**)**						
Married			0.76(0.20)			0.78(0.21)
Education level (ref: None/Urdu class)						
Completed at least Primary			0.80(0.20)			0.79(0.20)
Employment status (ref: Unemployed/Retired)						
Employed			0.98(0.26)			0.96(0.25)
Currently smokes tobacco (ref: No)						
Yes			0.87(0.22)			0.90(0.23)
Family enrolled in health expense support scheme (ref: No)						
Yes			1.28(0.31)			1.30(0.32)
Months since diagnosis			1.00(0.0014)			1.00(0.0014)

[1]Except highlighted interaction terms, which are quotients of odds ratios
se = standard error

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

Appendix Table 4.10: Ever Hospitalized vs Primary Care Experience – Logistic Regression, Subanalysis (Odds Ratio[1])

	(1)	95% CI	*p*	(2)	95% CI	*p*
PCE score (ref: 2-6)						
7/8	0.68*	[0.48,0.96]		0.57	[0.21,1.59]	
USC type (ref: Public)						
Private	0.89	[0.54,1.46]		0.87	[0.53,1.42]	
Chronic ACSC (ref: ASTH/COPD)						
CHD	2.39***	[1.56,3.66]		2.41***	[1.57,3.69]	
DM	0.65	[0.40,1.05]		0.66	[0.40,1.08]	
HTN	0.61*	[0.40,0.94]		0.62*	[0.41,0.95]	
Sex (ref: Female)			0.42[2]			0.98[3]
Male	1.14	[0.83,1.58]		1.15	[0.77,1.70]	
7/8 X Male				0.99	[0.46,2.14]	
Wealth quintile (ref: Less than 20)			0.61[2]			0.74[3]
20-40	1.52	[0.87,2.66]		1.24	[0.65,2.38]	
7/8 X 20-40				2.00	[0.70,5.71]	
40-60	1.07	[0.63,1.83]		0.91	[0.49,1.69]	
7/8 X 40-60				1.84	[0.59,5.75]	
60-80	1.24	[0.72,2.13]		1.14	[0.60,2.18]	
7/8 X 60-80				1.39	[0.43,4.49]	
Greater than 80	1.29	[0.74,2.26]		1.09	[0.56,2.11]	
7/8 X Greater than 80				1.81	[0.59,5.53]	
Caste (ref: SC/ST)			0.57[2]			0.60[3]
OBC	0.81	[0.54,1.24]		0.95	[0.57,1.56]	
7/8 X OBC				0.65	[0.29,1.49]	
General	0.77	[0.44,1.34]		0.88	[0.45,1.69]	
7/8 X General				0.74	[0.24,2.29]	
Has another chronic ACSC (ref: No)						
Yes	1.28	[0.90,1.82]		1.28	[0.90,1.82]	
Religion (ref: Non-Hindu)						
Hindu	1.55	[0.89,2.72]		1.56	[0.89,2.73]	
Age (centered)	1.01	[1.00,1.02]		1.01	[1.00,1.02]	
HW visits for chronic ACSC in past year	1.04*	[1.00,1.07]		1.04*	[1.00,1.07]	
Observations	1494			1494		

[1]Except highlighted interaction terms, which are quotients of odds ratios. [2]P-value assuming null hypothesis of categorical coefficients jointly equating 0. [3]P-value assuming null hypothesis of interaction coefficients jointly equating 0. Model (1) is logistic regression with lowest AIC (i.e. Model 2 in Appendix Table 4.8). Model (2) is logistic regression including interaction terms of interest with lowest AIC (i.e. Model 5 in Appendix Table 4.8).

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

Appendix Table 4.11: Ever Hospitalized (stratified by PCE), Logistic Regression - Subanalysis (Odds Ratio (OR))

	(1)	P-val	(2)	P-val
	OR$_{(se)}$		**OR$_{(se)}$**	
USC type (ref: Public)				
Private	0.81$_{(0.22)}$		1.02$_{(0.72)}$	
Chronic ACSC (ref: ASTH/COPD)				
CHD	2.41$_{(0.66)}$**		2.55$_{(1.10)}$*	
DM	0.79$_{(0.25)}$		0.33$_{(0.18)}$*	
HTN	0.58$_{(0.17)}$		0.68$_{(0.27)}$	
Sex (ref: Female)		0.71		0.44
Male	1.08$_{(0.22)}$		1.28$_{(0.40)}$	
Wealth quintile (ref: Less than 20)		0.93		0.36
20-40	1.25$_{(0.42)}$		2.45$_{(1.14)}$	
40-60	0.95$_{(0.30)}$		1.57$_{(0.82)}$	
60-80	1.16$_{(0.38)}$		1.63$_{(0.86)}$	
Greater than 80	1.07$_{(0.36)}$		2.06$_{(1.01)}$	
Caste (ref: SC/ST)		0.90		0.56
OBC	0.93$_{(0.24)}$		0.69$_{(0.24)}$	
General	0.86$_{(0.29)}$		0.74$_{(0.39)}$	
Has another chronic ACSC (ref: No)				
Yes	1.29$_{(0.26)}$		1.28$_{(0.48)}$	
Religion (ref: Non-Hindu)				
Hindu	1.23$_{(0.40)}$		3.10$_{(2.28)}$	
Age (centered)	1.02$_{(0.0079)}$*		1.00$_{(0.012)}$	
Health worker visits for chronic ACSC in past year	1.05$_{(0.021)}$*		1.00$_{(0.038)}$	
Observations	932		562	

Model (1) only includes observations with PCE scores of 2- 6. Model (2) only includes observations with PCE scores of 7/8; se = standard error

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

Appendix Table 4.12: Ever Hospitalized (stratified by Caste), Logistic Regression - Subanalysis (Odds Ratio)

