Subsidies, Information, and the Timing of Children's Health Care in Mali

Anja Sautmann*, Samuel Brown† and Mark Dean‡

This version: January 2022

Abstract

Sustained progress on child mortality requires better curative care. However, policy instruments intended to increase access to healthcare may only incompletely reduce underuse or create overuse. We conduct an RCT of 1,768 children in Mali that cross-randomizes subsidies and community healthworkers who visit families and monitor the child's health, and analyze how these interventions affect the targeting of acute care, which depends not just on overall demand, but on whether children receive care when actually sick. We collect nine weeks of daily symptom and health care data to measure demand conditional on need for care, as defined by WHO standards. Parents are over five times more likely to seek care when it is medically indicated, yet the probability of getting needed care remains below 5% in the control. Subsidies increase utilization by over 250%, significantly reducing underuse with moderate effects on overuse. Health-worker visits have no aggregate effects, but likely improve use of the subsidy for the youngest children.

Keywords: demand for acute care, children's health care, health care under- use and overuse, health care subsidies, community health workers, Mali

JEL codes: I15, O12

*The World Bank, corresponding author, email: asautmann@worldbank.org.

†Wayfair Inc., email: sambrown@wayfair.com.

‡Columbia University, email: mark.dean@columbia.edu.

Acknowledgements

We received invaluable advice and support from Andrew Foster, Duncan Thomas, and Ira Wilson. We would also like to thank Anna Aizer, Daniel Björkegren, Joseph Camardo, Caitlin Cohen, Jishnu Das, Seydou Doumbia, Chris Gill, Rachel Glennerster, Jessica Goldberg, Bentley McLeod, Yusuf Neggers, Emily Oster, Simone Schaner, Dan Silverman, and Dean Yang. Special thanks go to Hamadoun Bocoum, Zorina Curry, Judith Kom, and Fred Wensing, Mali Health and its staff and Board, and Innovations for Poverty Action. We are grateful for funding from Brown University through the Brown Seed Fund Award, the Population Studies and Training Center, and the Rhodes Center, from the Aga Khan Foundation, and from the ESRC/DFID Development Frontiers Award (ES/K01207X/1). The research protocol was approved by the IRB of Brown University (protocol number #1205000629) and the Comité National d'Ethique pour la Santé et les Sciences de la Vie (CNESS) (protocol No. 13/MSHP-SG/CNESS). The study is registered in the AEA RCT Registry with ID AEARCTR-0006603. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the views of the World Bank and its affiliated organizations, or those of the Executive Directors of the World Bank or the governments they represent.

1 Introduction

In the last two decades, great strides have been made in reducing child mortality, primarily through preventive care programs (e.g. Bhatt et al., 2015). Nonetheless, over five million children under five years died in 2018 alone (Hug et al., 2019). The current consensus is that further progress requires better care for children who are acutely ill. Two demand-side policies have played a key role in this effort: health care subsidies that provide free access to basic services, and home visits by community healthworkers (CHW), who monitor the health of the child and educate caretakers about symptoms.

The policy debate on how to fund primary care for children is longstanding, and a major push is underway towards subsidized or free care to achieve universal health care (UHC). The previous view, embodied in the so-called Bamako Initiative of African health ministers from 1987, had been that user fees are the only reliable way to maintain sustainability and quality of care (e.g. Akin et al., 1987; Jimenez, 1995; Litvack and Bodart, 1993). Yet today, multiple policy and international aid organizations advocate for the universal subsidization of basic primary care for small children and mothers (e.g. Save the Children, 2008; UK Secretary of State for International Development, 2009; Jamison et al., 2013). By 2016, 33 African countries had developed financing strategies to achieve UHC (Barroy et al., 2016; Cotlear and Rosemberg, 2018), and in 2019, Mali's Ministry of Health announced its intention to provide free children's and mothers' health care by 2022, at an estimated cost of $120 million, although it acknowledged funding gaps (Adepoju, 2019). While political turbulence and the Covid-19 crisis have stalled the reforms, this proposal will likely serve as a benchmark for future health policy in Mali. The removal of user fees has been accompanied by an expansion and formalization of community health worker (CHW) programs (Singh and Sachs, 2013). CHW provide preventive care and instruction, but also support curative care by guiding the use of formal care and monitoring children's symptoms. Recent estimates count over 300,000 CHW in Sub-Saharan Africa and over 2000 CHW in Mali alone (Saint-Firmin et al., 2018; 1 Million Community Healthworkers Campaign, 2021), and the Malian health reform includes an expansion of the existing CHW network.

As African health care systems move towards more fully subsidized access – at considerable cost – it is important for effective policy making and the sustainability of the health care system to understand how exactly healthcare demand is affected. Are unfilled health care needs better met? What share of expenses may be paying for unnecessary treatment? In other words, we need to understand the allocation of acute care. It is known that subsidies for *preventive* care can greatly increase demand and thereby reduce underuse (Ashraf et al., 2010; Dupas and Cohen, 2010; Ashraf et al., 2013; Dupas, 2014; Miguel and Kremer, 2004,

see also Kremer and Glennerster, 2012). But unlike for prevention, whether and when *acute* health care is needed depends on the child's health status, and it is up to the child's caretakers at home to monitor symptoms and make decisions about utilization of care.

Increased utilization in response to lower cost can lead to a more efficient allocation of care if there are access barriers, for example if parents face credit constraints, underestimate the child's health care needs, prioritize the costs to them or the family at large over the benefits to the child, or disregard the negative externalities of untreated infection. At the same time, subsidies may worsen the allocation and cause the waste of scarce resources if they lead parents to overuse care. The risk of overuse may be higher if geographical distance is not a primary barrier, as is the case in urban areas, and this is a particular concern given that increased demand in response to UHC will in practice challenge existing supply capacities. In this context, it is important to understand to what degree CHW can improve the allocation of acute care, either on their own or in combination with a subsidy program. If information is an important barrier, monitoring and health education provided by CHWs have the potential to increase care seeking among children in need, while crucially also preventing or reducing overuse.

Evaluating the allocation of acute care is a challenge, because even when utilization is measured, most data do not contain information on care seeking in response to symptoms. This can distort measured behavioral effects if illness incidence varies between treatment groups. Moreover, it makes it hard to interpret the existing evidence on the effects of demand side policies such as subsidies and CHW. For instance, one RCT in Ghana and a difference-in-difference analysis from South Africa document positive effects of user fee removal on some health outcomes for children (Tanaka, 2014; Powell-Jackson et al., 2014).[1] But randomized trials of health insurance subsidies in Nicaragua, Mexico, and, most recently, India have resulted in few health or utilization effects, with often low uptake and retention (King et al., 2009; Thornton et al., 2010; Malani et al., 2021). As Malani et al. also note, even very large health insurance trials may not be powered to detect mortality reductions. Given this mixed evidence and the challenge of analyzing effects on rare events, information on *utilization conditional on the child's health status* is central to interpreting the demand response to policy interventions. If utilitzation is low, such data can for example disentangle whether there is no significant unfilled need for care or whether an intervention failed to curb underuse, perhaps due to unobserved supply-side effects. If utilization is high, it can help understand what share constitutes overuse vs. appropriate use.

In this study, we measure effect of subsidies and CHW visits on healthcare demand condi-

[1]There are surprisingly few studies on the health effects of removing user fees, and review articles note the mixed quality of the evidence (Ridde and Morestin, 2012; Dzakpasu et al., 2013).

tional on illness, using novel health data collected at home. In partnership with the NGO Mali Health, we conducted a randomized control trial of a health care subsidy, which reduced primary care cost per formal care visit for children under five years by 72% on average, and a community healthworker (CHW) program, for which CHWs visit families biweekly and teach them basic health knowledge. The interventions were cross-randomized at the compound (dwelling) level, with a final sample of 1768 children from 642 compounds. Comprehensive quality controls at Mali Health's partner clinics and the small sample mitigate general equilibrium effects and allow us to focus on the demand response to the interventions.

Nine months after intervention start, we collected nine weeks of daily data on children's health and health care. We recorded all health consultations along with 14 symptoms that are key in the detection of the main causes of child mortality in resource-poor settings, and used this data to construct illness spells and estimate demand for formal health care during the spell. Building on WHO guidelines for CHWs, we can derive when a child should seek a formal medical evaluation by a doctor, based on the duration and type of symptoms.[2] The guidelines we apply are used by public health systems and NGOs in over 80 countries, including our partner NGO Mali Health, who based their CHW training on them. Given that the optimal solution to the social planner's problem of health care timing cannot be directly observed, they help us make a partial assessment of the effect of the interventions on the targeting of care. First, they provide a ranking by severity from a medical perspective and therefore relative value of care: a policymaker who wants to improve population health should aim to increase care seeking on days when care is required by these guidelines over other days, all else equal. Second, they allow us to measure whether the CHW actually improve adherence to the guidelines they teach (see also Section 3 for a discussion).

We organize our empirical results with the help of a framework that treats care seeking as a stopping problem, where parents decide to seek care on any day of a given illness spell conditional on spell length and symptoms. This captures the intuition that a set of initial symptoms will become more concerning as the illness persists or new symptoms arise. The value of waiting instead of seeking care immediately lies in the possibility of avoiding a facility visit altogether. We treat the WHO guidelines as the preferences of the policy maker. The policy maker may disagree with the parent at what point care should be sought,

[2]We used a set of symptoms as well as careseeking guidelines derived from the Integrated Management of Childhood Illness (IMCI) guidelines for community healthworkers. The IMCI was developed by Unicef and the World Health Organization. The version adapted for the use by community healthworkers is called C-IMCI, see WHO (2014); WHO Department of Child and Adolescent Health and Development (2005); UNICEF Health Section (1999); Rosales and Weinhauer (2003) and Arifeen et al. (2009). The guidelines are quite intuitive – for example, they prescribe immediate care if symptoms indicate a risk of malaria, but treat coughing or diarrhea as harmless unless they last unusually long or cause complications that point to pneumonia or dysentery (see section 3).

e.g. because of a different cost-benefit trade-off or a better understanding of the illness. Parents may therefore *overuse* care relative to the policymaker's assessment by going to the doctor too early, before care is required, or *underuse* it, by going too late. Subsidies will lower the parents' cost threshold and lead to earlier (more) care, which can represent either an reduction in underutilization or an increase in overutilization. Providing information about the child's health through the CHW has the potential to improve the allocation of care, but only if the parents' cost-benefit assessment is aligned with that of the policymaker. This may make the CHW and subsidy interventions complements in achieving better curative care: essentially, the CHW provide advice on when to seek care, and the subsidy allows the parent to follow through on that advice.

We observe 3747 illness spells – more than two per child – with an average length of 6.4 days, of which 3.0 are "care-required" days. We find that overuse according to WHO recommendations is rare in the control group, even though there is surprisingly large scope: about half of all illness spells end without ever requiring care.[3] By contrast, underuse is rampant, with a probability of care-seeking on a care-required day of five percent or lower. As a result, only 11% of spells that reach "care required" status actually receive formal care. Overall, there is evidence that cost constraints are more binding than information constraints: the probability of care is on average more than five times higher on days when care is required than when it is not, suggesting that parents are able to differentiate illness severity as embodied in the WHO care recommendations, but they delay the doctor visit longer than recommended.

The subsidy increased the probability of seeking care on any day of an illness spell by 250% and the total value of care received by over 80%. Importantly, this increase does not crowd out private spending on acute care, and the bulk of the increase occurs on care-required days. More than 70% of the doctor visits that the subsidy generates are recommended by WHO guidelines. By contrast, providing health information to parents through CHW visits has no aggregate effects on demand in our sample, consistent with parents already being able to distinguish need for care. That said, exploratory analysis uncovers substantial heterogeneity by age. For children up to one year old who receive the subsidy, CHW visits lead to a significant additional reduction in underuse of care. This important finding suggests that the subsidy and information interventions complement each other in improving care for

[3]Note that the idea of seeing the doctor too early hinges on the possibility that an illness may pass harmlessly without entering "care required" status. Nonetheless, a spell that enters "care required" status may end without treatment. "Care required" should be interpreted to mean that the risk of harm or death is sufficiently high to warrant the cost of care, even if the illness may ex post pass without apparent harm. Indeed, more than 85% of illness spells in our sample end despite not receiving any formal care, including those that would have required care according to the IMCI guidelines by the WHO.

the age group with the highest mortality risk. In an abridged 2014 follow-up survey, we find a matching increase in formal care for diarrhea among 0-2 year old children in the full program group only, although we are unable to classify whether this care is required by WHO standards (Dean and Sautmann (2022)).

