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Can Intense Exposure to Hand-Washing and Hygiene Information Campaigns Affect Children's Socio-Emotional Skills?

Evidence from Senegal

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Abstract

Hygiene information and practices play a critical role in preventing diseases, particularly among children. Hygiene behaviors practiced in the household have been linked to development outcomes such as socio-emotional skills. This paper exploits data from impact evaluation surveys of a hygiene information campaign conducted in Senegal, where the randomized design suffered from contamination between comparison groups. The variations in exposure and intensity to hygiene information campaigns captured in the surveys were used to understand contamination biases. Such variations were interacted with the presence of household communication assets to explore potential effects on children's socio-emotional scores. In the presence of contamination biases, the study exploited the longitudinal sample of children in the surveys to reduce time-dependent biases. For robustness, statistical matching was applied between the impact evaluation surveys and Demographic and Health Surveys conducted in 2008 and 2011. Socio-emotional outcomes were the imputed into Demographic and Health surveys to expand sample sizes. By applying matching techniques and imputing outcomes into a larger sample, impacts were non-negligible. Double-difference estimates showed that children's socio-emotional scores were higher when intervention status was interacted with the presence of communication assets within households. Without the presence of communication assets in the households the impacts were close to zero. Evaluating the effect of hygiene campaigns on children's socio-emotional skills is challenging because of the biases from contamination that exist when information flows between comparison groups. Targeted hygiene information to the poorest households is relevant for reducing risks of recurrent infections and enables better conditions for socio-emotional development of children.

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Introduction

Over the last two decades access to safe water in developing countries has improved. Since 1990, 2.3 billion people have gained access to improved sources of drinking water and approximately 2 billion people gained access to improved sanitation (WHO/UNICEF, 2014; WHO/UNICEF, 2012). One important aspect about accessing water is its relation with hygienic practices, such as hand washing, which play an important role in the prevention of diseases (Liu et at., 2012; Bolt, 2005). In this sense, hand washing becomes a crucial preventative measure in the spread of illnesses, particularly among children. Studies in different parts of the world have shown that hand washing prevents infectious diseases, which are leading killers of young children (Center for Disease Control and Prevention, 2012; Luby et al., 2011; Talaat et al., 2011; Curtis and Cairncross, 2003). A study in Pakistan, for example, showed that intense hand washing among infants in low-income households decreased diarrhea and respiratory infections by 50 percent (Luby et al., 2004). Moreover, hygiene behaviors and hand washing have been associated with long-term outcomes of children, such as growth and biometric indicators that proxy for child health (Langford et al., 2011).

Hand-washing practices have also been shown to reduce incidents of other diseases, particularly pneumonia (Rabie and Curtis, 2006), trachoma (Stocks et al., 2014), scabies, skin and eye infections (UNICEF 2014). This essential behavior improves the health and well-being of millions of children living in poverty, not only by reducing their chances of mortality, but also by favorably increasing their likelihood of future socioeconomic success (Eppig et al., 2010; Heckman and Carneiro, 2003). Economists often refer to these benefits as externalities. For instance, some studies have estimated the link between water, sanitation, health, cognitive and socio-emotional development, and their spillovers (Bhalotra and Venkataramani, 2012; Walker et al., 2007). Using state variation in diarrhea reduction, a study in Mexico evaluating the implementation of clean water found that early childhood infections drive cognitive and socio-emotional skills and academic achievement (Bhalotta et al. 2012). Another study conducted in rural India estimates two sources of externalities related to sanitation infrastructure, (1) when households move from open defecation to fixed-point or improved sanitation, and (2) the benefit to a neighbor from the spillover produced by neighbor's access to a fixed-point or

improved sanitation. Using a district-level household survey (2007-2008), the authors found significant direct benefits and concave positive externalities[1] for both improved sanitation and fixed-point defecation (Andres et al., 2014). Few studies have thus explored the link between handwashing and cognitive development. However Bowen et al (2012) use developmental quotients and children's growth as outcomes to measure the effect of a handwashing campaign, joined to a water disinfection intervention.

While recent studies demonstrate the direct effect of childhood infections on cognitive test scores (Venkataramani 2012), to our knowledge, no prior study has yet estimated the effects of hygiene and hand-washing information on socio-emotional skills of children. Considering the importance of health in childhood as a crucial factor for the development of cognitive and other critical abilities (Heckman 2008), this paper estimates the effects of intensified hand-washing information (through the presence of communication assets in the household) may influence cognitive development of children.

From the time the child is born until age four, the brain is not fully developed and an extended period of postnatal maturation is still occurring. For this reason, governmental and parental interventions are crucial for the child's cognitive and socio-emotional development, as well as the environmental conditions the child is exposed to. Employing Impact Evaluation Surveys collected by the Water and Sanitation Program (WSP) in Senegal, which administered a battery of communication, motor, and socio-emotional tests on infants, this study examines the potential effects of hand-washing interventions through the change in health behavior and parental awareness about their children's development.

The causal links between health or hygiene information and better developmental outcomes of children are based on evidence produced over the last few years (Conti and Heckman, 2010; Conti, et al., 2010). Some studies have shown that reducing the incidence of diarrhea, through delivering intensified hygiene information, affects mostly

[1] The relationship shows positive slopes between fixed-point open defecation and diarrhea prevalence with an increasing slope as open-defecation rates increase.

poor children. Children below 5 years old whose parents were exposed to intense handwashing, hygiene and sanitation information campaigns improved their development and socio-emotional scores, when they were 5–7 years old. These findings suggest that handwashing and hygiene promotion could be an important strategy for improving children's long-term welfare (Oberhelman et at., 1998; Bowen et al., 2012; Lancet, 2011). Similarly, other economic studies have shown that 40 percent of early deaths are caused by behavioral patterns, so targeting prevention through information is efficient and productive to reach these outcomes. Adequate health practices and caregiving time early on in children, from birth to age 5, are forms of preventive health and economic investments that drive cognitive improvements and future economic returns (McGinnis et al., 2002; Conti and Heckman, 2010).

For the purpose of this study, we explore the variation in exposure to sanitation information campaigns coupled with certain communication assets present in the household. Specifically, the differences of assets' ownership across households are used as proxy means to spread information within the household. Assets such as television, radio, and VCR/PC are considered. These assets may interact with the presence of hygiene and handwashing information campaigns which ultimately may have effects on parents' behavior and children's socio-emotional outcomes. Campaigns delivered through various interventions were captured in survey data, with the following characterization: 1) the exposure to a hygiene and sanitation information campaign with different levels of intensity[2], 2) ownership of communication assets in the household may be related to households' wealth but also to investment decisions made by household members, and 3) communication assets in the household affect directly the communication and socio-emotional skills of patents and, thus, their children. Under this profile of intervention, other similar interventions took place in treatment and control communities which equalized the exposure of basic information between groups, but the variation lies on the intensity of exposure to information campaigns of treated localities.

[2] Exposure to all information campaigns available provides exogenous variation to socio-emotional outcomes. Interaction between the exogenous variation of exposure and the presence of certain communication assets in the household may provide the attributed effect of the campaigns, with intrinsic sources of bias.

Context

Poor hygiene and recurrent disease have detrimental effects on adults, but it is important to emphasize why children are more vulnerable than adults. It is primarily the rapid development of the brain and cognitive functions in early years that make children suffer most in the presence of recurrent disease and poor hygiene. Young children's development is especially sensitive to negative effects such as early under nutrition, deprivation of care, and illness. Walker et al. (2007) estimated that at least 200 million children under the age of 5 fail to reach their potential in cognitive and socio emotional development. The number of affected children is calculated based on the prevalence of early childhood disease, stunting and the number of people living in absolute poverty as indicators of poor development. Poor sanitation and hygiene become an important source of disease and under nutrition among children.

Many studies have confirmed that poor hygiene behavior and inadequate sanitary conditions are key contributors to a number of infectious diseases in developing countries (Vivas et al. 2010). In this respect, young children are the most defenseless, as their immune systems have limited exposure to morbid conditions, and their hygiene behaviors are more likely to be careless. Located in West Africa, Senegal is a country with a population of approximately 14 million inhabitants, of which about 45 percent were reported to be under the age of 14 years in 2012 (World DataBank). Anecdotal evidence suggests that Senegalese are likely to share and ingest food using their hand due to cultural and social norms[3]. In fact, a study conducted in Sub-Saharan Africa that included Senegal, revealed that only 17 percent of the participants washed their hands with soap after using the toilet (Vivas et al., 2010). Lacking appropriate hygiene habits are likely to have negative health consequences, which might not only be experienced right away, but may manifest in the future.

When parents and caregivers of children have low exposure to critical hygiene and sanitation information, outcomes of children can be affected: recurrent episodes of

[3] The fecal-oral route is the main mode of transmission of intestinal parasites like *Blastocystis* and other gastrointestinal parasites, that affect predominantly children (Tan, 2008). Also, Senegal has the highest prevalence of *Blastocystis* in the world, based on El Safadi et al. (2014).

diarrhea lead to poor absorption of nutrients particularly for children at early ages, which can in turn cause growth faltering and reduced socio-emotional development in the longer term (Victora et al., 2008).

Program Description

The hand washing campaign programs in Senegal started with a nationally aired television and radio spots, education-entertainment events in market places, and small-group discussions conducted with women's associations and in the waiting rooms of health centers. This first phase of the hand washing promotion by the government was nationally implemented and all households were exposed to this campaign. In the second phase, the promotion campaigns were delivered in a 10-month communications campaign rolled out in 7 of Senegal's 11 regions[4]. The second phase had three large components: Local Communications Campaigns (LCC), Direct Communication Contact (DCC)—to stimulate hand washing behavior using an *entertainment-education* approach—and an Inter-Personal Communication (IPC) campaign—that was conducted at the household level and focused on influencing other hand washing determinants, such as beliefs or skills for which mass media was less suited.

The target population for the second phase included mothers and other caregivers aged 14 to 49, and children up to 13 years of age living in urban and rural areas. In order to measure the health and development impacts of the second phase of the campaigns, an Impact Evaluation was designed with an experimental approach. For simplicity, the treatment consists of all information campaigns delivered (exposed) to communities: mainly local mass media campaign, DCC and IPC activities[5]. The control group received only the less intense and limited mass media campaigns.

[4] Administratively, Senegal has 11 regions, (7 covered by WSP campaigns), with 34 departments and 430 localities. In rural areas such localities can be subdivided in villages or communities. The National Statistic Office divides the country for census purposes in census districts named *District de Recensement* (DR) which were also considered in the sampling strategy of the IE surveys to gain external validity in rural areas. The DRs were used as the unit of clustering the sample of the study.

[5] Other programs outside of WSP—run by the Ministry of Health and UNICEF in 2011—also contained elements of handwashing promotion through community events and household visits, and they implemented these activities in regions where data was collected for this impact evaluation. These other programs do not have documentation on the specific localities (communes and rural communities) where they implemented their activities, but it is possible that they covered control areas to the same extent that WSP-sponsored activities

The design of the mass media strategy focused on national and local channels of communication and included conventional media outlets such as local radio and TV, as well as billboards and other non-traditional and popular channels as well. Local DCC and IPC activities were rolled out in overlapping districts of the mass media communication campaigns and consisted of localized entertainment education and other entertaining events in roads, market places and schools, as well as visits to households, health centers and women's groups. DCC & IPC activities were implemented in localities in urban and rural areas, randomly assigned among locality clusters.

The impact evaluation surveys conducted at baseline and follow up showed that recall of exposure to program elements is the same in treatment and control clusters, perhaps because of contamination between groups induced by the national mass-media hand washing campaign. Nevertheless, the rich data collected in the survey can be used to explore certain drivers and determinants of cognitive and socio-emotional development of children which, combined with DCC and IPC campaign program's components, can shed light into those mechanisms that can make hygiene and behavioral change campaigns more effective. Thus, these linkages can contribute to better understanding of the conditions within households through which sanitation and hygiene information campaigns help induce changes in these important long-term indicators of early childhood development.

Program Evaluation Design

In order to establish a causal linkage between handwashing and hygiene behaviors (treatment) and socio-emotional development (outcome), a counterfactual is required. That is, a group of comparison is needed to analyze what would happen to the target group in the absence of the intervention. A randomized experimental evaluation reduces the possibility that observed changes in outcomes of the intervention group are due to endogenous factors. This process ensures a robust counterfactual measure of the causal

covered treatment areas. Therefore, the definition of the treatment of information campaigns refers to the intensity of those campaigns independently of the implementing agency that provided such information in treatment areas.

effect of the intervention. As mentioned, the intervention consisted of two components; one component was applied to the general population, and the second component was an intensified[6] campaign based on the program's target population (the treatment group). The intervention was the hand washing promotion via multiple communication channels. These included a local campaign carried out by television, radio broadcast, and billboards combined with the promotion of handwashing in a direct approach with consumer and interpersonal communication at the household level. However, due to substantial information exchange between households in the control and treatment clusters, the recall of exposure to basic hygiene elements was similar in treatment and control clusters. Thus the random assignment to treatment suffered from contamination between comparison groups which ultimately bias the identification of impacts. Still, given the exogenous variation between asset tenure and program outcomes it is possible to explore how the combination between exposure to the program (different intensity) and communication assets can lead to shifts in child development outcomes[7]. A main caveat of exploiting the data under this approach is that the marginal impacts of the two different hygiene information campaigns cannot be identified. Under this approach, the main assumption is that the presence of communication assets in the households ultimately facilitates the delivery of hygiene and sanitation messages and information contained in the hygiene campaigns.