	(1)	(2)	(3)
	OR(se)	**OR(se)**	**OR(se)**
PCE score (ref: 2-6)			
7/8	0.90(0.31)	0.60(0.14)*	0.64(0.33)
USC type (ref: Public)			
Private	1.50(1.04)	0.72(0.22)	0.90(0.52)
Chronic ACSC (ref: ASTH/COPD)			
CHD	2.78(1.34)*	2.31(0.72)**	2.04(1.17)
DM	0.26(0.18)*	0.95(0.33)	0.33(0.20)
HTN	0.49(0.22)	0.78(0.23)	0.32(0.19)
Sex (ref: Female)			
Male	1.05(0.41)	1.50(0.31)*	0.55(0.22)
Wealth quintile (ref: Less than 20)			
20-40	1.47(0.81)	1.81(0.63)	0.84(0.70)
40-60	1.19(0.57)	0.89(0.33)	1.84(1.18)
60-80	1.89(0.99)	1.23(0.45)	0.69(0.56)
Greater than 80	0.76(0.65)	1.20(0.43)	1.74(1.00)
Has another chronic ACSC (ref: No)			
Yes	1.55(0.63)	1.28(0.30)	1.42(0.65)
Religion (ref: Non-Hindu)			
Hindu	1(.)	1.51(0.48)	1.59(1.14)
Age (centered)	1.03(0.017)	1.00(0.0073)	1.05(0.022)*
Health worker visits for chronic ACSC in past year	1.02(0.035)	1.01(0.022)	1.12(0.057)*
Observations	262	918	308

Model (1) only includes observations in the SC/ST caste. Model (2) only includes observations in the OBC caste. Model (3) only includes observations in the General caste; se = standard error

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

Appendix Table 4.13: Ever Hospitalized (stratified by Sex), Logistic Regression - Subanalysis (Odds Ratio (OR))

		(1)	(2)
		OR (se)	**OR (se)**
PCE score (ref: 2-6)			
	7/8	0.67(0.17)	0.70(0.19)
USC type (ref: Public)			
	Private	1.44(0.73)	0.66(0.19)
Chronic ACSC (ref: ASTH/COPD)			
	CHD	2.17(0.70)*	2.66(0.87)**
	DM	0.72(0.27)	0.58(0.19)
	HTN	0.70(0.22)	0.52(0.16)*
Wealth quintile (ref: Less than 20)			
	20-40	1.76(0.64)	1.17(0.49)
	40-60	1.03(0.42)	0.97(0.37)
	60-80	1.06(0.41)	1.40(0.58)
	Greater than 80	1.39(0.53)	1.10(0.45)
Caste (ref: SC/ST)			
	OBC	0.69(0.19)	1.04(0.33)
	General	0.98(0.35)	0.65(0.28)
Has another chronic ACSC (ref: No)			
	Yes	1.35(0.32)	1.27(0.35)
Religion (ref: Non-Hindu)			
	Hindu	1.66(0.75)	1.62(0.58)
Age (centered)		1.00(0.0086)	1.02(0.010)
Health worker visits for chronic ACSC in past year		1.03(0.024)	1.04(0.025)
Observations		818	676

Model (1) only includes observations from women. Model (2) only includes observations from men; se = standard error

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

Appendix Table 4.14: Ever Hospitalized (stratified by SES), Logistic Regression - Subanalysis (Odds Ratio)

	(1)	(2)	(3)	(4)	(5)
	OR (se)	**OR (se)**	**OR (se)**	**OR (se)**	**OR (se)**
PCE score (ref: 2-6)					
7/8	0.43(0.18)*	0.64(0.21)	0.81(0.34)	0.63(0.27)	0.88(0.36)
USC type (ref: Public)					
Private	1.29(0.79)	5.32(4.05)*	0.48(0.22)	0.55(0.32)	0.39(0.19)
Chronic ACSC (ref: ASTH/COPD)					
CHD	2.10(1.04)	4.41(2.27)**	1.24(0.61)	1.08(0.74)	4.70(3.40)*
DM	0.86(0.50)	0.95(0.50)	0.71(0.37)	0.36(0.24)	0.68(0.46)
HTN	0.47(0.26)	0.89(0.40)	0.44(0.24)	0.53(0.28)	0.90(0.62)
Sex (ref: Female)					
Male	1.21(0.50)	1.04(0.36)	1.30(0.50)	1.69(0.76)	0.94(0.35)
Caste (ref: SC/ST)					
OBC	0.78(0.33)	0.92(0.38)	0.79(0.38)	0.51(0.22)	1.48(1.17)
General	0.94(0.61)	0.46(0.31)	1.20(0.68)	0.29(0.17)*	1.79(1.42)
Has another chronic ACSC (ref: No)					
Yes	1.14(0.57)	0.93(0.37)	1.78(0.64)	1.57(0.70)	1.86(0.63)
Religion (ref: Non-Hindu)					
Hindu	1.68(1.06)	1.44(0.88)	1(.)	0.72(0.64)	1.38(0.62)
Age (centered)	1.02(0.015)	1.01(0.013)	1.01(0.017)	1.00(0.018)	1.00(0.015)
Health worker visits for chronic ACSC in past year	1.06(0.044)	0.98(0.032)	1.08(0.038)*	1.07(0.041)	1.04(0.040)
Observations	275	277	282	244	383

Model (1) only includes observations in < 20% wealth quintile. Model (2) only includes observations in 20%-40% wealth quintile. Model (3) only includes observations in 40%-60% wealth quintile. Model (4) only includes observations in 60%-80% wealth quintile. Model (4) only includes observations in > 80% wealth quintile;
se = standard error

