The Effects of Community Health Worker Visits and Primary Care Subsidies on Health Behavior and Health Outcomes for Children in Urban Mali

Mark Dean Anja Sautmann*

January 2022

Abstract

Subsidized primary care and community health worker (CHW) visits are important demand side policies in the effort to achieve universal health care for children under five. Causal evidence on the effects of these policies, alone and in interaction, is still sparse. We report effects on diarrhea prevention, curative care, and incidence as well as anthropometrics for 1649 children from a randomized control trial in Bamako, Mali, that cross-randomized CHW visits and access to free health care. CHW visits improve prevention and subsidies increase the use of curative care for acute illness, with some indication of positive interaction effects. There is no evidence of moral hazard, such as reduced preventive care among families receiving the subsidy. Although there are no significant improvements in malnutrition, diarrhea incidence is reduced by over 70% in the group that receives both subsidies and CHW. Positive effects are concentrated among children ages 0 to 2.

*The authors thank Kris Ansin, Joseph Camardo, Mariam Fofana Diallo, Pierre Pratley, Diakaridia Traoré, and the team at Mali Health; Christine Blandhol, Samuel Brown, Seydou Doumbia, Andrew Foster, Emily Fuller, Ira Wilson, and Xinyi Zhang; and Hamadoun Bocoum, Judith Kom, Nicoló Tomaselli, and the Mali office of Innovations for Poverty Action. We thank the Population Studies and Training Center and the Rhodes Center at Brown University for funding. 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. All errors are our own. Mark Dean: Columbia University, mark.dean@columbia.edu. Anja Sautmann: World Bank, asautmann@worldbank.org.

1 Introduction

Despite impressive improvements in child and maternal health over the last decade, child mortality continues to be unacceptably high in many parts of the world. In Mali, and West Africa as a whole, under five mortality remained above 90 per 1000 in 2020, with even higher rates for the poorest households.[1] Many of these deaths are preventable. For example, 12.2% of under-five deaths in Mali in 2019 were due to diarrhea. A majority of these infections are caused by unsafe drinking water and poor sanitation, and only a small share receive the recommended treatment (Unicef [2021]).

In the effort to improve health outcomes for children and mothers and achieve universal health care (UHC), the global health community has focused on two key strategies: free or heavily subsidized basic health care, and home visits by community health workers who help bridge access barriers. While user fees for basic health services were considered a tool to maintain sustainability and quality of care in the 1990s (e.g. Akin et al. [1987]), there is now broad consensus that African countries should work towards eliminating user fees, at a minimum for mothers and young children (e.g. McPake et al. [2008], UK Secretary of State for International Development [2009], Jamison et al. [2013]). At the same time, international aid organizations and advocacy groups, like UNAIDS and the "One million community healthworkers" campaign, are pushing for various measures to strengthen the role of CHW in the last-mile delivery of health care, such as expanded numbers of CHW, acknowledgement of their role in national health systems and planning, and standardized training (Singh and Sachs [2013]).

These policies are central to proposed health reforms in Mali and across Africa. In 2019, Mali's Ministry of Health announced that the country intended to provide free children's and mothers' health care within three years, although there were still gaps in raising the funds to cover the estimated cost of $120 million (Adepoju [2019]).[2] By 2016, 33 out of 47 African countries had committed to a health financing strategy for universal health coverage (Barroy et al. [2016], Cotlear and Rosemberg [2018]). Although there is uncertainty about the total number of CHW, the 1 Million Community Healthworkers Campaign estimates over 300,000 CHW in Sub-Saharan Africa alone.

Despite these developments, the existing empirical research provides only a partial picture of the effect of these policies. Systematic reviews cite some support for positive effects of community health workers on a range of outcomes including child mortality and morbidity, but note the low quality of the evidence and need for further research (Lewin et al. [2010], Gilmore and McAuliffe [2013], Scott et al. [2018]). Similarly, there is a relative scarcity of rigorous evidence on the health outcome effects of removing user fees (Ridde and

[1] Under five mortality in 2020 in West and Central Africa was 91.4 and in Mali 91.0; for the lowest wealth quintile in Mali it was 117.1 (2019 data); Sub-Saharan Africa as a whole had an under five mortality of 73.3 out of 1000 life births. Source: IGME [2021].

[2] The reforms have been delayed due to the Covid-19 pandemic and political disruptions.

Morestin [2012], Dzakpasu et al. [2013], Lagarde and Palmer [2011]). Some exceptions exist: for example, a randomized control trial in Ghana found positive health effects on children who were anemic at baseline, and a difference-in-difference study using variation in access due to apartheid policies in South Africa found positive effects on children's nutritional status (Powell-Jackson et al. [2014], Tanaka [2014]). We know of no study that studies how CHW visits and health care subsidies interact.

Given that CHW visits to households combined with free care for children under five are cornerstones of current global health policy, and the population receiving both interventions is rapidly growing, it is crucial to learn more about both the individual effects of these two interventions as well as their interaction in different beneficiary populations. Here, we study the individual and combined effects of CHW visits and subsidies on measures of preventive and curative care for diarrhea and related health outcomes in peri-urban areas of Bamako, Mali.[3] We analyze data from a randomized control trial of the Action for Health program by the NGO Mali Health. Action for Health combines biweekly CHW visits with a subsidy that covers consultation fees and standard treatment for the most common illnesses among children under five at two local clinics in Sikoro.

The two program components were cross-randomized at the compound level and provided to eligible households starting in winter 2012-13. The main follow-up survey at the end of 2013 collected a detailed nine-week panel of complete health diaries to analyze demand for acute health care (Sautmann et al. [2020]). Here, we use data from a second follow-up visit in 2014 that focuses particularly on diarrhea-related behaviors and outcomes: preventive measures and knowledge indicators, incidence of diarrhea symptoms and acute care from an abridged 1-week health calendar, and measures of malnutrition. We are interested in the interplay of preventive and acute care and their individual and joint effects on health outcomes.

Diarrhea is one of the most important causes of death for children in the region; moreover, it provides a good case study because diarrhea outcomes are likely to respond to the full range of behaviors that the two interventions aim to change: preventing the intake of contaminated water or food is one of the most effective ways of avoiding diarrhea in the first place, and mild diarrhea cases can be treated at home, but serious cases (e.g., dysentery) require clinical care. In other words, there is an important role for all three: prevention, home care, and formal care.[4]

There are multiple reasons to think that CHW and subsidies (free care) interact with each other in determining health outcomes. First, CHW activities focus more on preventive care, while subsidies improve access to curative care. The two types of care could be substitutes in the health production function, that

[3]While CHW programs were originally intended for rural areas, many CHW work in urban or peri-urban areas. For example, 6% of Malian CHW are estimated to work in Bamako (Saint-Firmin et al. [2018]).

[4]By contrast, prevention is usually the only protection from viral disease, e.g. through vaccination. Other health issues are primarily addressed through curative care, such as bacterial infections.

is, access to one reduces the need for the other; or complements, that is, adequate prevention and acute care combined lead to greater health improvements than the sum of the individual effects.

In addition, there is the possibility of "spillovers" on behavior: since both preventive and curative care depend on the parent or caretaker's actions, receiving a prevention-focused intervention might affect choices about curative care, and the reverse. An important concern in this respect is moral hazard; in particular, access to free curative care may lead parents to reduce prevention efforts. However, there are also reasons to think that one intervention reinforces the other's effect on parents' behavior positively.[5] For example, Sautmann et al. [2020] show with a simple model that CHW visits are more likely to improve utilization of formal care if the subsidy aligns the parents' cost-benefit trade-off with the recommendations of the CHW. Essentially, the CHW advise parents when to seek care, and the subsidy makes it possible for the parents to actually follow this recommendation. On the prevention side, receiving CHW visits as part of a larger program that also provides free access to care may increase the credibility of the CHW – or it may even act as motivation for the CHW themselves.

We estimate the treatment effects in the three intervention groups – CHW visits only, subsidy only, and full Action for Health program – compared to the control group. We also test whether the effect of the two interventions combined is different from the CHW-only and subsidy-only effects.

We find promising effects of the CHW on measures of knowledge and prevention. Both groups that receive CHW visits have better knowledge of the recipe for oral rehydration solution (ORS) and higher self-reported use of water disinfection, although they are only weakly more likely to know the correct ages for exclusive breastfeeding, and an objective measure of water chlorine contents shows no effects. However, another objective measure, whether a mosquito bednet was hung correctly, is 14pp higher with CHW visits, suggesting that the lack of chlorination effects could also be measurement error or faulty use of the disinfection tablets, rather than lack of effort on the parents' part.