Overall, our results are consistent with cost constituting a primary barrier to appropriate care in our population, along with potentially higher information barriers for the lowest age group, in line with qualitative evidence on the greater difficulty parents have in recognizing illness in young children (Charlet et al., 2017). The results are encouraging for the planned roll-out of subsidized care in Mali, supported potentially by CHW activities focused on better curative care for infants. Our findings complement a study in Bamako by the NGO Muso and the Malian Ministry of Health in 2008-2015 (Johnson et al., 2013, 2018), which found reduced incidence of febrile illness and mortality after the introduction of CHW visits, user fee removal, and health system strengthening measures (although the program effects cannot be easily distinguished from other time trends). Our experiment directly shows changes in curative care seeking in response to the interventions, pointing to better formal care seeking as an important pathway for positive health outcome effects. The CHW effects for acute care utilization call for further study, given the important role of CHW interventions in health policy in general and in Mali in particular.

Our paper contributes more broadly to the literature on curative health care for children in low-income countries, aided by novel daily panel data. Research on policies intended to improve acute care is still fairly rare, with some exceptions, such as Powell-Jackson et al. (2014).[4] The problem of underuse is known to be severe for preventive goods, where the benefits are nearly universal, but also often abstract and far off. Our results show that underuse is similarly pervasive at the extensive margin of acute care, that is, the decision to visit a provider. We show that subsidies can substantially improve utilization at this margin. These results contrast with Cohen et al. (2015) and Lopez et al. (2022), who examine the effect of subsidies for malaria drugs at the point of purchase. Both papers document that there are significant rates of overtreatment that increase with subsidization. Similarly, patient audit studies have shown low-quality diagnostic and treatment choices, which often result in non-indicated or mis-targeted treatment, in a range of low and low middle income contexts Das et al. (2016); Currie et al. (2014). The reasons for overtreatment range from financial incentives for providers to patients demanding powerful medicines. This points to a challenging twin problem, where underuse at the extensive margin, in the form of too few contacts with the health care system, occurs simultaneously with overuse at the

[4]Das and Sánchez-Páramo (2003) have weekly data on illness and document the variation in demand that comes from differential illness incidence, but do not study demand interventions.

intensive margin, in the form of overmedication conditional on such a contact. Subsidies that increase access are more likely to induce overuse when there are fewer cost controls, such as those implemented by Mali Health. Thus, efforts to reduce the cost of care likely require accompanying measures to limit non-indicated or overly expensive treatment.[5]

An innovation in this paper is to apply hazard models to spell data collected at home to be able to estimate the effects of the interventions on care seeking conditional on health status. In section 5.5, we discuss the advantages of this approach for making out-of-sample predictions and for understanding selection effects in demand analysis based on health system contacts, that is, records of health consultations or health insurance claims. Since sickness spells can and do frequently end without treatment, selection bias is pervasive.[6] For example, we show that children with the subsidy who visit the clinic have been actually sick weakly *longer*, because the treatment succeeds at bringing children to the clinic whose parents tend to wait longer before seeking care.[7]

In a companion paper (Dean and Sautmann (2022)) we report data from a follow up survey conducted in 2014. Unlike the 2013 data we use here, the 2014 survey did not include detailed health diary data, and so cannot be used to study the impact of subsidies and CHW visits on healthcare demand conditional on health state, the central point of this paper. Instead, it focused on measures of health knowledge, use of preventive care, evidence of malnutrition, and diarrhea incidence and care. Using this broader set of measures, Dean and Sautmann (2022) do identify positive CHW effects, including complementary effects of CHW and subsidies, as we discuss in section 5.4.

Section 2 describes the policy environment and the RCT intervention and survey design. Section 3 discusses our use of the IMCI measures. Section 4 introduces a framework for demand for curative care and the effects of subsidy and information policies and section 5 describes the empirical results. Section 6 concludes with a brief discussion of policy implications.

[5]Also related is work by Fischer et al. (2014), who test for learning and reference dependence as they vary prices in door-to-door sales of over-the-counter drugs (but do not focus on over- or underuse).

[6]In most other spell data economists use, e.g. unemployment spells, there are no equivalent sources of censoring.

[7]One of the few data sets we are aware of that has panel spell data, the 1987 National Medical Expenditure Survey for the United States, includes only spells that lead to medical care use or work absenteeism. Gilleskie (1998) recognizes the selection problem but can only address it by estimating the probabilities of unobserved health events parametrically. With administrative data e.g. from insurance claims (Manning et al. (1987); Finkelstein et al. (2012)), illness spells can only be studied indirectly, by grouping claims into treatment episodes, see Stoddart and Barer (1981); Hornbeck et al. (1985); Keeler et al. (1988); Santos Silva and Windmeijer (2001). A public health literature studies the covariates of the delay in seeking care for specific diseases (see Storla et al. (2008) and Nguyen et al. (2010) for reviews).

2 Study Background and Data Collection

The Malian health care system builds on a network of community health clinics or *centres de santé communautaires* (CSCOMs). A CSCOM has typically one or two trained doctors on duty and sells prescribed medications through an attached pharmacy. At the time of the study, CSCOM care was partly subsidized, but primarily funded by user fees, in accord with the Bamako Initiative from 1987, which advocated self-sustaining, decentralized public health care across West Africa. The public health care system is flanked by a private formal sector with higher prices, and informal sources such as market stalls (see below).

This study was conducted in Sikoro, a peri-urban area of the capital of Mali, Bamako. Most roads are unpaved, and many dwellings are not connected to the water supply or the sewage system. In and after the wet season the incidence of waterborne diseases (diarrhea) and malaria is highest. Mali has high rates of maternal and child mortality, especially in rural areas. Poor urban areas have better health care access and lower rates of mortality, but still often lack basic health services. Mali's urban areas resemble those elsewhere in West and Sub-Saharan Africa, although literacy rates in Mali tend to be lower and fertility and child mortality rates higher (see table C.1 in the online appendix). This makes child health interventions particularly important here.

2.1 Study Design

Mali Health started the Action for Health (AfH) program in 2010 in collaboration with the two local clinics (CSCOMs) in Sikoro. The full AfH program combines subsidized health care and biweekly CHW visits.

The subsidy is administered via a personalized card that entitles the child to unlimited free consultations at a partner clinic, and free treatment and medication for any illness due to diarrhea/malnutrition, malaria, vaccine-preventable diseases, and respiratory infection (together causing the vast majority of child deaths outside of neonatal conditions). Families have to cover remaining expenses, for example for services that are not part of the standard treatment course for a given diagnosis.

The CHW have a range of tasks. Most importantly for this study, they track a set of simple health indicators and advise families when to visit a doctor or alternatively what care to provide at home, such as oral rehydration treatment (ORT) in mild cases of diarrhea. Additionally, they teach good health practices and dispense water chlorination tablets for households with no access to clean water.[8] CHWs are recruited locally and their train-

[8]We analyze effects of the two interventions on preventive care and longer-term health in a separate paper. We find no impact on illness incidence in the 2013 data used here, and measured chlorination levels in 2014 do not significantly differ between treatment groups. For more detail, see section 5 below and Dean and Sautmann, 2022.

ing follows the C-IMCI (Rosales and Weinhauer (2003)), a set of guidelines for community healthworkers that incorporates the WHO's and UNICEF's "Integrated Management of Childhood Illness" recommendations for when to refer children to formal health care (WHO (2014); WHO Department of Child and Adolescent Health and Development (2005); see also below).

Note that the role of the CHW may be more expansive in locations where formal care is less easily accessible. In rural areas, the CHW may for example provide basic medications and administer rapid tests. This is not the case in the CHW program we consider here. While CHWs programs were initially conceived as a way to reach patients in remote locations, many CHW work in practice in urban or peri-urban areas. Comprehensive data is sparse, but even in national CHW programs that target rural populations, a significant share of healthworkers operate in urban areas (e.g. 20% of CHW in Pakistan, Brook (2009)). In Mali, 6% of CHW work in Bamako ((Saint-Firmin et al., 2018)).

The research design took advantage of the second planned roll-out wave of AfH. Mali Health conducted a census in their expansion area in mid-2012 to enumerate all families with children under five years of age (or a pregnant mother) who satisfied a proxy-means test designed to select approximately the poorest third of households. After the baseline survey in 2012, data were collected in two surveys in 2013 and 2014 during the period of highest malaria and diarrhea incidence (September-November). All households identified in the census that were found at baseline were included in the random assignment to the different treatment groups and revisited in 2013.

In this study we use demographic, location, and household asset data collected in the baseline survey, and daily health diary data on children collected during the 2013 follow-up. The unit of randomization is the compound. A compound may house more than one household, and typically consists of a few rooms around a common courtyard with shared latrines and other facilities. After stratifying compounds by average household assets, number of eligible children, and location, each was assigned to the subsidy-only group, the CHW-only group, the full treatment group, or the control. The healthworkers in the two CHW treatment groups were trained and managed separately, to avoid spillovers.[9]

The focus of this study is to understand the demand for health care of the typical quality a

[9]It was not possible to assign healthworkers across the entire intervention area while keeping their travel distances manageable. Mali Health therefore paired healthworkers of similar experience and quality, and one of each pair was assigned to the healthworker only or the healthworker and subsidy group. The pairs were then assigned in an overlapping pattern by stratum. For example, pair 1 and pair 2 were each randomly assigned half of the families in the same stratum, and half of the families in a different stratum, each shared with another pair of healthworkers. In this manner, each stratum was assigned four healthworkers (two in each treatment group), the quality of the healthworkers in the treatment groups was matched, and no two strata had identical sets of healthworkers.

local medical professional (trained and certified in-country) can provide, holding the supply side constant. The reader may have two concerns in this regard. First, quality of care in public health care systems in developing countries is often low, which may mean in practice that patients receive care from an untrained individual or not at all (e.g. if the doctor is actually absent). Such quality problems affect how desirable the use of the health care system is, both from the parents' and the policymaker's point of view (see e.g. Das (2011); Das and Hammer (2005, 2007, 2014); Das et al. (2016); Das and Sohnesen (2006); Leonard and Masatu (2010); Leonard et al. (2002)). The clinics in this study were financially supported by Mali Health during the study and subject to regular quality control. We assume that the standard of care provided reflects the level of care that the WHO expects when they formulate treatment recommendations for low-income countries. The second concern is that subsidizing care might create supply side responses to our interventions, such as demand inducement and moral hazard by doctors. While we cannot rule out that such effects occurred, Mali Health controlled costs in the subsidy group using treatment guidelines for common diagnoses, spot checks on diagnosis and prescriptions using bills submitted to Mali Health, and the clinic's treatment records and accounting. We also found that the subsidy did not change the average value of services received per visit (see section 2.3). Lastly, the study sample is small relative to the overall population, mitigating general equilibrium concerns.

2.2 Sample Population

Mali Health identified 1804 eligible children in the census. At baseline, 1732 children were included in the study. The roll-out of AfH started three months after the baseline in early 2013. By the second survey round in Fall 2013, there were three refusals and an additional 162 children could not be surveyed, including five who passed away.[10] The remaining sample in 2013 contains 1567 children from 990 households in 642 compounds. Attrition between baseline survey (and treatment assignment) and follow-up is 8-11%; the group differences are not significant. At follow-up, 201 children were newly reported by the caretakers of existing study children. Newborn children in the treatment households were enrolled in AfH either by the healthworkers, or by a program officer who visited study households every three months. Since the caretakers' treatment choices are our outcome of interest, we consider these children part of the sample. We only included newly reported children 3-12 months old. Table C.2 in the online appendix shows the sample over the study period.

