Can text messages improve children's health? A case from rural Ecuador

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ABSTRACT

Almost half of all deaths in children under five years of age, globally, are attributable to undernutrition. Poor nutrition in the first 1,000 days of life can contribute to stunted growth which can lead to impaired cognitive ability and reduced school and work performance. Globally almost one in four children under five years of age – 149 million worldwide – were stunted in 2018.[2] Latin America is a region where stunting rates have dropped over the past two decades by almost 50%, with some notable exceptions. Ecuador is one of two regional outliers, where the rate of stunting in children under five matches the global average at 24 percent.[3] Some regions of Ecuador register rates of stunting as high as 49 percent of children under five. This evaluation tests the impact of a low-cost intervention that sent text messages to caregivers of children under five that encouraged regular health checkups, timely integration of solid foods, diet diversity, consumption of micronutrients, and good water and sanitation practices. The text messages aimed to influence agency freedom by affecting decision making and action by overcoming limited memory and attention through reminders. The evaluation found a 23 percent decline in the experience of symptoms of common illnesses. The evaluation also observed a large and statistically significant improvement in weight for height for children under two years of age: .32 standard deviation increase in weight-for-height.

Keywords: stunting, behavior change, RCT, nutrition, text messaging.

JEL codes: C93, D83, D91, I12

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[2] The Joint malnutrition estimates published by UNICEF, WHO, and the World Bank (March 2019) Available at: https://data.unicef.org/topic/nutrition/malnutrition/

[3] 2014 rate ENSANUT or ECV

I. Introduction

Almost half of all deaths of children under five years of age, globally, are attributable to undernutrition. Poor nutrition in the first 1,000 days of life can contribute to stunted growth, defined as a height-for-age level that is two standard deviations below the international standard. Child stunting has long term negative health impacts that are mostly irreversible including diminished cognitive and physical development, reduced productive capacity, poor health, and increased risk of degenerative diseases such as diabetes. (World Health Organization 2017) Almost one in four children under five years of age globally – 149 million worldwide – were stunted in 2018. Ecuador is an outlier for Latin America matching the global average with 24 percent of children under five stunted in 2014. Some regions of Ecuador register much higher rates of stunting such as Chimborazo where 44 percent of children under five were stunted in 2014.

Undernutrition and specifically stunting rates are often sticky. Many countries make large investments in improving health care, water infrastructure, and access to basic foods without seeing significant declines in their rates of malnutrition. This is the puzzle Ecuador faces. Ecuador has invested heavily in increasing community health care availability, provides public daycare, home visits to families with children under five living in poverty, as well as cash transfers to 40 percent of the poorest quintile. Ecuador observed an average annual growth rate of 4.4 percent between 2006 and 2014 and large decreases in poverty – from 36.7 percent of the population in 2007 to 22.5 percent of the population in 2014 (using national measures of poverty headcount) . Yet over the same period of time the stunting rate, nationally, only declined by 2 percentage points from 26 percent to 24 percent. In Chimborazo, the region where this research takes place, the rates of stunting declined faster but remain extremely high from 53 percent in 2006 to 44 percent in 2014.

To create change on nutrition indicators, investments in physical infrastructure and access to resources are necessary, but not sufficient. A recent Lancet systematic review of evidence on maternal and child nutrition (Bhutta et al. 2013) identified ten interventions that if implemented at 90 percent coverage could reduce nearly 15 percent of deaths of children under five. Almost all interventions required both access to adequate resources and caregiver behavior changes to achieve child health and nutrition goals. Many of the behaviors that would need changing, to improve child nutrition outcomes, are habitual, highly personal, and as a consequence hard to change, such as hand washing, water treatment, and breastfeeding duration.

Nutrition and health behavior change has been studied at length, particularly in the area of diet and exercise. Systematic reviews have identified that significant behavior change has been accomplished when interventions include education, goal setting, self-monitoring and involvement from authority figures (parents in the case of adolescent behavior change) (Rose et al. 2017). Social Cognitive Theory interventions, which include providing knowledge of risks and benefits, improving self-efficacy, goal setting, and social support, have also been found to be effective to increase physical activity and encourage diet change (Stacey et al. 2014).