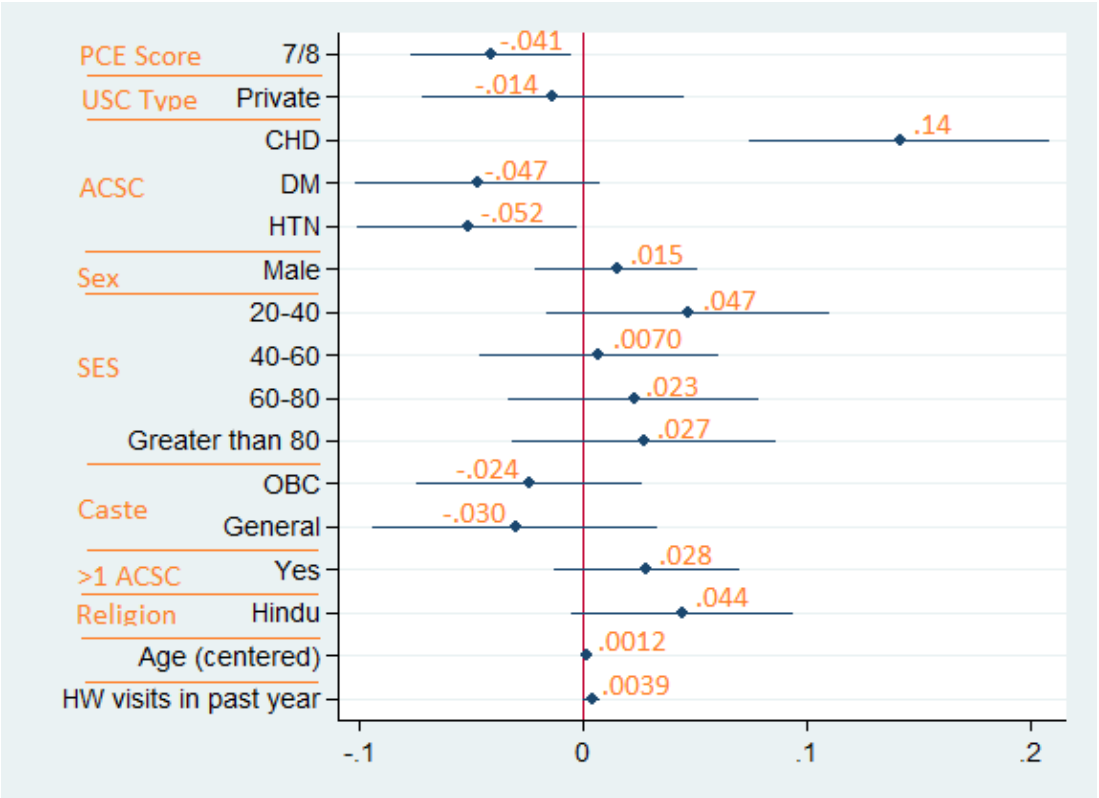
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix Table 4.15: Goodness-of-fit tests for Logistic Regression with Lowest AIC, without interactions

	Full data analysis	Subanalysis
Mean VIF	1.59	1.52
Area under ROC curve	0.67	0.68
Pearson's goodness-of-fit test, p-value	0.72	0.33
Hosmer-Lemeshow goodness-of-fit test, p-value	0.45	0.19