[6] Intensified campaign based on direct consumer contact events such as road shows, dramas, games, and street parades directed to engage and interact with caregivers and children to stimulate handwashing behavior; and interpersonal communication activities conducted one-on-one at the household level to convince caregivers to set up designated areas for handwashing with soap and water and influence other handwashing determinants such as beliefs or skills.

[7] In the Impact Evaluation surveys, there are no significant differences shown between comparison groups for most health outcomes. This may be due to recall bias. Recall bias represents a major threat to the internal validity of studies using self-reported data. It arises with the tendency of individuals to report past health events in a manner that is different between the two comparison groups. This pattern of recall errors can lead to differential misclassification of the related variable among individuals with a subsequent distortion of outcome measures. Conversely, socio-emotional tests collected are less ambiguous and show reduced recall bias because tests are applied directly to children and caregivers, the former being in direct contact with tested children.

Sampling Framework and Random Assignment of the Program

The sampling framework included three stages. In the first stage, the *collectivités locales* (*urban and rural communes*) were selected. The selection of *collectivités locales* was drawn from the universe of urban communes and *communautés rurales* included in the four selected regions. Two *collectivités locales*—Commune de Thiès and Touba Mosquée—were excluded from the sampling universe for being larger than the rest (Touba Mosquée was close to 500,000 residents and Commune de Thiès was around 250,000 residents; the population of the next seven largest cities was between 171,000 and 113,000); from the remaining list there was a random selection from the largest *collectivités locales.* The second stage involved sample cluster selection. The selection of clusters or Census Districts was drawn from the universe of clusters. The last stage of the sampling framework involved household selection. The selection of households was randomly drawn among all households within the selected clusters that had at least one child less than two years of age, and was proportional to the number of households per cluster.

The randomized assignment of *comunes* was done at the locality level, and it included 110 urban and rural (cluster) *villages* randomly selected (55 for treatment and 55 for control) among eligible *localites* distributed across 7 of the 11 regions of Senegal. The evaluation design objective was to test whether handwashing behavior can be improved among the poor through the use of promotional strategies, and assess the effectiveness of the program at improving the health of the population at risk of diarrhea, and incidence of sanitation-related diseases. The program targeted a population of mothers and other caregivers between the ages of 19-49 and infants up to 13 years of age, living in urban and rural areas of the country, with the main objective of delivering the information campaign and hygiene promotion contents to the "stewards" of child health within the household.

While the intervention was designed to improve the health and hygiene practices of the treatment population, the intervention also collected data on children's health and mental development. Taking this information, children's mental development was

analyzed using the data collected during the program. Hygiene practices within the household may impact child's mental development through different channels, such as nutrition, health, and high-quality supportive environments. The last channel includes mothers' behavior on health and nutrition, as these factors make mothers more responsive with the child's environment and his/her cognitive and socio-emotional development.

Potential Sources of Biases

The randomized experiment may be biased due to contamination of the control units and the impossibility of separating the treatment effects of both arms, the national campaign versus DCC and IPC campaigns. Clearly, because multiple hygiene and sanitation campaigns were delivered to households and communities in both comparison groups, in a relatively short period of time, there could be contamination in the randomized assignment. Also there could be *ascertainment biases* occurring when household members report outcomes that can have some sort of measurement error, such as knowledge, attitudes, and health information. Reporting knowledge about behaviors and attitudes tends to increase the ascertainment bias, which ultimately may drive part of the effect of the program. Also, *courtesy biases* can be present because survey work and the intervention rollout made it impossible to blind participants to their treatment status; for the follow up survey the interviewers were blinded to the intervention in each community in order to minimize this potential source of bias.

Data and Descriptive Statistics

Data

The data were gathered through three different stages: *a baseline survey*, a *longitudinal survey*, and a *post -intervention survey*, all of which were collected from a representative sample of the target population living in the four regions designated for the study. *The baseline survey* was collected before the intervention and conducted from June through August 2009. The data was finally collected from about 1,150 households in 110 clusters within eligible *urban and rural communautés*. This survey consisted of household, health, and community questionnaires, structured observations, and stool samples. *The longitudinal surveys* were collected in three time periods before the

intervention, and in three times, as a monitoring survey, after the intervention started. *The post-intervention follow up survey* was conducted in early 2011, and it collected, in great part, the outcomes collected in the baseline survey.

The survey reported an average of 70% of households with improved access to water and sanitation, but improved access among poorest households was just over 36%. The poor rely mainly on unprotected wells for water sources. Also, more than half of the poorest households practice open defecation, while the largest majority of non-poor households have access to improved sanitation. Access to improved water sources and improved sanitation varies significantly among regions; Fatick is the least privileged of the regions.

Diarrhea, Nutrition and Acute Respiratory Infections (ALRI) Indicators

Survey data showed that one in every 10 children had diarrhea symptoms in the previous 14 days. ALRI symptoms were reported only in 2.3% of the households. Diarrhea symptoms were lower among those households with access to a facility for handwashing with soap and water. Diarrhea and ALRI do not seem to be correlated with income; however surveys showed considerable regional differences. Anemia prevalence is observed in the majority of households, and does not seem to be highly correlated with income. Moreover, households without access to a facility for washing hands stocked with soap and water, without access to improved water, or without access to improved sanitation showed more hours devoted to care for child illnesses and have slightly higher anemia prevalence.

Children in poorer households were less likely to receive nutritional supplements such as vitamin A or iron pills. Nearly 13% of children in poor households reported underweight, and almost 20% reported stunted growth. Children among households with a designated place for handwashing with soap and water reported slightly lower levels of malnourishment.

Socio-Emotional Instruments and Scores

The collection of socio-emotional indicators was based on the Age and Stages Questionnaire (ASQ)[8] which covers a comprehensive list of growing indicators for children between 4 and 24 months of age. The subscales applied through the impact evaluation surveys included communication, gross motor and social-personal skills. The questionnaires were divided into two- to three-month age intervals for use with children 4-24 months of age. Scores are normed to indicate whether children are developing appropriately according to their age based on statistically standardized transformation to compare how far children are from the normal developmental thresholds. The ASQ-3 results in a score (out of 60) for each area (communication, gross motor, and personal-social skills) and these are compared to cut-off points on the scoring sheet. Scores beneath the cut-off points indicate a child may not be developing fully according to his or her age; scores near the cut-off points call for monitoring development stages; and scores above the cut-off suggest the child is on track developmentally.

The structure of the questionnaire first identifies eligible children for the ASQ questions, including age, presence of any type of developmental disorder or disease, and caregiving responsibilities. Once the subgroup of eligible children was identified, the modules were split according to the age of children. For the youngest children (ages 4-6 months), communication skills collected basic individual communications behaviors or expressions prevalent at children's age, including phonetic means of communication; for gross-motor skills of this age cohort caregivers are asked to provide basic movements done by children in particular situations and then corroborated with actual situations to replicate such behaviors; finally social-personal skills collected data based on child's reactions to personal stimuli or social environments.

As the age cohort of children progresses the types of questions becomes more elaborated to capture developmental stages according to current reported age. For the highest age cohort (22-24 months of age) the communications questions focused on

[8] ASQ is a standardized cognitive and socioemotional tests applied in most countries in the World to assess children's development. For more information see ASQ3-Guidelines, Materials and Methods. by Jane Squires, Jane Farrell, Jantina Clifford, Suzanne Yockelson, and Elizabeth Twombly Paul H. Brookes Publishing Co.

identifying the combination of words that a child uses to express ideas or feelings; for the gross-motor skills caregivers are asked how children interact with objects to conduct every day activities, including playing and leisure. These activities reflect the coordination and range of movements performed by children at this age for various activities. Finally personal-social skills for this age cohort are more complex in the sense that caregivers are asked how children interact with toys, people or social situations. Empathy of objects and people at this stage is critical to understand how the child is evolving socially and with his or her personal interactions.

The collection of ASQ scores was intended to measure behavioral trajectories and competence in relation to children's age. Such scores are meaningful to analyze when comparing growth and development with other related socio-economic indicators of the household and the caregiving activities at critical ages. These indicators may also quantify and approximate the quality of caregiver-child interaction, and the lack of learning opportunities (stimulation) as outcomes.

Treatment Group Balance and Summary Statistics

We first analyze indicators of the sample of children in the follow up cohort assuming equal expectation, as the treatment and control groups were equally likely to be selected at the baseline through the randomization process. Table 1 displays the descriptive statistics of the baseline and follow up cohorts, before and after the treatment following the same children in the baseline after the intervention. The baseline side of the table reveals there is no difference between the control and the treatment group in most of the variables accounted for. However, the variables TV, VCR, and Communication Skills produced coefficients that suggest that there is, in fact, a difference between the treatment and the control group. This difference is statistically significant at the 99 percent level for the first and second variables, and statistically significant at the 95 percent level for the third variable. In other words, the difference between the experiment group and the control group might be due to the difference in families' assets that exists between the two groups prior to the experiment, even without observed differences in income levels between groups (Table 1). Because these statistics are based on longitudinal data, the statistical test estimators that measure the existence of differences between comparison groups are more efficient compared to using cross sectional data to estimate the statistical

differences with the same number and pattern of observations. Table 1 shows similar results than those of the baseline side. Here again, more of the control variables show no difference between the control and the experiment group, except for those mentioned above. The results are similar to those found in the original project report summary statistics. While income per capita are, on average, the same for both groups, having TV or VCR, assets that are associated in theory with wealth, are statistically different for both groups.

Table 1a shows the differences in characteristics between comparison groups for the full longitudinal sample and the longitudinal sample with follow up attrition. It is important to highlight if these differences in the main outcome indicators prevail or if they shift drastically. If attrition occurs due to random circumstances, there could still be a balance of characteristics in the initial sample of children belonging to the treatment and control groups. The only consequence of attrition would be a reduced statistical power of the surveys. If these imbalances are pronounced in the presence of attrition, most likely the attrition would be highly correlated with the treatment status which could ultimately bias the estimates. In general, the results in this table point towards attrition explained randomly rather than by a factor intrinsically related to the treatment status. This is why most indicators show similar differences between the full longitudinal sample and the sample with attrition.

Furthermore, the survey questions *days with fever*, and *days with stomach pain* also yielded statistically significant coefficients, without considering asset tenure to receive campaigns' information. This can be interpreted that health related symptoms are also different for both groups, with better health symptoms experienced by the infants in the treatment group than by infants in the control group. Exploring the differences in cognitive skills between groups using panel data and adjusting estimates based on certain communications assets within the household shed light on the determinants of the changes in cognitive abilities of children in the presence of the communication campaign interventions.

Table 2 presents the descriptive statistics of the follow up cohort. That is, the table shows the means of the independent variables to test whether the outcome of health

diseases related to water sanitation are the same for both groups. The coefficients of almost half of the variables show that the treatment and the control groups are different in the follow up survey. Parental education, for example, shows statistically significant differences for the treatment and control groups. Separately, mother's education yielded a statistically significant coefficient (0.16) as well as father's education between comparison groups. The tenure of some durable goods in the household we used as a proxy for assets that helped conveying information from different types of hygiene and sanitation campaigns (such as TV, radio and VCR). The presence of such assets in the household implies that children whose parents have means to intense exposure of hygiene campaigns might have better information. Furthermore, for two types of cognitive skills of children (communication skills and motor skills) there are statistically significant differences between groups. Although the causal attribution cannot be induced entirely due to the nature of the contamination between groups, there could be a relevant pass-through of information from the campaigns in the presence of certain assets in the households. Without considering asset tenure, one would infer, based on Table 1, that the treatment had a negative impact on child development of 0.16 of one standard deviation in communication development skills, and of 0.18 of one standard deviation in motor development.

These results suggest that households with equal purchasing power levels might prefer to invest in different house assets. Those who chose to invest more in these types of assets may be able to better inform themselves and access information campaigns effectively. This, in turn, increases their exposure rate level to the intervention. Previous results from studies did not weigh and control for income differences, though there are studies that employ proxies, and they show differences in income levels and access to assets between the groups (Xuan and Hoat, 2013; Sidibe and Curtis, 2007). For instance, Bhalotra and Venkataramani (2012) examined the impact of waterborne infections in infancy, which manifest primarily with the symptom of diarrhea, on cognitive outcomes among a sample of Mexican teenagers. They used proxies to control omitted variables resulting from wealth disparities between clusters of households in different states in Mexico. To cope with omitted variable bias, they included state's per capita GDP, and infant respiratory disease mortality rate (proxy for living standards and health

environment quality, respectively) interacted with pre- and post-intervention literacy rates and average years of schooling in order to estimate accurate impacts from water quality reforms.

Finally, for robustness checks a description of matching and outcome imputations between surveys is presented in the annex.

Econometric Framework and Identification

Using empirical design from a randomized experiment framework helps us to create homogenous groups in the observed and unobserved characteristics at the initial stage of the analysis. Consequently, this reduces bias and allows the greatest reliability and validity of statistical estimates of the treatment effect. To test for theoretical prediction, this paper estimates the differences between the control and treatment group, with a simplest model without the interaction between household assets and the diffused media component (treatment group). This follows the functional form:

$$score_{ih} = \beta_1 + \beta_2(treatment_{ih}) + \beta_3(InfoAssets_{ih}) + \beta_4(X_{ih}) + \in_{ih}$$

where $score_{is}$ is the test score[9] for individual *i* in household *h*. The variable $Treatment_{ih}$ is a dummy variable in which 1 indicates that the group received the second component. The coefficient, β_2, is of interest. This coefficient assesses the average treatment effect on three different dependent variables: *Communication developmen*t, *Motor development* and *social-emotional development*[10]. For interpretation purposes, we standardized the dependent variables coefficients to have a mean of zero and standard deviation of one.