Kremer et al. 2019 review the behavioral development literature on health and identify several behavioral biases that limit investment in preventative health and treatment for chronic conditions, even when there are long term benefits of these behaviors. They review evidence that identifies high sensitivity to cost and convenience to health investments and explain how present bias and naivete can lead to procrastination in implementing health investments without deadlines. They also identify the role of inaccurate beliefs about costs and benefits of health investments, as well as how motivated reasoning can lead people to hold beliefs in line with what will provide highest utility.

This research tests the use of text messages to caregivers of children to encourage behavior change and improve child health. The channels through which text messages may work to change behaviors is

informed by literature in the fields of behavioral economics and psychology (Akerlof 1991; Banerjee and Mullainathan 2008, 2010; O'Donoghue and Rabin 1999, 2001; Frederick et al. 2002). Text messages can provide new information to inform decision making. Evidence from literature on information campaigns shows that information can be effective if salient and reinforced through multiple channels (Wakefield et al. 2010, La Ferrera et al. 2012). Text messages can also provide reminders to help caregivers overcome present bias by holding them accountable, or cognitive overload by making information more salient in the present. Text messages can harness social pressure and social norms to induce behaviors that may not be preferred by recipients (social norms in influencing behavior Bandiera et al. 2005). Text messages may also be a source of psychological or social connection with the perceived sender triggering a feeling that "someone" cares and more broadly hope (Duflo 2012).

With the rapid expansion in the prevalence of cell phones globally, the number of text message interventions have also increased. Results from existing ICT literature evaluating such policies' impacts on encouraging behavior change and improving wellbeing outcomes are mixed as they are often flawed by high cell phone number churn and low take-up due to cell coverage and intrahousehold usage of the phone. Nonetheless text message interventions have been used to encourage behavior change with evidence of some success in increasing breastfeeding (Jiang et al. 2014, Flax et al. 2014), use of micronutrients for children (Zhaou et al. 2016) and in non-health contexts to increase loan payment (Cadena et al. 2011, Karlan et al. 2013, 2014), and increase voter turnout (Aker et al. 2015). Similar interventions have had less success in increasing agricultural returns (Fafchamps and Minten 2012). This literature provides evidence of impacts on mostly self-reported behaviors.In most cases text messages are used to overcome present bias by reminding people of tasks they might otherwise put off until tomorrow. But debate remains on whether text messages can impact not only specific behaviors but also lead to meaningful change in health outcomes; no studies to date have shown impacts on anthropometric measures for children.

This research study uses a randomized control trial to test whether small behavioral nudges in the form of text messages can improve nutritional outcomes for children. Texting for Nutrition was a program that sent text messages to caregivers with children under three years of age. The text messages encouraged caregivers to use existing health services and put into practice behaviors to improve their children's nutrition such as attending regular health checkups, timely integration of solid foods, diet diversity, consumption of micronutrients, and good water and sanitation practices. Text messages were sent twice a week over 18 months.