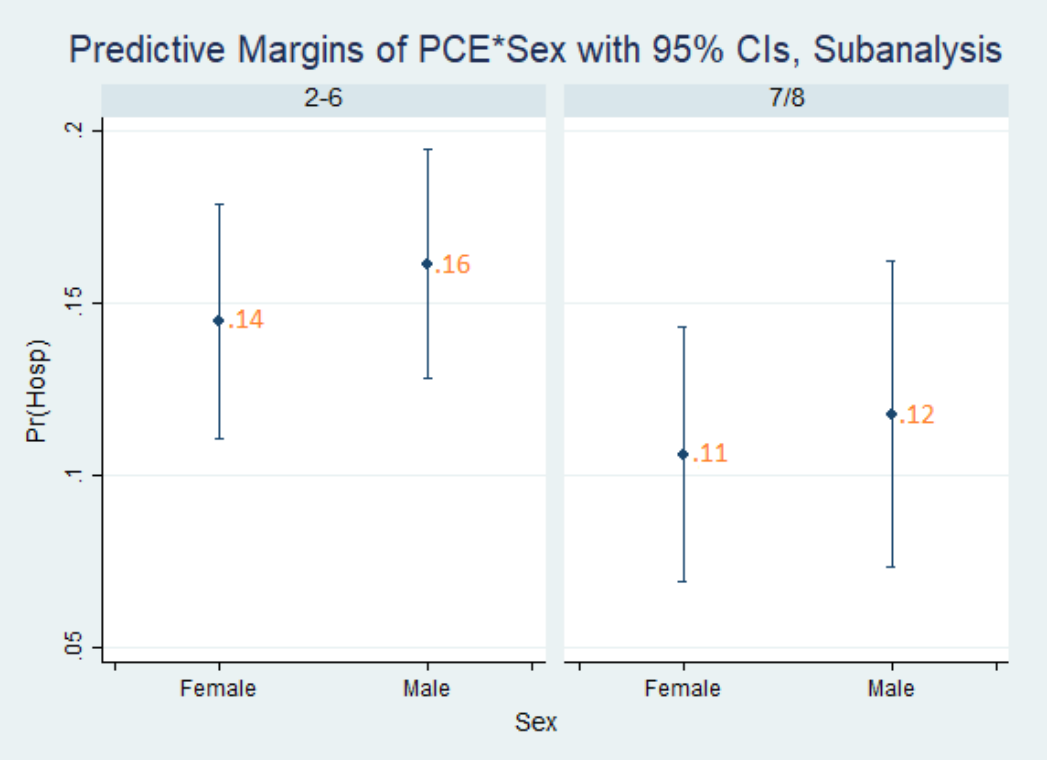
Figures for Subanalysis

Appendix Figure 4.1: Average Marginal Effects with 95% CI, Subanalysis



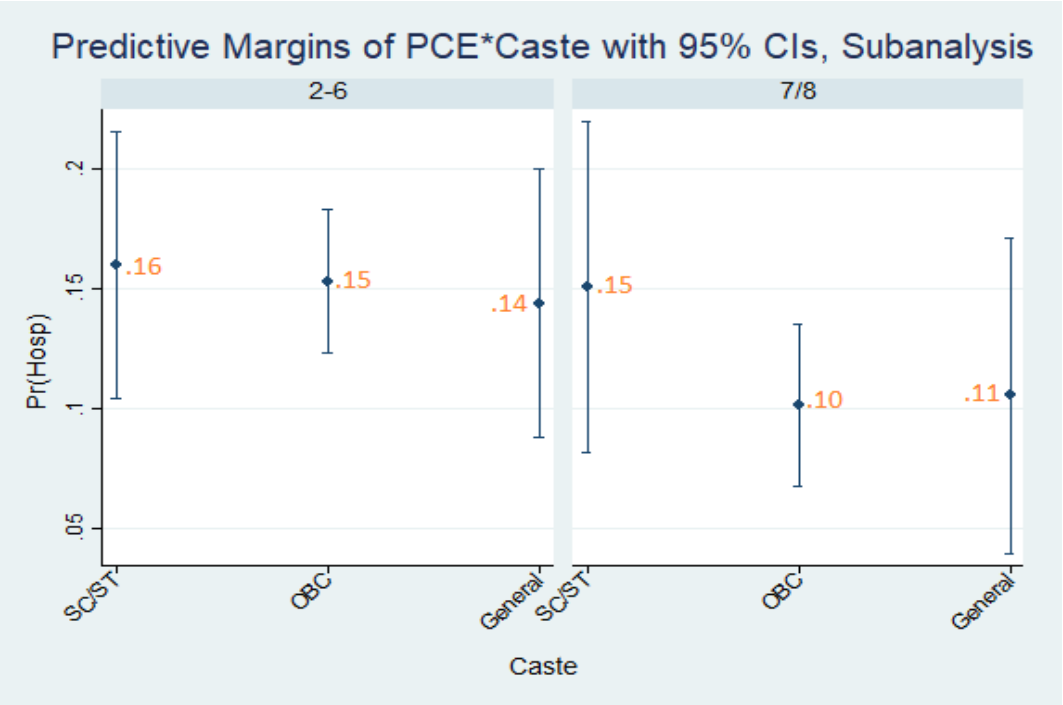
Note: Marginal effects of each variable on the probability of hospitalization for a chronic ACSC. For categorical variables, each category is compared to the reference category (each reference category is noted in Appendix Table 4.8). Calculations are based on logistic regression using key covariates and potential confounders with the lowest AIC, without interactions, i.e. Appendix Table 4.8 Model 2.

Appendix Figure 4.2: Predictive Margins of PCE*Sex



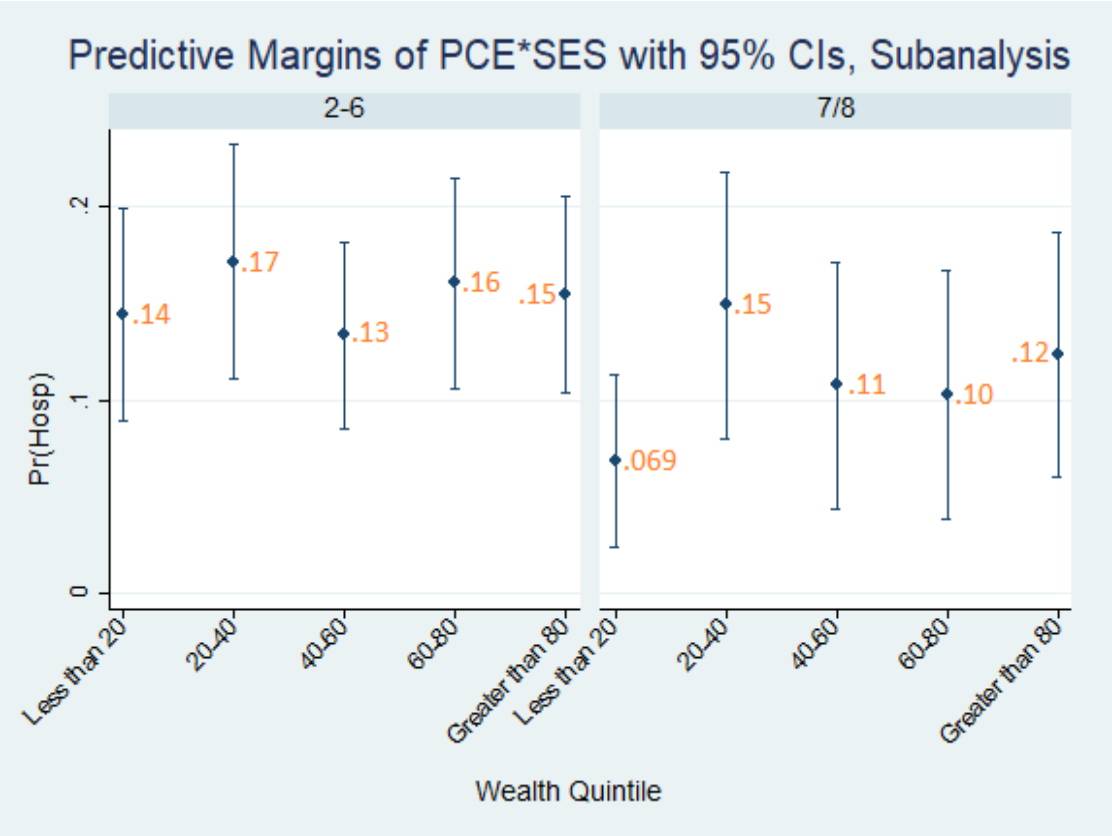
Note: Marginal probabilities of hospitalization for a chronic ACSC for each combination of PCE score and sex. Calculations are based on logistic regression using key covariates and potential confounders with the lowest AIC, with interactions, i.e. Appendix Table 4.8 Model 5.