We also find positive effects on curative care for children with diarrhea symptoms. Both groups receiving subsidies use oral rehydration treatment (ORT) significantly more often. There are also large (even though statistically not significant) increases in formal care in the full program group. When examining effects by age, we see a (significant) increase in formal care for age 0-2 children by 60% and significant increases in ORT use in age 2-4 children in the full group. Overall, the full-program group receives better care for acute bouts of diarrhea than the other groups.

Although we see mixed effects on anthropometric measures of malnutrition, a striking finding is that the full program group experiences a large and significant reduction in the number of days with diarrhea

[5] We use substitutes and complements here in the game-theoretic sense: x and y are substitutes in f if the marginal return to x (y) is decreasing in y (x), i.e., the cross-derivative is negative.

symptoms (out of the past 7 days), equivalent to over 70% of the control group average. While the effects in the other two treatment groups are not significant, they are negative as well, and we cannot reject that the full-program effect equals the sum of the CHW-only and subsidy-only effects. There is also a large (although not significant) decline in the number of days the mother/caretaker is concerned about the child's health.

Our results are overall encouraging for the combination of CHW and subsidy interventions. There is no evidence for moral hazard, and if anything, preventive behavior is slightly higher in the full-program group. Children in the full program group also get diarrhea significantly less often and receive better care when they do fall sick.

The findings in this paper complement the analysis of the 2013 data in Sautmann et al. [2020]. The 2013 paper does not analyze health outcomes or prevention, but instead quantifies the impact of subsidies and CHW visits on underuse and overuse of acute care, using a unique nine-week panel data set of complete illness spells, care sought, and cost. Health care demand is benchmarked against WHO-IMCI careseeking recommendations based on symptoms. Subsidies increased care seeking by 250%, with most of the increase in care classified as necessary by WHO guidelines. There were no CHW effects on average, but exploratory analysis indicated a complementarity between CHW and subsidies for the youngest children, similar to the effects on care for diarrhea in the 2014 follow-up reported here. Again, these findings are encouraging for layering CHW interventions with the expansion of UHC. In both surveys, we found the strongest effects of the CHW for the very youngest age groups, suggesting that CHW interventions for child health could potentially focus on children under 2 rather than under 5.

The next section describes healthcare and home environments in poor areas of urban Mali as well as the Action for Health program. Section 3 describes the experimental design and lays out a framework for thinking about the effects of CHW and subsidies individually and in combination. Section 4 describes the empirical results and section 5 provides a discussion and concludes.

2 Health Care in Mali and the Action for Health Program

Public health care in Mali is built around a network of community health clinics or *centres de santé communautaires* (CSComs). A typical clinic in Bamako is staffed with on average about 1.5 physicians, 4 medical trainees, 5 nurses and midwives, a lab technician, as well as technical and administrative staff (Lopez et al. [2022]). Most clinics have an attached pharmacy. At the time of the study, CSComs operated under the community-funding model of public health care advocated by the Bamako Initiative from 1987 and endorsed by governments across West Africa, meaning that the revenues from sales of medications and other user fees fund the operation of the clinic. The public health care system is flanked by a private formal sector with higher prices, and informal sources such as market stalls that only rarely sell prescription medications.

The study was conducted in a peri-urban area of the capital Bamako in the catchment area of two local clinics partnering with the NGO Mali Health. The compounds in our sample typically lie along unpaved roads without access to sanitation (compounds are multi-family dwellings sharing a courtyard and common facilities). In the months during and after the wet season, August-November, the incidence of diarrhea and malaria is highest. Mali has high rates of maternal and child mortality, especially in rural areas, and while poor urban populations have better health facility access and lower rates of mortality, families still often lack basic health care. Mali's rapidly growing urban areas resemble those elsewhere in West and Sub-Saharan Africa, although literacy rates in Mali tend to be lower. In addition, fertility and child mortality rates are higher, which makes child health interventions particularly important (Sautmann et al. [2020]).

Mali Health started their Action for Health (AfH) program in 2010. Action for Health combines subsidized health care and community healthworker visits (CHW). Children are enrolled at birth (or at roll-out) and receive the program until age 5. 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, e.g. WHO [2020]). Families have to cover the remaining expenses, for example for services that are not part of the standard treatment course for a given diagnosis, and any visits to non-participating providers. The subsidy reduced the average cost to the family of visiting a formal provider by 71% (CFA 933 vs. CFA 2850, approximately USD 1.89 vs. USD 5.76 at 2014 exchange rates) and 70-77% of households who received the subsidy reported their visit as "free" compared with 12-14% for households not receiving the subsidy (Sautmann et al. [2020]). The value of care received, using prescription records and medications taken, was similar in both groups.

The activities of the CHW build on the 13 Essential Family Practices as defined by the Malian government. They track simple health indicators including various symptoms and danger signs, height and weight, and mid-upper arm circumference (MUAC), and advise families when to visit a doctor. They teach families how to prepare and use oral rehydration solution (ORS) in mild cases of diarrhea. They also monitor and teach preventive behaviors, such as vaccinations and bed net use, good breastfeeding practices to protect young children from ingesting contaminated water, and hand washing. They deliver water disinfection tablets to households with unsafe water access and teach water purification. CHWs are recruited locally and their training builds on 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 (WHO [2005]).

All subsidized clinical care was provided by medical professionals and staff trained in country. The clinics in this study were financially supported by Mali Health. For cost control purposes, Mali Health conducted

spot checks on diagnosis and prescriptions using bills submitted to Mali Health and the clinic's treatment records and accounting. As a result, per-visit value of care was unaffected by the interventions (see above). These quality control measures mean there may be differences in the level of care received relative to an unmonitored CSCom. However, the qualifications of care providers and the facilities and materials they can access are typical for peri-urban Mali.

3 Experiment and Data Collection

The experiment took advantage of a planned roll-out wave for the Action for Health program in early 2013. Mali Health conducted a household census in 2012 and selected twice as many households as could have been enrolled in the absence of the experiment, using a proxy-means test for the poorest third of families.

All compounds with one or more eligible households were randomly assigned to either a subsidy-only, CHW-only, full-program, or control group.[6] The unit of randomization is the compound, since we expect spillover effects for CHW visits among households who share their living space. The randomization was stratified by average household assets in the compound, number of eligible children at baseline, and compound location. The CHW in the CHW-only and the full-program group were trained and managed in separate teams to reduce spillovers.

The baseline data was collected in Fall 2012, and the first follow-up took place in 2013. The 2013 data contains detailed health calendars covering 9 weeks, including all healthcare visits, treatments received, and symptoms observed. This data was used in Sautmann et al. [2020] to study the effect of the interventions on the targeting of primary care for children (utilization conditional on a classification of the child's symptoms as either "care required" or "care not (yet) required" according to IMCI symptom charts).

Our analysis here uses the baseline data along with data collected in the second follow-up survey in 2014. This data contains an abridged health calendar that focuses on diarrhea symptoms along with care received over the 7 days preceding the survey visit. In addition, we collected anthropometrics, preventive knowledge and behavior, self-reported receipt of treatment, and other indicators, with a focus on information relevant to malnutrition and diarrhea. Enumerators were unaware of the experiment or treatment arms.

The original treatment groups had been kept intact for a second year, and children in enrolled families in one of the treatment arms continued to receive the subsidy, CHW visits, or both, regardless of age. Moreover, any children born into these families were also enrolled into the same treatment. However, it is worth noting that Mali Health was aware of the findings from the 2013 data collection that the CHW program had relatively low impacts on acute care seeking (Sautmann et al. [2020]). While the interventions were ongoing, Mali Health continued to provide additional training to CHWs. This might affect comparability of the CHW

[6] The per-household cost of the CHW and subsidy components is approximately the same, so Mali Health was able to provide just one arm of the program to twice as many households.

effects in 2013 and 2014. Note also that between the two follow-up surveys Mali Health had received a gift that allowed them to supply all beneficiary households in need with treated mosquito nets (both in the three treatment groups and in other Action for Health households not part of the sample). For ethical reasons, it was decided not to withhold this benefit from any households in the treatment groups that did not currently own treated nets. This may affect the incidence of health concerns in the three treatment groups.