[9] A cognitive assessment provides information about a child's intellectual strengths and weaknesses, as well as insight into her overall cognitive potential. The test gives general information about a child's abilities compared to others her age in several areas. The tests are intended to be a predictor of how well and in what ways a child will learn new information. The tests used are based on the ASQ-third edition test to assess cognitive development of children. It consists of three sections (communications, motor and social skills) where each section has 11 to 14 questions used to aggregate them in a single index for each cognitive component. Each index is then standardized in its distribution to allow comparability.

[10] Cognitive development refers to the progressive and continuous growth of perception, memory, imagination, conception, judgment, and reason. Cognition also involves the mental activities of comprehending information and the process of acquiring, organizing, remembering, and using knowledge (Owens, 2008; Nicolosi, Harryman, and Kresheck, 1989). Communication skills relate to the ability of children below 2 to 4 years old to process language effectively. Motor skills correspond to children development of movements. Motor skills can be hindered by the presence or incidence of disease in

Also, these scores are normalized in children's age. That is, the scores are adjusted on children who have the same age (in months). *InfoAssets$_{ih}$* is the variable that includes assets owned by individual *i* in household *h* through which they receive media information such as TV, Radio, VCR, and PC. The effects of these information assets are given by coefficient β_3. The variable *X* is a vector of household characteristics including income per capita, age of mother, age of mother, sex, and mother's education. Given that the localities and the households were assigned randomly to the treatment and control group, the groups are not balanced in some indicators, so performing a simple comparison of means might yield inconsistent and biased estimate of the causal average treatment effect. To correct for this problem, we employ the panel data to estimate the causal Average Treatment Effect. The Education Production Function is denoted as,

$$score_{ih} = \beta_1 + \beta_2(treatment_{ih}) + \beta_3(PostT_{ih}) * (IA_{ih}) + \beta_4(X_{ih}) + \in_{ih}$$

where $score_{ih}$ is the test score for individual *i* in household *h*. The variable $treatment_{ih}$ is a dummy variable (1 = group received intensified treatment, 0 = otherwise) that captures the difference between the control and treatment group. The variable, *PostTreatment (PostT)*, is the dummy variable (1= if area was under the intensified campaign at the moment of follow up, 0=otherwise) that captures the effect of the treatment after 2 years of the program. The average treatment effect of the program on these developmental skills is β_3, which is the coefficient of interest. *InfoAssetih* is the variable that includes information systems such as, TV, Radio, PC, and VCR owned by individual *i* in household *h* through which they receive media information. X is a vector of household characteristics described above.

The term ϵih represents the error term for individual *i* in household *h*. The regression method answers the following questions: Does hand-washing intervention (i) increase communication skills? (ii) increase motor skills? (iii) increase socio-emotional skills? (iv) does the initial imbalance of the information assets affect the treatment and therefore impact the control and treatment group equally? And if these initial imbalances are taken into consideration v) what is the program's net effect?

children at early ages. Social skills refer to when the child produce behaviors that elicit their environment and information transmitted by close family members or other means of information. For further review of these skills see (WHO, 2006).

Results

In order to analyze the change in socio-emotional development that can be attributed to the intervention interacted with the availability of information and communication assets in the household, two empirical approaches were employed. We first 1) estimated the effect of the hand washing program on children under 4 years of age, and then 2) estimated the effect of the program following the same children in the control and treatment group by taking advantage of the longitudinal data. The first empirical approach included all the children in the households two years after the program had initiated. We made the assumption of equal expectation, as all children were likely to be selected through randomization. The first empirical approach included household assets that can be utilized for any information consumption, including the second component of the sanitation and hygiene information campaigns. This should not affect either the coefficient of interest or its significance. The second empirical approach included children from 0 to 2 years of age at the baseline. This approach takes into account initial differences between the infants in the control and treatment group. In this case, the inclusion of household assets related to mass media provision should not change either the significance or the magnitude of the coefficient of interest.

Developmental stages of children are related with age, disease incidence and caregiving, the last two partially related to positive behaviors of hygiene within the households. A graphical analysis of developmental skills and age between the treatment and control depicts the differences in skills in the presence of the program at different ages of children.

Follow-up Graphical Analysis of Socio-emotional Scores[11]

Figure 1 shows the relationship between the communication development of the children after the treatment for the control and treatment groups. It is observed that at early ages in both groups children begin and follow different paths in the acquisition of communication skills. While infants in the control group begin at a greater advantage, as they grow older, however, this upper hand advantage sharply decreases and continues to fall thereafter at a constant rate. In contrast, children in the treatment group, while they start at a less favorable point, experienced a marked increase (except for months 12 to 15) in communication skills development. In other words, scores in communication skills converge, for both groups, at early ages up to 24 months. This suggests that children who were older when they receive the treatment (month 25 to 35) might be affected at a higher degree by the treatment than younger children. It can be inferred then that exposure to hygiene information at an early age shifts communication skills needed for habit formation and behavioral change.

Figure 2 depicts the story for motor skills. Here too the control and treatment group start at different junctures but children below 24 months old where not exposed to the program, with the control group possessing higher Motor skills than the treatment group. The largest differences are seen at early ages. Although this difference narrows, as children grow older, the gap remains and even widens again at a later point. Figure 2 suggests that providing health and sanitary information to households might be important in developing motor skills, which are key abilities for children long lasting welfare. However, unlike communication skills convergence between groups exposed to the program (25 to 35 months old) does not manifest, only a closing gap trend is shown between motor scores.

Figure 3 shows the relationship between social-emotional skills and handwashing program. The effects are heterogeneous depending on children's age. Social skills show

[11] For each item, a caregiver responds "Not yet", "Sometimes", "Yes". These three responses are scored 0, 5, and 10. A child's ASQ score is the sum of all items in each domain (communication, gross motor, personal-social). Within each age group, we also calculated Z-scores, defined as the mean divided by the standard deviation within each age group. We assigned missing scores for a given domain to children who did not complete the item set for that domain.

differences between treatment and control between 10 and 35 months of age. Nevertheless, children in the control group between 10 and 23 months of age do much better than those in the treatment group, but those in the treatment group older than 24 months of age outperform their counterparts in the control group.

Differences in socio-emotional scores between baseline and follow-up for comparison groups

Table 3 show the relationship between *Communication Skills* and *Handwashing Program* Model 1 shows that when no controls are included, the difference between the treatment and control is -0.160 and statistically significant at the 90 percent level. When controls are included in Model 2, the coefficient of interest shows that this difference remains statistically significant, though its value increases slightly to -0.149. The coefficient of interest drops again in Model 3, when the variable *Radio*, along with an interaction term, *Treatment*Radio*, are added to the model. This difference, however, is not statistically significant. While Model 4 produces similar results than that of Model 3, the variable, *TV*, has 0.27 standard deviation positive effect on children's *Communication Skills*. Even the interaction effect between TV and treatment status shows a positive, yet statistically insignificant, coefficient. Similar results are observed when we account for other home electronic devices, like VCR (or DVD), and PC in Model 5 and Model 6. Taking together, having home electronic devices, which are closely related to household wealth and the higher household valuation to acquire information, appears to have a significant and positive impact on infants' communication skills. Table 4 presents the relationship between *Handwashing* program and *Motor Skills*. Our coefficient of interest remains significant in all the models above, except in Model 3 and 4, suggesting there is a difference between the control and treatment group. Household possessing TV, VCR (or DVD), and PC show gains of 0.41, 0.22, and 0.52 in *Motor Skills*, respectively. Therefore, having home electronic devices, which reflects the family's wealth show once more to have an impact on children ability to execute movements effectively.

Table 5 presents the relationship between *Handwashing* and *Social Skills*. No difference is observed between the control and treatment group in any of the models. This is true even after adjusting for explanatory and interaction terms. The variables, *TV* and

VCR (or DVD), suggest that when households' possess these home electronic devices, the social skills of the children increase by 0.31and 0.22 standard deviations, respectively. This table also provides information as to how important household income is as a determinant of the development of infants' social skills. Due to the initial differences in the control and treatment group, we use differences in differences estimator with panel data. Employing this method increases precision in assessing the treatment's net effect.

Differences in Differences using panel data

Handwashing behavior

According to Table 6, the treatment group had lower hand washing habits than the control group at the beginning of the study. This means people did not wash their hands after using the toilet. The inclusion of controls should increase our precision, as they included household basic characteristics and socio-economic characteristics, including income, just as in previous models. It is observed, however, that there is not a significant variation of the coefficient of interest. The table also shows that the addition of household assets does not improve the hand washing practices of the treatment group. Both the control and treatment group decreased their handwashing behavior after the treatment. It is worth noting that TV and VCR appear to have positive impacts on handwashing behavior in the presence of the program. This suggests that information assets and wealth may drive hygienic behavior.

Panel data graphical analysis

Figure 4 shows the differences in *Communication Skills* between the baseline and follow up cohorts for those that reported handwashing in both baseline and follow up surveys. The differences in cohorts appear to be more pronounced at early stages of infancy, favoring the treatment group. It can also be observed that this difference begins to decrease and reverse favoring the control group steadily from ages 28 months old onwards.

Figure 5 shows the relationship between baseline and follow up Motor Skills scores for treatment and control groups that reported handwashing in both periods. . The graph indicates that the difference in motor skills between the baseline and follow up rounds change at different times in infancy. From ages 25 to about 34 months of age, for example, this difference favors the control group, but from 34 months old onwards, the children in treatment group experience a constant advantage, though the difference is less pronounced in motor skills over their counterparts in the control group.

In Figure 6 the Social Skills scores differences between the baseline and follow up cohort is observed for those who reported handwashing. Here too, the difference in social skills is mixed, with the treatment group having higher social skills in the beginning and then losing that advantage for a period of time, then later again experiencing a greater level in social skill development. Panel data provide a more accurate estimation on the impact of the treatment on cognition, as the same group of children is followed through time. As we observed, there appears to be no difference between the treatment and control groups.

Table 7 shows the difference in difference estimations using panel data with all communication/information assets included in one model for each cognitive skill test (communication, motor and social). The dependent variable in the first two columns is Children Communication skills. Column 1 shows the estimates for communication skills adjusting for control variables but without taking into account communication/information household assets. At the baseline, the treatment group appears to have started with a significant negative difference than did the control group at the baseline. However, this difference is not significant two years after the treatment (Interaction between the treatment and the follow up). Although the inclusion of the asset variables (TV, Radio, VCR, and PC) increase the coefficient of interest (from -0.13 to -.09), this increment is not significant. Moreover, the variables TV and PC display a positive and significant relation to the communication skills of children, producing an increase in of 0.20 and .22 (1/5) of one standard deviation, respectively.

While these two estimations (column 1 and 2) include income per capita as control variable, the results yielded by TV, Radio and VCR might reflect not only household wealth, but also might indicate household preferences in regards of owning and investing in these assets. In the case of motor skills and social-personal skills, column 3 and 4, the estimations present similar results. These results show that the treatment did not have much of an impact in the development of these skills. The initial differences in TV and VCR might have had an impact on the treatment. This suggests that both unobserved preferences such as possessing systems of information and wealth itself, seem to have an impact on cognitive skills development. One important aspect is to estimate if interacting each information/communication asset in the household with the exposure to treatment enhances or hinders the overall effect of the program on cognitive skills of children.

For this purpose the panel regressions are estimated with these above mentioned interactions for each communication skills. Table 8 shows six specifications that test the contribution of each information asset with the treatment and their effects on Communication Skills. With the exception of Model 3, the coefficients of interest are statistically significant across all models. These results suggest that there is a difference between the control and the treatment group, and that there is, in fact, an effect (at the 90 and 95 level of confidence) produced by the treatment for these motor skills in children. Since the treatment might have a different effect on the outcome depending on whether a household possesses a radio, we added an interaction term, *Treatment*Radio*. The coefficient of the interaction term suggests that the treatment impact depends, in part, on having a radio or not. In addition, just like in the non-panel data regression tables, the variables, TV, VCR (or DVD), and PC, also appear to have a positive and significant effect alone on helping children develop Communication Skills. The magnitude effect produced by these regressors is not trivial. They appear to be responsible for significantly increasing infants Communication Skills by 0.22, 0.20, and 0.47 standard deviations, in that order. The interaction term of the treatment and communication/information assets is positive and significant for TV and VCR with coefficients with a combined effect of 0.08 and 0.07 of one standard deviation in Communication Skills, respectively.

Table 9 shows that the relationship between Motor Skills and Handwashing program is the same for the control and the treatment group. In this table, again, some of the explanatory variables, TV, VCR (or DVD) and PC once more appear to have a positive and significant effect on helping children develop motor skills. The magnitude effect produced by these variables is not small. They explain 0.34, 0.29, and 0.67 standard deviations, respectively, in motor skill development at the 99 percent confidence level. In this case there are no combined effects between the information/communication asset and the treatment status as all interactions for each of these assets with the treatment dummy are not statistically significant.

Table 10 shows the results for social skills. Interestingly, the regressors TV, VCR (or DVD), and PC emerge again as factors having a positive and significant effect on developing children's social skills. The effect size yielded by these factors is nontrivial. They explain an increase of 0.28, 0.25, and 0.40 standard deviations, respectively, in Motor Skill development at the 99 percent confidence level. For the interaction term, only the treatment*radio interaction showed a positive and statistically significant coefficient of almost 1/3 of one standard deviation in the social skills scores of children. Radio is an asset that in this case portrays most effectively the messages contained in the hygiene promotion campaigns across households, resulting in the enhancement of these types of skills.