Appendix Figure 4.3: Predictive Margins of PCE*Caste



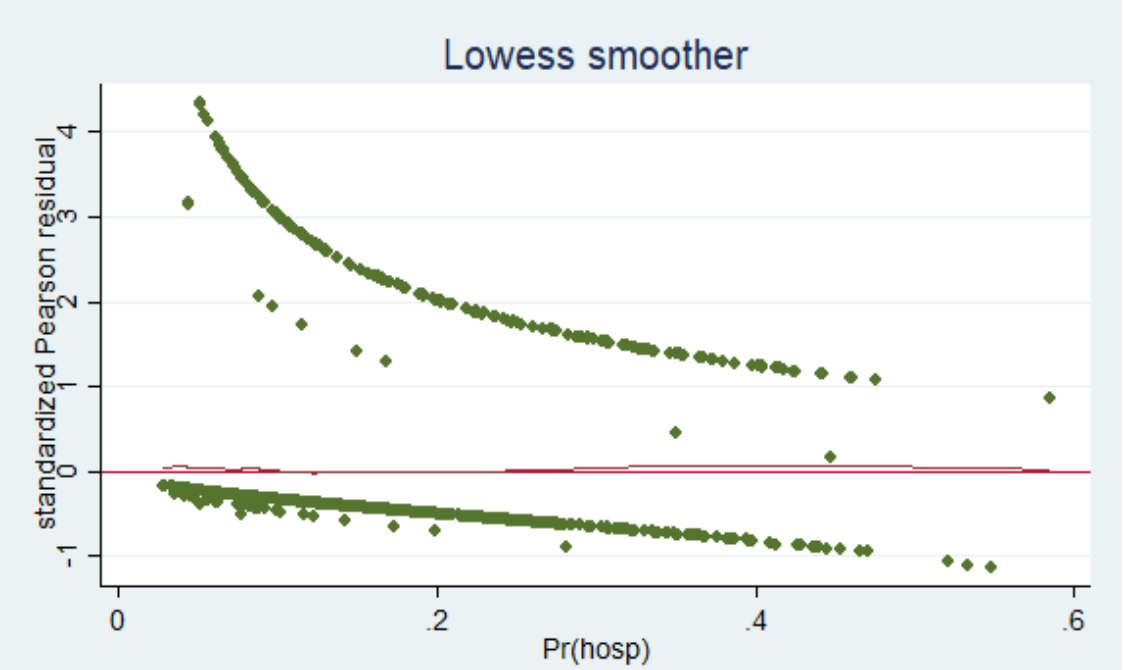
Note: Marginal probabilities of hospitalization for a chronic ACSC for each combination of PCE score and caste. Calculations are based on logistic regression using key covariates and potential confounders with the lowest AIC, with interactions, i.e. Appendix Table 4.8 Model 5.

Appendix Figure 4.4: Predictive Margins of PCE*SES



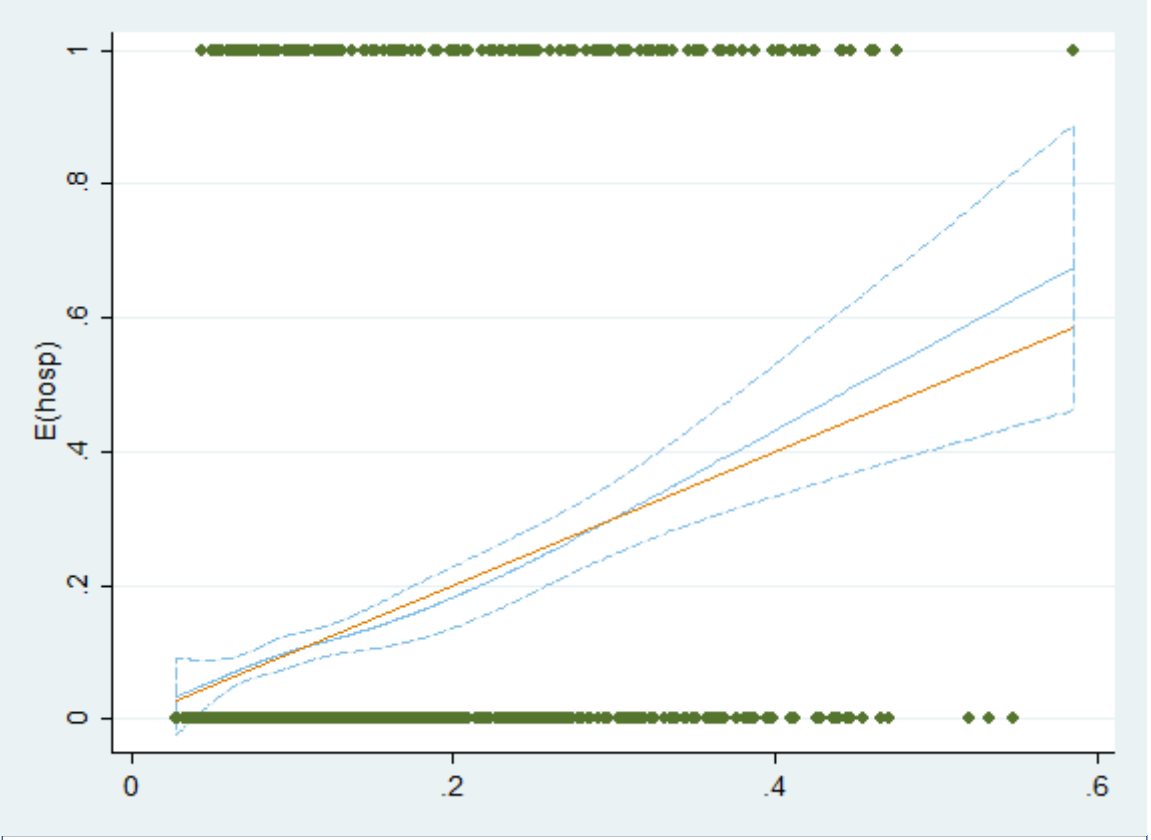
Note: Marginal probabilities of hospitalization for a chronic ACSC for each combination of PCE score and wealth quintile. Calculations are based on logistic regression using key covariates and potential confounders with the lowest AIC, with interactions, i.e. Appendix Table 4.8 Model 5.