3.1 Balance and Attrition

The primary unit of analysis is the child or the caretaker (typically the mother). We describe the evolution of the sample here in terms of the number of children in the different waves. At baseline, we enrolled 1732 children in the data collection. In both follow-up survey rounds, some children could not be found. In both years, 5 children died; additionally, families had moved or were traveling and in one case a family refused to further take part in the study. Newborn children in the treatment households were enrolled in Action for Health either by the CHW or by a program officer who visited study households at least every three months. This follows the standard protocol for Action for Health, and since the caretakers' treatment choices and resulting health improvements are our outcome of interest, we consider these children part of the sample. It is possible that the treatment allocation affected fertility, but we consider the risk to representativeness greater if we were to exclude these children.

Figure 3 in Appendix A includes a CONSORT diagram detailing both attrition and addition of new children throughout the study. After the first follow-up in 2013, which included 1768 children, 217 children left the survey for various reasons, 12% of the sample. An ANOVA test fails to reject the hypothesis that attrition is equal across treatment groups. At the same time, 98 children were added to the sample. Again, ANOVA fails to reject the hypothesis that additions were equal across treatments. Table 1 tests for balance for a set of covariates at the child, household, and compound level. Each column is a regression on three treatment arm dummies with stratum fixed effects and clustered standard errors, using the same specification as in the regressions below. Only one coefficient in the table is significantly different from zero. We control for these covariates in the main regressions.

3.2 Framework and Hypotheses

Figure 1 shows in schematic form what effects we might expect from the two treatment components, subsidies and CHW visits. Subsidies that reduce the cost of care at the CSCom are likely to primarily increase care seeking with a formal provider in the case of acute illness. Positive effects arise from better access to curative care, provided that the child indeed receives this care when it is needed.[7] The CHW visits are more

[7]We are able to analyze in detail how the subsidy changes the utilization of (formal) curative care conditional on the child's health status, and in particular how it affects the risk of health care overuse (vertical arrow on left in Figure 1). This risk arises more frequently in curative care than in preventive care, because formal care only benefits a child with an illness that actually

Table 1: Balance: Covariates by treatment group.

	Child	Household Head					Household				Compound
	Is male	Age (years)	Head is literate	Majority ethnicity	Head is male	Head has salaried job	Head is over 50	No. of members	Own home	Log assets	Distance to clinic
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
CHW visits	−0.015	0.075	−0.024	−0.065	−0.041	0.010	0.001	−0.133	0.024	−0.227	−0.015
	(0.037)	(0.106)	(0.048)	(0.053)	(0.032)	(0.032)	(0.046)	(0.306)	(0.046)	(0.268)	(0.060)
Subsidy	0.022	0.031	0.031	−0.049	−0.014	−0.001	−0.019	0.152	0.024	0.233	−0.034
	(0.034)	(0.101)	(0.047)	(0.052)	(0.031)	(0.032)	(0.046)	(0.299)	(0.046)	(0.229)	(0.061)
Full program	0.014	−0.001	0.107**	−0.080	−0.003	−0.022	0.052	0.359	0.045	0.265	−0.055
	(0.035)	(0.102)	(0.047)	(0.052)	(0.032)	(0.031)	(0.047)	(0.285)	(0.046)	(0.224)	(0.060)
Mean	0.515	4.148	0.464	0.648	0.852	0.117	0.424	6.050	0.421	6.205	6.024
N	1649	1649	900	900	900	900	900	900	900	900	583

Notes: Each column is a regression of the variable in the top row onto the three treatment group dummies. All regressions include stratum fixed effects and cluster the standard errors at the compound level. There are between 1 and 6 households and up to 12 children in a compound. The number of observations reflects the total number of children ((1)-(2)), households ((3)-(10)) and compounds (11), not including missing observations.
Significance levels: * 0.1, ** 0.05, *** 0.01.

likely to improve preventive care, through teaching caretakers appropriate health behaviors, such as correct breastfeeding, hand washing, and bed net use, and through providing supplies such as water disinfection. These direct effects are represented by the vertical arrows in Figure 1. Acute care and preventive care combine to generate better health outcomes by reducing the incidence and severity of illness.

Our experimental design allows us to analyze the effects of each program component separately as well as in combination. The full program may have different impacts on health outcomes than the sum of each component alone. The first pathway for such an interaction is through the health production function (bottom of Figure 1). In principle, acute and preventive care may be substitutes in the health production function: acute care may affect overall health less when prevention is strong, or conversely, prevention may be less needed when the child always receives prompt acute care in the case of illness. Alternatively, both inputs affect health in different ways and work together: prevention reduces the incidence of illness and acute care reduces the severity of any remaining illness spells. This means that their health effects are additive and may even be complements, i.e., each type of care becomes more effective in the presence of the other.[8]

In addition, there may be interaction effects of the two interventions on the levels of each type care the child receives. These are represented by the diagonal arrows in Figure 1. For prevention, for example,

requires care and responds to treatment, whereas non-indicated treatment may have no, or even negative, effects on health outcomes, not to mention that it wastes resources. The 2013 data collection and analysis in Sautmann et al. [2020] pursue these questions in detail.

[8]We use complements and substitutes to mean that one input increases or decreases the marginal productivity of the other, see footnote 5.

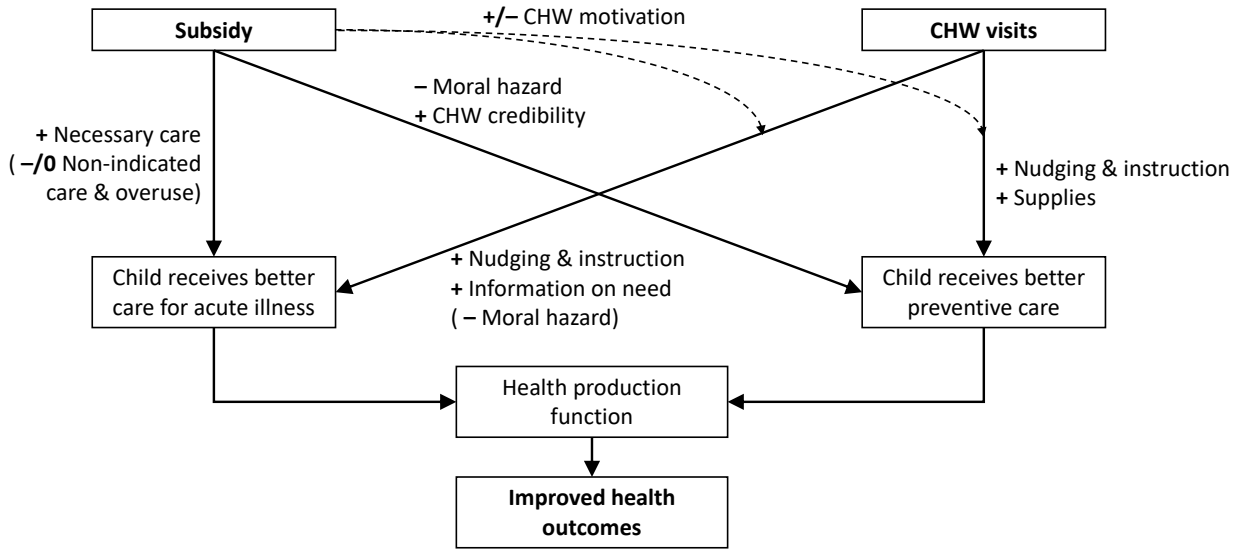

Figure 1: Schematic pathways for treatment effects. The vertical arrows denote the direct effects of the subsidy treatment on acute care, and the CHW on preventive care, both provided by the child's caretaker. The diagonal solid and dotted arrows show potential interaction effects in the full program arm through the behavior of caretakers and CHW, respectively. Acute and preventive care combine in an (unobserved) health production function to determine overall health outcomes.

the CHW provide advice and instruction on sanitation and deliver water disinfectant, but it is up to the parents to actually implement the measures promoted by the CHW, including using the disinfection tablets regularly. Caregivers may or may not increase their preventive behavior, and moreover, there response may differ depending on whether they also receive the subsidy treatment. An immediate concern could be that parents take less care to use prevention knowing their child can see a doctor for free: a form of moral hazard where the beneficiaries reduce effort in response to program benefits. On the other hand, parents may be more willing to follow the advice of a (lay) CHW if they also receive the subsidy, for example because the link with the CSCom strengthens the CHW's credibility.

