Effectiveness of peer detailing in a diarrhea program in Nigeria

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Abstract

Diarrhea causes over 500,000 deaths of children under five years old globally each year. A combination of oral rehydration salts (ORS) and zinc is regarded as the most effective treatment to prevent diarrhea-related deaths among children. We study the effectiveness of a Clinton Health Access Initiative (CHAI) program in Nigeria, aimed at increasing usage of ORS and zinc. Peer detailers (educators) reinforce the benefits of the treatment to patent and proprietary medicine vendors (PPMVs), a main source of healthcare in the country. Two aspects of program effectiveness are analyzed: PPMV knowledge that this combination is the most effective treatment and PPMV inventory of ORS and zinc. Hypothesis tests reveal that the percentage of PPMVs with knowledge of the most effective treatment increases significantly in most states after peer detailing. Surprisingly, no significant patterns were detected regarding the percentage of PPMVs with inventory of ORS and zinc. Logistic regression results suggest that PPMVs that were detailed have significantly higher odds ratios for both knowledge and inventory. We conclude with a discussion regarding our findings regarding the overall effectiveness of the CHAI program, limitations of the study, as well as suggestions for future activities for CHAI to support their information dissemination program.

Introduction

As the second leading cause of death among children under five years old, diarrhea is responsible for more than 500,000 deaths globally each year [1, 2]. The majority of deaths occur in low- and middle-income countries where children are exposed to risk factors such as unsafe drinking water, poor sanitation and hygiene practices, micronutrient deficiency, malnutrition, and lack of access to high-quality healthcare [3-5]. Diarrhea is the presence of loose and watery stool usually caused by viral infection in the digestive system, becoming dangerous and deadly when it depletes body fluids resulting in profound dehydration. To treat diarrhea, the World Health Organization recommends the combination of oral rehydration salts (ORS) and zinc [6]. ORS prevents dehydration, the primary mechanism by which diarrhea leads to death, and zinc shortens the duration of diarrhea and prevents its reoccurrence in the 2-3 months following supplementation. Increasing utilization of this combined treatment may prevent over 90% of diarrhea-related deaths among children [7, 8]. However, few children in need are receiving this treatment [9-11] for reasons that are multifaceted, possibly involving policy barriers, manufacturing and supply constraints, low provider and consumer awareness and demand and decision-theoretic considerations by health providers [12].

Nigeria is a country with a population that suffers from an estimated 77,000 diarrhea-related deaths each year [1]. To address this challenge, the Ministry of Health (MOH) of Nigeria has developed a National Essential Medicines Scale-up Plan and established a National Essential

Medicines Coordinating Mechanism (NEMCM) to bring together resources and investments from government institutions, non-government organizations, and private companies [13]. The Clinton Health Access Initiative (CHAI) is one of the partners supporting the MOH to undertake activities promoting the usage of ORS and zinc in Nigeria (ORS/Zinc Program) [12]. CHAI's efforts focused on eight states in Nigeria: Bauchi, Cross River, Lagos, Kano, Kaduna, Katsina, Niger, and Rivers. Thirty six percent of children under-five live in these eight states, and diarrhea prevalence ranges from 5% to 25.7% [14, 15].

Patent and proprietary medicine vendors (PPMVs) are private medicine retailers for whom the licensure requirements do not include any formal training [16-19]. These individuals exist to bridge the gap created by a dearth of pharmacists. Access to primary health care is poor in Nigeria and 75% of the Local Government Areas (LGAs) in the country do not have a registered pharmacist [Pharmacy Council of Nigeria, personal communication, September 2016]. PPMVs are therefore an important source of care and many children with illnesses directly seek healthcare from PPMVs [15]. With 43% of PPMVs' shops located in rural areas, PPMVs play a crucial role in making healthcare accessible to the poor and most vulnerable people [18]. The Pharmacy Council of Nigeria (PCN) is the regulatory body which oversees PPMVs; however, many PPMVs fail to register with PCN, opting rather to register with their professional association, the National Association of Patent and Proprietary Medicine Dealers (NAPPMED) [18].

CHAI aims to increase the usage of zinc and ORS by working with NAPPMED to conduct peer detailing of PPMVs. Peer detailing involves the recruitment of respected members of the NAPPMED to conduct shop-to-shop visits and mentor other retailers on diarrhea management, including identification of danger signs and when individuals should be referred for treatment.

Other programs aimed at increasing the knowledge and usage of zinc and ORS amongst private providers, particularly in the informal sector, show mixed results and vary greatly in intervention type, environmental context, and scale. The Diarrhea Alleviation Through Zinc and ORS Treatment (DAZT) program in the states of Gujarat and Uttar Pradesh in India included support to the government on policies and procurement, trainings for public clinic and community healthcare workers, continuing medical education sessions to private formal healthcare providers (i.e. trained physicians), and drug detailing visits to private drug vendors and chemists by pharmaceutical representatives. An external evaluation of the program in Gujarat found drug-detailing visits were predictive of self-reported recommendation of zinc and ORS treatment for diarrhea [20].