Appendix Figure 4.5: Standardized Pearson residual vs. Predicted Probabilities, Subanalysis



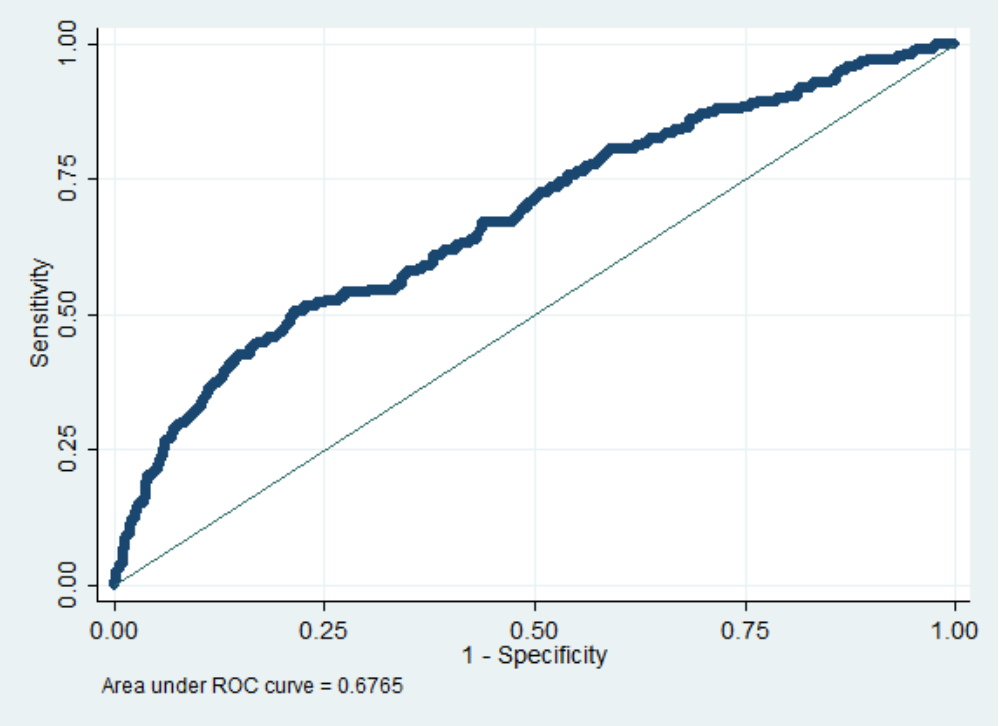
Note: Calculations are based on logistic regression using key covariates and potential confounders with the lowest AIC, without interactions, i.e. Appendix Table 4.8 Model 2

Appendix Figure 4.6: Weatherman Plot, Subanalysis



Note: Blue curve is a restricted cubic spline of the average observed binary outcome vs. predicted probabilities, banded by the 95% CI. The orange line is a y=x line. Calculations are based on logistic regression using key covariates and potential confounders with the lowest AIC, without interactions, i.e. Appendix Table 4.8 Model 2.

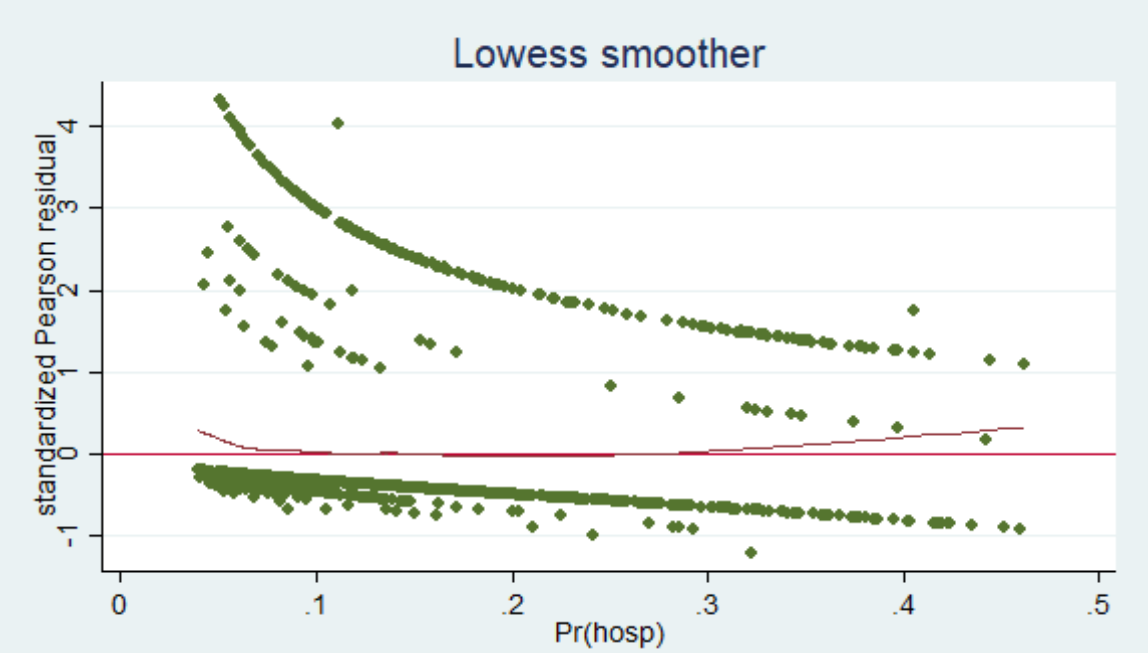
Appendix Figure 4.7: ROC curve, Subanalysis



Note: Calculations are based on logistic regression using key covariates and potential confounders with the lowest AIC, without interactions, i.e. Model 2 in Table 2s