Table 1 shows sample characteristics and balance. We find few significant differences between the treatment groups. There are on average more than six people in a household, due

[10] Our sample population moves a fair amount, but households that relocated inside the program area were followed and remained eligible for Action for Health; only children who left the area entirely or could not be tracked are not included.

in part to polygamous marriages. About half of the household heads are literate and 73% speak the *lingua franca* Bambara. Households report on average about US$6600 in assets, with an owner occupancy rate of 41%. Only 13% of household heads earn a regular salary. The closest source of formal health care is on average 546 meters away (less than 0.4 mile). The average child age is about three years. The study children are well below age-typical weight for height (normalized using W.H.O. reference distributions). We control for these covariates in the analyses below, except weight for height, which may be an outcome of parents' health behaviors.

2.3 Health Calendar

We collected daily information on symptoms, health consultations, and medications taken in weekly visits over the course of nine weeks from the child's primary caretaker (usually the mother). Caretakers could use pictorial diaries (figure B.1 in the online appendix) to mark off symptoms and health-related events. The surveyor then reconstructed the child's health history during the visit. There was a concern that parents would respond to the observation by the surveyors, for example by watching their children more closely. Ultimately this drawback was outweighed by the benefits of detailed coverage without the problems associated with long recall periods (Das et al., 2011). The surveyors were carefully instructed not to comment on the child's health, and to emphasize that they had no medical qualification. While we cannot rule out all Hawthorne effects, we believe our precautions mitigated them, combined with the fact that the calendar data collection had been piloted over six weeks after the baseline in 2012, thus creating some habituation.[11]

Symptom Calendar. The list of symptoms was designed in collaboration with Mali Health staff and based on the C-IMCI guidelines by the WHO (see also below). The C-IMCI is designed for use by CHW who have no prior medical experience. It consists of simple rule charts that use important and easy-to-spot symptoms to broadly classify a child's illness and establish need for care. These properties mean we can collect symptom reports from mothers and surveyors who are not medically trained. The survey explicitly asks about convulsions, fits, or spasms; lethargy or unconsciousness; inability to drink; vomiting; coughing; difficulty breathing; more than three loose stools; blood in the stool; sunken eyes; and unusually hot (cold) skin. We constructed four more symptoms from the "other" category: skin conditions (e.g. spots, rash, itch), cold symptoms, ear pain, and injuries. We observe on average 60

[11]Since the survey took place towards the end of the rainy season, illness rates were declining over the course of the panel, so we cannot assess if a time trend is due to a fading Hawthorne effect. However, in the baseline pilot of the health diaries, initially elevated symptom reporting rates stabilized at a lower level after the first week of surveying and then declined at a slower and more continuous rate (data available on request). This is consistent with data on doctors, who rapidly return to unobserved length and quality of doctor-patient interactions even when observed by other doctors (Das et al., 2008).

days per child, and children exhibited symptoms on average on 18 days. Cold symptoms, coughing, and unusually hot skin were most frequent. Section 3 below gives more detail on how symptoms translate into illness spells and care-seeking recommendations. Appendix B provides a description of how the health calendar information was collected and shows recorded symptom days by treatment group in table B.1.

Consultations. At each surveyor visit, mothers were asked if they discussed their child's health with anyone in the preceding week, and the surveyors recorded role or occupation of the person seen, facility, waiting time, treatments received and costs incurred.[12]

Table 2 provides an overview of these health care "consultations". The 735 formal consultations in our data are provided by CSCOMs and CSREFs (reference hospitals), and private doctors, hospitals, clinics, and pharmacies. Parents occasionally see several providers in the same day, for example when they get a prescription at a clinic and then purchase medication elsewhere. We group visit records that are linked in this manner and classify them by the "most formal" consultation in the group. The value of care is approximated using the full price of care.[13] Note that the sizable difference in costs and value of care even without a subsidy is due to families seeking outside help to pay for the child's care, e.g. from relatives or friends.

The table shows that the subsidy program reduced the average cost of a visit to the household by 71%, from CFA 2850 to 933 (476 CFA equaled 1 USD in 2013). Among the formal-care visits in the control and CHW-only groups, 14% and 12% were reported as free, vs. 70% and 77% in the subsidy groups, respectively. Parents paid if they visited other providers than the two partner clinics or did not claim the AfH benefit, or the child received services not covered under AfH.

CSCOMs provide similar value per visit with and without the subsidy, suggesting that the type and quality of health care received, conditional on visiting a clinic, is similar. In an uncontrolled setting, it is likely that doctors respond to the subsidy by raising treatment costs or prescribing unnecessary treatments. This is not the case here, due to Mali Health's quality and cost control, implemented after initial increases in costs during earlier program roll-outs.

[12]In order to facilitate the recording of drugs prescribed, purchased, and taken, mothers were asked to keep the packaging of any medications their child took. The surveyors could search and fill the drug from a database of brand and generic names of about 300 medications commonly sold in Mali.

[13]Value of care is imputed using prices recorded for consultations and medications where the respondent reported having paid the full price themselves. We use these prices combined with provider information, brand name, and point of purchase to construct the median price by source. If the respondent reported another person paying for care or was in the subsidy group, we compare the sum of median prices for the services received with the private expenses the respondent reported and use the higher value. This reflects the cost of care to the family, the NGO, or a third party.

Wait times at the CSCOM are somewhat longer with the subsidy. This could be because subsidized patients receive more comprehensive medical tests such as malaria tests, which require waiting. We cannot rule out that they see different personnel, or even are made to wait longer than other patients. However, given the good relationship of the cooperating clinics with Mali Health, the income stream AfH patients provide, and Mali Health's efforts at quality control, we deem this possibility unlikely. For this the clinic staff would also need to check in advance of the consultation which patients have the subsidy.

Private formal providers are pricier than CSCOMs and have longer wait times. There are many purchases from informal sources that come at low monetary and almost no time cost. The low prices (under 50 US cents) suggest that they also provide little value. Typical informal sources are peddlers, stalls, or shops, healers, or Islamic marabouts; individuals who are not trained to diagnose illness. For our analysis, we do not treat these as demand for (formal) health care. We also do not count pharmacy purchases not associated with a doctor visit because pharmacists do not carry out a diagnosis. Pharmacy visits alone are also not subsidized by AfH or promoted by the CHW.

We also recorded CHW visits if they were mentioned among the consultations by the parent (we did not explicitly ask about them to prevent reporting bias from associating the survey with Mali Health, for example if parents believe we are monitoring the healthworkers). Parents reported 0.46 visits per child in the CHW-only group, but 1.64 in the full program group (not shown). This may raise concerns about differential program delivery, but we found similar effects in the 2014 follow-up survey that suggest measurement error.[14]

3 IMCI Classification and Illness Spells

Throughout the paper, we identify "overuse" and "underuse" of care *relative to the IMCI guidelines* proposed by the WHO. The C-IMCI is part of the community and family arm of the IMCI itself, the WHO's and UNICEF's primary children's health program, which has been adopted by over 80 countries (Bryce et al., 2004). The C-IMCI goes through a set of simple checks in order to spot danger signs and classify symptoms into gastrointestinal

[14]In 2014, we prompted parents to report visits from any NGO workers who measured the child's weight or height in the last 2 weeks, and we asked whether the child had a card entitling them to receive free health care at the clinic (still avoiding direct mention of Action for Health). We found that 12% more CHW visits were reported in the full program group than in the CHW-only group, but we also found that 10% of families reported visits in the subsidy-only group, and we cannot reject that the sum of the CHW-only and subsidy-only effects equals the full program effect. Moreover, we found both a greater share of families reporting the subsidy card in the full-program group than the subsidy-only group and a share of respondents reporting the subsidy in the CHW only group (Dean and Sautmann, 2022). Together, these numbers suggest misreporting or misidentification of aspects of the different program components of Action for Health. It is possible that some of the reported CHW visits in the full program group were clinic staff making home visits, which suggests some measurement error in formal care received.

illness, respiratory illness, malaria, and so on. It targets the causes of about 70% of child deaths.[15] All diagnostic tests can be operationalized in the field. The effectiveness of these checks in identifying the underlying disease was rigorously tested (see Gove (1997) and the studies therein). Based on the duration and severity of symptoms, the C-IMCI algorithms make recommendations for when formal medical care should be sought (see below). The C-IMCI is explicitly tailored to a developing-country context, and we assume that its care-seeking recommendations take into account factors like the expected quality of care and resource constraints.[16]

What justifies the use of the IMCI to assess need for care? Ultimately, we are interested in assessing the allocation of acute care. However, the optimal allocation is unobserved. Demand for children's health care is likely distorted by market imperfections such as credit constraints. Parents may not fully internalize their children's welfare or externalities due to contagion. Moreover, households may not be able to interpret symptoms and assess the value of visiting the doctor in different health states. All of these imply that parents' health care demand is not socially (or even privately) optimal. At the same time, solving the social planner's problem of optimal resource allocation requires too many parameters for which there are no good estimates, from the production-side trade-off between supplying health care and other goods, to the true preferences of the household.

Given the correlation of the IMCI diagnostic algorithms with serious illness, they provide some guidance for assessing welfare, even if imperfectly. First, they constitute an approximate solution to an optimization problem: conditional on the limited information an outside observer can use to make a recommendation, for an organization that is prepared to devote resources to children's health, which mapping from health states to care utilization has the greatest effects on expected mortality and morbidity? At a minimum, this provides a *ranking*; from a medical standpoint, care in the "care required" state is more valuable than otherwise, even if the total amount of care is not optimal.

Many policymakers may indeed agree that all children should receive care when the IMCI recommends it. For example, a child with malaria symptoms should be seen by a doctor regardless of parental preferences or wealth. Moreover, it is unlikely that parents have private information that indicates that no care is needed even though the IMCI recommends care.[17]

[15]The five main causes are diarrhea, pneumonia, measles, malaria, and malnutrition. According to Unicef estimates, around 50,000 children under five died in Mali in 2017, 17% of whom died of pneumonia, 10% of diarrhea, and 14% of malaria.

[16]Mayo Clinic recommendations for children in the United States, for example, have lower thresholds for seeking medical advice. They advise to call a doctor after 24 hours of diarrhea, and state on fever: "When in doubt, go ahead and call your child's doctor, whether you think your baby's temperature is abnormally high or abnormally low." (Mayo Clinic, 2014, 2016).

[17]The reverse seems more plausible, i.e. parents may observe symptoms that require medical care but are

The "care required" designation may thus be considered a lower bound for underuse.

Last but not least, comparing parents' behavior to the IMCI recommendations indicates to what degree they follow the CHW's care seeking advice. Thus, even if they do not characterize the social optimum, the WHO guidelines capture important information, giving them a role in evaluating the effects of demand-side health care policies. Studying demand in detail in this manner complements studies that measure mortality or health outcomes. While the objective of the interventions is of course ultimately to improve health, only direct information about health care utilization can teach us whether and how parents' behavior changes and if there are problems with targeting such as use of care when the child is not actually sick.

Classifying illness spell days. The IMCI charts define an intuitive set of rules to determine need for care. For instance, cough and cold symptoms typically point to a viral infection and do not require medical care, unless they persist for 14 days or longer, which potentially indicates a more serious illness like tuberculosis. Diarrhea alone can be treated with home remedies, but in the presence of sunken eyes (dehydration) or blood in the stool (dysentery) requires immediate attention. Applying these rules to symptom records, every day in an illness spell can be classified as either an "early" day (i.e. before care should be sought) or a "care required" day (on or after the day at which care should be sought). We focus on "pre-care" spell days up to the first contact with the health system, since symptoms might be affected by treatment.As an example, consider a child who is coughing for three days, on the third day develops a fever and takes cough drops from a peddler, is prescribed paracetamol at the CSCOM on day 5, and symptoms subside after day 8. This is a five day pre-care spell with three care-required days (days 3-5). If the child had not received care, it would be an eight-day spell, with days 3-8 being care-required days. Appendix B describes the approach in detail.