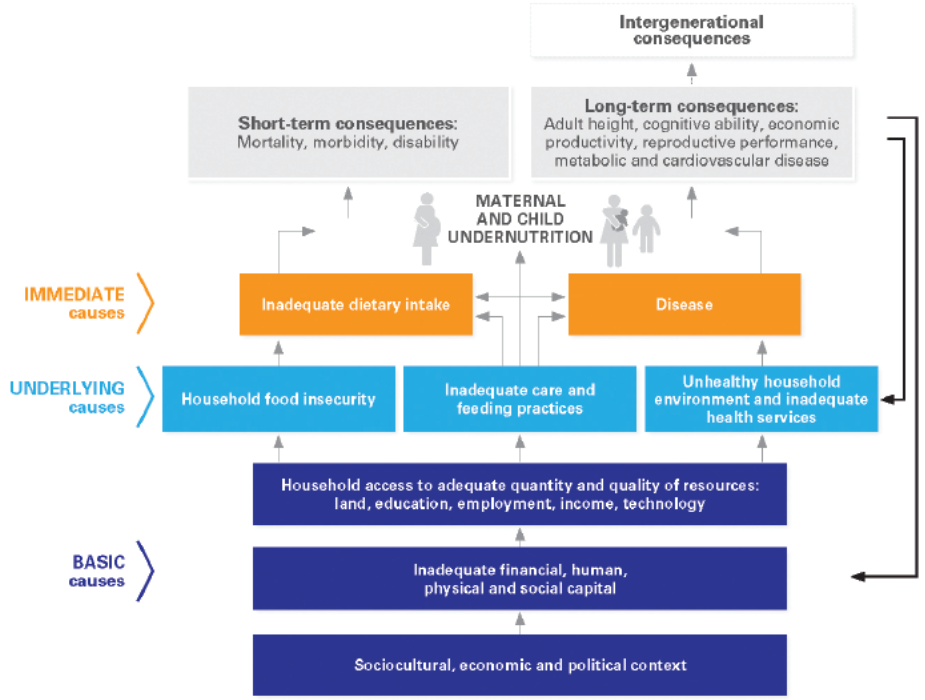
Using endline data collected five months after program completion (18 months after program initiation), we find that the Texting for Nutrition intervention had large and statistically significant impacts on improving child health and nutrition. Using an index of 9 potential illnesses, the treatment group was 9.3 percentage points less likely to have experienced illness in the last two weeks than the control group, representing a 23 percent decline in experienced symptoms. The full sample of children under six years of age, observed an increase in weight for height by .07 standard deviations. The subpopulation of children under two experienced larger gains in anthropometric measures with a .35 standard deviation increase in weight-for-age, a .32 standard deviation increase in weight-for-height, and a .31 standard deviation increase in BMI-for-age. These findings were all statistically significant and robust to controlling for additional characteristics. The intervention did not have any statistically significant effects on stunting.

II. A Review of the Literature

The *UNICEF Conceptual Framework of the Determinants of Child Undernutrition* defines optimal nutrition as being obtainable when children have affordable, diverse, nutrient-rich foods, receive appropriate maternal and child-care practices, have access to quality health services, and live in a healthy environment

including safe water, sanitation, and good hygiene practices. The framework identifies the immediate causes of undernutrition as inadequate dietary intake and disease. It identifies the underlying causes of these conditions and groups them into three broad categories of factors: food, health, and care, which are each affected by social, economic and political factors.

UNICEF CONCEPTUAL FRAMEWORK OF THE DETERMINANTS OF CHILD UNDERNUTRITION



The black arrows show that the consequences of undernutrition can feed back to the underlying and basic causes of undernutrition, perpetuating the cycle of undernutrition, poverty and inequities.

Source: Adapted from UNICEF, 1990.

The UNICEF framework has been applied to the Ecuadorean context to identify primary correlates with stunting both at the national and regional levels using 2014 data (Gutiérrez et al. 2018). This analysis identified that household consumption levels, being indigenous, growing up in high altitude areas, having more children under five years old in the household, no access to public water, and no bathroom in the household were all statistically significant factors correlated with higher rates of stunting. This study also identified the ages of 12 to 35 months as the range with highest levels of stunting. A mother's education level had been a significant factor in 2006 but was no longer so in 2014.

Achieving optimal nutrition requires both access to resources and caregiver agency to put these resources to use to achieve child health and development. A recent Lancet systematic review of evidence on maternal and child nutrition interventions (Bhutta et al. 2013) identified ten interventions that if implemented at 90 percent coverage could reduce nearly 15 percent of deaths of children under five. They include: folic acid supplementation or fortification prior to conception, maternal protein and calcium supplementation, multiple micronutrient supplementation in pregnancy, promotion of breastfeeding, appropriate complementary feeding, vitamin A supplementation in children 6-59 months of age, management of severe acute malnutrition, and management of moderate acute malnutrition. Each of these interventions are relevant to the Ecuadorean context. Their implementation would require access to adequate resources as well as caregiver behavior changes, so as to make decisions and take actions in line with achieving child health and nutrition goals.

Nutrition and health behavior change has been studied at length, particularly in the area of diet and exercise. Systematic reviews have identified that significant behavior change has been accomplished when digital interventions include education, goal setting, self-monitoring and involvement from authority figures (parents in the case of adolescent behavior change) (Rose et al. 2017). Social Cognitive Theory interventions, which include providing information of risks and benefits, targeting improving self-efficacy, goal setting, and social support to overcome barriers, have also been found to be effective to increase physical activity and encourage diet change (Stacey et al. 2014). Recent literature on large scale social and behavior change communication combining intensive interpersonal counseling (home visits) with mass media (TV and radio spots) and community mobilization (community meetings) have been shown to positively impact breast feeding and complementary feeding practices in Bangladesh, Ethiopia, Vietnam and Brazil (Kim et al. 2019, Kim et al. 2016, Menon et al. 2016, Rawat et al. 2017, Coutinho et al. 2013).