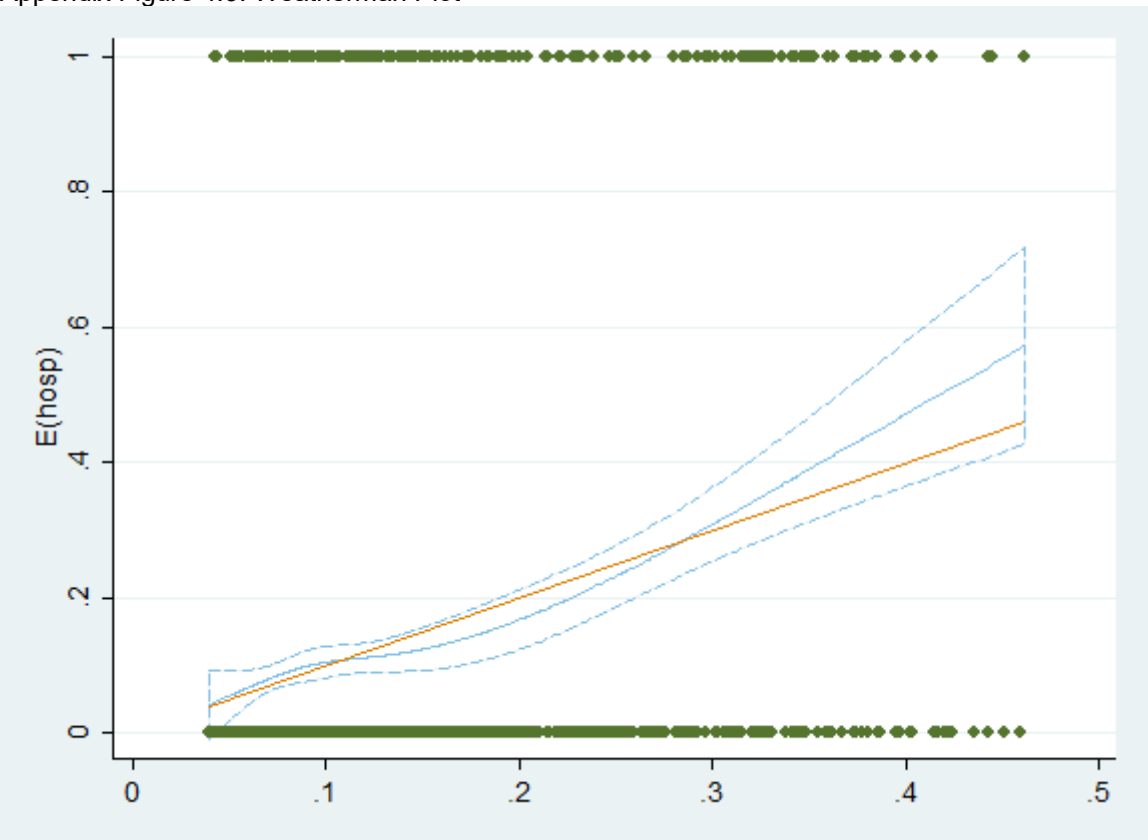
Figures: Goodness-of-fit (Full data analysis)

Appendix Figure 4.8: Standardized Pearson residual vs. Predicted Probabilities



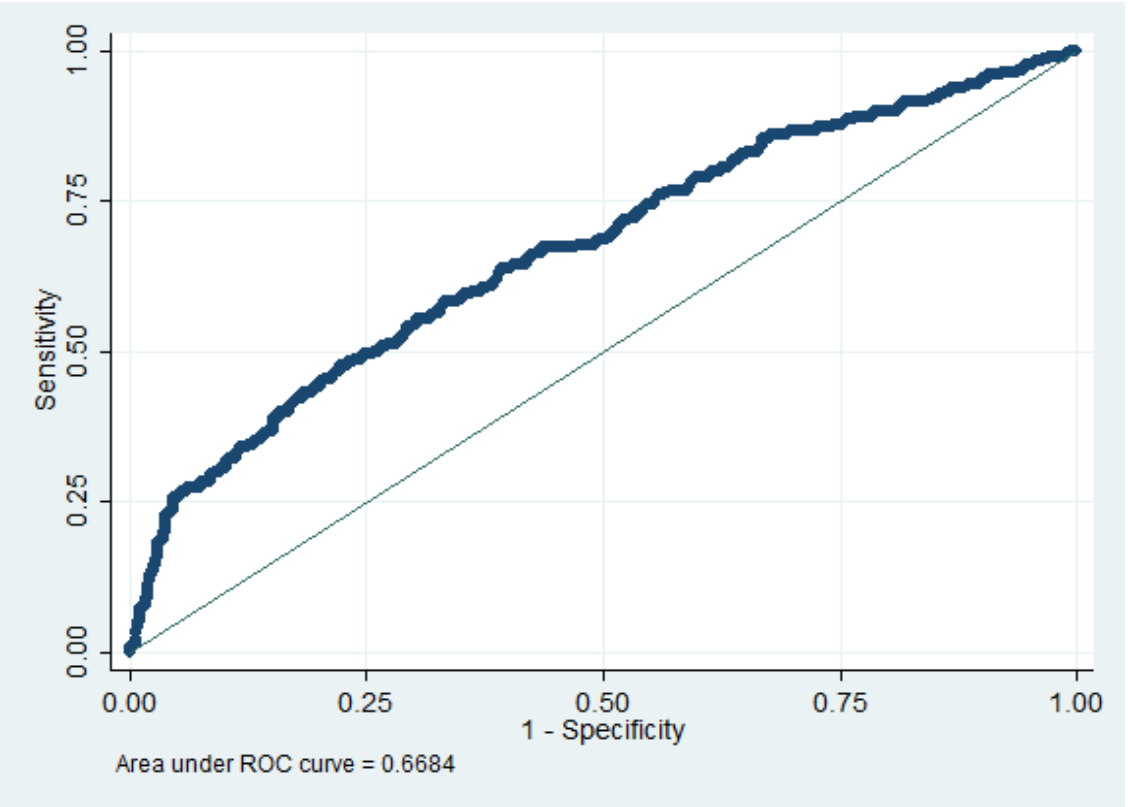
Note: Calculations are based on logistic regression using key covariates and potential confounders with the lowest AIC, without interactions, i.e. Table 4.2 Model 2

Appendix Figure 4.9: Weatherman Plot



Note: Blue curve is a restricted cubic spline of the average observed binary outcome vs. predicted probabilities, banded by the 95% CI. The orange line is a y=x line. Calculations are based on logistic regression using key covariates and potential confounders with the lowest AIC, without interactions, i.e. Table 4.2 Model 2.