Table 3 shows untreated days per child (possibly in several illness spells), and the percentage of days on which each symptom is present, in total and split into early and care-required days. On average, 16.3 of 59.8 observed days per child (27%) were (pre-care) illness spell days, and on six of those there was a need for care. Convulsions, lethargy, inability to drink, and vomiting should trigger immediate care, so they always occur on care-required days. The biggest contributor to need for care is fever (unusually hot skin). While cold symptoms and cough rarely in themselves indicate a need for care, they often occur in conjunction with other, more serious symptoms and therefore the spell day is still classified as "care required". The data show that the children in our sample are often ill with symptoms that point to dangerous conditions like malaria, but also often experience less severe symptoms, so they

not covered by the IMCi, such as injuries.

are in need of a doctor evaluation only 37% of the time.

The symptoms we collected do not cover all possible illnesses, but focus on conditions that mothers and surveyors can easily recognize. As an example, breaths per minute and "chest indrawing" are IMCI indicators of respiratory illness, but require experience and training (and a stopwatch) to measure. We also interpret the IMCI guidelines conservatively, for example for diarrhea (where the recommendation is for a CHW to return to the family after five days to check on the child's status, but we assume a need for care only when complications arise). Moreover, the IMCI itself is not exhaustive. As a result, our classification as "care required" contains noise and generally represents a lower bound for need for care.

Appendix Table B.2 summarizes the observed pre-care spells. Due to spells recorded in the first week of the survey or after survey interruptions, 464 illness spells are potentially left-censored, that is, they may have started before the first recorded day. We exclude these spells from our main analysis.[18] This leaves us with 3747 spells, with an average length of 6.43 days (6.92 st. dev.). Within these spells, there are on average 3.4 early days and 3.0 care-required days. Only 503 spells, or 13.4%, end with a consultation; in all other spells, the child eventually recovers from the illness unaided. Note that spontaneous recovery, that is, recovery without use of formal care, is common and an important feature of acute illness in general. It is the reason that some acute care may be overuse: section 4 describes that "waiting out" an illness and avoiding health care expenses can be optimal if unaided recovery is possible, and in this case it may be overuse to visit a doctor early. By contrast, if recovery could only occur with medical care, "too early" use of acute care would not be an issue; care should always be provided immediately, and any delay would constitute underuse.[19]Conversely, it should also be noted that ex post observed spontaneous recovery does not preclude that a given spell should have received care ex ante, based on the risk of a more severe illness that might have serious consequences if left untreated.

There are between 907 and 967 spells in the four treatment groups (see table 5 below). This implies that there are no significant effect on illness incidence, at least in the first year of program receipt, a fact we discuss further in section 5.4. Although our approach of estimating conditional demand mitigates selection concerns due to differences in incidence, we consider the balanced spell numbers an advantage for internal validity, as we are sure to compare demand in response to similar illness patterns. To the extent that the program has

[18]Left-censoring means that need for care cannot be determined, because the day of the spell is unknown. Left-censored spells are on average 10.2 days long. Our main results are robust to treating these spells as not left-censored (see also below).

[19]We discuss below that recovery is a form of right-censoring, because we do not observe when parents would have sought care if the child had *not* recovered. Right-censoring is here an integral part of the data generating process, and important for understanding health care demand, especially because a large number of spells do not end in formal care.

longterm incidence effects, *and* incidence affects parents' decisions to seek care in response to the same symptoms, it could mean that our analysis is not capturing (longterm) effects of the treatments on conditional health care demand in full.

4 Demand for Acute Health Care

We sketch a simple model for the decision to seek health care in response to acute illness, in order to derive notions of overuse and underuse and to make predictions for the impact of AfH policies on health care demand. All formal statements are in Appendix A. Our framework is based on two central observations. First, demand for acute care arises in response to a negative health shock that causes discomfort – and risk of harm – to the child until it passes. Second, there is learning about the severity of an illness over time. For many illness spells, it is likely that the child will recover without the aid of a clinic visit, and it is worth tolerating some disutility from sickness while waiting. As time goes by, the probability of recovery without treatment decreases, and further suffering (or worse) can only be avoided by seeking care. Thus, the demand decision becomes *when* during an illness spell to visit a formal care provider.

Formally, denote the parent's belief that the illness will continue another day by π_t. Each day t of the spell, the parent decides to either visit a provider who can evaluate and treat the child, or wait another day, and with probability $(1 - \pi_t)$ the illness passes on its own. With uncertainty about the underlying illness, π_t is increasing in illness days t due to Bayesian updating: continued symptomaticity reveals an illness with lower probability of recovery (Lemma 1). This implies a decreasing value of postponing treatment, since it becomes less likely that the child will recover on their own. As a result, parents optimally follow a simple cut-off strategy: seek care when belief π_t exceeds some threshold K (Proposition 1). K depends on the benefits as well as the monetary and non-monetary costs of care C. C is increasing in the (expected) price of care.

We assume that the policymaker faces a similar stopping problem, although with different parameters π^* and K^*. This agrees with expert care seeking recommendations such as the IMCI (see previous section), which take into account duration of symptoms as an indicator for health care needs. Such recommendations cannot be explained without learning and the possibility of recovering without treatment: if π_t^* (or π_t) was constant over time, the choice to seek care would be a simple yes/no decision on the first day of illness, because getting earlier care for the same illness is always better.

This model of the decision to seek care illustrates why we need daily diary data to analyze the allocation of health care. On the one hand, even when a spell that enters "care required" status eventually receives care, there can be underuse. On the other hand, a doctor visit

when care is not yet required constitutes overuse, even if the spell later turns worse and requires care (and note that early in such a spell, a health care provider may well ask the parent to return at a later date without deciding on a treatment course).

Effect of a subsidy: Consistent with current policy consensus, we assume that the parents' treatment threshold K is weakly greater than that of the policymaker K^*: the policymaker may evaluate the financial costs differently from a parent with credit constraints, or she may incorporate the long-run human capital benefits or reduced infection risk for others. Assume for now that parent and policymaker share beliefs π. This case is illustrated in Panel A of figure 1 (numerical details in the appendix). Learning over time implies $\pi_t < \pi_{t+1}$ (solid black line). If the child is still sick in period $t+1$, the policymaker would like her to receive care because $\pi_{t+1} > K^*$, but since $\pi_{t+1} < K$, the parent will not take her to the doctor. This is an incidence of *underuse,* or visiting the doctor *too late* relative to policymaker preferences.

A subsidy lowers the care-seeking threshold of parents by reducing the treatment cost C. Panel A illustrates how this increases utilization in all periods and can reduce underuse in $t+1$. However, if K is reduced by too much, for example to K', *overuse*, or *early* care, may now occur in t (since $K > \pi_t > K'$). In a heterogeneous population, a subsidy policy may eliminate some, but not all, underuse, yet simultaneously create some overuse.

Effect of information: Disagreement may additionally occur due to differences in beliefs about the recovery probability, so that $\pi_t \neq \pi_t^*$. If these differences are due to the parents' poor information, a situation might arise as in Panel B of figure 1: the policymaker can distinguish a more severe and a less severe illness (π^{*S} and π^{*L}) while the parent holds average beliefs π. Examples are diarrhea spells with or without signs of dehydration, or a generalized fever vs. a fever combined with symptoms that point to malaria (see also appendix). Lack of information can lead to both *overuse and underuse,* because parents take the same action regardless of illness severity. For example, at K the parent will always seek care in period $t+1$ – but for many thresholds K^*, including K, the policymaker would prefer care for the severe illness in t, but no care for the less severe illness in $t+1$.

Subsidies cannot address simultaneous overuse and underuse from poor information, because they will only monotonically increase utilization. By contrast, a successful information policy may improve allocative efficiency. Take behavior at threshold K^*: an uninformed parent with belief π will always seek care in t and $t+1$, but an informed parent will exactly share policymaker preferences and delay care in period t in the case of the less severe illness. Thus, if the information intervention *aligns the beliefs of the parents with those of the policymaker* it may complement the subsidy by directing care (only) to the children who need it.

To summarize, if the main barrier to a good allocation of care is high cost, parents in

the control group will seek care primarily on care-required days, but we will see significant underuse. If poor information is an important allocative barrier, then care seeking will be only weakly correlated with "care required" status, and we may see both overuse and underuse (observation 1). A subsidy will increase utilization, thus decreasing underuse, but also potentially increasing overuse (observation 2). If the subsidy aligns the cost thresholds K and K^* and the CHW intervention aligns beliefs π and π^*, then the two interventions may complement each other in decreasing both underuse and overuse (observation 3). Observation 3 is a motivation for combining subsidies with information policies: subsidized care gives families access to health services, while better information ensures that they make efficient use of this benefit.

A few notes are in order. First, as can be seen in the graph, whether information unambiguously improves the allocation of care from the policymaker perspective depends on whether the cost cutoffs K and K^* are aligned. This is because upon receiving information that alters π, parents will still align their behavior with their own cutoff K, not with K^*. This may be a positive or negative change from the policymaker perspective. We will return to this point when we discuss age-specific CHW effects in section 5.3. Second, we focus here only on the role of the CHW in providing symptom information. In Action for Health (as in most CHW programs), the CHW have other tasks, in particular in prevention. This may have effects on the incidence of illness. However, we think of information as the main potential channel through which they may affect demand for formal care conditional on illness. We discuss other effects of the CHW briefly in section 5.4.

5 Results

The degree to which the effects of subsidies and information provision above are realized depends on the severity of the various constraints families experience, and is therefore an empirical question. We begin the empirical analysis by documenting the impact of subsidies and CHW on unconditional utilization of acute care. Our main analysis reports on the impact of our three treatments on health care use *conditional* on health status.

5.1 Unconditional Health Care Utilization

Table 4 shows regressions of a set of per-child outcomes on dummies for the three treatment groups, along with a statistical test that the effects in the subsidy-only group are the same as in the full treatment group. All standard errors are clustered at the compound level. Columns (1) to (3) show the number of formal consultations per child, in total and split into CSCOM and other formal care. (4) to (6) report the effect of the program on private expenditure per child, again first in total and then for CSCOM and other formal care separately. Column (7) reports wait times, and (8) and (9) report total and CSCOM value of care (see above)

per child.

Subsidies increase the number of formal care visits by 175-202 percent (0.38-0.44 visits), and the total value of care consumed by 83-84 percent (CFA1386-1409) relative to the control. The demand elasticity is clearly high: the subsidy increases the number of CSCOM visits per child by 263-312%, relative to the decrease in the CSCOM visit cost by 71% (table 2). There may be some substitution out of other formal care, but overall demand for private care is low, and none of these substitution effects are significant. Remarkably, the subsidy has almost no effect on families' total health expenditure on their children. This implies that there is no crowding out; the subsidies fully translate into additional health care consumption. The subsidy groups also pay higher non-pecuniary costs for their child's health care, as evidenced by the increase in time spent waiting for treatment by about 17 minutes per child.

In stark contrast to the effects of the subsidy, the CHW intervention has no average effects on unconditional health care use.

5.2 Health Care Use Conditional on Need for Care

While the unconditional effect of the subsidy is encouraging, the increase in formal care could be a real increase in access for sick children, but also unnecessary doctor visits. The CHW may have no impact on care seeking at all, or improve the allocation of care without changing overall use. To differentiate these possibilities we examine conditional demand.