On the acute care side, there is a similar possibility of an interaction effect with the CHW through the behavior of parents. First, in mild cases of diarrhea, the caretaker should monitor hydration and may provide ORT as necessary. Rehydration solution can be prepared at home using salt, sugar, and water, and the recipe is taught by the CHW. Positive effects on curative care may therefore arise because the CHW can nudge the parents to be proactive and provide knowledge to deal with mild cases of illness.

One of the main activities of the CHW in the realm of acute care, however, is that they directly monitor the child's health during the biweekly visits and in the process teach parents to spot symptoms. The IMCI algorithms are designed to discern signs of serious illness and ensure that a child in need of evaluation sees a formal care provider. We may think of this as the CHW providing information about the child's health

status that is aimed at improving the targeting of formal care. For a child with diarrhea, a visit to a formal healthcare provider is recommended in more serious cases, such as symptoms for five days or more, dehydration, or blood in the stool.

As argued in Sautmann et al. [2020], the effect of information provision can be ambiguous, because the child's caretakers will in general use new information to align care seeking with their own preferences, rather than those of the policymaker (here represented by the CHW care seeking recommendations). Information on its own can improve targeting – e.g., by alerting parents who are not aware how ill their child is – but it may also have no or even a negative effect: simply put, the parent might learn to interpret symptoms but use their knowledge to postpone a doctor visit as long as possible. This friction may arise in particular due to high (private) costs of formal care to the parents, vs. the (social) benefits to the child or to others. This provides a strong case for CHW and subsidies acting as complements: the subsidy helps align the preferences of parents and policymaker by reducing private cost, while the CHW provide the necessary information to act on these preferences.[9]

Lastly, while we focused here on the behavior of parents as a potential factor that introduces interaction effects, note that another channel is the behavior of the CHW themselves (dotted arrows in Figure 1). Specifically, it is possible that the CHW exert different levels of effort in the CHW-only vs. the full-program group. The direction of the effect could go either way. The CHW may feel more motivated when families are able to act upon advice to seek care due to the subsidy, in particular when it comes to tracking the child's symptoms week to week. Conversely, the CHW may perceive their work as more important when the family does not have access to the subsidy, and this may in particular affect their preventive work.

4 Results

All our regressions estimate intent-to-treat effects and include three treatment group dummies – CHW visits, subsidy, and full program – along with the covariates from table 1 (dummying out missing variables) and stratum fixed effects. Each column is a regression with the variable in the top row as the outcome. In different specifications we also report p-values for various tests: (i) "CHW = full" and "subsidy = full" test whether the full program has the same effect as one of the program arms separately, and (ii) "CHW+subsidy = full" tests if the arms are complements or substitutes, that is, whether the full program effect is larger or smaller than the sum of effects of the individual program components.

All regressions cluster the standard errors at the compound level. The number of observations varies depending whether the unit of analysis are children, their caregivers (the respondents), households, or com-

[9] A negative effect of the CHW visits on acute care is also possible; for example, parents may not visit a doctor even when care is free and the child appears ill, perhaps in the belief that the illness could not be serious given all the preventive measures taken. This is again a form of moral hazard. We consider this less plausible as the available evidence shows that parents are very aware when their child is not well.

Table 2: Prevention: caretaker's knowledge and behavior.

	Caretaker's knowledge		Water disinfection				Malaria protection
			self-reported			measured	
	Knows ORS recipe	Knows age of excl. breastfeeding	Given last year	Used last 7 days	Used today	Water chlorine content (ppm)	Bed net hung correctly
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CHW visits	0.330***	0.096*	0.230***	0.125***	0.095***	0.056	0.146***
	(0.044)	(0.053)	(0.030)	(0.038)	(0.030)	(0.040)	(0.046)
Subsidy	0.067*	−0.057	0.023	−0.013	0.006	0.020	0.082*
	(0.037)	(0.054)	(0.022)	(0.035)	(0.027)	(0.043)	(0.045)
Full program	0.498***	0.046	0.357***	0.169***	0.083***	0.027	0.141***
	(0.040)	(0.052)	(0.037)	(0.038)	(0.028)	(0.048)	(0.044)
Control group mean	0.167	0.554	0.008	0.120	0.058	0.170	0.662
N	1016	1016	1015	1015	1015	1016	1649
p-value: CHW = full	0.00	0.33	0.00	0.26	0.69	0.51	0.91
p-value: C+S = full	0.10	0.93	0.03	0.27	0.65	0.43	0.17

Notes: All regressions include stratum fixed effects, control for covariates, and cluster standard errors at the compound level. "Knows ORT recipe": mother can explain how to make oral rehydration treatment for diarrhea. "Knows age of exclusive breastfeeding": mother answers "6 months" when asked how long a baby should be exclusively breastfed. "Given last year": reports receiving water disinfectant tabs in the last year. "Used last 7 days": self-reported use of water disinfectant. "Water chlorine content" measured chlorine in parts per million. "Any chlorine detected": dummy for nonzero chlorine content. "Bed net hung correctly": the enumerator asked to see the bed net under which the child sleeps (if any) and noted whether it was hung correctly or could be hung easily, vs. stored or not available.

Significance levels: * 0.1, ** 0.05, *** 0.01.

pounds. For age-standardized danger signs of malnutrition, we report results only for children under 5. We first report the main results on prevention, acute care, and illness incidence and anthropometric outcomes, and then discuss the findings further in section 5.

The analysis focuses on health care and health outcomes related to diarrhea and malnutrition.[10] Diarrhea is most frequent - and particularly dangerous - among the youngest children, and Sautmann et al. [2020] showed that there may be heterogeneity in the utilization of curative care by age. We therefore also analyze age-specific effects of subsidies and CHW for acute care and illness incidence.

4.1 Prevention Behaviors and the Effects of CHW

Table 2 shows effects on indicators that measure knowledge and prevention behavior of the caregiver and should be primarily affected by the activities of the CHW. In areas with poor sanitation, exclusive breastfeeding helps prevent gastrointestinal (GI) disease before month 6. Afterwards, safe water is an important factor in prevention. If diarrhea does occur, a simple and effective home remedy is oral rehydration treat-

[10]The program's effect on malaria care and incidence would have been of interest as well, but the distribution of insecticide-treated malaria nets to all households in the three treatment groups invalidates comparisons between them.

ment. Columns (1) and (2) in Table 2 show indicators for whether the respondent could report the recipe for homemade oral rehydration solution (ORS) and whether they knew the age until which children are ideally exclusively breastfed (6 months). Column (3) is an indicator whether the caretaker (mother) reports that she received water tablets as part of a health NGO program last year. Columns (4)-(5) show self-reported use of water disinfectant, and (6) shows water chlorine content measured with detection strips. Column (7) shows an indicator for whether the mother could show the enumerator a correctly hung mosquito bed net under which the child sleeps.

The CHW have significant positive impacts on health knowledge (columns (1)-(2)) and self-reported water disinfectant use (columns (4)-(5)) in both the CHW only and the full program groups. In order to overcome experimenter demand effects in self-reported use, we also measured water chlorine content using test strips. There is no evidence for any *objective* impact of the free chlorine tablet distribution on chlorine in the water (column (6)). Households either over-report disinfectant use or use the tablets incorrectly. It is worth noting that nearly 50% of the control group show some chlorine detected in the drinking water, indicating that many households do have access to chlorinated water sources or undertake disinfection on their own accord.

By contrast, we find strong effects of both the CHW only and the full program intervention on the correct use of the mosquito net (column (7)). We report this measure here because it is another objective check of an important day-to-day health behavior (over and above the free distribution of the bed nets that benefited all three treatment groups, likely the cause of the weakly significant positive effect in the subsidy group). Note that even in the control group, 66% of children had a correctly hung net. In the subsidy-only group, which received free bed nets but no instruction, the rate is 8% higher (10% significance level). However, the CHW raise the share of children who sleep with mosquito protection by over 14%.[11]

For most measures of knowledge and prevention, there is no strong evidence of a subsidy effect, as we would expect. In most measures we also do not see a strong interaction effect between the subsidy and CHW. There is no evidence of moral hazard, but there is also no strong positive interaction. One exception is column (1): mothers are significantly more likely to know the recipe for ORS in the full program group than in the CHW group. We also see a marginally statistically significant (10% level), although quantitatively large, positive effect of 6.7% in the subsidy-only group. The test that the effect of CHW and subsidy combined equals the full program effect is still marginally rejected at the 10% level, due to the strong full-program effect of a nearly 50% increase. We will discuss ORT more below, because it may also be prescribed or recommended by a provider and therefore constitutes a special case.