The focus of this research is on the use of text messages to change caregiver behaviors to improve child health. Text messages are a communications tool that can provide new information to inform decision making and reminders to keep information salient and encourage behaviors on the decisions caregivers may have already made, and help reinforce goals, and hold people accountable by encouraging specific behaviors. The channels through which messages may change behaviors can be informed by literature in the fields of behavioral economics and psychology that discuss several behavioral biases that influence peoples' actions.

Present Bias. (Akerlof 1991; O'Donoghue and Rabin 1999, 2001; Frederick et al. 2002) Text messages could combat present bias by reminding people, in the present, of decisions they have made in other time periods or about benefits they may experience in the future, making these future benefits more salient and reducing present bias.

Cognitive dissonance and emotions. (Lerner et al. 2015, Banerjee and Mullainathan 2008, 2010) Text message reminders may combat putting off thinking about difficult issues (cognitive dissonance and myopic behavior). These biases may be present in this context as parents may not want to think about a child's health if they don't know how to address problems they observe, text message reminders may bring these issues to mind.

New information upon which to act. The text messages may provide new information that informs decision making and behaviors. This is related to the larger literature on information campaigns attempting to change behaviors (Wakefield et al. 2010, La Ferrera et al. 2012). As well as the influence of media more generally on behaviors: television on children's school performance (Gentzkow and Shapiro 2008) adults' participation in social activities and trust (Olken 2009) female autonomy, school enrollment, and fertility (Jensen and Oster 2009) and radio soap opera on beliefs and norms Rwanda (Paluck 2009), voters' behavior (Gentzkow 2006; DellaVigna and Kaplan 2007).

Social norms or peer pressure. Text messages may harness social pressure and social norms to induce behaviors that may not be preferred by recipients (social norms in influencing behavior Bandiera et al. 2005).

Affinity for sender, trust, and positive encouragement. Underlying all of the text message interventions, may be a less visible mechanism at play of a psychological or social connection with the perceived sender that encourages hope, self-efficacy, or accountability making recipients feel that "someone" cares about them. (Duflo 2012)

With the rapid expansion in the prevalence of cell phones globally, the number of text message interventions have also increased. Results from existing ICT literature evaluating such policies' impacts

on encouraging behavior change and improving wellbeing outcomes are mixed as they are often flawed by high cell phone number churn and low take-up due to cell coverage and intrahousehold usage of the phone. Nonetheless there is a growing literature of interventions that have shown impacts in several fields.

In health, there have been positive impacts on increasing treatment adherence (antiretroviral therapy: Pop-Eleches et al. (2011), TB daily treatments: Nglazi et al. (2013)). In the area of child health and nutrition, randomized control trial studies have found that sending expectant mothers and mothers of newborn children text messages about breastfeeding led to statistically significantly longer median exclusive breastfeeding duration in China (Jiang et al. 2014), timely breastfeeding initiation and delayed introduction of water in Nigeria (Flax et al. 2014). Rokicki et al. (2017) show that providing information through text messages about sexual and reproductive health can increase reproductive health knowledge and reduce self-reported pregnancies among sexually active study participants.

In the area of savings, Dean Karlan with co-authors conducted a number of studies that provide evidence that text messages can help keep savings "top of mind." Karlan et al. (2014) showed that text messages about large expenditures clients hoped to make in the future, curbed smaller daily expenditures in the present. Karlan et al. (2013) and Cadena and Schoar (2011) also found that the use of reminders and particularly reminders with the names of loan agents, potentially harnessing fear or social pressure, increased on-time loan repayment.

More generally, cell phones have been shown to be a useful tool to gather agricultural information on market prices, weather, and agricultural practices through text messages or through mobile phone coverage expansion has been shown to have large impacts on sale prices and decisions by farmers and fishermen about when to sell and at what price (Jensen 2007, Aker 2010, Fafchamps et al. 2012, and Casaburi et al. 2016).