Analysis. We present three complementary pieces of analysis. First, table 5 shows disaggregated pre-care spells by treatment group and "care required" status, and the number and proportion that receive formal care.[20]

Table 5 is the joint outcome of illness incidence and demand and therefore does not allow us to isolate the effect of the policy interventions on parents' behavior. To do so we estimate the daily hazard of formal care, that is, the daily probability that the parents seek care on pre-care spell day t conditional on not having seen a doctor yet. Figure 2 shows the simple average hazard of seeking care on each spell day, by treatment group and "care required" classification, estimated by regressing care seeking on a full set of interacted indicators for day

[20]Table C.3 in the appendix shows a complete breakdown of all formal consultations during and outside a spell. Only 5% of visits occur outside a spell, reported by mothers as follow-ups, visits for prevention (e.g. vaccinations), or "other". Of the remaining consultations, 88% (or 494) constitute the first formal visit during a spell of illness. These "acute care" visits are the target of the WHO care-seeking recommendations. Visits after a first acute visit cannot directly be judged using the C-IMCI standards. However, almost all of them occur after a spell entered "care required" status and when the child is still exhibiting symptoms. This might indicate a more hands-on treatment approach by doctors when care is subsidized. Anecdotally, CSCOM doctors lament that it is very hard to convince patients to come back after a first visit, so that they often prescribe treatments for a range of conditions at once. We also know that patients often do not buy everything prescribed at a doctor visit. With subsidized care, doctors may be able to ask the parents to return to try a different treatment approach if the child's condition has not improved.

of the pre-care spell, care-required status, and treatment group. Since this non-parametric approach does not show treatment effects in a concise way, we additionally estimate a Cox proportional hazard model. Formally, the hazard at t conditional on covariates x_{it} is

$$h(t|x_{it}) = \lambda_0(t)e^{x'_{it}\beta}.$$

This assumes an unrestricted baseline hazard $\lambda_0(t)$, but the covariates x_{it} shift the probability of seeking care proportionally on every day t of the illness spell.[21] Treatment effects are captured by CHW and subsidy indicators and their interaction. Table 6 reports the estimated hazard ratios (the proportional increase in the probability of seeking care). Models (2), (4), and (6) control for basic household characteristics. All regressions include stratum fixed effects.[22]

Specifications (3) to (6) separately interact the CHW and the subsidy×CHW indicators with an indicator for "care required" and "early" in order to understand to what degree the CHW may lead parents to behave differently on early and care-required days. If the CHW reduce both overuse and underuse, the effect of the CHW should be negative on early, but positive on care-required days. Models (5) and (6) additionally interact subsidy and care-required indicators. In appendix table C.7 we replicate the estimates but include left-censored spells as if they were not censored as a robustness check; the results are similar.

Results. Table 5 shows that the illness profiles in our sample provide significant *scope* for both underuse and overuse (IMCI based). Out of 955 spells in the control (2.1 per child), half (476) eventually require care. On the other hand, 479 spells, about one per child, never enter care-required status before recovery. The parents' decision is clearly a dynamic problem: 210 spells enter care-required status only later on. Put another way, out of 689 spells that initially do not indicate a need for care, 30.5% eventually require care.

We organize our results using the observations from Section 4. First off, parents behave very differently on early and care-required days. Table 6 shows that a parent in the control group is 5.3 to 5.7 times more likely to seek care when it is required according to the C-IMCI. In figure 2, the probability of care-seeking on any "early" day is below one percent, but much higher when care is required, although never higher than six percent. As a result, there is significant underuse but relatively little overuse. Table 5 shows that 89% of spells that require care do not get it, whereas 4% of "early spells" receive treatment.[23] These results

[21] As we show in appendix figure C.1, the proportionality assumption delivers a good description of our data.

[22] Of the controls, only assets affect health care demand positively and significantly, while the distance to the closest provider as a measure of non-monetary costs has the expected (negative) sign, but is not significant.

[23] The difference in the care-seeking probabilities per day and per spell is driven by the ratio of early to

suggest that information is not a primary barrier to care. The stark difference in care seeking by care-required status implies that parents are able to gauge the relative seriousness of their child's illness, much more so than perhaps expected *ex ante*. High levels of underuse coupled with low levels of overuse instead suggest a high cost barrier (Observation 1).

Next, we examine the impact of the subsidy (Observation 2). The subsidy should decrease underuse, but may also increase overuse. In models (1) to (4) in table 6, the subsidy increases the conditional probability of care-seeking significantly and by at least 249 percent. We cannot reject that the *proportional* impact of the subsidy is roughly the same on early and care-required days (see tests $Se = Sr$ and $Se{+}CHWe{+}SCHWe = Sr{+}CHWr{+}SCHWr$). However, given the higher baseline hazard, this implies that the *absolute* increase in care seeking is much larger on care-required days. This can be seen clearly in Figure 2. It suggests again that an important barrier to needed health care is simply the cost of care.

As a result, Table 5 shows that 9% and 11% percent of "early" spells end in a consultation in the subsidy treatment groups, vs. 29 percent of "care-required" spells. By this metric, the subsidy increases overuse by 5-7 percentage points and decreases underuse by 18-19 percentage points. The last column of Table 5 also shows overuse vs. use when care is required as a proportion of *consultations*. 25 percent of consultations on average occur on an early day in the control, and thus constitute overuse. This number is essentially unchanged in the subsidy groups. However, our analysis reveals that there is little room to reduce overuse, given that the hazard of care on any given early day is so low. By contrast, with 71% of "care-required spells" without a consultation, there is substantial room to decrease underuse further.

Again, unlike the encouraging findings about subsidizing care, we find little impact of the CHW treatment on conditional demand, either in overall terms or separately on early and care-required days. The hazard rates plotted in Figure 2 look similar between the groups with and without the CHW, a result confirmed by the estimates in table 6; on average the CHW do not appear to improve the allocation of care. Given the extremely low probability of early care seeking to begin with, it is perhaps not surprising that the CHW do not significantly decrease overuse; however, they also do not significantly increase care-seeking on care-required days. There is also little evidence of an interaction between CHW and subsidies.

5.3 Health Worker Effects by Child's Age

Very young children are much more vulnerable to illness than older children. The World Bank reports in 2013 that 63% of all under-five mortality in Mali occurred in infants. Worldwide,

care-required days within a spell. Note that we are considering pre-care spells (not illness spells), so that the consultation always occurs on the last day of the spell.

this proportion ranged from 57-93%. This suggests that the benefits from subsidizing acute health care may be greatest very early in life. The benefits of providing information may also be greater, both because parents may be less experienced, and because it is harder to determine illness severity in a non-verbal infant. We therefore conduct an exploratory analysis in which we examine treatment effects by age. Figure 3 shows nonparametric daily care seeking probabilities by treatment group and care-required status for ages 0 to 5 (note differences in y-axis scale). In the appendix, we also estimate Cox hazard models for the youngest and oldest children separately (table C.5) and with a linear age variable interaction (table C.6).

A few observations about age-specific effects emerge. First, the point estimates suggest that the difference in care-seeking for age-0 children between early and care-required days is smaller than for other children. In addition, care-seeking probabilities decrease in age. The low probability of care seeking for age-0 children in the "subsidy only" group, especially when care is required, is a stark break from this pattern, compared to other ages and compared to the full program group. Lastly, for older children, care seeking is *lower* in the groups with than without CHW. The Cox hazard point estimates support this (detailed discussion in the appendix). But for the youngest children, the increase in care-seeking in the group that receives both interventions relative to the subsidy-only group is large and significant.

The sample is small and power low, so these results are indicative only. However, they support the notion that parents are less certain about when care is required when their child is very young, that is, information barriers are higher. They also suggest that parents see care as more valuable for younger children, i.e. the cost barrier is lower. Lastly, the CHW complement the subsidy for the youngest children, in the sense that the full program group seeks care significantly more often than the other treatment groups, primarily reducing underuse. This suggests that the healthworkers may have an important role for the success of the program among the youngest children, even if there are no average effects on all children.

The results could suggest that the CHW do improve information on (WHO based) need for care, but the effect on demand is ambiguous. This is consistent with the framework we proposed earlier: when policymaker and parent share the cost threshold K^*, more accurate beliefs π have the potential to reduce both overuse and underuse. But Panel B of figure 1 also shows a potential *negative* effect when K and K^* are not aligned. Specifically, a parent with threshold $K > K^*$ who learns to distinguish severe and less severe illness will actually stop seeking care for the less severe case in $t+1$, and thus increase underuse. They use new information to align better with their own preferences based on K, not K^*, which is here counterproductive for the goals of the policymaker. Applied to the current context, note that IMCI care-seeking rules (and thus K^*) are the same for all children under five. For

the youngest children with the subsidy, the parents' cost threshold K may be close to that of the policymaker, and they may also find it more difficult to assess their child's need for care. Thus, the healthworkers lift the information constraint and improve the allocation by reducing underuse (observation 3). However, for older children without the subsidy, parents may apply a much higher K , and so the healthworkers may not unambiguously improve the allocation, and in some case potentially even increase underuse (as observed for the oldest children in the CHW-only group). Essentially, parents use the additional information to decide *against* health care visits that the policymaker deems necessary. The effect on the oldest children cannot be explained by the CHW simply informing parents about the subsidy.

There are other possible explanations for these effects. One is based on the specifics of the program. Households were visited in approximately three-months intervals by Mali Health employees, and during those visits, any newborn children or children of program mothers who moved (back) into the household were enrolled into Action for Health. It is possible that parents in the subsidy-only group more often missed the enrollment visits, or did not understand the child's eligibility change, whereas the CHW in the full program group helped them enroll. Some features of the design guarded against this issue;[24] nonetheless, it remains possible that the CHW provide valuable information about subsidy eligibility.

In summary, our results suggest that CHW and subsidy interventions might be complements for the youngest children, who are most vulnerable to adverse consequences of serious illness, and contribute most to continued high child mortality rates. However, our model and results of CHW effects on younger vs. older children suggest some important potential caveats to health information policies that aim to change caretaker choices through information policies. Given the widespread use of and advocacy for CHW interventions, there is need for further research about both the overall CHW effects on care seeking behavior and the exact mechanisms behind them.

5.4 Findings from the 2014 Follow-Up

In a companion paper, Dean and Sautmann (2022), we report on a 2014 follow-up survey that collected an abridged (7 day) health calendar for diarrhea symptoms as well as information on preventive care and measures of malnutrition. The aim of this follow-up was to understand the individual and combined effects of subsidies and CHWs for health behaviors and outcomes more broadly, focusing on the example of diarrhea, for which there is an important role for all three, prevention (measures against the ingestion of contaminated water), home care (oral rehydration therapy, or ORT, for mild cases) and curative care by a formal provider (clinical

[24]For example, all parents already had at least one child in the program and thus knew how the program worked. Our analysis is also restricted to children four months and older who should have received at least one enrollment visit.

evaluation for more severe cases).

The 2014 findings support the notion that CHW and subsidy policies work together in improving health. The CHW improve a broad range of prevention indicators, while the subsidy increases acute care such as ORT use. Regarding formal care specifically, we find significant increases for the 0-2 age group in the full program group only. The data from 2014 does not allow the construction of complete illness spells and therefore we cannot assess whether this care was required in all cases, but the patterns are consistent with the subsidy and CHW acting as complements in the improved use of formal care for the youngest children, as above. In the full-program group, we find significant reductions in the number of days the child is ill with diarrhea, and these effects are again concentrated among the 0-2 age group. However, the 2014 data shows only weak effects on longterm malnutrition indicators (weight for age and arm circumference).

It is interesting that we see reduced diarrhea incidence in the 2014 data but no such comparable effects in 2013.[25] There could be a number of reasons. First, 2013 was the first rainy season under Action for Health. It is possible that the effects of some aspects of the program simply manifested only after a longer period of exposure. Another reason may be that the main causes of acute illness, such as malaria and respiratory illness, are infectious. The children in AfH constitute only a small percentage of the population (about 20% of people in the study households, which in turn make up a fraction of the local population), so the program may not be able to reduce infection rates for most types of illnesses. GI infections may be an exception because some of the preventive measures that the CHW teach, such as hand washing and water disinfection, benefit the whole household, and as habits change over time, children may get sick with diarrhea less. In other words, effects on incidence for diarrhea captured in 2014 are more pronounced than for the full set of possible symptoms in the 2013 data. Lastly, morbidity and mortality are concentrated among the very youngest children. The data suggests that the benefits of the program mostly accrue to these age groups, and it may be that only by 2014 the younger children who benefitted from the program for a sustained period make up a large enough share of the sample to affect average outcomes.