The second exception is column (3), which is a self-reported measure whether the household has ever

[11] In Appendix B, Table 5 we show self-reported receipt of a free mosquito net in the last year. The effect sizes in all three treatment groups are almost exactly identical, reflecting the distribution to all of Mali Health's beneficiary households that did not yet own a net, see section 3.

received water disinfectant tablets from an NGO. Here, the effect of the full project is significantly larger than that of the CHW only or of the sum of the CHW and subsidy effects. Interestingly, this holds only for this one water disinfection indicator. Self-reported use of the tablets over the last 7 days is somewhat higher in the full program group, but the difference is not significant, and self-reported use on the same day is almost identical in magnitude. We note that the CHW distribution of water tablets is partially determined by the household's prior access to safe water: some compounds have access to communal taps or protected wells and do not receive the tablets, and this partially explains the overall low rates of receipt. It does not explain the difference between CHW and full program effects in column (3).

As discussed earlier, it is possible that the subsidy program increases the effectiveness or motivation of CHW, and this could be a potential source for the interaction effect in columns (1) and (3). We therefore analyzed other measures of self-reported intervention receipt, reported in detail in Appendix B, Table 5. However, there is no clear evidence for a complementarity driven by higher CHW effort or credibility in the full-program group. The overall low number of reported visits suggest that many parents do not see the CHW visits as significant, do not recall them, or do not receive them, for whatever reason (this could include the respondent being absent during the day due to work). While the share of reported visits is 11-13% higher in the full program arm than in the CHW-only arm, a non-negligible share of families also report CHW visits in the subsidy-only arm, significantly more than in the control. Mirroring this pattern, many families report receiving free care in the CHW-only arms, and the share that report the subsidy in the full-program group is higher than in the subsidy-only group. Overall, the numbers suggest high error rates and an incomplete understanding of the Action for Health program. The most likely explanation seems that parents under-report the individual program components more often when they do not receive both program parts, perhaps because the full program is more valuable and salient. This may well serve to reinforce good health behaviors in the parents, but we cannot draw firm conclusions about differences in CHW behavior.

4.2 Acute Illness: Care Received

Table 3 combines information on health care utilization conditional on the child being ill (columns (1)-(3)) with data on the incidence of symptoms (columns (4)-(7)), obtained from a 7-day health calendar over the week preceding the survey. For diarrhea, we first asked respondents to report all days on which the child had diarrhea in the last week. If diarrhea was reported, we asked about days with more than three loose stools, and days with blood in the stool (a danger sign that may indicate dysentery). We also asked whether the respondent was concerned about the child's health on any day. For care received, we recorded any visits to CSComs or associated reference hospitals (CSRef), any other formal provider visits (private or non-profit clinics and hospitals) and whether ORT was given.

Table 3: Acute care for diarrhea and incidence of diarrhea (last 7 days).

	Acute care received			Incidence (no. of days out of 7)			
	CSCOM/ CSREF	Any formal care	ORT given	Any diarrhea	Three or more loose stools/day	Blood in the stool	Mother concerned
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CHW visits	0.041	−0.014	0.127	−0.047	−0.046	−0.026	0.114
	(0.089)	(0.139)	(0.108)	(0.057)	(0.049)	(0.027)	(0.112)
Subsidy	−0.060	−0.088	0.174**	−0.061	−0.051	−0.027	−0.037
	(0.076)	(0.119)	(0.079)	(0.057)	(0.050)	(0.023)	(0.101)
Full program	0.170	0.088	0.266**	−0.149***	−0.131***	−0.022	−0.118
	(0.105)	(0.184)	(0.121)	(0.051)	(0.043)	(0.026)	(0.100)
Control group mean	0.083	0.222	0.000	0.210	0.161	0.045	0.492
N	102	102	102	1649	1649	1649	1649
p-value: CHW = full	0.28	0.59	0.39	0.02	0.01	0.87	0.03
p-value: subsidy = full	0.04	0.31	0.45	0.04	0.02	0.79	0.40
p-value: C+S = full	0.21	0.38	0.85	0.56	0.57	0.33	0.18

Notes: All regressions include stratum fixed effects, control for covariates, and cluster standard errors at the compound level. The outcome in (1) is an indicator whether the caretaker reported that an NGO worker who checked on the child's health visited in the last two weeks. (2)-(4) report measures of acute care received and include only children with any diarrhea symptoms in the last 7 days. (5)-(8) report diarrhea symptom incidence and caretaker's concern for the child's health (in number of days with occurrence, out of 7).

Significance levels: * 0.1, ** 0.05, *** 0.01.

We begin by analyzing curative care, and specifically acute care received for diarrhea. Note that the sample in columns (1)-(3) includes only children with diarrhea symptoms[12] Columns (1) and (2) show no significant effect of the subsidy on the use of formal care, either on its own or as part of the full program. While this may seem surprising in the light of the results of Sautmann et al. [2020], the same paper also provides a potential explanation for this finding. Using the more detailed data from the 2013 survey, Sautmann et al. [2020] find that the increase in healthcare utilization following the subsidy largely occurs on days in which care is required according to the WHO guidelines. Diarrhea on its own does not fall into this category, unless it has lasted for more than 5 days or is accompanied by other symptoms. It is likely that formal care is not the appropriate response to many of the diarrhea spells in the sample.[13]

Indeed, mild diarrhea cases can be treated with ORT, which can be prepared at home. Alternatively, pre-mixed ORS packets can be purchased, and providers may also recommend ORT in addition to or in place of prescription medication. Column (3) of Table 3 shows that ORT use is higher than in the control by 12.7 to 26.6 percentage points in all three treatment groups, and significantly so in the groups that receive the

[12]Unconditional use of care is uninformative, because illness incidence varies between treatment groups, see below.

[13]The 2014 data reported here constitutes a small sample of spells and does not cover a long enough period to identify spells in which care was required per WHO guidelines in an unbiased manner.

subsidy. The difference between the full program group and the other groups is not significant but of large magnitude. Recall that we saw that the CHW significantly increase knowledge of ORS among caretakers. The effect is stronger in the full-program group, and there is an effect in the subsidy-only group as well. These patterns are consistent with parents learning about ORT from CHW as well as from CSCom staff, and possibly using the subsidy to purchase more ORS packets.

The results of table 3 mask important differences across age groups. Panels 1 and 2 of figure 2 additionally show the effects on use of any formal care (corresponding to column (2)) and ORT (column (3)) broken out into two-year age groups.[14] Panel 1 shows that the increase in formal care use in the full program group is concentrated among young children. Children age 0-2 who receive the full program have an over 0.6 higher chance than the control group of seeing a formal care provider, and the effect is statistically significant at the 1% level. Children who receive only the subsidy do not show a corresponding effect, suggesting a positive effect of the CHW on care seeking propensity. Panel 2 of figure 2 shows that the 2-4 age group who receive the full program see a significant increase in ORT use (whereas the subsidy group shows moderate increases in all age groups that are not individually significant).

Although we need to interpret these findings with caution due to the small sample, the evidence overall suggests that the full program group benefits from significantly better care for acute diarrhea. Parents in the full-program group more often seek formal care for the youngest, most vulnerable children, and use ORT more often for the older children. This is consistent with the CHW helping steer parents' use of different curative care options. Both the CHW and the subsidy contribute in different ways to better awareness and use of ORS, a low-cost, effective treatment for mild diarrhea cases.

The age-specific effects on formal care use complement those found in Sautmann et al. [2020] from the first year of the intervention: the CHW in the full-program group significantly increased medically recommended curative care for the youngest children, over and above the subsidy-only group. A possible explanation is that information about the child's health status provided by CHW improves acute care seeking for young children, even when access is free. An alternative, program-specific explanation may be that the CHW educate parents of newborns on eligibility or support them in claiming the subsidy benefit.

[14] Note that children over 5 would have aged out of the sample under normal conditions.