The household and individual effects of hygiene information and promotion on cognitive abilities of children may have externalities over other households with geographical proximity. For instance, recent research (Andres et al., 2014) shows that two sources of benefits related to sanitation infrastructure access on early childhood health: a direct benefit a household receives when moving from open to fixed-point defecation or from unimproved sanitation to improved sanitation, and an indirect benefit (externality) produced by the neighborhood's access to sanitation infrastructure.

As mentioned earlier in this paper, information is relevant to induce behavior change of individuals which in turn shifts their valuation towards certain household assets that can improve the wealth and wellbeing of its members. For example, Coffey (2014)

investigated that both open defecation and improved sanitation access are useful measures of sanitary environments to which a child ultimately is exposed. The greater the fraction of households that do not use a toilet, or that do defecate in the open, the greater the chance that a child comes into contact with germs or parasites. As children are exposed to disease, this may have implications for their cognitive abilities at early ages.

For the poorest households (first two quintiles), Figures 7, 8 and 9 show the association between average fitted values of communication, social and motor skills, respectively, and children's age; with and without *TV* asset present in the household. The fitted values and confidence intervals showed that there are higher averages for the poorest households with treatment status compared to control households. In most cases, as ages of children progress, there is even a flat or increasing curve of cognitive skills, with overall confidence intervals decreasing as age progresses. The importance of poverty status can give light into the importance of access to basic or improved sanitation in creating a disease environment that adversely affect nutritional status. Since the surveys also collect open defecation practices and improved sanitation access, it is important to show at which point the externalities of sanitation might be present. This is because when sanitation externalities are present there may be a higher induced behavior change than expected.

Figure 10 shows a negative relationship between improved sanitation and open defecation when the proportion of households in each of these indicators is aggregated by district/city level. The gap between the comparison groups shows that at the same level of open defecation, the treatment group may have higher access to improved sanitation, compared to the control group. After a district shows more than 40% open defecation the gap widens and it increases even more after each district reaches 65% open defecation rates. The increasing gap by treatment status may indicate the presence of externalities across households as those in the treatment group decide to have more access to improved sanitation compared to those without exposure to treatment.

Finally, Figure 11 shows a u-shaped relationship between handwashing and improved sanitation access, aggregated by district/city level. In this case externalities of

handwashing exist just at very high rates of improved sanitation coverage. In this case it is shown that improved sanitation access may drive much of the benefits of handwashing, but just at very high rates of access. Information campaigns may have externalities for those sets of household with different sanitation coverage levels and for different wealth cohorts. This may well be an area of further research.

Estimates for lowest-income quintiles

Final estimations were conducted in survey subsamples based on income quintiles. Panel data on children below 5 years old was used to determine whether low income versus higher income cohorts showed differentiated effects of all handwashing promotion programs and among different cognitive outcomes.

As explained earlier, because of contamination issues in some components of the program (treatment status) there could be potential bias driving results. However, the relative size of the effects of the interaction term between treatment exposure and asset tenure may highlight if effects are indeed differentiated according to the income cohort where households belong to.

Table 11 shows the results of these estimations[12]. Results for the effects variables and interaction were only statistically significant for communications and motor skills of children. In terms of communication skills, the interaction of the treatment status and the communications asset tenure in the household showed around 1/3 increase of one standard deviation in the communication scores of children for the lowest quintiles of income (I & II), and yet for higher income cohorts the interaction coefficients showed a progressive reduction in the effects (0.13 of one standard deviation for quintiles III and IV; and -0.008 of one standard deviation for quintile V). Although the magnitude of effects may contain some bias, there are indeed differences between income cohorts of the effects that program exposure and communication assets in the household have on developing communications cognitive skills in children.

[12] Only effects coefficients reported from quintile regressions of the full specification model. This full specification model included independent variables that control for parents education, other sources of income, and household basic characteristics.

For motor skills both program and interaction term coefficients are not statistically significant for any of the income subgroups. However, the trend is similar in the magnitude of the coefficients by income cohort: lowest quintiles of income show larger interaction effects compared to higher quintiles of income. This tendency reinforces the results for the communication skills trends. Although tenure of communications assets might be determined by income, these results show that even after contemplating income as an adjusting variable, households may be driven to purchase these types of assets because of the value added these may have in improving the cognitive development of children. These results may well also show that independently from parents' education, there is a tendency of lower income households to have communications assets because in some way they value this asset as an important channel to reinforce educational messages across children at early ages. Indeed these results show some evidence that early life information that produce health outcomes, shape also childhood cognitive skills.

Matching results

Table 12 summarizes the results of separate matching samples from DHS and IE surveys. All matched estimates used the same explanatory variables from the previously reported models[13]. For the PSM estimates the estimates between the longitudinal impact evaluation surveys and the imputed outcomes into DHS surveys is contrasting. The coefficients of the interaction effects (between the information campaigns and TV presence in the household), for the impact evaluation sample, are positive and significant for all socio-emotional scores (motor, communication and social). These interaction effects with the DHS matched samples are statistically insignificant yet with similar magnitudes in the coefficients. The heterogeneity of effects based on different samples indicates the presence of potential observed and unobserved biases. Nevertheless, the results from the imputed DHS samples are more precise since they entail matching of characteristics with larger samples. The value added of constructing counterfactuals based on statistical matching results in improving the balance of comparison groups,

[13] Only estimators of the interaction effect between communication assets and socio-emotional outcomes reported in the table.

particularly because of the presence of biases in the control group in the recall of information contained in intervened units (Table 13 and 14).

The balancing between treatment and control enhanced statistical inference through the application of other matching methods. Table 12 also shows the interaction effects using nearest neighbor and kernel matching, with the same imputation techniques on outcome variables into the DHS surveys. The results show that for the impact evaluation surveys the nearest neighbor and kernel estimations are statistically significant and positive for communication and motor skills with the presence of TV, radio and other communication assets. Yet, such effects are still low. However, with the imputed DHS surveys the results are predominantly statistically insignificant, but with similar levels of magnitude of the coefficients compared to those estimated with the impact evaluation surveys. Such results indicate that the presence of contamination in information transmission between comparison groups introduced biases in observed characteristics that could lead to overestimation of treatment effects.

Conclusions

Understanding hygiene promotion programs aimed at changing hygiene and sanitation behaviors and ultimately preventing diseases in developing countries is important for policy makers, practitioners, researchers, and societies as a whole. Furthermore, the relationship and pathways between hygiene promotion programs and children's mental development is little understood. To obtain a picture about the effectiveness of a hygiene information campaign program in Senegal, we used two rounds of an impact evaluation survey with possible sources of biases and contamination between comparison groups. Yet the data provided useful information to explore some pathways of hygiene information transmission across rural households and developmental outcomes of children. At early ages, children's cognitive development is observed through a wide range of behaviors and skills. However, poor hygiene and inadequate sanitation will potentially prevent children from developing these developmental foundations, particularly when they face recurrent disease and children's caregivers provide poor hygiene practices. In this respect, infants from low-income

families are more susceptible to face these conditions as they often lack the environment conducive to learning and caregiving necessary for proper hygiene.

The relevant nuances of hygiene information campaigns are found on the frequency and quality of information, and the means used to spread such information, but the program design and impact evaluation data did not permit identifying such nuances. Nevertheless there is some recent evidence on this issue. Regassa et al. (2011) found that both the educational status of the caregivers (or head of household) and the direct contact with health extension workers significantly affect the utilization decision of sanitation and hygiene information by rural households. However, little evidence exists on how different types of information campaigns (e.g. personalized, mass media, or a mix of both) can have differentiated impacts on households receiving hygiene or sanitation information, and subsequently how children's caregivers within households provide adequate hygiene to children. Some information campaigns are designed to rely on the *means of communication* to boost the effect of information on households. Different designs of campaigns thus attain different objectives according to the means of information transmission outside and inside the household.

This paper relates the timing of a hand washing intervention and the influence it can have on a child's cognitive and socio-emotional development during the first five years of his or her life. Taking advantage of an experimental intervention conducted in Senegal, this study estimated the impact of hand washing on cognitive development of young children. The evidence cannot reject the possibility that there is a relationship between hand washing and the developmental skills of the intervened children. However, the differences at the baseline between treatment and control groups on socio-emotional scores of children are influenced by both household communication assets and contamination in random assignment of program components. Also, significant differences in hand washing behaviors are explained by both the presence of certain communications assets within households and potential contamination biases. Still there is still room to conduct further research that addresses developmental skills driven by household choices or preferences. The existing household differences in communication assets tenure, independently of household income, and its interaction with handwashing promotion campaigns and behavior change confirm that the equal expectation assumption

was not fulfilled at baseline.

Both comparison groups, the control and treatment, were intervened by the media coverage (the first component of the treatment) amplifying the differences in hand washing behavior prior to the second intervention. The combination of the program and these types of assets in the household might also have the potential to impact the cognitive development in three ways: 1) the first component of the intervention, mass media hand washing campaign, could have an effect on the way the second component of the evaluation was implemented, and consequently, exposed the control and treatment groups to rather different hygiene information, 2) communication assets at home might indicate differences in household wealth but also household investment preferences, and 3) it is reasonable to state that communications asset tenure at least indirectly affects the communication and socio-emotional skills of the child. Considering the aforementioned aspects, the causal effect of the treatment on children's cognitive development is not straightforward and requires further investigation[14]. Also, the evidence shows no significant difference between these skills on children in households with the same wealth levels but it does show effects across different information assets after the intervention; there were, however, significant differences in these outcomes at the baseline.

Furthermore, looking at the follow up data (two years after the implementation), the relationship between hand washing and cognitive development is mixed. First, the specification that estimates the average treatment effect including covariates (as income per-capita) shows that this effect is close to zero. The addition of household assets into the specification above does not change the results. However, the interaction of exposure of the program with the tenure of certain communication assets (such as TV, VCR), appears to have a statistically significant impact on children's cognitive development. Due to the initial differences in the control and treatment group, we use a differences-in-differences estimator with panel to obtain more parsimonious results. We find no relevant impact of the intervention on cognition. Yet again, the same interaction (between

[14] A further extension of the analysis conducted will include the estimation of bounds on treatment effects (Manski (1993), Heckman and Smith (1993)) in order to provide more accurate information on the bias and the treatment effects on the population.

household assets and the diffused media component) showed effects on cognitive development of children below 5 years old. These results are consistent even after adjusting for a set of household characteristics. One area of further research on these issues can identify the pathways through which the presence of communications assets in the household and observed hygiene behaviors reflect skewed household preferences towards investing in improving children's communication skills, which may in turn explain cognitive development changes.

Policy Recommendations

Considering the importance that adequate hygiene has in preventing infectious diseases and in contributing to cognitive growth, this paper suggests that sanitation and hand washing should be a part of all early care and education programs, combined with expansion of water supply, to promote the positive mental health of all young children. Young children's mental development creates an essential foundation for early learning and development. The results of these types of hygiene and sanitation evaluations help understand how programs can improve targeting and how program benefits may be distributed. Therefore, programs targeting less-affluent households more intensively are paramount to prevent future remediation in disadvantaged children, at a much higher cost. Hygiene promotion can thus improve the benefits and even the effectiveness of water and sanitation programs in developing countries at relatively low costs, if the targeting is oriented towards the poorest (Sijbesma and Christoffers, 2009). Likewise, it is unquestionable that adding hygiene and sanitation information campaigns components into health, social protection or education programs is viable since information flows between social and economic strata; and have the potential to be effective at scale, provided that sufficient attention is given to ensuring the quality, intensity and means of communication of campaigns into the program intervention (Rajaraman et al., 2014). Testing different campaign designs, in terms of intensity and means of communication, calls for future research that identifies the causal effect of hand washing programs on poor children's cognitive development. Also, while there is a growing body of research focused on the links between socio-emotional skills on schooling and labor market outcomes,

there is little evidence on the intra-household factors that spur socio- emotional skills during early childhood development.

Consistent with findings by Scott et al. (2008), the results show that TV and radio assets in the household led to higher rates of reported hygiene behaviors. Failure of mass media to reach target intended audiences, particularly in lower socio-economic groups, and the additive effect of exposure, underscores the need to implement integrated communication programs utilizing a variety of complementary communication channels. Still, more research is needed to identify the links between disease incidence of children, their nutritional status, and cognitive development outcomes in the presence of intensified and personalized hygiene campaigns. More research is needed to understand which types of information transmission mechanisms are more effective in modifying hygiene behaviors: personalized direct-contact communication campaigns or more elaborated information campaigns that rely on particular communication channels.

Finally, the main problem with randomized control trials of hygiene information campaigns is the high rate of information transmission between households pertaining to treatment and control groups, leading to substantial contamination. Another lesson learned is that hygiene and sanitation communication campaigns tend to use intermediate outcomes such as knowledge, attitudes and behaviors to measure program effects. Nevertheless, these intermediate outcomes might be insufficient to assess the broader effects of a program since these indicators only assess program effects over the short-run. Designing hygiene promotion evaluations to test changes in social norms, adopted behaviors, and children's developmental or cognitive indicators could be a more robust option to capture the impacts that hygiene and sanitation information campaigns have over the long-run.

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Methodology Annex

Matching and Imputation of Socio-emotional Scores

In absence of a pure experimental design and potential unobservable bias, units receiving treatment and those excluded from treatment may differ in their treatment status but also in other characteristics that affect both participation and the outcomes of interest. To generate robust impact estimates we used DHS/MICS 2008 and 2010-11 to merge the impact evaluation surveys by region, department and district. The sample size of the DHS survey for 2008 comprised 9,200 households and for 2010-2011 the total household surveyed reached 8,200 households.