5.5 Advantages of estimating demand conditional on health status

Censoring and Selection Bias. Our data make a strong case for collecting illness data in the home and analyzing spells with a hazard model, due to the issue of censoring with

[25]The similar number of spells across treatment groups is consistent with the balanced symptom incidence by treatment group, reported in table B.1 in the Appendix. Treatment rates remain overall low and treatment occurs fairly late in the spell, so the program has only a small effect on pre-care spell length and none on overall spell length (see also below for a discussion in the context of censoring).

spontaneous recovery: we do not observe how long parents would have waited to see a doctor when the child gets better without care. Spontaneous recovery is integral to the decision to delay care in the first place – there would be otherwise no benefit to waiting. Even care-required spells often end with unaided recovery, illustrating the challenge of improving child mortality through acute care: we need to treat many spells in order to prevent the small portion that may become truly dangerous to the child.

One effect of censoring is that the observed pre-care spell length systematically underestimates true time-to-care, and effects on spell length do not fully reflect changes in daily care seeking probability. For example, there will be spells that are censored (ending without care) at high K, but uncensored (ending in care) at low K (leading to increases in utilization). Table C.4 in the appendix correspondingly shows that the subsidy reduces (pre-care) spell length by only 14 percent, even though we found that it increases the care seeking probability five-fold.

This problem is exacerbated in data that contains only uncensored spells, such as data collected during consultations with the health care provider, or from health insurance events as in Gilleskie (1998) — unfortunately often the only data we have. Table C.4 shows in fact that the average uncensored spell in our sample is weakly *longer* in all treatment groups than in the control. Our hazard estimates confirm that this is entirely selection bias: the large number of additional visits in the subsidy groups tend to be from families who wait on average longer for care, and so they raise the average time to care in the group. Put differently, when underuse is rampant but responds strongly to an intervention, we show that data collected at the point of use are subject to selection effects so strong that they reverse the estimated impact of the intervention on some aspects of care-seeking behavior. Similar effects arise when asking retrospective information on health for a specific (short) period of time.[26] Even recognizing that selection bias may occur, data of uncensored spells only would not permit the researcher to distinguish selection e.g. from moral hazard (parents waiting longer before getting care with the subsidy).[27]

Application: Predicting Care-Seeking for Alternative Illness Environments. Our study estimates demand for care conditional on detailed health information. A benefit of this

[26] An example are the Demographic and Health Surveys (DHS). The DHS questionnaire asks about diarrhea and fever spells and treatment sought within the last two weeks. Shorter spells are observed in full, but longer spells are likely to be censored by the visit date. Moreover, detailed questions about treatment are asked only about spells that are ongoing at the time of the survey. See Heger Boyle et al. (2018), especially questions 518 and 527 and following.

[27] Note that the Cox model assumes proportionality and so does not permit for demand changes that exhibit both selection into care *and* an increase in time-to-care under the subsidy (which might occur with a decrease in care seeking on early spell days but an increase later in the spell). However, figure 2 and the proportionality test in Appendix C.5 show that the proportionality assumption reflects the data well.

approach are more accurate out-of-sample predictions. In Appendix C.6, we demonstrate this by projecting health care demand for a set of hemorrhagic fever spells (Ebola and Marburg disease), where detailed descriptions of the course of illness are available. This illustrates how records of conditional care-seeking behavior might help improve estimates of undetected infections and time-to-care for those who contract a specific illness, for instance in the initial phases of new disease outbreaks. More generally, we can make predictions of behavior in other disease environments. In Mali, policymakers might be for example interested in predicted behavior in the dry season, when respiratory illness is more prevalent than malaria and diarrhea.

6 Conclusion

The prevailing view in international health policy today is that subsidies are needed to close remaining gaps in access to care. The potential benefits are large: by some estimates, improved access to primary care could prevent 29%–40% of post-neonatal deaths in developing countries. Less than 26% of malaria cases in children are estimated to receive adequate treatment, and 411,000 children died of malaria in 2013 in Africa alone.[28] Many countries have begun to remove health care user fees for children, and Mali announced plans to adopt this policy in 2019. However, we have relatively sparse evidence how this affects patterns of utilization.

This study aims to open the "black box" of health care demand-side interventions. We estimate health care use conditional on health status to remove confounding effects of illness incidence, and benchmark care-seeking against the need for care according to WHO medical standards. By surveying all (potential) health care users we avoid selection bias due to spontaneous recovery.

Our results have very encouraging implications for the subsidy debate. First, a primary barrier to effective care seeking in the urban population we study is indeed the cost of care. Underuse is rampant: care is either sought late in the spell or, in the majority of cases, not at all. The welfare cost of subsidies could be prohibitive if they lead to substantial mistargeting and overuse of health care, risking overburdening the severely limited capacity of health care systems in poor countries and thus diverting resources away from those most in need. However, while subsidies nearly triple health care usage in our sample, the additional demand comes largely from children for whom medical care is required according to WHO guidelines. One reason is that parents have some ability to recognize differences in illness severity and are nearly six times more likely to seek care on 'care required' days compared

[28]United Nations Inter-Agency and Expert Group on MDG Indicators (2015); WHO Global Malaria Programme (2015); Bhutta et al. (2008).

to 'early' days.

The degree to which parents can spot illness suggests that information about the health status of the child *a priori* can only have limited additional effects, and in aggregate this is what we find; the CHW visits do not affect average care-seeking probabilities significantly. However, they do reduce underuse among the most vulnerable (youngest) children who receive the subsidy. This is consistent with findings from one year later where formal care for diarrhea is again increased significantly for children age 0-2, and diarrhea incidence is significantly reduced, in the full program group only.

The role of CHW visits for curative care seeking deserves additional research. Our data points to parents being less able to recognize need for care in very young children, which suggests a role for policies that guide parents' use of formal health care this group. At the same time, the age-specific effects and our model of the effect of information on care seeking suggest that parents may make differential use of information they are given, depending on the cost threshold they apply in deciding about seeking care. Unintended and heterogeneous responses to health information policies are an interesting question for additional research more broadly. NGOs like Mali Health might consider a model in which the CHW focus their advice on acute care seeking on the youngest children, for whom the effects are most likely to be beneficial.

References

1 Million Community Healthworkers Campaign. Operations room, 2021. URL: http://1millionhealthworkers.org/operations-room-map/ (accessed: 02/01/2022).

Paul Adepoju. Mali announces far-reaching health reform. *The Lancet*, 393(10177):1192, 2019.

John Akin, Nancy Birdsall, and David de Ferranti. *Financing Health Services in Developing Countries: An Agenda for Reform*, volume 34. World Bank, 1987.

Shams E Arifeen, DM Emdadul Hoque, Tasnima Akter, Muntasirur Rahman, Mohammad Enamul Hoque, Khadija Begum, et al. Effect of the integrated management of childhood illness strategy on childhood mortality and nutrition in a rural area in Bangladesh: a cluster randomised trial. *The Lancet*, 374(9687):393 – 403, 2009.

Nava Ashraf, James Berry, and Jesse M. Shapiro. Can higher prices stimulate product use? Evidence from a field experiment in Zambia. *American Economic Review*, 100(5):2383–2413, 2010.

Nava Ashraf, B. Kelsey Jack, and Emir Kamenica. Information and subsidies: Complements or substitutes? *Journal of Economic Behavior and Organization*, 88:133–139, 2013.

Helene Barroy, Laurent Musango, Justina Hsu, and Nathalie Van de Maele. *Public Financing for Health in Africa: from Abuja to the SDGs*. World Health Organization, Geneva, 2016.

S. Bhatt, D. J. Weiss, E. Cameron, D. Bisanzio, B. Mappin, U. Dalrymple, et al. The effect of malaria control on plasmodium falciparum in Africa between 2000 and 2015. *Nature*, 526 (7572):207–211, 10 2015.

Zulfiqar A Bhutta, Samana Ali, Simon Cousens, Talaha M Ali, Batool Azra Haider, Arjumand Rizvi, et al. Interventions to address maternal, newborn, and child survival: what difference can integrated primary health care strategies make? *The Lancet*, 372(9642): 972–989, 2008.

Simon Brook. Lady health worker programme evaluation 2007-09. *Oxford Policy Management Policy Expertise*, 2009.

Jennifer Bryce, Cesar G Victora, Jean-Pierre Habicht, J Patrick Vaughan, and Robert E Black. The multi-country evaluation of the integrated management of childhood illness strategy: Lessons for the evaluation of public health interventions. *American Journal of Public Health*, 94(3):406–415, 2004.

Danielle Charlet, Allisyn C. Moran, and Supriya Madhavan. Summary findings from a mixed methods study on identifying and responding to maternal and newborn illness in seven countries: implications for programs. *Journal of Health, Population and Nutrition*, 36(1):48, 2017.

Jessica Cohen, Pascaline Dupas, and Simone Schaner. Price subsidies, diagnostic tests, and targeting of malaria treatment: evidence from a randomized controlled trial. *American Economic Review*, 105(2):609–645, 2015.

Daniel Cotlear and Nicolas Rosemberg. *Going Universal in Africa: How 46 African countries reformed user fees and implemented health care priorities*. World Bank, 2018.

Janet Currie, Wanchuan Lin, and Juanjuan Meng. Addressing antibiotic abuse in China: an experimental audit study. *Journal of Development Economics*, 110:39–51, 2014.

Jishnu Das. The quality of medical care in low-income countries: From providers to markets. *PLoS Medicine*, 8(4):1–2, 2011.

Jishnu Das and Jeffrey Hammer. Which doctor? combining vignettes and item response to measure clinical competence. *Journal of Development Economics*, 78(2):348–383, 2005.

Jishnu Das and Jeffrey Hammer. Location, location, location: residence, wealth, and the quality of medical care in Delhi, India. *Health Affairs*, 26(3):w338–w351, 2007.

Jishnu Das and Jeffrey Hammer. Quality of primary care in low-income countries: Facts and economics. *Annual Review of Economics*, 6:525–553, 2014.

Jishnu Das and Carolina Sánchez-Páramo. Short but not sweet: New evidence on short duration morbidities from India. *World Bank Policy Research Working Paper*, February 2003.

Jishnu Das and Thomas Pave Sohnesen. *Patient Satisfaction, Doctor Effort and Interview Location: Evidence from Paraguay*. World Bank, 2006.

Jishnu Das, Jeffrey Hammer, and Kenneth L. Leonard. The quality of medical advice in low-income countries. *Journal of Economic Perspectives*, 22(2):93–114, 2008.

Jishnu Das, Jeffrey Hammer, and Carolina Sánchez-Peramo. The impact of recall periods on reported morbidity and health seeking behavior. *World Bank Policy Research Working Paper*, 5778, 2011.

Jishnu Das, Alaka Holla, Aakash Mohpal, and Karthik Muralidharan. Quality and accountability in health care delivery: Audit-study evidence from primary care in India. *American Economic Review*, 106(12):3765–3799, 2016.

Mark Dean and Anja Sautmann. The effects of community health worker visits and primary care subsidies on health care for children in urban Mali. *mimeo*, 2022.

Pascaline Dupas. Short-run subsidies and long-run adoption of new health products: Evidence from a field experiment. *Econometrica*, 82(1):197–228, 2014.

Pascaline Dupas and Jessica Cohen. Free distribution or cost-sharing? Evidence from a randomized malaria prevention experiment. *Quarterly Journal of Economics*, 125(1):1–45, February 2010.

Susie Dzakpasu, Timothy Powell-Jackson, and Oona M.R. Campbell. Impact of user fees on

maternal health service utilization and related health outcomes: a systematic review. *Health Policy and Planning*, 29(2):137–150, 01 2013. ISSN 0268-1080. doi: 10.1093/heapol/czs142. URL https://doi.org/10.1093/heapol/czs142.

Amy Finkelstein, Sarah Taubman, Bill Wright, Mira Bernstein, Jonathan Gruber, Joseph P. Newhouse, Heidi Allen, Katherine Baicker, and Oregon Health Study Group. The Oregon health insurance experiment: Evidence from the first year. *Quarterly Journal of Economics*, 127(3):1057–1106, 2012.