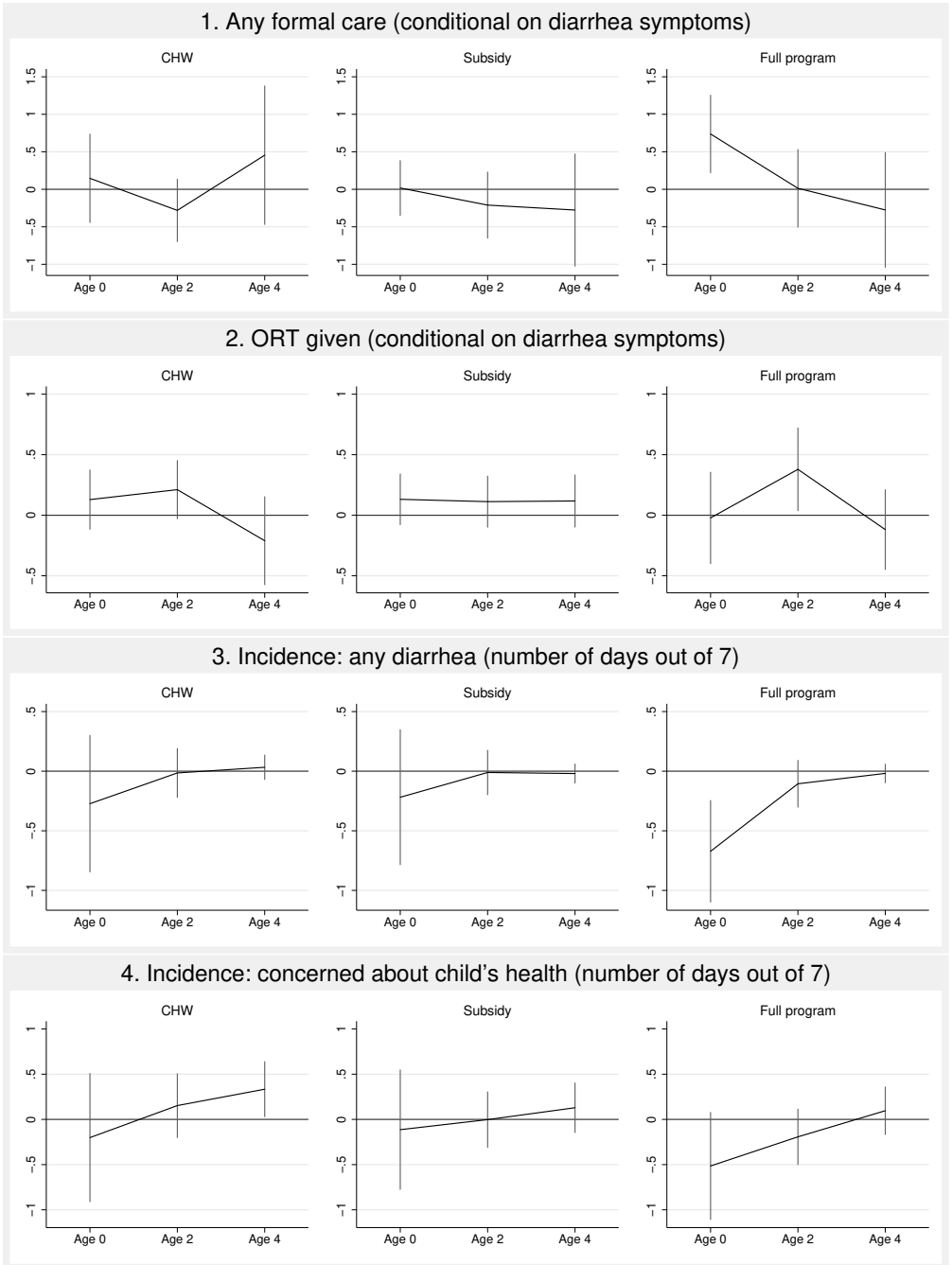

Figure 2: Treatment effects in two-year age groups, relative to control group, with 95% CI. Panels 1 and 2 report care received conditional on exhibiting diarrhea incidence (sample of 102 children); panel 3, number of days with diarrhea; panel 4, number of days caretaker was concerned.

4.3 Acute Illness: Incidence

Columns (4) to (7) of Table 3 report on illness incidence: three diarrhea symptoms as well as the subjective concern of the mother about the child's health. Children who are being weaned are the most vulnerable to GI problems, since they are exposed to food and water for the first time, and diarrhea incidence for the 0-2 year age group is typically highest. We therefore show age-specific effects on diarrhea and mother concern in panels 3 and 4 in figure 2 as well.

Strikingly, Table 3 columns (5) and (6) show large and significant reductions in diarrhea incidence in the full program group. The effect size is equivalent to over 70% of the control group mean of 0.21 days. We can reject that the effect is the same as in either the CHW-only and subsidy-only groups, but do not reject that it is the sum of the two individual effects. From Figure 2, incidence reductions are driven by the age 0-2 group, and the effect is significant at the 1% level in the full-program group. The magnitude is remarkable: the average number of days with diarrhea symptoms in the 0-2 age group is 0.75, and the estimated effect is -0.67 days, or a reduction by 90%. We see negative but not significant effects on days with "blood in the stool," which is a fairly rare danger sign.

The effects in column (8) of Table 3 for mother's concern are not statistically significant, although the large negative coefficient in the full-program group indicates a similar pattern as the other measures. The effect is again strongest among 0-2 year olds but still not significant at the 5% level (Figure 2, panel 4). There is an unexplained significant positive effect in the CHW group for 4 years and older. It is worth noting that mothers report on average 0.5 days out of 7 (7%) with a concern about their child's health, highlighting the pressure that the caregivers of the children in our sample experience.

4.4 Malnutrition Indicators: Weight and MUAC

In Table 4, we report results for weight and MUAC, two indicators of malnutrition that may respond to lower incidence and better treatment of diarrhea. Columns (1) and (3) report raw treatment effects on weight in kilograms and MUAC in millimeters. Columns (2) and (4) report indicators for two danger sign indicators for children under 5 years: weight for age below -2 standard deviations, and MUAC below 125 mm. Note that many children at the time of the 2014 follow up are older than 5 and therefore excluded from these indicators. Other reasons for missing data were outliers flagged during the age normalization procedure.[15]

There are few significant effects, and the negative effect of the subsidy on raw weight is puzzling and may be a random outlier. A lot of precautions were taken to minimize measurement error, partly informed by the challenging measurement conditions (e.g. no flat, hard surfaces to place a scale). Each child was weighed twice, and the two measurements compared. If there was a difference of more than 0.1kg, a third

[15]We used the standards defined by the Unicef IGROWUP macro for weight for age, see latest version at Unicef [2019].

Table 4: Anthropometrics and malnutrition indicators.

	Weight (kg)	WfA less than -2	MUAC (mm)	MUAC below 125
	(1)	(2)	(3)	(4)
CHW visits	0.023	−0.060*	−0.392	−0.004
	(0.204)	(0.036)	(1.027)	(0.012)
Subsidy	−0.448**	0.012	−0.616	−0.000
	(0.185)	(0.036)	(0.971)	(0.012)
Full program	−0.015	−0.035	−1.206	−0.017*
	(0.172)	(0.033)	(1.020)	(0.010)
Control group mean	14.653	0.196	152.990	0.022
N	1635	1069	1631	1060
p-value: CHW = full	0.85	0.42	0.45	0.20
p-value: subsidy = full	0.01	0.13	0.55	0.07
p-value: C+S = full	0.13	0.78	0.89	0.39

Notes: All regressions include stratum fixed effects, control for covariates, and cluster standard errors at the compound level. Regression (2) does not include covariates. Weight for age is provided only for children under 5 years of age for whom age standardization is available. "MUAC" is mid upper arm circumference and "WfA" is Weight-for-Age (z-score). Values below 125mm and -2, respectively, indicate moderate acute malnutrition for children under 5. Regressions (3) and (5) only include children under 5.

Significance levels: * 0.1, ** 0.05, *** 0.01.

measurement was taken.[16] Weakly, columns (2) and (4) suggest that the CHW might have some effect on the incidence of malnutrition danger signs. The age specific effects in Figure 4 of Appendix B for weight for age (significant reductions in dangerously low weight for age in the 0-2 age group in the CHW-only and the subsidy-only group) suggest again that program effects occur primarily at the lowest ages, likely due to the incidence profile of diarrhea, but we do not see a corresponding effect in the full program group.

5 Discussion and Conclusion

Overall, our results are encouraging for combined interventions of both removal of user fees and employment of community health workers who visit households in an urban context.