Appendix Figure 4.10: ROC curve



Note: Calculations are based on logistic regression using key covariates and potential confounders with the lowest AIC, without interactions, i.e. Table 4.2 Model 2.

Appendix for Chapter 5 (Aim 3)

Appendix Table 5.1: Odds Ratio for Reporting Fair/Poor Self-Rated Health (No Interactions)

	Model 1[1]		***Model 2[2]***	
Independent Variables	***Odds Ratio [95% CI]***		***Odds Ratio [95% CI]***	
Average Competence Score < 45	1.01	[0.95,1.07]	1.00	[0.94,1.06]
Average Competence Score > 45	0.86	[0.74,1.00]	0.87	[0.75,1.01]
Sex (ref: Female)				
Male	0.83*	[0.68,1.00]	0.90	[0.73,1.11]
Age (decades)	1.12	[0.99,1.26]	1.39***	[1.20,1.60]
Age (decades) ^2	1.06***	[1.04,1.09]	1.01	[0.98,1.04]
Wealth index X 10	0.94	[0.87,1.01]	0.95	[0.87,1.03]
Employment status (ref: Unemployed/Retired)				
Employed	0.73*	[0.57,0.95]	0.67**	[0.51,0.87]
Marital status (ref: Not married)				
Married	1.30	[0.98,1.72]	1.04	[0.78,1.40]
How often care could be received if needed (ref: Not Always)				
Always	0.96	[0.77,1.20]	0.97	[0.76,1.23]
Family enrolled in health expense support scheme (ref: No)				
Yes	1.01	[0.72,1.43]	1.01	[0.71,1.44]
Education level (ref: None/Urdu class)				
Completed at least Primary			0.81*	[0.65,0.99]
Observations	5683		5180	

[1]Model 1 provides the odds ratio of reporting fair/poor SRH for a unit increase in average competence score, adjusted for equity indicators and all considered sociodemographic variables, excluding education level, which was only asked of individuals who were at least 4 years old. [2]Model 2 includes the same predictors as Model 1, and education level.

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

Appendix Table 5.2: Odds Ratio[a] for Reporting Fair/Poor Self-Rated Health (Including Interactions)

	Model 1[1]		*Model 2[2]*	
Independent Variables	***Odds Ratio[a] [95% CI]***		***Odds Ratio[a] [95% CI]***	
Average Competence Score < 45	1.00	[0.93,1.08]	1.00	[0.92,1.08]
Average Competence Score > 45	0.73*	[0.57,0.93]	0.72*	[0.54,0.96]
Sex (ref: Female)				
Male	0.85	[0.70,1.04]	0.93	[0.75,1.16]
Average Competence Score < 45 X Male	1.01	[0.98,1.05]	1.01	[0.98,1.05]
Average Competence Score > 45 X Male	0.91	[0.82,1.01]	0.92	[0.83,1.02]
Age (decades)	1.08	[0.96,1.22]	1.35***	[1.17,1.56]
Age (decades) ^2	1.07***	[1.04,1.09]	1.01	[0.98,1.05]
Average Competence Score < 45 X Age quartiles (ref: <= 15 yrs)				
Average Competence Score < 45 X [15 yrs - 39 yrs]	0.98	[0.94,1.02]	0.99	[0.94,1.03]
Average Competence Score > 45 X [15 yrs - 39 yrs]	1.16	[0.99,1.37]	1.18	[0.95,1.46]
Average Competence Score < 45 X [40 yrs – 59 yrs]	0.96	[0.91,1.02]	0.98	[0.92,1.04]
Average Competence Score > 45 X [40 yrs – 59 yrs]	1.28**	[1.06,1.53]	1.25	[0.99,1.57]
Average Competence Score < 45 X [60 yrs - 95 yrs]	0.96	[0.90,1.02]	0.96	[0.89,1.02]
Average Competence Score > 45 X [60 yrs - 95 yrs]	1.36**	[1.12,1.66]	1.38**	[1.08,1.75]
Wealth index X 10	0.94	[0.87,1.02]	0.95	[0.87,1.03]
Average Competence Score < 45 X Wealth Index tertiles (ref: Wealth index X 10: 0-4)				
Average Competence Score < 45 X Wealth Index *10: 5	1.03	[0.95,1.11]	1.02	[0.95,1.11]
Average Competence Score > 45 X Wealth Index *10: 5	0.99	[0.80,1.22]	1.00	[0.81,1.25]
Average Competence Score < 45 X Wealth Index *10: 6-10	1.05	[0.98,1.13]	1.04	[0.97,1.12]
Average Competence Score > 45 X Wealth Index *10: 6-10	1.07	[0.88,1.31]	1.06	[0.86,1.30]
Employment status (ref: Unemployed/Retired)				
Employed	0.75*	[0.58,0.98]	0.68**	[0.52,0.89]
Marital status (ref: Not married)				
Married	1.32	[1.00,1.75]	1.06	[0.79,1.43]
How often care could be received if needed (ref: Not Always)				
Always	0.98	[0.78,1.23]	0.98	[0.77,1.24]
Family enrolled in health expense support scheme (ref: No)				
Yes	1.03	[0.73,1.45]	1.03	[0.72,1.46]
Education level (ref: None/Urdu class)				
Completed at least Primary			0.80*	[0.65,0.99]
Observations	5683		5180	

[a]Except highlighted interaction terms. [1]Model 1 includes interactions between average competence score and equity indicators, i.e. sex, age and wealth index, while adjusting for all considered sociodemographic variables, excluding education level, which was only asked of individuals who were at least 4 years old. [2]Model 2 includes the same predictors as Model 1, and education level.

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