Greg Fischer, Dean Karlan, Margaret McConnell, and Pia Raffler. To charge or not to charge: evidence from a health products experiment in Uganda. *NBER Working Paper*, 20170, 2014.

Donna B. Gilleskie. A dynamic stochastic model of medical care use and work absence. *Econometrica*, 66(1):1–45, 1998.

Sandy Gove. Integrated management of childhood illness by outpatient health workers: technical basis and overview. the who working group on guidelines for integrated management of the sick child. *Bulletin of the World Health Organization*, 75(Suppl 1):7, 1997.

Elizabeth Heger Boyle, Miriam King, and Matthew Sobek. IPUMS-Demographic and Health Surveys: Version 5. Model Questionnaire for Females, 10 2018.

Mark C. Hornbeck, Arnold V. Hurtado, and Richard E. Johnson. Health care episodes: definition, measurement and use. *Medical Care Research and Review*, 42(2):163–218, 1985.

Lucia Hug, David Sharrow, and Danzhen You. Levels & trends in child mortality report 2019: Estimates developed by the UN Inter-agency Group for Child Mortality Estimation. *UNICEF*, 2019.

Dean T Jamison, Lawrence H Summers, George Alleyne, Kenneth J Arrow, Seth Berkley, Agnes Binagwaho, Flavia Bustreo, David Evans, Richard GA Feachem, Julio Frenk, et al. Global health 2035: a world converging within a generation. *The Lancet*, 382(9908):1898–1955, 2013.

Emmanuel Jimenez. *Human and physical infrastructure: public investment and pricing policies in developing countries*, volume 3, chapter 43, pages 2773–2843. Elsevier, 1995.

Ari D Johnson, Dana R. Thomson, Sidney Atwood, Ian Alley, Jessica L. Beckerman, Ichiaka Koné, et al. Assessing early access to care and child survival during a health system strengthening intervention in Mali: A repeated cross sectional survey. *PLoS One*, 8(12): e81304, 2013.

Ari D Johnson, Oumar Thiero, Caroline Whidden, Belco Poudiougou, Djoumé Diakité, Fousséni Traoré, et al. Proactive community case management and child survival in peri-urban Mali. *BMJ Global Health*, 3(2), 2018.

Emmett B. Keeler, Joan L. Buchanan, John E. Rolph, Janet M. Hanley, and David M. Re-

boussin. The demand for episodes of medical treatment in the health insurance experiment. *RAND Working Paper*, 1988.

Gary King, Emmanuela Gakidou, Kosuke Imai, Jason Lakin, Ryan T. Moore, Clayton Nall, et al. Public policy for the poor? A randomised assessment of the Mexican universal health insurance programme. *The Lancet*, 373(9673):1447–1454, 2009.

Michael Kremer and Rachel Glennerster. Improving health in developing countries: evidence from randomized evaluations. In *Handbook of Health Economics*, volume 2, chapter 4, pages 201–315. Elsevier, 2012.

Kenneth L. Leonard and Melkiory C. Masatu. Using the Hawthorne effect to examine the gap between a doctor's best possible practice and actual performance. *Journal of Development Economics*, 93:226–234, 2010.

K.L. Leonard, G.R. Mliga, and D. Haile Mariam. Bypassing health centres in Tanzania: revealed preferences for quality. *Journal of African Economies*, 11(4):441, 2002.

Jenny I. Litvack and Claude Bodart. User fees plus quality equals improved access to health care: Results of a field experiment in Cameroon. *Social Science and Medicine*, 37(3):369 – 383, 1993.

Carolina Lopez, Anja Sautmann, and Simone Schaner. Does patient demand contribute to the overuse of prescription drugs? *American Economic Journal: Applied Economics*, 14(1): 225–60, 2022.

Anup Malani, Phoebe Holtzman, Kosuke Imai, Cynthia Kinnan, Morgen Miller, Shailender Swaminathan, Alessandra Voena, Bartosz Woda, and Gabriella Conti. Effect of health insurance in India: a randomized controlled trial. Technical report, National Bureau of Economic Research, 2021.

Willard G. Manning, Joseph P. Newhouse, Naihua Duan, Emmett B. Keeler, and Arleen Leibowitz. Health insurance and the demand for medical care: Evidence from a randomized experiment. *American Economic Review*, 77(3):251–277, 1987.

Mayo Clinic. Diseases and conditions: Fever, May 2014. URL `http://www.mayoclinic.org/diseases-conditions/fever/basics/symptoms/con-20019229`.

Mayo Clinic. Diarrhea: Symptoms and causes, October 2016. URL `http://www.mayoclinic.org/diseases-conditions/diarrhea/symptoms-causes/dxc-20232937`.

E. Miguel and M. Kremer. Worms: Identifying impacts on education and health in the presence of treatment externalities. *Econometrica*, 72(1):159–217, 2004.

Hoa L. Nguyen, Jane S. Saczynski, Joel M. Gore, and Robert J. Goldberg. Age and sex differences in duration of prehospital delay in patients with acute myocardial infarction: A systematic review. *Circulation: Cardiovascular Quality and Outcomes*, 3:82–92, 2010.

Timothy Powell-Jackson, Kara Hanson, Christopher J.M. Whitty, and Evelyn K. Ansah.

Who benefits from free healthcare? Evidence from a randomized experiment in Ghana. *Journal of Development Economics*, 107:305–319, 2014.

Valéry Ridde and Florence Morestin. A scoping review of the literature on the abolition of user fees in health care services in Africa. *Health Policy and Planning*, 27(3):1–11, 2012.

Alfonso Rosales and Kristin Weinhauer. *C-IMCI: Community Integrated Management of Childhood Illness*. Catholic Relief Services, 2003.

Patrick Pascal Saint-Firmin, Birama Djan Diakite, Sara Stratton, and Christine Ortiz. Community health worker program in Mali under threat: Evidence to drive advocacy efforts. *Health Policy Plus Policy Brief*, 2018.

João Santos Silva and Frank Windmeijer. Two-part multiple spell models for health care demand. *Journal of Econometrics*, 104:67–89, 2001.

Save the Children. *Freeing up healthcare: A guide to removing user fees*. McPake, Barbara and Schmidt, Alice and Araujo, Edson and Kirunga-Tashobya, Christine, London, 2008.

Prabhjot Singh and Jeffrey D Sachs. 1 million community health workers in Sub-Saharan Africa by 2015. *The Lancet*, 382(9889):363–365, 2013.

G. L. Stoddart and M. L. Barer. Analysis of demand and utilization through episodes of medical services. *McMaster University working paper*, 81-06, 1981.

Dag Gundersen Storla, Solomon Yimer, and Gunnar Aksel Bjune. A systematic review of delay in the diagnosis and treatment of tuberculosis. *BMC Public Health*, 8(15), 2008.

Shinsuke Tanaka. Does abolishing user fees lead to improved health status? Evidence from post-apartheid South Africa. *American Economic Journal: Economic Policy*, 6(3):282–312, 2014. ISSN 19457731, 1945774X. URL `http://www.jstor.org/stable/43189399`.

Rebecca L. Thornton, Laurel E. Hatt, Erica M. Field, Mursaleena Islam, Freddy Solís Diaz, and Martha Azucena González. Social security health insurance for the informal sector in Nicaragua: a randomized evaluation. *Health Economics*, 19(S1):181–206, 2010.

UK Secretary of State for International Development. *Eliminating World Poverty: Building our Common Future*. Department for International Development White Paper, London, 2009.

UNICEF Health Section. *Integrated Management of Childhood Illness: Household and Community Component*. Kenya-Mugisha, Nathan and Pangu, Kasa, 1999.

United Nations Inter-Agency and Expert Group on MDG Indicators. *The Millennium Development Goals Report 2015*. United Nations, 2015.

WHO. *Integrated Management of Childhood Illness: Chart Booklet*. World Health Organization, 2014.

WHO Department of Child and Adolescent Health and Development. *Handbook IMCI: Integrated Management of Childhood Illness*. World Health Organization and UNICEF,

2005.

WHO Global Malaria Programme. *World Malaria Report 2014*. World Health Organization, 2015.

Tables and Figures

Table 1: Demographics and balance.

	Child characteristics				Characteritics of household head				Household characteristics			Compound
	Gender	Age (yrs)	Weight for height	Is literate	Speaks Bambara	Gender	Has salary	Age > median	Number of members	Owner occupiers	Total assets in log USD	Log distance to closest formal care
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Subsidy only group (S)	0.016	-0.018	0.112	0.033	-0.062	-0.018	-0.000	-0.002	0.175	0.073	0.424	-0.066
	(0.04)	(0.09)	(0.12)	(0.05)	(0.05)	(0.03)	(0.04)	(0.05)	(0.32)	(0.05)	(0.28)	(0.06)
CHW only group	-0.015	0.036	0.042	-0.027	-0.044	-0.026	0.001	-0.011	-0.073	0.074	0.266	-0.004
	(0.04)	(0.10)	(0.14)	(0.05)	(0.05)	(0.03)	(0.03)	(0.05)	(0.32)	(0.05)	(0.27)	(0.06)
Subsidy x CHW group (SCHW)	0.025	-0.018	0.032	0.117**	-0.079	-0.003	-0.037	0.043	0.321	0.042	0.149	-0.079
	(0.03)	(0.10)	(0.13)	(0.05)	(0.05)	(0.03)	(0.03)	(0.05)	(0.31)	(0.06)	(0.27)	(0.07)
Control group mean	0.515***	2.706***	-0.655***	0.467***	0.729***	0.903***	0.131***	0.418***	6.234***	0.405***	6.458***	6.238***
	(0.02)	(0.06)	(0.09)	(0.04)	(0.04)	(0.02)	(0.03)	(0.03)	(0.21)	(0.04)	(0.18)	(0.04)
Observations	1763	1768	1306	1242	1242	1241	1242	1256	1238	1208	1208	642

Notes: Coefficients from a regression of the outcome variable on treatment indicators. Standard errors clustered at the compound level in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2: Consultation numbers, average costs to the patient's family, value of services received, and wait times per visit in hours.

	Number of visits	Cost per visit (to household)		Value per visit (total cost)		Waiting time per visit in hours (caretaker)	
CSCom (all)	646	1344	(106)	3767	(114)	0.74	(0.04)
CSCom (with subsidy)	508	933***	(108)	3794	(129)	0.78**	(0.04)
CSCom (without subsidy)	138	2850	(254)	3666	(252)	0.59	(0.07)
Private provider	89	5470	(543)	-	-	1.24	(0.19)
Informal/no consultation	2691	218	(11)	-	-	0.04	(0.01)

Notes: CSCOM refers to local clinic or associated reference hospital (CSREF). Private provider is a private doctor, hospital, or health center provided e.g. by the Red Cross. Informal includes peddlers, market, traditional or religious healers, midwives, and pharmacy visits without a formal consultation. Costs, prices, and wait times are added for all connected consultations, e.g. doctor visit and medication purchase. Costs per visit are for consultation and treatment as reported by the caretaker. Value/total cost is imputed from private cost and median prices, by consultation type and treatment received. Standard errors in parentheses. Significance levels for a t-test between free care and no-free care consultations. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 3: Days of (untreated) illness per child, by need for care (IMCI); and proportion of days on which each symptom is observed.

Pre-care days per child:	All		Early		Care required	
	Mean	SD	Mean	SD	Mean	SD
Total number	16.31	(14.32)	10.34	(9.38)	5.97	(8.68)
Percentage of total number on which each symptom is present:						
Convulsions, fits, or spasms	0.32%		0%		0.66%	
Lethargic or unconscious	3.95%		0%		10.27%	
Unable to drink or breastfeed	1.17%		0%		3.29%	
Vomiting everything	5.39%		0%		15.58%	
Coughing	33.42%		62.56%		35.38%	
Difficulty breathing	4.46%		8.58%		5.85%	
> 3 loose stools	8.54%		11.84%		12.75%	
Blood in the stool	0.61%		0.06%		1.39%	
Sunken eyes	2.18%		0.31%		5.27%	
Unusually hot skin	32.04%		17.68%		74.00%	
Other: rash, spots, or itch	2.85%		5.74%		1.28%	
Other: cold symptoms	50.76%		92.01%		37.31%	
Other: ear ache	1.01%		1.13%		1.90%	
Other: wound, injury, or burn	3.62%		6.82%		1.60%	
Other symptoms	4.90%		9.04%		2.54%	

Notes: The first four symptoms are danger signs and always occur on "care required" days. Symptoms that do not themselves indicate need for care can co-occur on care-required days

Table 4: Utilization, private expenditure, and value of treatment by treatment group.