In Ghana, a randomized controlled trial was conducted to evaluate the impact of an 8-week SMS campaign on knowledge and practices of licensed chemical sellers (LCS). The study results showed the SMS campaign led to 6.6 percentage point increase ($p \leq 0.05$) in self-reported recommendation of ORS and zinc without anti-microbials or anti-diarrheals, but made no difference in treatment recommendation when approached by a mystery client [21].

Interventions using a social franchising model also show differing results. A social franchising and telemedicine program in Bihar, India did not show improvements in appropriate treatment of diarrhea at the community level. The study found that the WHP-Sky program's network of providers constituted a small market share of healthcare providers in the study clusters. Only 2.9% of diarrhea cases sought care from the WHP-Sky program's network of providers [22].

In Myanmar, a randomized control trial of a social franchising model using local community health workers found a significant impact of the model on ORS and zinc use among children under-five with diarrhea. By the end of the study, 13.8% of children under-five with diarrhea received ORS and zinc in the intervention arm compared to 1.8% in the control arm [23].

Lastly, a census study of PPMVs in Kogi and Kwara states in Nigeria found PPMVs who had formal healthcare training were associated with stocking ORS, but few other PPMV characteristics were predictive of correct knowledge of optimal treatments and stocking behavior [24]. The study did not include knowledge or stocking of zinc as an outcome.

This paper examines the effectiveness of peer detailing as a method for improving correct knowledge and stocking patterns of ORS and zinc in the context of Nigeria and PPMVs. We rely on two outcome measures for the effectiveness of peer detailing - inventory of zinc and ORS at PPMVs and PPMV awareness that this combination is the most effective treatment. Specifically, we focus on answering the following questions: (i) Following peer detailing, is there a change in the inventory of ORS and zinc at PPMVs? (ii) Following peer detailing, does PPMV awareness of the most effective treatment for children's diarrhea improve?

The remainder of this paper is organized as follows. We first describe the data sets that were used as part of the analysis and then we provide a detailed description of the exploratory data analysis, highlighting key findings. Next, we discuss the statistical methods used to analyze the data. The subsequent section describes our results regarding the effectiveness of peer detailing, based upon our statistical analysis. We then provide a further discussion of the key findings and the limitations of the current study. Finally, we suggest additional data collection programs and the insights they could potentially provide.

Data Collection and Description

In this section, we describe the survey data that was analyzed. We set the stage by first providing background about the peer detailing process. Specifically, we focus on peer detailing that was rolled out in eight states in Nigeria – Bauchi, Cross River, Lagos, Kano, Kaduna, Katsina, Niger, and Rivers – as mentioned previously, these states collectively account for 36% of children under five years old in Nigeria [14].

Peer detailing involves NAPPMED leaders conducting shop-to-shop visits to mentor other PPMVs on diarrhea management. Prior to the peer detailing program, centralized, one-day trainings were conducted with PPMVs to orient them to the correct treatment for diarrhea. Through NAPPMED, CHAI encouraged PPMVs to join the one-day training, though PPMVs decided whether to opt-in or not. In total, 17,849 PPMVs attended the 1-day training. After the training, CHAI recruited and trained 583 NAPPMED executives on peer-detailing. Peer detailing was designed to reinforce the messages disseminated at the centralized trainings. The detailers were trained on interpersonal skills and provided mobile devices installed with a software monitoring tool to track how many peer detailing visits were made and to assist the peer detailer in identifying knowledge gaps during their visit. The peer detailers were expected to visit each PPMV in their respective LGA at least once per calendar quarter to provide them educational information regarding diarrhea case management and ORS and zinc. Peer detailers also left behind informational materials, such as posters, on ORS and zinc to reinforce appropriate provider behavior and encourage product stocking. Between August and December 2015, two cycles of peer detailing were conducted, and the monitoring data shows that 42,576 detailing visits were made.

To study the effect of peer detailing, independent surveys were conducted. The first survey, conducted between July 10 and July 30, 2015 before peer detailing (the "Before Detailing" survey), provided a measure of baseline PPMV understanding about diarrhea treatment and the medicines they stocked. This survey covered PPMVs in all eight states of interest in Nigeria. Subsequent to the peer detailing, a second survey was conducted in two phases (the "After Detailing" survey): the first phase between November 20 and December 22, 2015 and the second between January 30 and February 23 of 2016. These two phases jointly covered all eight states of interest in Nigeria. (Please see Table 1 for details.)