The steps to conduct the matching were the following:

1. Merge of households between surveys (DHS and IE) based on geographical location.

2. Statistical matching based on two different methods to verify consistency of matched households. The first method used was a propensity score matching[15] because of the plethora of characteristics within each type of survey considered to generate a reliable statistical match of households. The propensity score uses a parametric approach (probit) that estimates the probability of treatment assignment conditional on observed baseline characteristics. The propensity score is a balancing score: conditional on the propensity score, the distribution of observed baseline covariates will be similar between treated and untreated subjects. In the case of the surveys, the

[15] Much of the literature on matching focuses on propensity score matching methods. Using the Rosenbaum and Rubin (1983) theorem, the matching procedure can be broken down into two stages. In the first stage, the propensity score $Pr(D = 1|Z)$ is estimated, using a binary discrete choice model. In the second stage, individuals are matched on the basis of their predicted probabilities of participation.

treatment status was assigned to those households in the DHS survey that showed similar characteristics to the treatment group in the impact evaluation surveys, and all non-treatment areas were added statistically as controls (with high propensity for the control group). Matching variables considered corresponded to main household characteristics, assets, access to public services, education, employment and income reported by household members, and common health indicators measured in both types of surveys, such as diarrhea incidence, respiratory illnesses, and enteric diseases[16]. Once the propensity scores are obtained we estimated the average treatment effect based on the weights produced by this procedure.

3. Non-parametric matching to complement the propensity score method and gain robustness in the results. We estimated non-parametrically the average treatment effect based kernel density and nearest neighbor matching. Both PSM and non-parametric estimates showed similar results. The non-parametric methods provided a balancing test before and after both estimations and it is based on matching estimators that compare the outcome of each treated person to a weighted average of the outcomes of all the untreated persons, with the highest weight being placed on those with scores closest to the treated individual. By using a nearest neighbor estimate it is not guarantee of minimizing the bias, since the characteristics between both units will be, in general, very similar, but many untreated units are not used for the estimation. Kernel estimates incorporate more untreated units. The caliper of 0.25 showed convergence of balance between comparison groups.

After groups are matched and the samples are increased based on the number of treatment and control units in the DHS survey, we then employ an imputation method for socio-emotional outcomes in the DHS data. The DHS data of 2010 also provides data on access to communication assets representative of the whole country[17]. The imputation

[16] To avoid the biases that this may generate, matching methods find a non-treated unit that is "similar" to a participating unit, allowing an estimate of the intervention's impact as the difference between a participant and the matched comparison case.

[17] The DHS 2010 reports that 74% of households own a radio and 52% a television. Senegal is in 10th place for Facebook usage in Africa. In addition, the number of mobile phones rose from 7.0 million to 10.71 million between 2009 and 2012, reaching 88% mobile penetration. The country had 528,358 internet subscribers by the end of June 2012, there were 375,556 mobile internet users, and 95,412 people were connected to ADSL lines (itnewsafrica.com, 2012). Radio and television have a greater

was conducted using the *mi impute chained* command in Stata V.12. The model included all the variables common to the evaluation surveys. Dependent variables on socio-emotional skills were imputed based on socio-demographic characteristics and non-missing information of independent variables. The observed values of the dependent variable provided information about on those households where outcome variables were imputed; and the information available from those observations were used in the imputation model. Once imputation was conducted the estimation of effects with DHS data followed the same specification used with the impact evaluation surveys.

Other Descriptive Statistics

The surveys' results provide useful information for the creation of variables that measure the wellbeing of participants. These variables include, access to water, sanitation and hand washing facilities, prevalence of child diseases such as diarrhea and respiratory infection, child growth and development, anemia and parasites prevalence. The average household in Senegal is comprised of 6.1 members, out of whom 2.4 are children under the age of five, and the total monthly income is equivalent to USD23 per capita. Most families have a fifty-year old male as the head of the household; only 27 percent have ever attended school. The average salary from primary or secondary jobs was equivalent to USD50, and the average family among the poorest has no electricity and uses wood for cooking. The longitudinal sample that we are analyzing is composed of children between 0 and 4 years old. At baseline, there are 4,180 children between 0-4 years old, with 2,053 children in the control group, and 2,127 children in the experiment group. However, the cognitive development test was only applied to those between 0 and 2 years of age or approximately 1,869 children, of which 910 children were in the control group and 959 in the treatment group. Of these, only 715 and 751, respectively, were found in the follow up. No significant imbalances were found in the presence of attrition.

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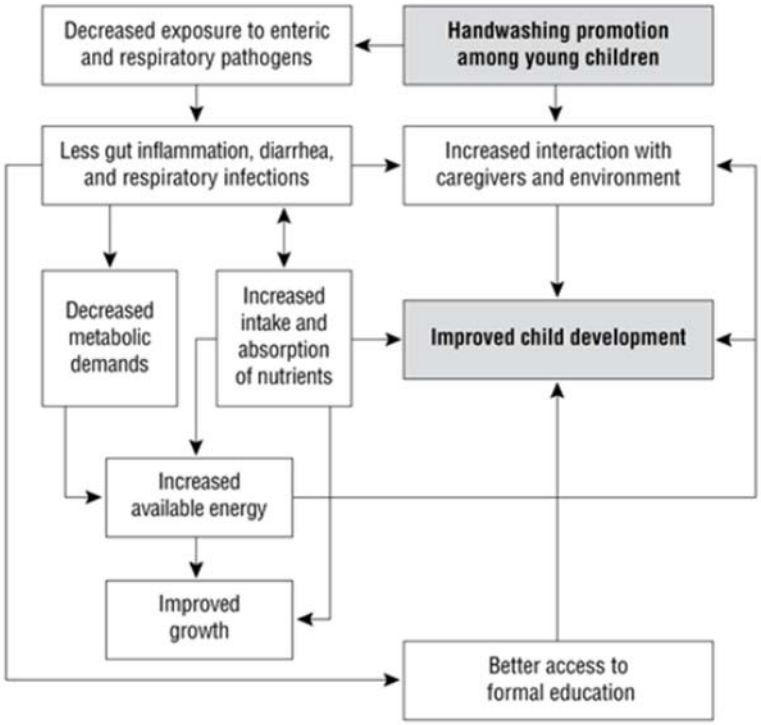
reach than the internet and newspapers, due to high levels of illiteracy. In addition, most newspapers are unaffordable on an average salary (African Media Barometer, 2013), and 25% of the population have internet access, though this number continues to grow (ITU, 2012). Radio is the dominant form of news transmission with approximately 80 community, public, and private commercial radio stations (US Dept. of State, 2013).

Chart Annex

Chart 1. Pathways among hygiene information, handwashing promotion, child growth and development



Source: Bowen et al. (2012). "Association Between Intensive Handwashing Promotion and Child Development in Karachi, Pakistan A Cluster Randomized Control Trial." *Arch Pediatr Adolesc Med.* 166(11):1037-1044

Tables Annex

Table 1. Descriptive Statistics of Socio-emotional scores and basic household characteristics, panel data children only

	Baseline				Follow up			
	Control	Treatment	Diff	S.E.	Control	Treatment	Diff	S.E.
Head HH age	50.54	51.18	-0.64	(.726)	51.82	51.65	0.17	(.713)
Mother's age	37.77	37.91	-0.14	(.650)	38.77	39.19	-0.42	(.663)
Income Per-capita	5434	5150	285	(1,114)	5953	6858	-905	(906)
Members	6.20	6.33	-0.13	(.394)	6.65	6.65	0.00	(.454)
Communication Skills	0.01	0.02	0.01	(.051)	0.03	0.05	0.02	(.051)
Motor Skills	0.01	0.03	0.02	(.052)	0.04	0.06	0.02	(.052)
Social Skills	0.00	0.02	0.02	(.052)	0.01	0.03	0.02	(.054)
Days with Fever	1.51	1.45	0.06	(.112)	0.93	0.98	-0.05	(.093)
Days with Stomach pain	0.10	0.05	0.04	(.029)	0.13	0.18	-0.05	(.040)
Days with Nausea	0.02	0.04	-0.02	(.021)	0.03	0.06	-0.03	(.023)
Days with Vomiting	0.22	0.22	0.00	(.048)	0.10	0.12	-0.02	(.032)
Age	13.20	12.71	0.49	(.317)	36.22	35.74	0.48	(.316)
Observations	715	751			715	751		

*** Significant at the 1 percent

** Significant at the 5 percent

* Significant at the 10 percent

Source: Handwashing project Surveys, SENEGAL

Table 1a. Descriptive Statistics of the Panel Data

	Longitudinal (with attrition of Children at follow up)				Full Sample Longitudinal Sample			
	Control	Treatment	Diff	t-value	Control	Treatment	Diff	t-value
Hand wash knowledge	0.83	0.83	0.00	0.25	0.78	0.80	-0.02	-1.32
Education (yrs) head	3.55	3.59	-0.04	-0.22	3.41	3.36	0.05	0.36
Radio	0.71	0.73	-0.02	-0.853	0.69	0.72	-0.02	-1.43
TV	0.52	0.37	0.14	5.543***	0.50	0.37	0.13	7.543***
PC	0.04	0.05	-0.01	-0.599	0.03	0.04	-0.01	-1.10
VCR	0.20	0.13	0.07	3.418***	0.21	0.14	0.07	5.348***
Communication Skills	-0.11	-0.02	-0.09	4.671***	-0.07	0.04	-0.11	6.554***
Motor Skills	-0.10	0.03	-0.14	3.129**	-0.07	0.01	-0.08	7.881***
Social Skills	-0.05	0.01	-0.07	1.03	-0.05	0.05	-0.10	0.78

*** Significant at the 1 percent, ** Significant at the 5 percent. Source: Handwashing project Surveys, SENEGAL

Table 2. Descriptive Statistics of the follow up

	Control	Treatment	Diff	S.E.
Parental Edu	0.76	0.59	0.17	(.069)**
Father's Ed	3.69	3.81	-0.11	(.150)
Mother's Ed	3.24	3.08	0.16	(.070)***
Head HH age	51.61	52.64	-1.03	(.788)
Mother's age	38.80	39.57	-0.77	(.727)
Income Per-capita	6444	7197	-753	(1114.2)
No. Members	5.74	6.28	-0.54	(.509)
Radio	0.72	0.76	-0.04	(.024)
TV	0.54	0.36	0.18	(.027)***
VCR	0.24	0.16	0.08	(.022)***
PC	0.04	0.06	-0.01	(.012)
Communication Skills	-0.08	0.08	0.16	(.056)***
Motor Skills	-0.09	0.08	0.18	(.056)***
Social Skills	-0.04	0.03	0.06	(.056)
Days with Fever	0.88	0.93	-0.04	(.097)**
Days with Stomach pain	0.12	0.21	-0.10	(.045)**
Days with Nausea	0.02	0.06	-0.03	(.023)
Days with Vomiting	0.08	0.12	-0.04	(.033)

Variables used as controls in subsequent models.
Source: Handwashing project, SENEGAL

Table 3. Communication skills and hand washing program, no panel data

	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	-0.160*	-0.149*	-0.093	-0.161	-0.110	-0.162**
	(0.084)	(0.079)	(0.126)	(0.106)	(0.087)	(0.081)
Radio			-0.033			
			(0.099)			
Treatment*Radio			-0.070			
			(0.149)			
TV				0.272***		
				(0.094)		
Treatment*TV				0.155		
				(0.125)		
VCR					0.345***	
					(0.098)	
Treatment*VCR					-0.077	
					(0.139)	
PC						0.305**
						(0.136)
Treatment*PC						0.161
						(0.162)
Constant	0.083	0.016	0.038	-0.100	-0.051	0.015
	(0.059)	(0.063)	(0.094)	(0.083)	(0.065)	(0.064)
Controls	No	Yes	Yes	Yes	Yes	Yes
Observations	1238	1238	1237	1237	1237	1237
Mean Dep. Variable	.00439	.00439	.00357	.00357	.00357	.00357
SD Dep. Variable	.988	.988	.988	.988	.988	.988

Notes: Clustered standard errors

*** Significant at the 1 percent

** Significant at the 5 percent

* Significant at the 10 percent

Source: Handwashing project Surveys, SENEGAL

Table 4. Motor skills and hand washing program, no panel data

	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	-0.176**	-0.160**	-0.130	-0.103	-0.158*	-0.164**
	(0.084)	(0.079)	(0.125)	(0.103)	(0.087)	(0.081)
Radio			0.036			
			(0.092)			
Treatment*Radio			-0.042			
			(0.143)			
TV				0.412***		
				(0.110)		
Treatment*TV				0.024		
				(0.142)		
VCR					0.223**	
					(0.106)	
Treatment*VCR					0.079	
					(0.140)	
PC						0.522***
						(0.154)
Treatment*PC						-0.124
						(0.234)
Constant	0.094	0.001	-0.025	-0.182**	-0.036	-0.005
	(0.062)	(0.066)	(0.079)	(0.087)	(0.072)	(0.067)
Controls	No	Yes	Yes	Yes	Yes	Yes
Observations	1238	1238	1237	1237	1237	1237
Mean Dep. Variable	.00715	.00715	.00733	.00733	.00733	.00733
SD Dep. Variable	.992	.992	.993	.993	.993	.993