	Number of visits per child			Private cost per child (CFA)			Wait time per child (hrs)	Value per child (CFA)	
	All formal	CSCom	Other formal	Total	CSCom	Other formal		Total	CSCom
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Subsidy only group (S)	0.379***	0.402***	-0.023	-77.523	215.880	-129.134	0.275***	1386.066***	1665.570***
	(0.06)	(0.05)	(0.03)	(275.29)	(134.08)	(175.97)	(0.10)	(374.75)	(263.11)
CHW only group	0.022	0.017	0.005	459.660	207.295	-33.815	0.039	387.381	126.962
	(0.04)	(0.03)	(0.03)	(295.11)	(134.88)	(179.80)	(0.08)	(313.59)	(154.89)
Subsidy x CHW group (SCHW)	0.439***	0.478***	-0.039	-220.833	186.633	-231.538	0.307***	1409.314***	1773.584***
	(0.06)	(0.05)	(0.02)	(245.47)	(128.40)	(166.57)	(0.09)	(315.97)	(221.90)
Control group mean	0.217***	0.153***	0.065***	1461.672***	353.302***	369.797**	0.264***	1671.343***	523.071***
	(0.03)	(0.02)	(0.02)	(192.35)	(60.64)	(153.38)	(0.06)	(204.40)	(81.12)
p-value S = SCHW	0.421	0.286	0.309	0.565	0.859	0.343	0.771	0.953	0.739

Notes: Coefficients from a regression of the outcome variable on treatment indicators. 1768 observations. Standard errors clustered at the compound level in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: All spells vs. spells with a consultation by treatment group; conditional care-required status.

	spells	consultations (spells with consultation)	consultations as % of all spells	consultations as % of all consultations
Control				
care never required	479	18	4%	25%
care required	476	53	11%	75%
entered during spell	*210*	*22*	*10%*	
total	**955**	**71**	**7%**	100%
CHW group				
care never required	402	13	3%	20%
care required	516	52	10%	80%
entered during spell	*308*	*30*	*10%*	
total	**918**	**65**	**7%**	100%
Subsidy group				
care never required	449	40	9%	23%
care required	458	133	29%	77%
entered during spell	*195*	*57*	*29%*	
total	**907**	**173**	**19%**	100%
Full program group				
care never required	463	50	11%	26%
care required	504	144	29%	74%
entered during spell	*275*	*80*	*29%*	
total	**967**	**194**	**20%**	100%

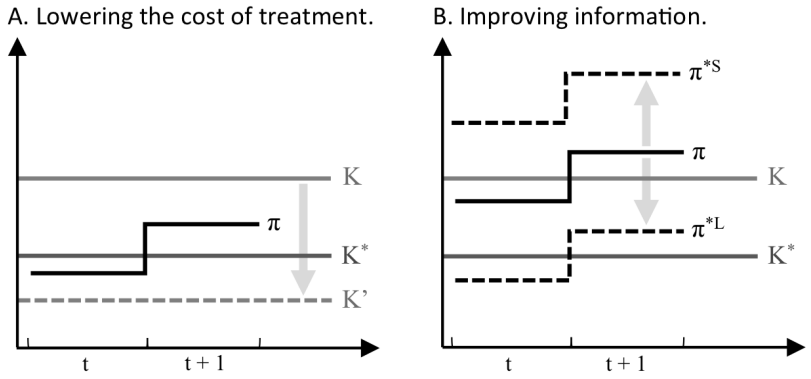
Notes: includes only uncensored and right-censored spells. "Care never required" indicates spells with early days only. "Care required" includes spells that either consist entirely of care-required days, or start with an early day and eventually enter care-required status ("entered during spell"). A spell cannot revert from care-required status except through recovery.

Table 6: Treatment effects in a Cox proportional hazard model.

	(1)	(2)	(3)	(4)	(5)	(6)
Care required	5.284***	5.366***	5.592***	5.714***	5.367***	5.509***
	(0.63)	(0.64)	(0.88)	(0.92)	(1.40)	(1.45)
Subsidy	2.563***	2.525***	2.561***	2.523***		
	(0.45)	(0.45)	(0.45)	(0.45)		
Subsidy x early (Se)					2.450***	2.426***
					(0.74)	(0.74)
Subsidy x care req. (Sr)					2.599***	2.557***
					(0.50)	(0.50)
CHW	0.915	0.886				
	(0.20)	(0.19)				
CHW x early (CHWe)			0.910	0.877	0.882	0.853
			(0.34)	(0.33)	(0.36)	(0.35)
CHW x care req. (CHWr)			0.914	0.884	0.923	0.892
			(0.21)	(0.20)	(0.21)	(0.21)
Subsidy x CHW	1.218	1.240				
	(0.31)	(0.31)				
Subsidy x CHW x early (SCHWe)			1.366	1.414	1.428	1.471
			(0.56)	(0.58)	(0.68)	(0.70)
Subsidy x CHW x care req. (SCHWr)			1.176	1.192	1.159	1.176
			(0.31)	(0.31)	(0.32)	(0.32)
Covariates		Y		Y		Y
p-value Se = Sr					0.855	0.872
p-value CHWe = CHWr			0.991	0.983	0.916	0.917
p-value CHWe+SCHWe=CHWr+SCHWr			0.568	0.532		
p-value Se+CHWe+SCHWe = Sr+CHWr+SCHWr					0.752	0.704
N	23836	23836	23836	23836	23836	23836

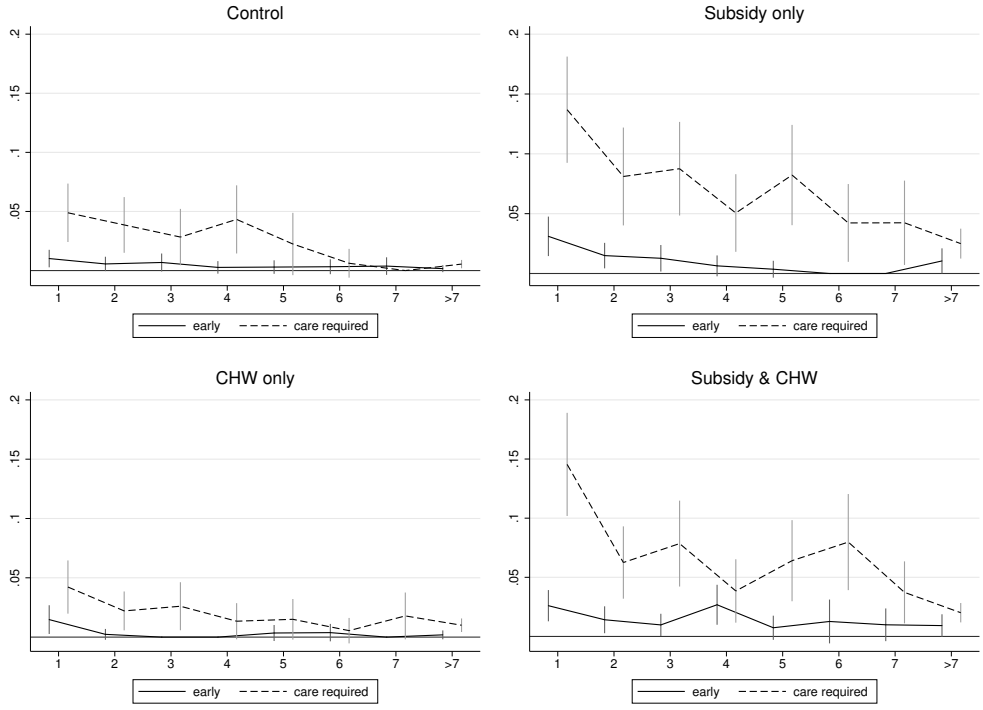
Notes: table reports hazard ratios, uncensored and right-censored spells only. Covariates include household assets; distance to closest formal care provider; gender, age, literacy of household head; and child gender. Stratum FE included. Standard errors clustered at the compound level in parentheses. * $p < 0.10$, ** $p < 0.05$, * $p < 0.01$.

Figure 1: The effect of providing a subsidy (A) and of aligning parents' beliefs with those of the policymaker (B).



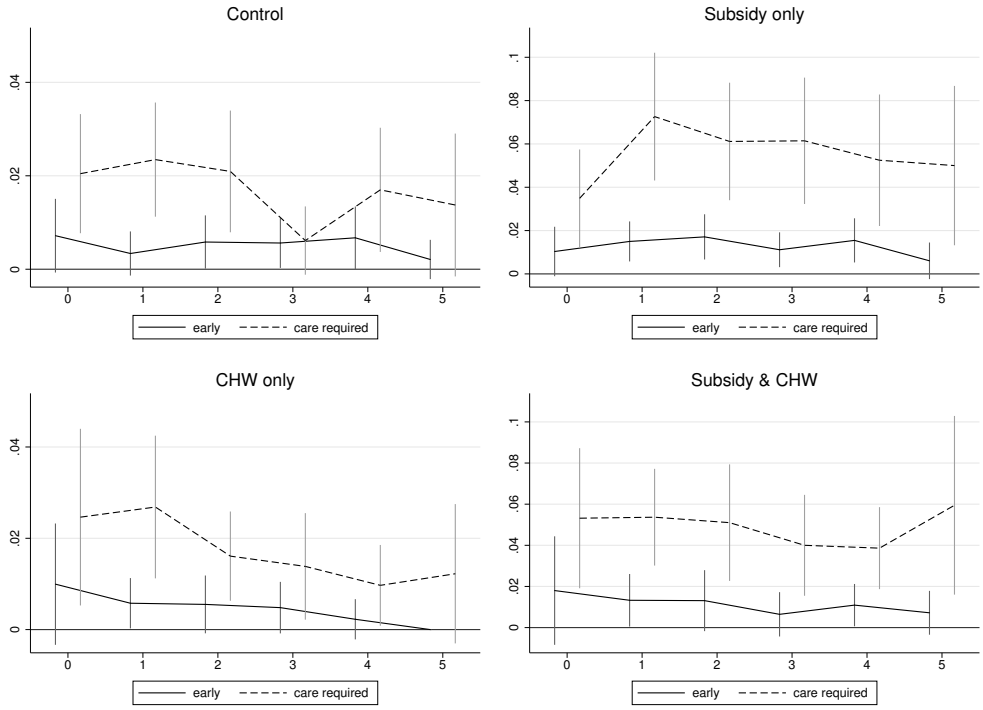
Notes: the probability of not recovering π is increasing conditional on the spell continuing, due to learning about the illness. We assume parents have a higher cost threshold than the policymaker ($K \geq K^*$). Panel A: beliefs are aligned so $\pi = \pi^*$, Panel B: parental beliefs π are the average of the policymaker's beliefs π^{*S} and π^{*L}.

Figure 2: Average daily probability of care seeking by day of the spell and treatment group, early vs. care-required classification according to the C-IMCI.



Notes: x-axis shows day of the spell; spell days after day seven are grouped. Graphs show point estimates of a fully dummied-out linear regression model along with 95% confidence intervals. Standard errors clustered at the compound level.

Figure 3: Average daily probability of care seeking by age of the child in years and treatment group, "early" vs. "care-required" classification according to the C-IMCI.



Notes: x-axis shows age of the child in years; children over 5 years are dropped. Graphs show point estimates of a fully dummied-out linear regression model along with 95% confidence intervals. Standard errors clustered at the compound level. Note difference in scale on the y-axis in Control and CHW only group (left) vs. subsidy only and full program group (right).