The PPMV surveys were conducted with the intention of independently studying the effectiveness of the CHAI peer detailing program. The surveys sampled PPMVs independently from the peer detailing monitoring database. It was not possible to sample from the peer detailing monitoring database since the names of many PPMVs were identical and the same PPMV may have been detailed more than once during the program, thus appearing more than once in the monitoring database. Additionally, one objective of sampling independently from the monitoring database was to assess whether peer detailers were systematically canvassing all PPMVs during their detailing or potentially detailing only certain PPMVs. To recruit PPMVs for the survey, PPMVs were randomly sampled using stratified multi-stage cluster sampling. The 2006 national census was used as the primary sampling frame. During the 2006 national census, the land area of Nigeria was divided into 665,000 smaller contiguous areas called enumeration areas (EAs). Prior to study selection, the EAs were stratified into urban EAs and rural EAs for each state, as defined by Nigeria's Population Commission (the only exception being Lagos where all EAs are classified as urban). A computer-generated simple random sample of EAs was taken within each state, with approximately half of the EAs coming from urban areas and the other half from rural areas. Sampling was independent for each survey (Before Detailing and After Detailing). In the Before Detailing survey, the study sampled 80 EAs in Lagos, 144 EAs in Kano, 156 EAs in Rivers, 58 EAs in Bauchi, 58 EAs in Cross River, 55 EAs in Kaduna, 57 EAs in Katsina, and 56 EAs in Niger. In the After Detailing survey, the study sampled 80 EAs in Lagos, 146 EAs in Kano, 156 EAs in Rivers, 95 EAs in Bauchi, 95 EAs in Cross River, 88 EAs in Kaduna, 90 EAs in Katsina, and 90 EAs in Niger.

Using maps obtained from the Population Commission, trained interviewers walked the entire area of the EA and conducted a census of PPMVs in the EAs. In an effort to identify any PPMVs that may influence the health and wellness of individuals residing in any EA, interviewers were also tasked with interviewing community members and leaders to identify PPMVs outside the EA who were common sources of care for people living in the EA. After listing all PPMVs located within the EA and also PPMVs located outside the EA but commonly used by community members residing in the EA, interviewers explained the survey to the PPMVs and requested verbal informed consent to conduct the survey. Interviewers conducted in-person surveys with PPMVs, asking a broad range of questions touching on subjects relating to knowledge and attitudes of PPMVs towards diarrhea and its treatments. The interviewer also recorded information about the quantities of medication in stock (inventory levels). To identify PPMVs that were detailed, interviewers asked, "In the last 1 month, were you visited by anyone promoting ORS and Zinc?" The data was captured electronically on Android smartphones programmed with the data collection app SurveyCTO.

The Before Detailing and After Detailing surveys both used the same survey instrument. Each survey consisted of five modules including PPMV identification, outlet characteristics, awareness and attitude to diarrhea treatments, medicine inventory audit, and marketing exposure. The survey aimed to collect data on availability of treatments of various children's diseases (e.g., diarrhea and pneumonia). Table 1 provides a summary of the number of PPMVs included in each survey as well as the timeframe for each of these activities.

From the surveys, we extracted the questions that provided insight into the PPMVs' overall awareness of the most effective treatment for children's diarrhea as well as questions that provided information regarding inventory levels of ORS and/or zinc. To determine whether the PPMV was aware of the most effective treatment for children's diarrhea, interviewers asked the PPMV what they would recommend for treating non-bloody diarrhea in a child under five years old. Interviewers recorded the response of the PPMV using pre-coded, multiple choice options programmed into the data capturing software. If the PPMV selected only ORS and zinc – to the exclusion of any other treatment – then the PPMV was marked as being aware of the most effective treatment for diarrhea. A series of questions were used to determine whether the PPMV had individual ORS sachets in stock, individual zinc blister packs in stock, and ORS-zinc co-packages in stock. If the PPMV either had co-packages in stock or had both ORS sachets and individual zinc blister packs, then the PPMV was marked as having stock of ORS and zinc. The survey did not gather information regarding inventory levels.

Discussions with subject matter experts highlighted some confounding factors that may influence a PPMV's awareness of the most effective treatment for children's diarrhea as well as the chance that the PPMV will stock this treatment. For example, PPMV level of education, whether the PPMV has any health-related degree, PPMV location (rural versus urban), and whether the PPMV received any training on children's diarrhea (and if so how recently) were all suggested as factors that could impact PPMV stocking of the most effective treatment. Our analysis considered the potential impact of these confounding factors. Table 2 lists the questions in the survey and also highlights the associated confounding factors.

Results

For our analysis, we deployed a variety of statistical techniques including exploratory data analysis, descriptive analyses, and hypothesis testing.