The CHW have significant effects on indicators of preventive knowledge and behavior, such as breastfeeding practice and knowledge of ORS. Even though we do not find significant impacts on objectively measured water disinfection, self-reported disinfectant use is higher in the CHW treatment arms. There is a possibility that self-reports are inflated due to experimenter demand effects. However, the significant effects of the CHW on (objective) mosquito net hanging are not consistent with mere over-reporting and suggest that the problem could also be incorrect use of the disinfectant by the household, or of the water tests that our enumerators used. It will be important to understand better why self-reported and measured disinfection

[16] Children were weighed on their own if over two and with their mother if below two years of age.

diverge, especially in the context of evidence from Kenya that chlorine solution dispensers at water sources increase use and greatly reduce child mortality (Haushofer et al. [2021]). On the curative care side, the subsidy significantly increases the use of oral rehydration treatment for children acutely ill with diarrhea.

The effects on preventive and curative care behaviors by parents are equal or greater in the full program group in almost every aspect of care seeking. In families receiving both interventions, caretakers are more knowledgeable about ORS and self-report higher water disinfectant use. Moreover, formal care is increased significantly in the 0-2 age group, while ORT use is significantly higher among 2-4 year olds. Overall, the findings suggest better targeting and use of care in the group receiving both interventions, although with the caveat that the sample size of 102 children with diarrhea is small. This is consistent with the results on formal care seeking in the 2013 survey, which show that the CHW complement the subsidy in increasing medically needed care for the youngest children.

The two interventions seem to work particularly well together for the use of ORT, likely due to the fact that ORT use is promoted by both CHW and formal healthcare providers. We saw that the subsidy-only group significantly more often receive ORT than the control. They are also 9.7% more likely than the control to know the recipe for ORS (Table 3, column (4)). For both receipt of ORT and ORS knowledge, effects are largest for households that received both CHW visits and the subsidy.

Overall, the interventions are successful at changing parents' care giving behavior, and we do not find any evidence for moral hazard on the part of the parents, in the sense that households for example reduce prevention in response to subsidized care. If anything, both preventive knowledge and behaviors and curative care are most improved in the full-program group.

Likely as a result, we find that the full program group has significantly lower diarrhea incidence than the other groups, driven by the youngest children, who are also the most vulnerable group, with the highest incidence in the control. The number of days with diarrhea is reduced by over 70% of the control group incidence for the sample as a whole, and by over 90% in the 0-2 age group. While the reduced incidence implies gains in children's well being, we do not find clear effects of the two interventions on indicators of malnutrition.

A robust interpretation of the evidence is that the CHW improve prevention, the subsidy improves curative care, and, when households receive both interventions, the reduction in diarrhea incidence represents the sum of these two effects. There is suggestive evidence of stronger CHW effects on some prevention activities when parents have access to free care as well. We argued earlier for two possible channels in which the subsidy treatment might strengthen CHW effectiveness: one is through motivating CHWs, the other is through increasing their credibility with parents. The former is of interest for any CHW programs, while the latter is particularly relevant for non-profit health program providers designing their own interventions, such as Mali

Health. The indirect question format of the data on treatment receipt introduces measurement error, and therefore does not provide a conclusive test of these channels. However, respondents may report the Action for Health benefits more often in the group receiving both interventions because each makes the other more salient, possibly contributing to better health care behaviors on the parents' part. These possibilities may be a fruitful area for further research.

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.

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.

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

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.

Brynne Gilmore and Eilish McAuliffe. Effectiveness of community health workers delivering preventive interventions for maternal and child health in low- and middle-income countries: a systematic review. *BMC Public Health*, 13(1):847, 2013. URL https://doi.org/10.1186/1471-2458-13-847.

Johannes Haushofer, Michael Kremer, Ricardo Maertens, and Brandon Joel Tan. Water treatment and child mortality: Evidence from Kenya. *NBER Working Paper*, 29447, 2021.

UN IGME. Un inter-agency group for child mortality estimation: Under five mortality, 2021. downloaded from: https://childmortality.org/data (accessed: 01/28/2022).

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.

Mylene Lagarde and Natasha Palmer. The impact of user fees on access to health services in low-and middle-income countries. *Cochrane Database of Systematic Reviews*, (4), 2011.

Simon Lewin, Susan Munabi-Babigumira, Claire Glenton, Karen Daniels, Xavier Bosch-Capblanch, Brian E Van Wyk, Jan Odgaard-Jensen, Marit Johansen, Godwin N Aja, Merrick Zwarenstein, et al. Lay health workers in primary and community health care for maternal and child health and the management of infectious diseases. *Cochrane database of systematic reviews*, (3), 2010.

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.

Barbara McPake, Alice Schmidt, Edson Araujo, and Christine Kirunga-Tashobya. *Freeing up Healthcare: A*

guide to removing user fees. Save the Children, London, 2008.

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.

Anja Sautmann, Samuel Brown, and Mark Dean. Subsidies, Information, and the Timing of Children's Health Care in Mali. *World Bank Policy Research Working Paper*, (WPS9486), 2020.

Kerry Scott, S. W. Beckham, Margaret Gross, George Pariyo, Krishna D. Rao, Giorgio Cometto, and Henry B. Perry. What do we know about community-based health worker programs? a systematic review of existing reviews on community health workers. *Human Resources for Health*, 16(1):39, 2018. URL https://doi.org/10.1186/s12960-018-0304-x.

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

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.

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

Unicef. Update of IGROWUP Stata macro prevalence module, 2019. URL: https://github.com/unicef-drp/igrowup_update (accessed: 01/28/2022).

Unicef. Diarrhoea, 2021. URL: https://data.unicef.org/topic/child-health/diarrhoeal-disease/ (accessed: 01/28/2022).

WHO. *Handbook IMCI: Integrated Management of Childhood Illness*. World Health Organization (Department of Child and Adolescent Health and Development) and Unicef, 2005.

WHO. Children: improving survival and well-being, 2020. URLL: https://www.who.int/news-room/fact-sheets/detail/children-reducing-mortality (accessed: 09/08/2020).