This literature provides evidence of impacts on mostly self-reported behaviors. No studies to date have shown impacts on anthropometric measures for children.

III. Background and Intervention

a. Background and context

This research took place in one of the worst performing provinces of Ecuador, in terms of child nutrition: Chimborazo, where 44 percent of children under five years of age were stunted in 2014. Lack of adequate access to quantity and quality resources was a reality for most families. Poverty affected 53 percent of households[4]. Poverty constrained the types of foods families could afford to purchase, and if families were farming, poverty often led them to sell nutritious foods instead of consuming them in the household.

Inadequate human and social capital also contributed to undernutrition in Chimborazo. Families were often unaware that their child was suffering from undernutrition and did not know what types of care and feeding practices could improve their child's health.[5]

[4] ECV 2014, author's calculation using national poverty line of $84.40 US dollars per capita income.

[5] The 2007 World Bank study, Nutritional Failure in Ecuador: Causes, Consequences, and Solutions identified that access to knowledge on good nutritional practices, mother's level of education, and access to health centers and to nutritional counseling, are all correlates of malnutrition. A mother's height and expectation regarding her child's height is highly relevant to stunting outcomes. Other things being equal, women who did not realize that their child was too small at birth are more likely to have a stunted child, today.

The sociocultural context was also highly relevant in Chimborazo. Forty-seven percent of the population in Chimborazo was indigenous[6]. Nationally, in 2014, indigenous children had almost two times the probability of being stunted. Findings from World Bank 2007 identified that challenges to improve nutrition outcomes specific to indigenous populations in Ecuador were driven by the intersectional incidence of higher rates of poverty, high rates of rural residence, language barriers to access health centers, poor quality of available services, and distrust of or a reluctance in seeking medical attention from non-indigenous providers. Field work,[7] collected in preparation for this study, showed that these challenges remained. We found that most children under three years of age in rural areas had attended few of the recommended regular health checkups for their age. Low levels of engagement with health workers contributed to a lack of knowledge on the part of caregivers and made public health campaigns promoted by health workers ineffective. As a result, vitamin and micronutrient supplement take-up was low and misinformation about adequate use was common.

Poor water quality and inadequate sanitation contributed to unhealthy household environments. In 2014, 51 percent of households reported drinking the water they had in the household without any form of treatment[8]. The 2010 census showed a large rural-urban divide, approximately 20 percent of rural households, in Chimborazo, did not have any type of bathroom or latrine (open defecation), compared to only 0.4 percent in urban households. The 2014 ECV data for the province of Chimborazo showed that this urban rural divergence persisted as only 26 percent of rural households had a water tap within the household, compared to 85 percent in urban areas. Having access to tap water within the household is extremely important for hand washing frequency and timing in relation to bathroom usage and food preparation. The 2012 DHS (ENSANUT in Spanish) captured self-reported frequency of handwashing[9] prior to eating, after using the bathroom, and the use of soap in hand-washing. In rural areas nationally, 58 percent of households reported washing hands after using the toilet; 44 percent reported always using soap when washing hands, and only 40 percent of households reported washing hands before eating.

Gutiérrez et al. 2018 applied the UNICEF framework of the determinants of child undernutrition to identify statistically significant factors correlated with higher rates of stunting nationally using the 2014 ECV data. They found the following characteristics to be significant: household consumption levels, being indigenous, growing up in high altitude areas, having more children under five years old in the household, no access to public water, and no bathroom in the household. They also identified the ages when the prevalence of stunting was greatest to be between 12 and 35 months.

b. Intervention

The provincial government of Chimborazo (GAD Chimborazo) together with the World Bank designed and implemented the *Texting for Nutrition* program to improve child nutrition by encouraging changes in caregiver behaviors. Caregivers faced a range of obstacles to achieving healthy nutrition for their children, the Texting for Nutrition program targeted 8 behaviors, which included:

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[6] ECV 2014, author's calculation.

[7] In 2013 and 2014, we conducted focus groups with local nutritionists, caregivers, and with government staff that conducted home visits.

[8] ECV 2014, author's calculation. Treatment includes filtration, chlorination, boiling, or purchasing water.

[9] The module focuses on risk factors for adolescent health; thus the sample is not representative of the caretaker population in Chimborazo. Still, it provides a useful proxy.