Exploratory data analysis helped provide some initial insight into the data that was gathered in the surveys. Figure 1 shows the percentage of PPMVs with ORS and zinc inventory, in each of the eight states, before and after detailing. Based on the survey results, the percentage of PPMV across the eight states in Nigeria included in our study (a case we refer to as "All") with ORS and zinc in stock after detailing is lower than the percentage prior to detailing. Looking at the results for each state, Cross River, Kaduna and Kano show increased inventory levels while Bauchi, Katsina, and Rivers display a noticeable decrease. These results suggest that detailing did not increase availability of ORS and zinc. We note, however, that factors that may contribute to inventory levels are complicated and may possibly involve warehouse supply issues, distribution networks, and profit considerations. In Section 5, we discuss this in greater detail and provide suggestions for additional data that may be collected and analyzed to yield further insights.

Figure 2 shows the percentage of PPMVs surveyed before and after detailing with awareness of the most effective treatment for children's diarrhea. We observe a noticeable increase in the percentage of PPMVs with awareness of the most effective treatment for children's diarrhea. With the exception of Katsina, all states in our study show an increase in the percentage of PPMVs with awareness of the most effective treatment. This suggests that peer detailing may have been successful in spreading information that the combination of ORS and zinc is the most effective treatment. The observed lack of inventory for zinc and ORS may potentially be associated with an increased distribution of treatment to patients rather than PPMV lack of awareness. This sort of co-dependence illustrates some of the challenges in evaluating the intervention.

Hypothesis Tests

We conducted hypothesis tests to determine the significance of these changes before and after detailing. In particular, we conducted proportional z-tests to determine whether there are significant differences in both proxy measures, i.e., the percentages of PPMVs with inventory of ORS and zinc as well as the awareness that their combination is the most effective treatment for children's diarrhea. Here, the null hypotheses are that there is no increase in the proportion of PPMVs with inventory or awareness of the most effective treatment for children's diarrhea. The alternative hypotheses are that there is an increase in the corresponding proportions. In other words, we used one-tailed tests. We used 5% as the significance level. Note that the z-statistic is calculated as

$$z = \frac{p_{\text{after}} - \mathrm{p}_{\text{before}}}{\sqrt{p_{\text{all}}(1 - p_{\text{all}})(\frac{1}{n_1} + \frac{1}{n_2})}}$$

where p_{before} and p_{after} are the proportions of PPMVs with inventory or awareness of ORS and zinc before and after peer detailing, respectively; p_{all} is the pooled sample proportion; n_1 and n_2 are the numbers of samples (surveys) before and after peer detailing, respectively.

Inventory change before and after peer detailing

Table 3 provides z-statistics and their corresponding p-values for one-sided proportional z-tests of percentage increases of inventory of ORS and zinc, for all states combined and each state separately. No significant change is detected when analyzing consolidated results across all eight states. On a state level, however, Cross Rivers, Kaduna, and Kano display an increase in percentage of PPMVs with ORS and zinc after detailing compared with prior to detailing. These results are consistent with the results found in the exploratory data analysis. With respect to overall availability, there seems to be no evidence of an increase in percentage of PPMVs with inventory of ORS and zinc.

Knowledge change before and after peer detailing
Similarly, Table 4 provides z-statistics and their corresponding p-values for one-sided proportional z-tests of percentage increases of the PPMVs with awareness of the most effective treatment for children's diarrhea across all eight states and for each individual state. In contrast to the findings regarding treatment availability, a significant increase with respect to PPMVs with awareness of best treatment across all eight states is identified after detailing. On a state level, increases in percentages for all states except Katsina are significant. These results are also consistent with the exploratory analysis suggesting that the percentage of PPMVs with awareness of the most appropriate treatment for children's diarrhea increases after peer detailing.

Regression Modeling

A logistic regression approach was taken to determine the proxy measures and peer detailing, after including relevant confounding factors. Specifically, we built simple models considering each covariate separately to determine the effect of the variable of interest as well as potential confounding factors without adjustment of other factors. Then, we developed more complex models with adjustment of confounding factors to investigate the effect of peer detailing on the inventory and knowledge level of the PPMVs. In addition, we analyzed the effects of the interaction between detailing and training to determine whether previous related training impacted the effect of detailing. For the regression analysis, we identify PPMVs as having been detailed in the previous month based on responses to a question in the After Detailing surveys.

Association between inventory and peer detailing
As discussed in the section on data collection and description, we considered confounding factors that may influence the effectiveness of peer detailing. As a reminder, Table 2 provides a detailed description of these confounding factors. In Table 5 we provide the estimated odds ratios from logistic regressions with and without adjustment of confounding factors for inventory of ORS and zinc.

When ignoring the confounding factors, the estimated odds ratio of holding inventory of zinc and ORS for PPMVs who were detailed and of those who were not detailed in the previous month is 1.998 (95% C.I.:1.756 to 2.270). This effect is significant. In logistic regressions of inventory with confounding factors, all confounding factors were identified as significant.

When considering confounding factors, keeping all other factors the same, the estimated odds ratio of holding inventory of zinc and ORS for PPMVs who were detailed and of those who were not detailed in the previous month is 1.694 (95% C.I.: 1.478 to 1.941). This effect is also significant. Again, the effects of all confounding factors were significant.