A Consort Diagram

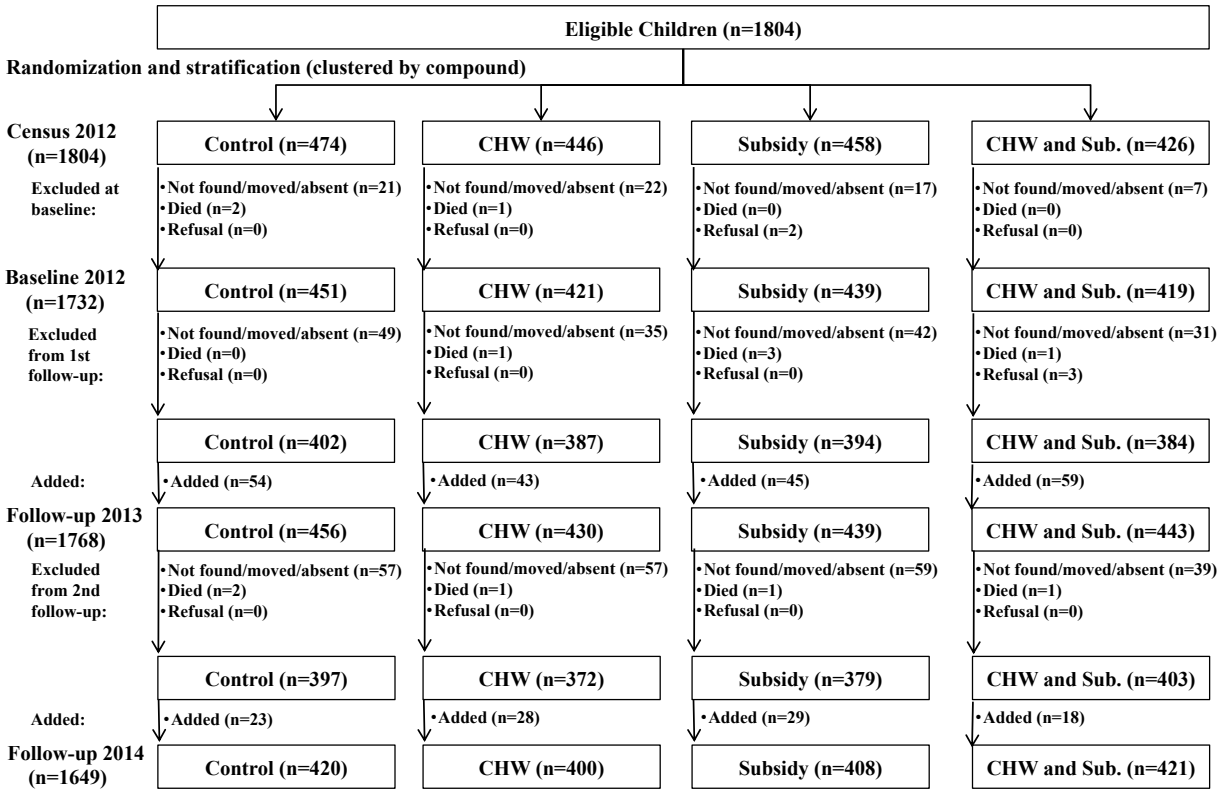

Figure 3: Consort diagram of children in each treatment arm, showing the evolution of the sample throughout the study. The census was conducted by the NGO Mali Health. At baseline, surveyors re-identified the households from the census and listed all children. At each follow-up, households (if found and did not refuse) re-confirmed all children and any households/children not listed in previous rounds were added. This included children newly born into the household as well as children returned from absences etc.

B Additional Results

B.1 Treatment effects on Anthropometrics by Age

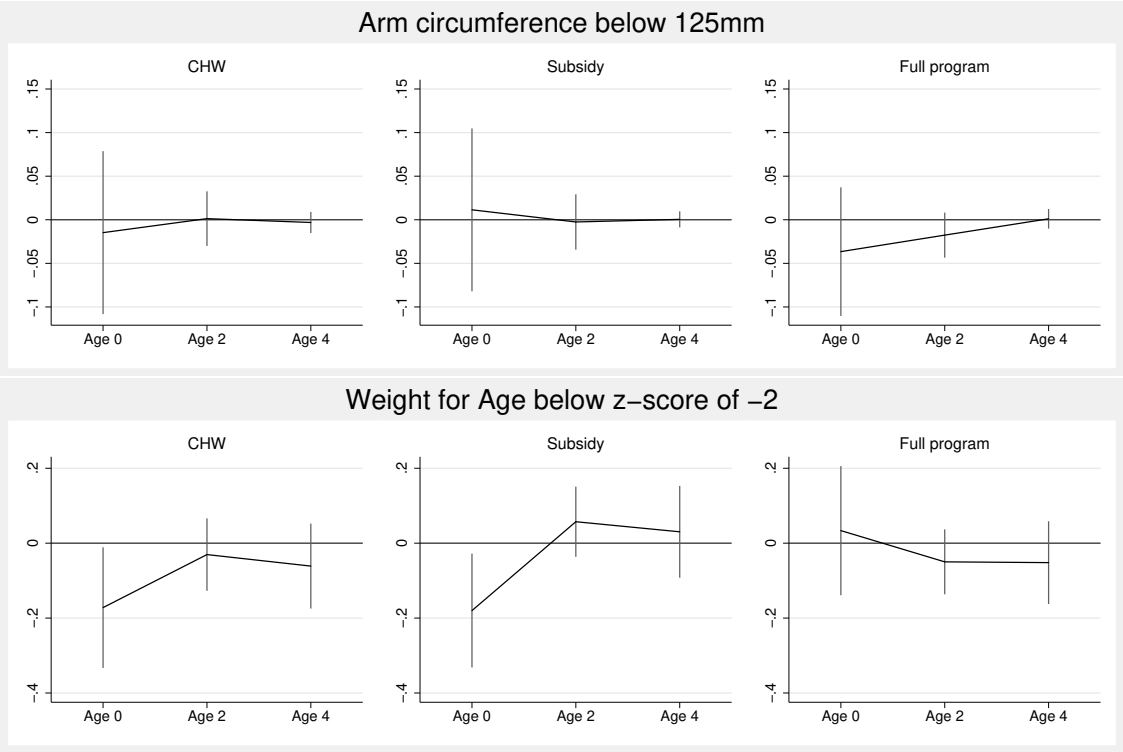

Figure 4: Effect on indicators for malnutrition relative to control group with 95% CI in two-year age groups.

B.2 Self-Reported Receipt of Program Benefits

Table 5 shows what caretakers say about the receipt of various Action for Health components. Mali Health was not directly mentioned and the surveyors were blinded to the experiment. The respondent was first asked if the child received any kind of health program. Columns (1)-(3) report self-described receipt of a health program and active recall of either of the two Action for Health components. Columns (4) and (5) additionally include affirmative responses to two follow-up questions to learn indirectly about program receipt (prompted recall): whether the child has a physical card that entitles them to free visits at the community clinic, and whether an NGO worker visited the household to measure the child's weight and height. Column (6) asks mothers who directly or indirectly reported CHW visits in (5) whether a visit was received in the last 2 weeks. Lastly, column (7) is included in the table to show that all treatment groups were equally likely to receive treated mosquito bednets (see section 3 on the experimental design).

The numbers suggest that there is overreporting or misreporting of the benefits received: relative to the control group, an additional 6.4% to 8.5% of the CHW-only group report subsidized care (columns (2)

Table 5: Health care program receipt.

	Child in any health program (1)	Receives subsidy (2)	Receives CHW visits (3)	Subsidy or card reported (4)	Health worker visits reported (5)	NGO/HW visit last 2 weeks (6)	Received bed net (7)
CHW visits	0.581***	0.064***	0.532***	0.085***	0.551***	0.409***	0.311***
	(0.042)	(0.022)	(0.042)	(0.022)	(0.042)	(0.040)	(0.037)
Subsidy	0.630***	0.532***	0.259***	0.650***	0.336***	0.097***	0.327***
	(0.036)	(0.035)	(0.041)	(0.034)	(0.041)	(0.026)	(0.037)
Full program	0.753***	0.573***	0.645***	0.743***	0.688***	0.530***	0.324***
	(0.031)	(0.040)	(0.038)	(0.032)	(0.035)	(0.037)	(0.037)
Control group mean	0.055	0.017	0.047	0.019	0.107	0.014	
N	1648	1648	1648	1648	1648	1641	899
p-value: CHW = full	0.00	0.00	0.02	0.00	0.00	0.02	0.78
p-value: subsidy = full	0.00	0.41	0.00	0.03	0.00	0.00	0.96
p-value: C+S = full	0.00	0.66	0.02	0.87	0.00	0.67	0.00

Notes: All regressions include stratum fixed effects, control for covariates, and cluster the standard errors at the compound level. "Child in any health program": mother was asked whether the child is enrolled in any health program. "Receives subsidy" and "Receives CHW visits": mother describes these two services as part of the program. "Subsidy or card reported" and "Health worker visit reported": includes mothers who respond affirmatively to an indirect question to confirm program receipt; whether the child has the card that entitles them to program benefits at the clinic, and whether an NGO worker visited to measure the child's weight and height. "NGO/HW visit last 2 weeks": mothers reported any NGO/HW visits *and* that a visit occurred in the last 2 weeks. "Received bed net": at household level, whether a free mosquito net was received. Significance levels: * 0.1, ** 0.05, *** 0.01.

and (4)), and an additional 25.9% to 33.6% of the subsidy-only group report CHW visits, on top of the 4.7%-10.7% reported in the control group (columns (3) and (5)).

The full program effects are significantly higher than the individual group effects in all columns (3) to (6). It is possible that the subsidy groups receive home visits from clinic staff or describe clinic consultations or administrative visits from Mali Health in an ambiguous way. It is also possible that the CHW-only group mistake a vaccine card for the Action for Health subsidy card. Lastly, the differences between the full-program and individual-intervention groups may be recall error, reflecting that the program benefits are more salient when children receive the full program.

As discussed above, it is also possible that there are truly more CHW visit in the full program group. The CHW in the CHW-only group may feel less motivated, for example because they question the purpose of regularly monitoring the child's symptoms, or because parents are less inclined to listen to them. However, we would expect that CHW in the CHW-only group visit their families at least some of the time: the CHW are monitored and managed in small groups of around 10, and they record health data for children that their supervisor and CSCom staff have access to. Moreover, CHW motivation does not explain why households in the CHW-only group believe they received access to free care at the clinic. In sum, the significant rates of misreporting mean that the evidence is inconclusive on CHW motivation effects.