Figure 1: Targeted Behaviors

	Behavior	Theme
1	On-time visits to local health centers for well-baby check-ups at months 1, 2, 4, 6, 9, 12, 15, 18, and 24 or when a child was sick	Health visits
2	Consumption of nutritional supplements with a focus on a locally available iron supplement: *Chispas*	Nutritional supplements
3	Timely integration of solid foods for children at six months	Complementary feeding and diet diversity
4	Feeding diverse locally grown nutritious foods	
5	Regular hand washing by caregivers (prior to preparing food, after defecation, and with soap)	Water Sanitation and Hygiene
6	Consumption of potable water by children	
7	Maintaining clean cooking and food preparation spaces	
8	Exclusive breastfeeding from birth through six months of age	Age specific

For the purposes of this program and research caregivers in Chimborazo were defined as mothers, fathers or other adult care providers of children between the ages of 0 and 3 years and pregnant women at the time of registration. Caregivers could only register for the program if they had an active cell phone in their household[10].

Caregivers received text messages twice a week[11] in 4 rounds, beginning in January 2015 and ending in June 2016. Each round was between 6 and 13 weeks of text messages, with resting weeks in between rounds. In total, households received approximately 85 text messages.

The messages included a mix of content to encourage behaviors including new information, reminders to keep information "top-of-mind", positive encouragement to caregivers, and social norms language.[12] These content types were mixed throughout the different thematic types of messages. The days messages were sent varied by geographic location (canton) based on local market days. Market days were ideal days to receive the messages because caregivers were both more likely to have cell phone coverage and these were also days caregivers ran errands such as buying food for the household or going to health centers.

[10] According to the 2014 Encuesta de Calidad de Vida (ECV), cell phone ownership in Chimborazo was high: approximately 74% percent of households in rural areas and 92 percent in urban areas at least one member of the household owned a cell phone. Discussions with key informants revealed that among rural households in Chimborazo, men often carry and operate cell phones. Given that our target population for change is pregnant women and primary caregivers of children 0-3 (male or female), text message content was crafted to include both parents, and encourage all cell phone users to share messages received with their partners and family.

[11] Focus groups conducted, prior to text message development, with caregivers from Chimborazo, identified that the preferred frequency was twice a week and the ideal window of time to receive messages was between 4pm and 7pm. We used random assignment to assign the time of day within the 4-7pm window that each household would receive messages. A given household's assigned time was used for all messages sent throughout the entire program for that household.

[12] Prior to initiating Texting for Nutrition, the team conducted six focus groups with caregivers in Chimborazo and key informants. The focus groups applied a qualitative research methodology to explore the types of text message content that caregivers would like to receive, strategies for framing, wording and preferred timing and frequency.

IV. Experimental Design

We used a randomized control trial design to estimate the causal impacts of the Texting for Nutrition intervention. The evaluation was designed to respond to two primary research questions:

1) What was the impact of the Texting for Nutrition intervention on the nutrition and health status of children?
2) Was the impact of the Texting for Nutrition intervention greater for some types of message content as compared to others?

To address these questions, the evaluation used random assignment at multiple levels. The first level was in the assignment to control and treatment groups clustered at the *parroquia* level. Randomization at the *parroquia* level was employed to limit the risk of spillovers[13]. Randomization at this level was done using pairwise matching, a technique that was encouraged by Bruhn and McKenzie (2009) to enhance probability of balance in studies with small numbers of clusters (54 in this study). Using this methodology, we first created pairs of *parroquias* that were very similar along several observable characteristics, and then randomly assigned treatment within each pair of parroquias. We conducted the pairwise match using the characteristics listed in

[13] In rural areas of Chimborazo, *parroquias*, for the most part, have their own town center, which are often a 15-20 minute drive from neighboring *parroquia town centers*.

Figure **1**.