Association between knowledge and peer detailing

We next study the impact of peer detailing on PPMV awareness of the most effective treatment for children's diarrhea. Table 6 provides estimated odds ratios from logistic regressions with and without adjustment of confounding factors.

Without consideration of confounding factors, the estimated odds ratio of awareness of the most effective treatment for PPMVs who were detailed and of those who were not detailed in the previous month is 2.497 (95% C.I.: 2.158 to 2.889). This effect is significant. In logistic regressions of inventory with confounding factors, all confounding factors were significant.

When considering confounding factors in a multiple regression model and keeping all other factors the same, the estimated odds ratio of awareness of the most effective treatment for PPMVs who were detailed and of those who were not detailed in the previous month is 1.861 (95% C.I.: 1.597 to 2.173). Again, this effect is significant and all the confounding factors were found to be significant.

Association between inventory/knowledge and interaction of detailing and training

Prior studies have shown that previous training (within 1 year or in 2-3 years) has a positive effect on both inventory and awareness of the most effective treatment of children's diarrhea. Here, we study whether this related training can enhance the effect of detailing. Table 7 provides estimated odds ratios from logistic regressions with interaction of detailing and training for inventory and proper knowledge of the best treatment for children's diarrhea.

With respect to inventory of both zinc and ORS, keeping all other factors the same, the effect of detailing on PPMVs who received related training within a year is significantly higher than on PPMVs who received training 2-3 years prior or who never received training. This is suggestive of the potential benefit of frequent information dissemination as this may result in PPMVs maintaining higher levels of inventory of ORS and zinc.

On the other hand, regarding awareness of the most effective treatment for children's diarrhea, keeping other factors the same, there is no significant effect of detailing for PPMVs who previously (within one year or 2-3 years prior) received related training as compared with those who never received training.

Discussion

In this section, we discuss our learnings from the process of applying data analysis techniques to a pre-existing real-world survey dataset and also highlight some potential implications of our work. We begin by delving into the limitations of the study. Since one of our objectives was to provide initial recommendations to guide the program's future strategies, we also provide suggestions on additional data collection activities that could potentially be instituted, along with the analyses and insights that they may enable.

Study Limitations

A limitation of our study is that a complete database of PPMVs is nonexistent as PPMVs are informal drug sellers without any licensure requirements. PPMVs open and close their businesses frequently. As a result, the study utilized a random sampling procedure adopted from other similar drug outlet studies [25]. A result of the random sampling data collection strategy was that the same PPMVs were not necessarily contacted before and after detailing. As such, we were unable to accurately pair before and after detailing responses for each PPMV. Such a pairing would have provided the benefit of yielding additional insight into PPMV behavior and into the effectiveness of the CHAI program. Further, our analysis relied on the assumption that the random samples collected for each survey are representative of the universe of PPMVs in the region of study. However, it is difficult to verify whether the samples collected are representative of the large number of PPMVs in Nigeria, particularly as there is a rapidly changing status of these workers.

Another challenge is the inability to understand the effect of peer detailing on the most pertinent measures, such as actual dispensing practices by PPMVs or the number of diarrheal deaths. Other studies have shown informal healthcare providers do not often practice what they know, even for seemingly simple to treat diseases such as diarrhea [21, 26]. Measuring actual practice through direct observation, standardized patient interviews, or client exit interviews would provide better measures of provider practice.

The limited time period over which data was collected restricted our ability to analyze the impact of potentially important factors such as pre-existing time trends. Absent multiple years of historical data, we were unable to measure the possible impact of seasonality in inventory or cyclical patterns in the disease.

Classification of PPMVs as to whether they were detailed may also be subject to recall bias since PPMVs self-reported this in the survey. We were unable to match PPMVs from the detailing database to the surveys since the names of PPMVs and their shops were not uniquely identifiable. We find no reason for PPMVs to misreport being detailed other than a general positive response bias. Additionally, the recall period for detailing was one month, and this short recall period did not cover the entire detailing period from August to December 2015. Peer detailers were expected to detail all PPMVs in their area once a quarter. Thus, some PPMVs detailed more than a month ago may have been classified as having not been detailed due to the short recall period.

As we have alluded to earlier, a host of potential confounding factors may impact the accuracy of our findings. For example, our data set does not contain information regarding differences in education levels of PPMV owners. Other important factors that could be relevant include the locations of medication storage facilities, roads (availability and conditions), regional health differences, etc. Absent available data on these and other potential confounding factors, we recognize that the conclusions of this study serve as a preliminary indication of the effectiveness of peer detailing. Availability of more data would likely provide more substantial insights regarding the information dissemination activities.