Notes: Clustered standard errors

*** Significant at the 1 percent

** Significant at the 5 percent

* Significant at the 10 percent

Source: Handwashing project Surveys, SENEGAL

Table 5. Social skills and hand washing program, no panel data

	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	-0.062	-0.050	0.057	0.006	-0.045	-0.056
	(0.077)	(0.073)	(0.119)	(0.097)	(0.081)	(0.074)
Radio			0.105			
			(0.102)			
Treatment*Radio			-0.145			
			(0.147)			
TV				0.311***		
				(0.102)		
Treatment*TV				0.058*		
				(0.027)		
VCR					0.215*	
					(0.115)	
Treatment*VCR					0.065*	
					(0.031)	
PC						0.255
						(0.203)
Treatment*PC						0.036
						(0.274)
Constant	0.036	-0.019	-0.095	-0.159**	-0.056	-0.021
	(0.056)	(0.058)	(0.080)	(0.078)	(0.064)	(0.059)
Controls	No	Yes	Yes	Yes	Yes	Yes
Observations	1238	1238	1237	1237	1237	1237
Mean Dep. Variable	.00565	.00565	.00532	.00532	.00532	.00532
SD Dep. Variable	.989	.989	.989	.989	.989	.989

Notes: Clustered standard errors

*** Significant at the 1 percent

** Significant at the 5 percent

* Significant at the 10 percent

Source: Handwashing project Surveys, SENEGAL

Table 6. Impact of the program on Hand washing behavior with asset holding (individuals)

Treatment	-0.05	(0.031)*	-0.05	(0.034)
Follow	-0.12	(0.025)***	-0.13	(0.030)***
Treatment*Follow Up	0.05	(0.035)	0.06	(0.030)*
Radio	-0.01	(0.021)	0.06	(0.020)***
TV	0.07	(0.018)***	0.02	(0.025)
VCR	0.07	(0.015)***	0.07	(0.018)***
PC	0.02	(0.034)	0.01	(0.039)
Constant	1.24	(0.029)***	1.29	(0.044)
Controls	No		Yes	
Observations	2438		2438	
R-square	0.1477		0.1492	

Notes: Clustered standard errors

*** Significant at the 1 percent

** Significant at the 5 percent

* Significant at the 10 percent

Table 7. Cognitive skills and Handwashing program, all communication assets (individuals)

	Communication		Motor		Social-Emotional	
	1	2	3	4	5	6
Treatment	-0.126*	-0.091	-0.085	-0.040	-0.047	-0.010
	(0.069)	(0.068)	(0.072)	(0.071)	(0.069)	(0.065)
Follow	0.050	0.053	0.007	0.012	0.027	0.028
	(0.062)	(0.062)	(0.074)	(0.073)	(0.065)	(0.066)
Treatment*Follow Up	-0.056	-0.060	-0.024	-0.033	-0.016	-0.021
	(0.087)	(0.088)	(0.095)	(0.096)	(0.086)	(0.087)
Radio		0.142**		0.135***		0.103*
		(0.058)		(0.051)		(0.056)
TV		0.198***		0.271***		0.179***
		(0.052)		(0.062)		(0.049)
VCR		0.056		0.076		0.102
		(0.063)		(0.068)		(0.069)
PC		0.223**		0.414***		0.170*
		(0.099)		(0.082)		(0.094)
Constant	-0.040	-0.018	0.102	0.097	-0.065	-0.072
	(0.118)	(0.116)	(0.125)	(0.124)	(0.094)	(0.101)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2365	2353	2365	2353	2365	2353

Notes: Clustered standard errors

*** Significant at the 1 percent

** Significant at the 5 percent

* Significant at the 10 percent

Source: Handwashing project Surveys, SENEGAL

Table 8. Communication skills and hand washing program, panel data (individuals)

	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	-0.117*	-0.153**	-0.005	-0.126*	-0.130**	-0.150**
	(0.061)	(0.062)	(0.108)	(0.074)	(0.066)	(0.062)
Radio			0.051			
			(0.088)			
Treatment*Radio			0.194*			
			(0.115)			
TV				0.216***		
				(0.070)		
Treatment*TV				0.081*		
				(0.046)		
VCR					0.200**	
					(0.080)	
Treatment*VCR					0.066**	
					(0.027)	
PC						0.471***
						(0.122)
Treatment*PC						0.195
						(0.178)
Constant	0.071	-0.019	-0.038	-0.068	-0.034	-0.011
	(0.044)	(0.113)	(0.120)	(0.115)	(0.112)	(0.111)
Controls	No	Yes	Yes	Yes	Yes	Yes
Observations	2802	2365	2363	2363	2359	2358
Mean Dep. Variable	.0115	.00337	.00245	.0035	.0033	.00351

Notes: Clustered standard errors

*** Significant at the 1 percent

** Significant at the 5 percent

* Significant at the 10 percent

Source: Handwashing project Surveys, SENEGAL

Table 9. Motor skills and hand washing program, panel data

	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	-0.095	-0.096	0.043	-0.035	-0.067	-0.100
	(0.068)	(0.066)	(0.104)	(0.075)	(0.068)	(0.064)
Radio			0.023			
			(0.077)			
Treatment*Radio			0.185*			
			(0.106)			
TV				0.340***		
				(0.077)		
Treatment*TV				0.050		
				(0.107)		
VCR					0.293***	
					(0.075)	
Treatment*VCR					0.005	
					(0.125)	
PC						0.673***
						(0.125)
Treatment*PC						-0.161
						(0.156)
Constant	0.035	0.105	0.074	0.009	0.075	0.113
	(0.052)	(0.117)	(0.126)	(0.119)	(0.117)	(0.114)
Controls	No	Yes	Yes	Yes	Yes	Yes
Observations	2802	2365	2363	2363	2359	2358
Mean Dep. Variable	-.0138	-.031	-.0311	-.0307	-.0315	-.0312

Notes: Clustered standard errors

*** Significant at the 1 percent

** Significant at the 5 percent

* Significant at the 10 percent

Source: Handwashing project Surveys, SENEGAL

Table 10. Social skills and hand washing program, panel data

	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	-0.023	-0.054	0.183	0.027	-0.028	-0.051
	(0.060)	(0.061)	(0.111)	(0.075)	(0.065)	(0.062)
Radio			0.107			
			(0.080)			
Treatment*Radio			0.316***			
			(0.113)			
TV				0.281***		
				(0.067)		
Treatment*TV				-0.130		
				(0.091)		
VCR					0.245***	
					(0.090)	
Treatment*VCR					-0.039	
					(0.129)	
PC						0.400***
						(0.137)
Treatment*PC						-0.161
						(0.175)
Constant	0.006	-0.054	-0.140	-0.151	-0.085	-0.052
	(0.043)	(0.093)	(0.109)	(0.104)	(0.098)	(0.092)
Controls	No	Yes	Yes	Yes	Yes	Yes
Observations	2802	2365	2363	2363	2359	2358
Mean Dep. Variable	-.0054	-.0297	-.0302	-.0302	-.0295	-.0295

Notes: Clustered standard errors

*** Significant at the 1 percent

** Significant at the 5 percent

* Significant at the 10 percent

Source: Handwashing project Surveys, SENEGAL

Table 11. Presence of hand washing Promotion (all components), communications assets tenure and interacted effect by income groups

Communication Skills	Quintiles I and II	Quintiles III and IV	Quintile V
Treatment	0.204*	0.198***	0.090
Standard Error	(0.11)	(0.08)	(0.06)
Communication Asset	0.509***	0.245**	0.124*
Standard Error	(0.14)	(0.10)	(0.07)
Interaction Effect	0.379*	0.130	-0.008
Standard Error	(0.20)	(0.12)	(0.08)
Constant	0.640***	0.129	0.749***
Sample Size	564	480	193
Motor Skills			
Treatment	0.098	0.122	-0.029
Standard Error	(0.11)	(0.07)	(0.04)
Communication Asset	0.565***	0.551***	0.394***
Standard Error	(0.07)	(0.09)	(0.06)
Interaction Effect	0.168	0.014	0.018
Standard Error	(0.25)	(0.23)	(0.09)
Constant	-0.970***	0.069	0.559***
Sample Size	577	491	197

Standard errors in parentheses.
Only panel data estimations.

Note: Clustered standard errors
*** Significant at the 1 percent; ** Significant at the 5 percent; * Significant at the 10 percent
Source: Handwashing project Surveys, SENEGAL

Table 12. Impact Estimators with Matching methods and outcome imputation to DHS surveys

Matching method	Impact Evaluation Longitudinal Surveys (children below 5 years old)			DHS Imputed Scores (Children below 5 years old)		
	ASQ Communication Average Scores	ASQ Motor Average Scores	ASQ Social Scores	ASQ Communication Average Scores	ASQ Motor Average Scores	ASQ Social Scores
PSM Matched						
Interaction Treatment*TV	**0.133*** **	**0.117*** **	**0.159***	0.154	0.146	**0.217***
t-value	*11.64*	*10.94*	*1.75*	0.41	*0.38*	*2.13*
Interaction Treatment*Radio	**0.136*** **	**0.108*** **	0.007	0.202	0.164	0.044
t-value	*9.67*	*8.20*	*0.49*	*0.13*	*0.84*	*0.91*
Interaction Treatment*Other Media	**0.133*** **	**0.112*** **	**0.023***	**0.169***	0.202	**0.060***
t-value	*16.16*	*14.57*	*2.90*	2.12	*0.19*	1.98
Nearest Neighbor Match						
Interaction Treatment*TV	**0.125*** **	**0.101*** **	0.014	0.038	0.143	0.087
t-value	*10.25*	*8.44*	*1.21*	*1.21*	*1.17*	*1.09*
Interaction Treatment*Radio	**0.101*** **	**0.087***	-0.011	**0.028***	**0.147***	0.030
t-value	*5.17*	*4.25*	*-0.66*	*1.65*	*2.29*	*1.41*
Interaction Treatment*Other Media	**0.131*** **	**0.104*** **	**0.025***	**0.065*** **	0.133	0.052
t-value	*13.85*	*11.68*	*3.10*	*4.65*	*0.80*	*0.31*
Kernel Matching						
Interaction Treatment*TV	**0.132*** **	**0.116*** **	**0.027***	0.103	0.151	0.058
t-value	*14.27*	*12.14*	*3.18*	*0.25*	*0.64*	*0.92*
Interaction Treatment*Radio	**0.122*** **	**0.102*** **	0.003	0.096	**0.196***	0.026
t-value	*8.15*	*5.80*	*0.19*	*0.37*	*2.15*	*0.89*
Interaction Treatment*Other Media	**0.135*** **	**0.113*** **	**0.024***	**0.071***	0.153	0.034
t-value	*16.64*	*18.51*	*3.62*	*2.11*	*0.37*	*0.19*

…Continued						
Observations						
Treatment PSM	752	752	752	1173	1070	1098
Treatment Nearest Neighbor	569	245	299	621	534	573
Treatment Kernel Matching	569	245	299	621	534	573
Control PSM	361	361	361	528	509	616
Control Nearest Neighbor	291	150	173	435	486	580
Control Kernel Matching	589	242	395	651	617	735

Note: Interaction terms raise issues very similar to those raised by non-linear terms: if the interaction term isn't included in the imputation model, the coefficient on the interaction term will be biased towards zero in the analysis model. Same specification used with previous regressions but only interaction coefficients reported in the table.

Clustered standard errors in brackets

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

$p<0.001$

Source: Handwashing project Surveys, SENEGAL

Table 13 Recall Periods for Socio-emotional scores and media outlets

	Z score: ASQ communication	Z score: ASQ motor	Z score: ASQ personal/social
Remembers TV message	0.248***	0.215***	0.229***
	[0.0518]	[0.0572]	[0.0591]
Remembers radio message	0.0246	0.0157	0.0141
	[0.0475]	[0.0500]	[0.0541]
Remembers print message	-0.0574	-0.0438	0.0698
	[0.0440]	[0.0418]	[0.0558]
Remembers household visit	0.0264	-0.0305	-0.0502
	[0.0504]	[0.0510]	[0.0561]
Remembers community event	0.0568	-0.0135	0.0813
	[0.0530]	[0.0644]	[0.0568]
Constant	-0.137**	-0.0747	-0.173**
	[0.0501]	[0.0571]	[0.0610]
Observations	2302	2260	2471

Clustered standard errors in brackets
* p<0.05, ** p<0.01, *** p<0.001
NB: Results the same when controlling for any TV watching (not shown)
Source: Handwashing project Surveys, SENEGAL

Table 14 Recall of program elements is correlated with some better handwashing practices

	HW w/ soap after fecal contact in last 24hr	HW w/ soap before food prep in last 24hr	HW w/ soap before feeding child in last 24hr	HW w/ soap before eating in last 24hr	Cleanliness of caregiver hands
Remembers TV message	0.115***	0.0211	-0.0119	0.028	0.629***
	[0.0266]	[0.0168]	[0.0127]	[0.0191]	[0.0994]
Remembers radio message	0.0168	0.01	0.00104	0.0621***	-0.0796
	[0.0220]	[0.0180]	[0.00917]	[0.0169]	[0.0858]
Remembers print message	0.0366	0.0241	0.0116	0.0536**	0.0988
	[0.0248]	[0.0176]	[0.00955]	[0.0184]	[0.106]
Remembers household visit	0.00905	0.0311	0.000597	0.0176	-0.293**
	[0.0246]	[0.0193]	[0.0101]	[0.0198]	[0.101]
Remembers community event	0.0907**	-0.0375	0.0205	0.0479	0.0506
	[0.0293]	[0.0270]	[0.0128]	[0.0274]	[0.118]
Constant	0.326***	0.169***	0.0345***	0.141***	7.573***
	[0.0280]	[0.0193]	[0.00816]	[0.0150]	[0.111]
Observations	2728	2728	2728	2728	2099