Figure 2: Variables Used in Parroquia Level Pairwise Matching

	VARIABLE	Description
1	Urban	Parroquia average number of urban residents (2010 Census)
2	Age	Parroquia average age of children (in months) who registered for the program and resided in qualifying households. (Program Registration Documentation)
3	Edu_second	Parroquia average number of households that at least one member that has completed secondary school or more. (Program Registration Documentation)
4	Check_ups	Parroquia average for children 0-35 months old that have had their last health checkup as recommended by the local health guidelines for their age. (TDI)
5	Chispaz	Parroquia average number of households that responded affirmatively to having a child receive a nutritional supplement yesterday (Iron or Chispas) (TDI)
6	Diarrhea	Parroquia average number of households that responded affirmatively to having a child with diarrhea yesterday. (TDI)
7	Lact_yes	Parroquia average number of households that responded affirmatively to having a child that consumed breast milk yesterday (TDI)
8	Pov	Parroquia average number of households that did not satisfy the basic needs poverty line (INEC)
9	Ind	Parroquia average number of households of people that self-identify as indigenous (2010 Census)
10	total_pop	Parroquia total population (2010 Census)
11	pc_salud	Number of health centers per capita in each parroquia (Administrative data; centro_salud/total_pop)

We randomly assigned one parroquia within each matched pair to treatment and one to control. This resulted in treatment and control groups each with 27 parroquias.

This level of assignment allowed for the estimation of overall program impact using a first stage regression specification with endline data only to estimate the following equation:

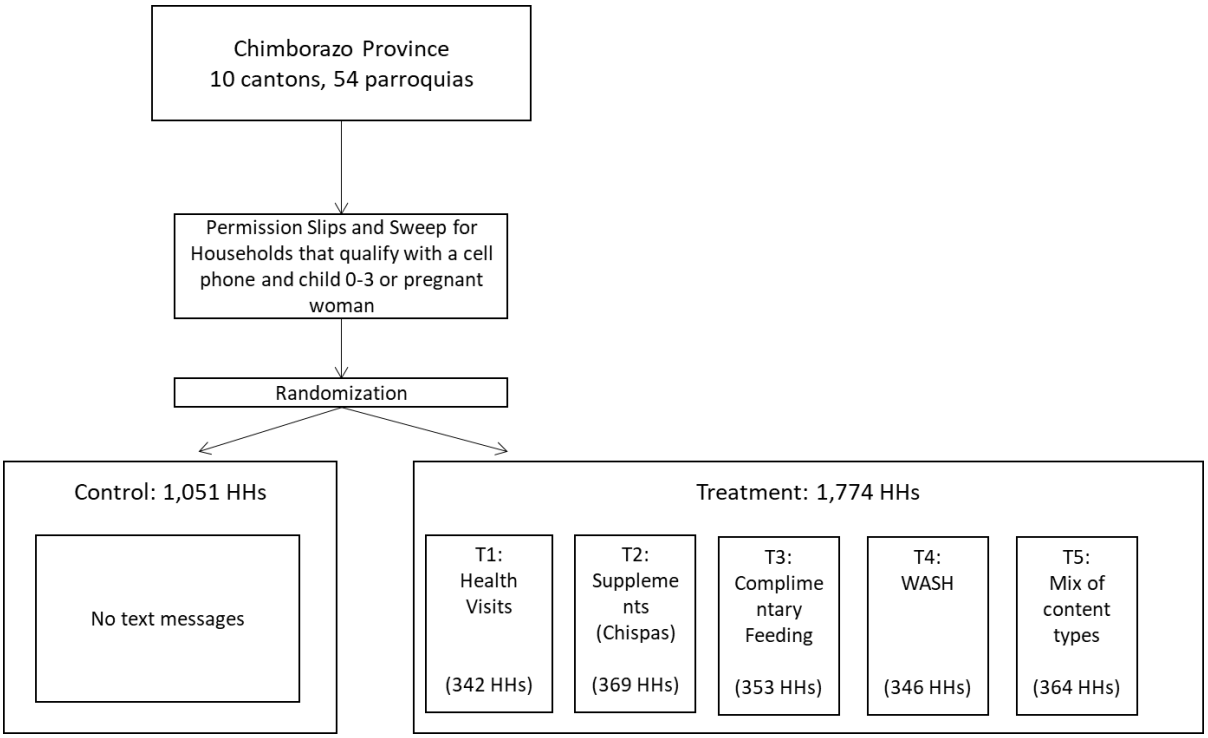
Equation 1

$$Y_i = \alpha + \beta_1 treat_{ip} \underline{+ \delta_1 i.pair + \delta_2} X_i + \varepsilon_{ip}$$

In this equation, the coefficient β_1 represents the effect of receiving the text message intervention for the treatment group – grouping all treatment arms into one treatment group. We include pair fixed effects (a dummy for each of the 27 pairs less one). X_i represents individual level controls for characteristics for which the treatment and control groups were unbalanced at the individual level. At this level, we use robust standard errors clustered at the parroquia level.