Suggestions for Future Activities

Our results hint that the recency of detailing and training is important but the collection of longitudinal data would enable a better understanding of this phenomenon. Analytical time series and intervention models with specific functional forms that measure the knowledge decay of detailing could be fit to such data. The results of these models could then be used to optimize detailing schedules. However, we acknowledge that such longitudinal data may be difficult to collect. Specifically, discussions with subject matter experts have identified two challenges. First, it is difficult to uniquely identify PPMVs since many have similar names. As such, a database that records names of each PPMV would prove to be difficult to maintain. We also considered uniquely identifying the location of PPMV shops based upon their geocoordinates. This too proved to be challenging as many are in close spatial proximity. An additional challenge in maintaining an accurate listing of PPMV shops is the frequency with which these shops open and close.

Another suggested stream of analysis is to characterize how additional features such as gender, location, years of experience, and the education level of PPMVs impact the effectiveness of detailing. With the impact of these factors better understood, these insights may be used to prioritize and schedule detailing efforts to maximize health outcomes. Such analysis requires sufficient samples to identify significant relationships on these features as well as data connecting the stocking of ORS and zinc to actual morbidity and mortality data as well as disease burden information, which is difficult to acquire at the appropriate granularity.

The intent of our study was to measure the benefits of peer detailing. It is clear that true benefit would be gauged by associating the intervention with improved health outcomes and reduced number of deaths in the geographical areas in which the detailing was deployed. As mentioned earlier, improved PPMV knowledge of the most effective treatment for diarrhea as well as changes in inventory levels are only intermediate process measures of the true desired improved outcomes that one hopes to measure. We suggest future studies include measurements of patient health outcomes using household surveys and provider practice using standardized patient interviews, client exit interviews, and direct observation.

Finally, as our results also hint, the overall problem of disseminating the best treatment for diarrhea is as much a supply and distribution issue as it is a PPMV education issue. We suggest future research involving mathematical modeling formulations to help study these issues in detail; problems of potential interest include but are not limited to decisions around warehouse location to minimize the cost of distribution, allocation of ORS and zinc stock to maximize impact, and determining who to train for detailing and more generally, allocating resources for detailing activities.

Conclusions

In this paper, we presented an initial data analysis of surveys to study the effectiveness of peer detailing in the context of a ORS/zinc program in Nigeria. Based on the results of hypothesis tests and logistic regressions, we find some evidence that peer detailing improves PPMVs' overall knowledge of the most effective treatment for children's diarrhea. The percentage of PPMVs with awareness of the most effective treatment increased in seven of the eight states included in our study. Analysis of logistic regressions reveals the estimated odds ratio of awareness of the most effective treatment for PPMVs who were detailed and of those who were not detailed in the previous month is 1.861 (95% C.I.: 1.597 to 2.173), given the other confounding factors remain the same.

On the other hand, it is difficult to identify general patterns over the entire survey area regarding the impact of detailing on inventory levels. At a state level, compared to the percentage of PPMVs with inventory of zinc and ORS before detailing, Cross Rivers, Kaduna, and Kano show significant increases after detailing. In addition, the logistic regression analysis suggests that detailed PPMVs have higher odds of having both zinc and ORS in stock as compared with PPMVs that were not detailed in the previous month, given other confounding factors remain the same. That is, the detailed PPMVs are more likely to have both zinc and ORS in stock while no significant increase can be detected on the overall inventory of the region. This suggests that further investigation should be conducted to learn about the supply distribution.

The differences in the impact of detailing on inventory levels and awareness of the most effective treatment for childhood diarrhea suggest that additional activities are required to address the high-level objective of reducing diarrhea-related death in Nigeria among children. The lack of proper awareness of the most effective treatment for children's diarrhea may not be the sole issue preventing children in need from receiving zinc and ORS.

Ethical Considerations

Ethical approval for the CHAI surveys was obtained from the National Health Research Ethics Committee of Nigeria (NHREC). All PPMVs were provided information on the benefits and risks of the study and verbal informed consent was sought prior to the interviews. CHAI also obtained permission from each of the state governments.

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Figures and Tables

Figure 1 Percentage of the PPMVs with inventory of zinc & ORS for all the samples and for each state