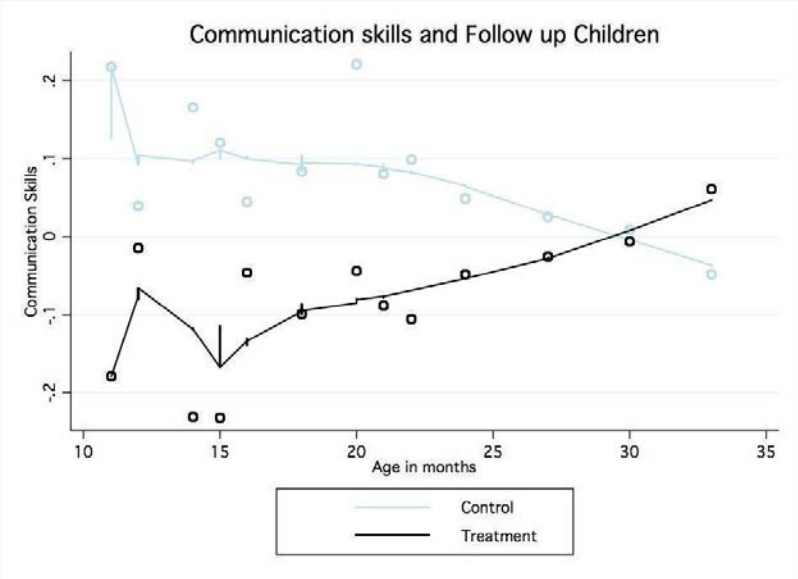
District-clustered standard errors in brackets

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

Source: Handwashing project Surveys, SENEGAL

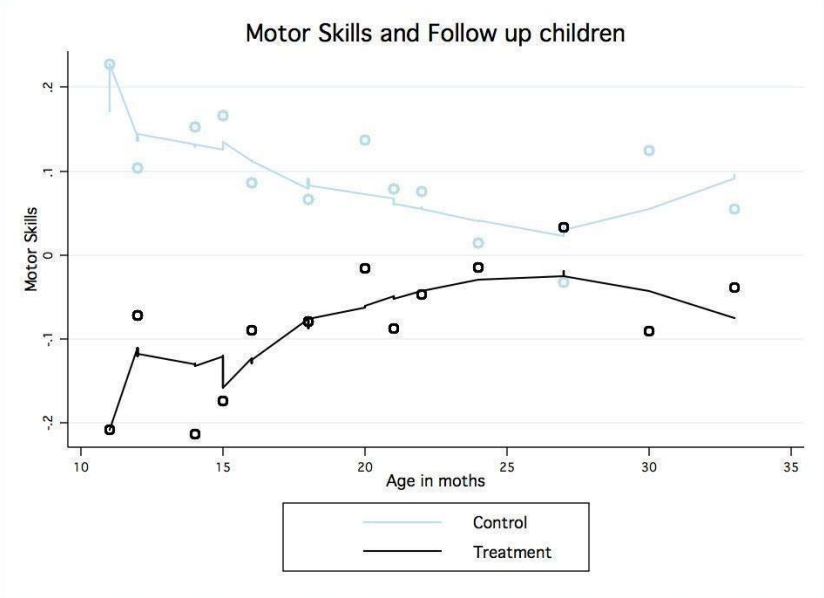
Graphs Annex

Figure 1. Communication Skills in Children after two years of the program



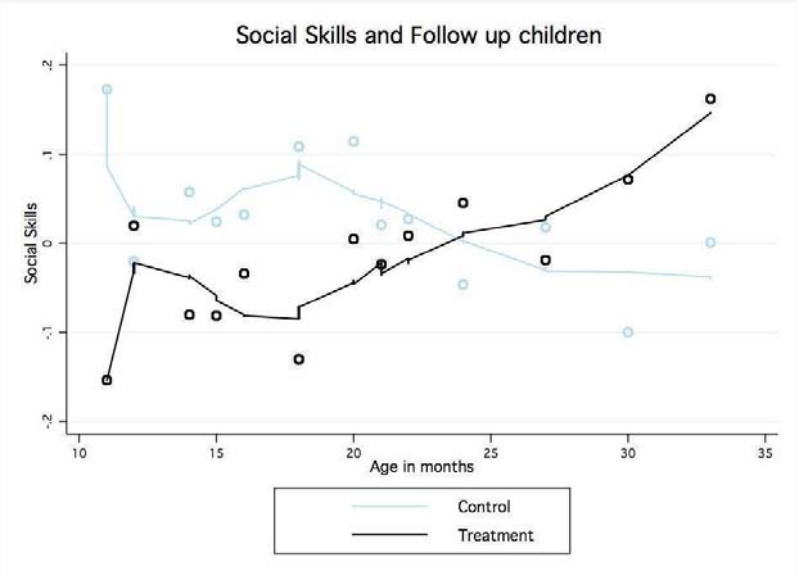
Source: Own estimations

Figure 2. Motor Developmental Skills in Children after two years of the program



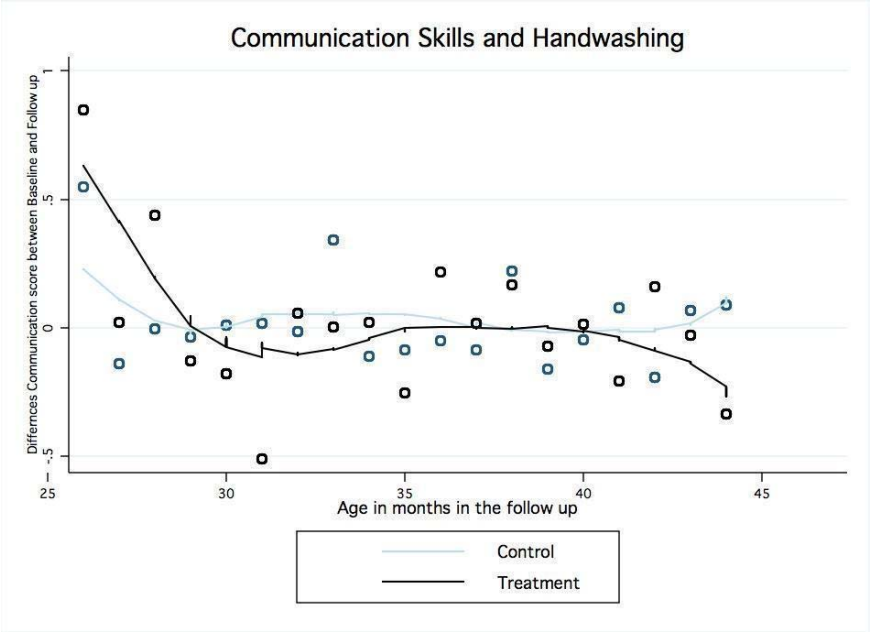
Source: Own estimations

Figure 3. Social-emotional Skills in Children after two years of the intervention



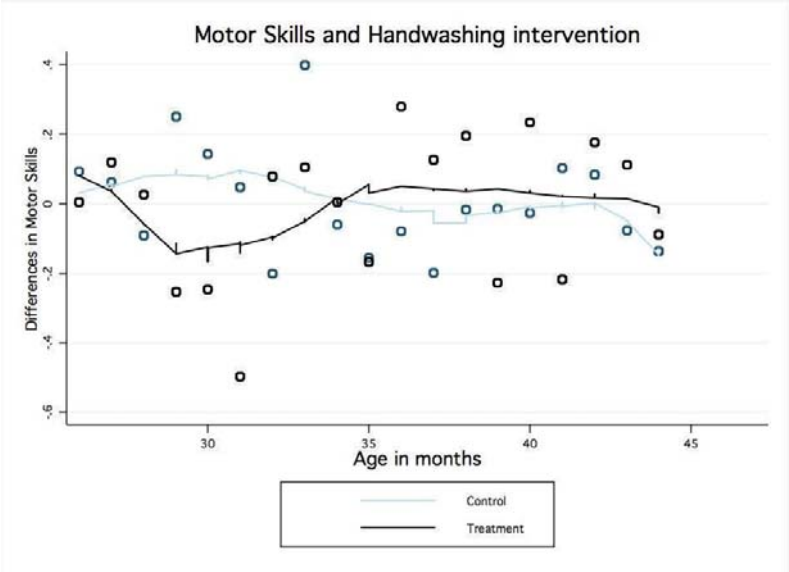
Source: Own estimations

Figure 4. Differences in Communication Skills in same Children in the baseline and two years after the program



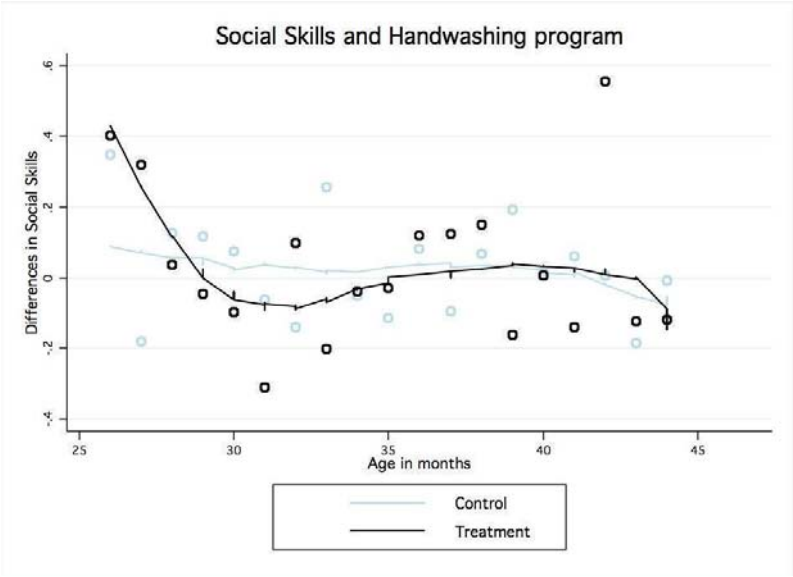
Source: Own estimations

Figure 5. Differences in Motor Skills in same Children in the baseline and two years after the program



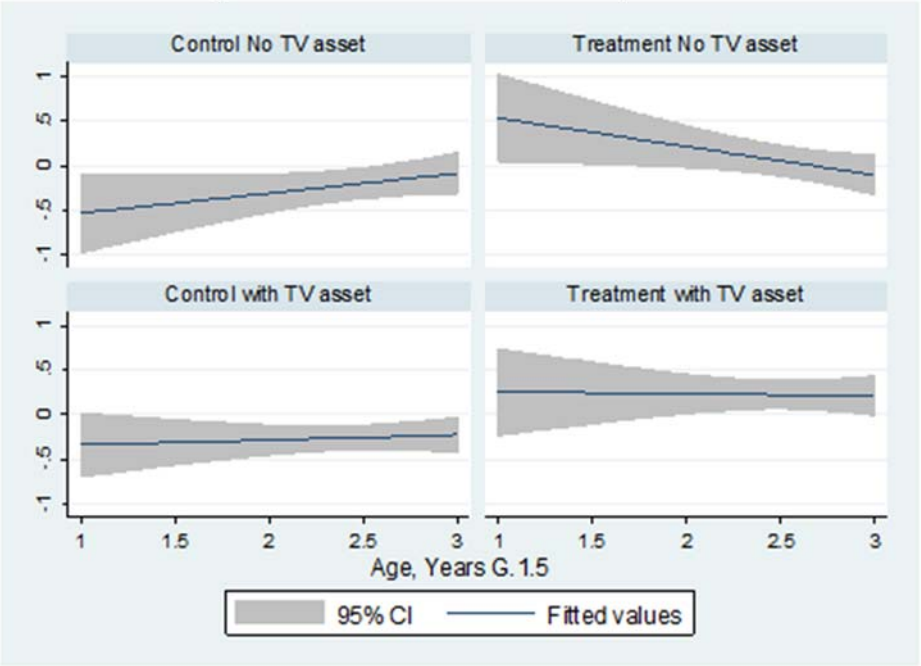
Source: Own estimations

Figure 6. Differences in Social Skills in same Children from baseline until two years after the program



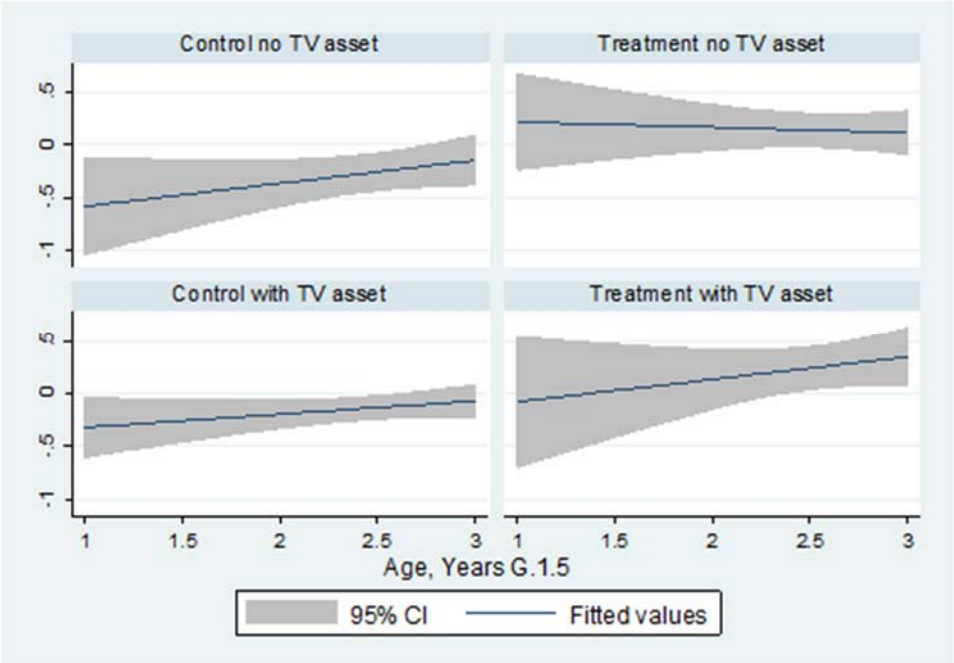
Source: Own estimations

Figure 7. Differences in communication skills (baseline vs. follow up) for first two quintiles of income (poorest) for children between 1 and 3 years old



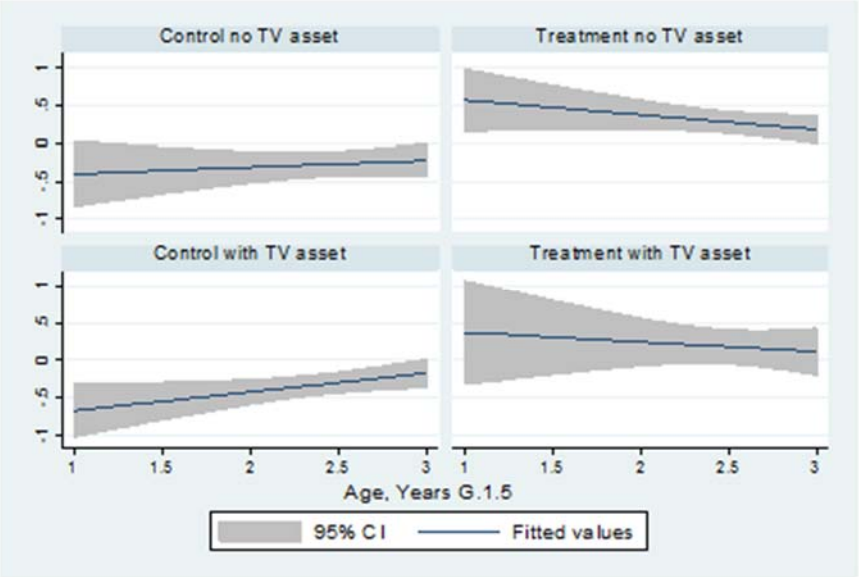
Test applied at baseline for children 4 to 24 months.
For follow up may include older ages, based on those interviewed at baseline.
Source: Own estimations

Figure 8. Differences in social skills (baseline vs. follow up) for first two quintiles of income (poorest) for children between 1 and 3 years old



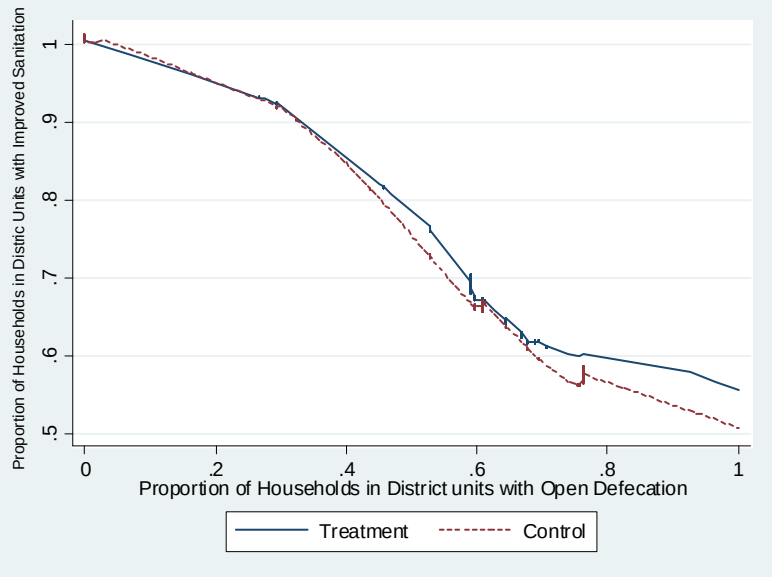
Test applied at baseline for children 4 to 24 months.
For follow up may include older ages, based on those interviewed at baseline.
Source: Own estimations

Figure 9. Differences in motor skills (baseline vs. follow up) for first two quintiles of income (poorest) for children between 1 and 3 years old



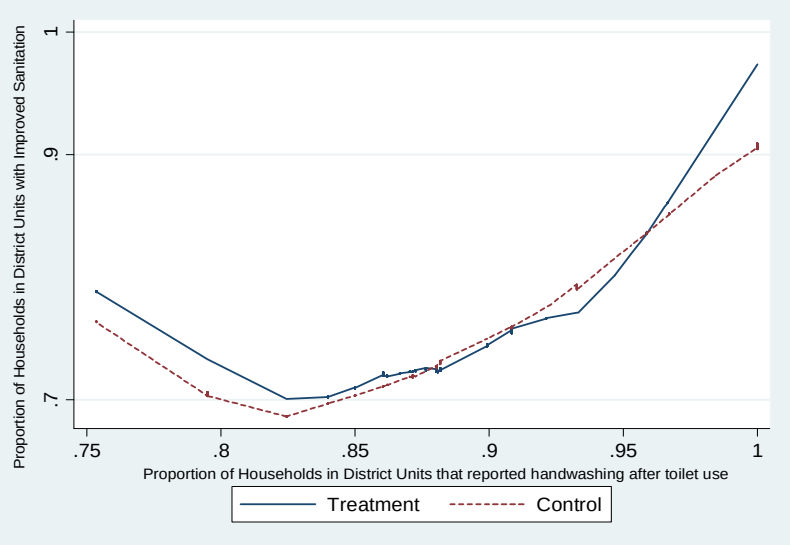
Test applied at baseline for children 4 to 24 months.
For follow up may include older ages, based on those interviewed at baseline.
Source: Own estimations

Figure 10. Variations in Open Defecation between comparison groups, district/city levels



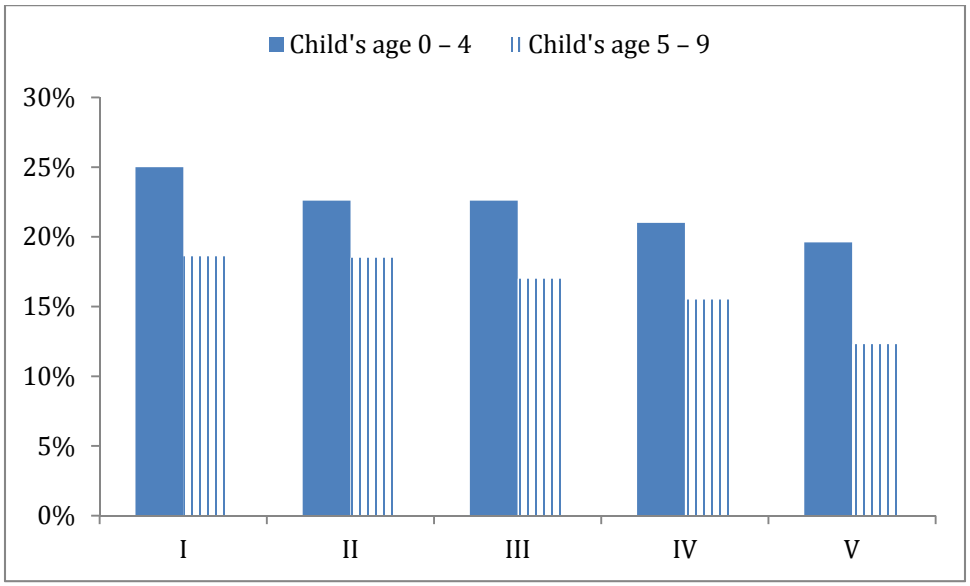
Source: Own estimations

Figure 11. Variations in handwashing and improved sanitation by comparison groups, district/city levels



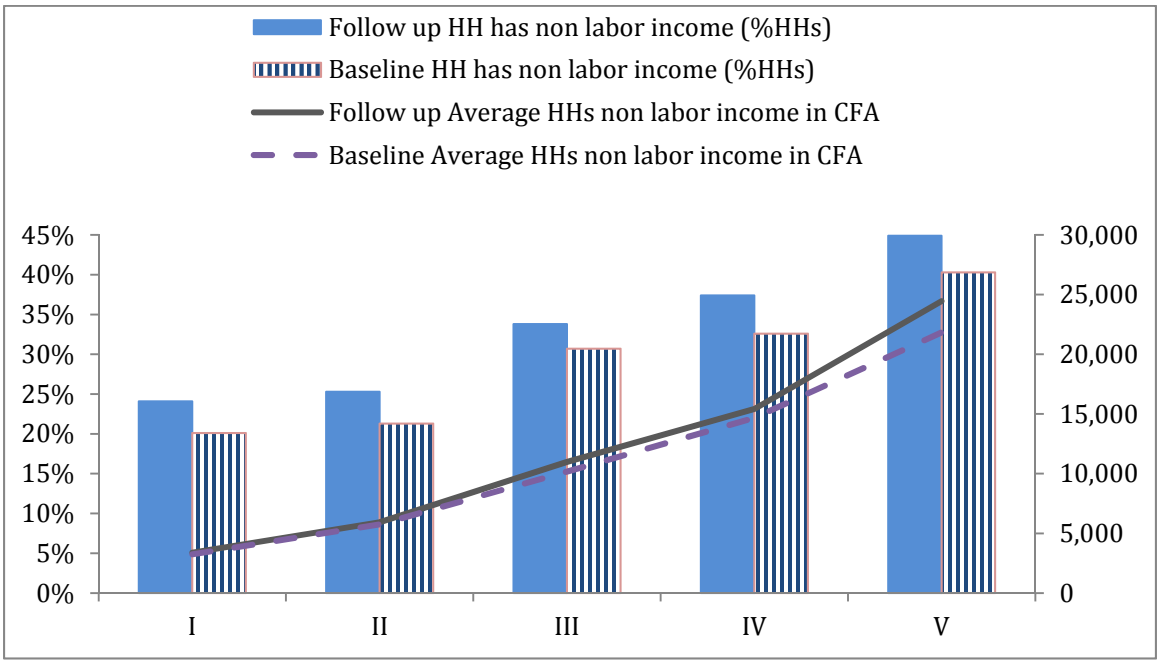
Source: Own estimations

Figure 12. Percent distribution of children below 5 and 10 years old (to all household members) by household's income quintile



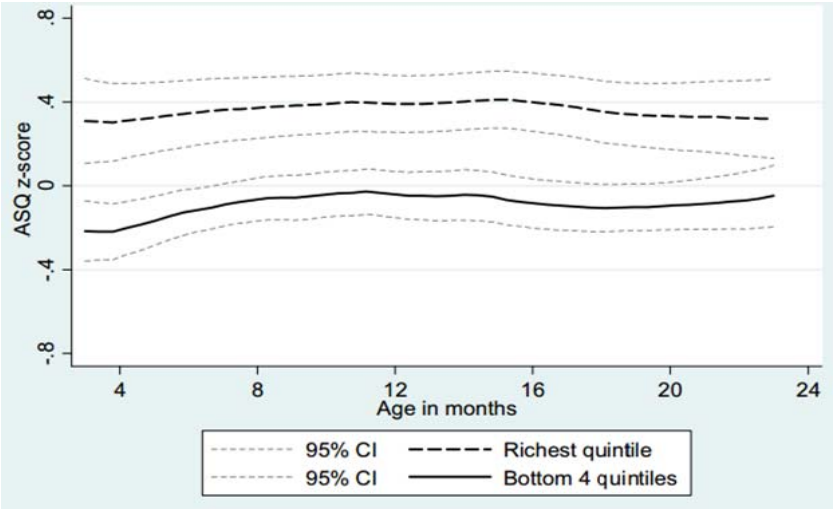
Source: Own estimations

Figure 13. Distribution of Matched samples non-labor income levels and percent of total income, by income quintiles



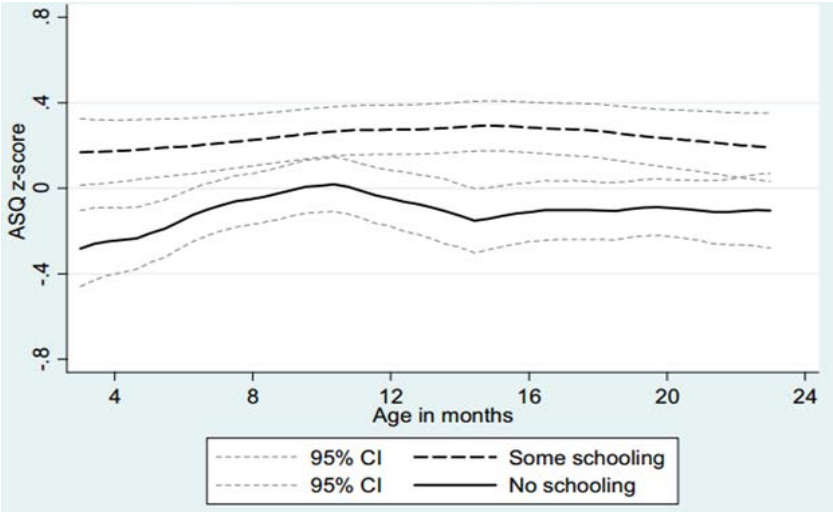
Source: Own estimations

Figure 14 Nationally representative ASQ scores for Children (4-24 months) for lowest and highest income quintiles, Senegal



Source: Gertler et al., 2012. Socioeconomic gradients in child development in very young children: Evidence from India, Indonesia, Peru, and Senegal. PNAS. Vol 109. Sup 2.

Figure 15. Nationally representative ASQ scores for Children (4-24 months) by level of schooling, Senegal



Source: Gertler et al., 2012. Socioeconomic gradients in child development in very young children: Evidence from India, Indonesia, Peru, and Senegal. PNAS. Vol 109. Sup 2.