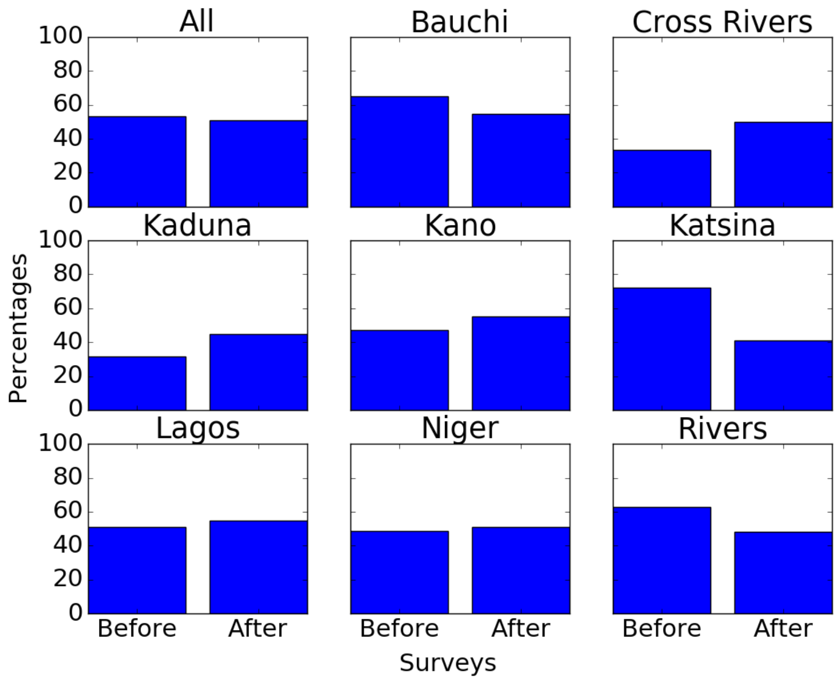

Figure 2 Percentage of the PPMVs with proper knowledge of the best treatment for children's diarrhea for all the samples and for each state

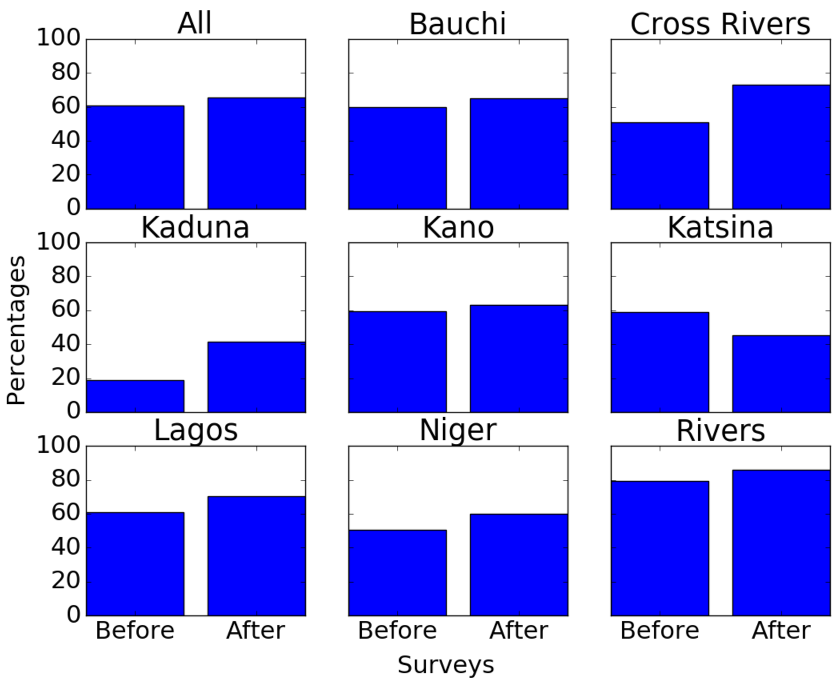

Table 1 Basic statistics of the surveys

	Surveys	*# Samples*	*States Covered*	*Survey Date Ranges*
Before Detailing	2015 3rd Quarter	3777	All (Bauchi, Cross Rivers, Kaduna, Kano, Katsina, Lagos, Niger, Rivers)	7/10/15 – 7/30/15
After Detailing	2015 4th Quarter	2675	Kano, Lagos, Rivers	11/20/15 – 12/22/15
	2016 1st Quarter	1907	Bauchi, Cross Rivers, Kaduna, Katsina, Niger	1/30/16 – 2/23/16

Table 2 Features of interest and their associated survey questions

No.	*Type*	*Names*	*Descriptions*	*Survey Question Associated*	*Choices*
CP1	-	Co-packs	Presence of co-packs of zinc and ORS in PPMV inventory	Do you have a medication in stock today whereby ORS and Zinc are co-packaged?	Binary: Yes/No
ZN1	-	Zinc	Presence of zinc in PPMV inventory	Do you have any ZINC tablets for treating diarrhea in stock today?	Binary: Yes/No
OR1	-	ORS	Presence of ORS in PPMV inventory	Do you have any Oral Drip or ORS in stock today?	Binary: Yes/No
-	Response Variable	Zinc & ORS	Presence of Co-packs or both Zinc and ORS in PPMV inventory	Combination of results from the three questions above	-
KA1	Response Variable	Knowledge	PPMV knowledge of the best treatment for children's diarrhea	What treatments would you recommend to treat a child with diarrhea/stooling?	Binary: Yes/No
ME8	Independent Variable	Detailing	Detailed in the past month	In the last month, were you visited by anyone promoting ORS and Zinc?	Binary: Yes/No
OC7	Confounding Factor	Degree	Health-related qualifications of PPMV workers	Does anyone working in this place, including yourself (and the owner) have a health-related qualification?	Binary: Yes/No
ID5	Confounding Factor	Sector	Location of PPMV (urban or rural area)	-	Binary: Urban/Rural
OC9(A)	Confounding Factor	Training	Received diarrhea treatment related training in the past 3 years	During the past 3 years, have you received any training on diarrhea treatment?	Multiple: Yes, within 1 year; Yes, 2-3 years ago; No

Table 3 Proportional z-tests for percentage change of inventory of zinc and ORS for (i) each of the eight states included in the study and (ii) combined results across all eight states included in the study. The ** symbol indicates significant result.

	All	Bauchi	Cross Rivers	Kaduna	Kano	Katsina	Lagos	Niger	Rivers
Differences (p_{after} - p_{before})	-2.41	-10.68	16.23	13.09	7.89	-31.29	3.59	2.26	14.62
P-values	0.986	0.999	0.001**	0.000**	0.000**	1.000	0.106	0.279	1.000

Table 4 Proportional z-tests for percentage change of the PPMVs with proper knowledge of the best treatment for children's diarrhea for (i) each of the eight states included in the study and (ii) combined results across all eight states included in the study. The ** and * symbols indicate significant and marginally significant results, respectively.

	All	Bauchi	Cross Rivers	Kaduna	Kano	Katsina	Lagos	Niger	Rivers
Differences (p_{after} - p_{before})	4.89	5.35	22.49	22.48	3.52	-13.95	9.60	9.56	6.64
P-values	0.000**	0.058*	0.000**	0.000**	0.064*	0.997	0.000**	0.007**	0.000**

Table 5 Logistic regression model estimates for inventory of zinc & ORS associated with the peer detailing. C.I. refers to confidence interval. Referent indicates the reference level categorical factors with multiple choices.

Factors	Unadjusted			Adjusted		
	Odds Ratio	95% C. I.	P-value	Odds Ratio	95% C. I.	P-value
Detailing	1.998	(1.756, 2.270)	0.000	1.694	(1.478, 1.941)	0.000
Degree	1.829	(1.626, 2.056)	0.000	1.418	(1.252, 1.606)	0.000
Sector: Urban	1.487	(1.320, 1.675)	0.000	1.507	(1.330, 1.707)	0.000
Training: < 1 yr	Referent	-	-	Referent	-	-
Training: 2-3 yrs	1.153	(0.979, 1.357)	0.088	1.207	(1.022, 1.425)	0.027
Training: None	0.505	(0.442, 0.576)	0.000	0.622	(0.541, 0.716)	0.000

Table 6 Logistic regression model estimates for proper knowledge of the best treatment for children's diarrhea associated with the peer detailing. C.I. refers to confidence interval. Referent indicates the reference level categorical factors with multiple choices.

Factors	Unadjusted			Adjusted		
	Odds Ratio	95% C. I.	P-value	Odds Ratio	95% C. I.	P-value
Detailing	2.497	(2.158, 2.889)	0.000	1.861	(1.597, 2.173)	0.000
Degree	1.910	(1.689, 2.162)	0.000	1.306	(1.142, 1.493)	0.000
Sector: Urban	1.306	(1.154, 1.478)	0.000	1.318	(1.153, 1.507)	0.000
Training: < 1 yr	Referent	-	-	Referent	-	-
Training: 2-3 yrs	0.766	(0.638, 0.919)	0.004	0.796	(0.662, 0.958)	0.016
Training: None	0.330	(0.285, 0.381)	0.000	0.448	(0.385, 0.522)	0.000

Table 7 Logistic regression model estimates for inventory and proper knowledge of the best treatment for children's diarrhea associated with the peer detailing interacted with training history. C.I. refers to confidence interval. The * symbol indicates interaction terms. Referent indicates the reference level categorical factors with multiple choices.

Factors	Inventory			Proper Knowledge		
	Odds Ratio	95% C. I.	P-value	Odds Ratio	95% C. I.	P-value
Detailing	1.802	(1.467, 2.217)	0.000	1.662	(1.313, 2.106)	0.000
Degree	1.274	(1.106, 1.467)	0.000	1.309	(1.142, 1.493)	0.000
Sector: Urban	1.446	(1.255, 1.478)	0.000	1.317	(1.151, 1.505)	0.000
Training: < 1 yr	Referent	-	-	Referent	-	-
Training: 2-3 yrs	0.931	(0.736, 1.669)	0.554	0.777	(0.621, 0.974)	0.029
Training: None	0.775	(0.640, 0.939)	0.009	0.419	(0.351, 0.500)	0.000
Detailing * < 1 yr	Referent	-	-	Referent	-	-
Detailing * 2-3 yrs	0.659	(0.458, 0.948)	0.025	1.059	(0.715, 1.567)	0.777
Detailing * None	0.723	(0.511, 1.023)	0.068	1.332	(0.936, 1.896)	0.111