The second level of randomization employed was at the household level. We randomly assigned households, within the treatment group, into five treatment arms based on text message content themes: T1: Health Visits, T2: Nutritional Supplements, T3: Complementary Feeding and Diet Diversity, T4: Water Sanitation and Hygiene, and T5: A mix of text message contents from T1-T4. This random assignment was stratified using three dichotomous variables: whether the household had a child under one year of age at baseline, whether the household had one member or more that had completed secondary school at baseline, and whether the household lived in a parroquia with a majority urban population at baseline.

Figure 3: Trial Design



We use the household level random assignment to address our second research question by comparing the effects of each treatment arm to the control group. We use the following equation to estimate the effects of each treatment arm:

Equation 2

$$Y_i = \alpha + \beta_1 treat1_p + \beta_2 treat2_p + \beta_3 treat3_p + \beta_4 treat4_p + \beta_4 treat5_p + \delta_1 i.pair + \underline{\delta_2 X_i} + \varepsilon_{ip}$$

In this equation, the left-out group is the control group. Each of the β coefficients represent the estimate of the effects of a given treatment arm compared to the control group. At this level, we include pair fixed effects and controls for individual level characteristics that were not balanced at baseline. In addition, we also include the three baseline characteristics that we used in the stratified random assignment into treatment arms: if the household had a child under one year of age, if the household had at least one member that completed secondary school, and if the household lived in an urban area. We use robust standard errors clustered at the parroquia level.

V. Data Collection

c. Sampling Strategy

The first step in designing the follow-up sample was establishing how we would determine the sample structure. Because this study was designed to test the effects of the intervention on both child nutrition and health outcomes as well as caregiver behaviors, we had to make a choice in cases where the child had changed caregivers or if the caregiver no longer lived with the child, whether we would "follow the child", "follow the caregiver" or both. Due to financial constraints, we were not able to follow both. We decided to "follow the child" because our primary interest was understanding the health and nutrition impacts for

children. With this in mind, we established exclusion criteria to match this decision and also based on the quality of the initial program registration data, which was the basis for follow-up surveys.

1) Households were excluded from the sample if there were no reference children's names listed.
    a. This was the case for enrolled pregnant women who did not have any other children under the age of 3 living in the household at the time of enrollment. 254 observations satisfied this exclusion criteria. This was done because we did not have a reference child to apply the "follow the child" rule.
    b. This was also the case for 12 households that did not have any children's names listed on the enrollment form (due to poor registration data).
2) Households with absolutely no address information (due to poor registration data) were dropped from the sample. 46 observations satisfied the criteria.
3) Households were dropped from our sample (prior to applying the intervention) if registered cell phone numbers were duplicates with other households 29 observations satisfied this exclusion criteria.

In total 338 households were excluded from the sample frame. Leaving a sample frame of 4,337 households.

The selection of the sample for follow-up surveys within the control and treatment groups was done with the objective of preserving a maximum number of clusters in the sample (54). To do this, we applied a rule for random selection within each treatment arm and control group. Parroquias with 60 or fewer observations would retain all observations in the sample. Parroquias that had a higher number of observations would have a random selection to identify which observations would be included in the sample. Within the parroquias that had more than 60 observations we used their proportional weights in the full sample to determine the number of observations selected. Within these criteria random selection was applied.

In addition to the random selection for our sample, we also selected replacements, when there was "space" within each parroquia to do so. In total from the sample frame of 4,337 households that satisfied the inclusion criteria we selected a sample of 3,000 households and 881 replacement households.

d. Sample design

Attrition in the formal sense does not exist because we are presenting the results of a single data collection round. However, the replacement of households within our sample due to challenges locating the reference child and their caregiver influence the population that is represented in our sample. Replacements were used in the following cases:

- Duplicate cases (within the original registration data): 165 reference children; 4 percent[14]
- Incorrect address: 213 reference children; 6 percent
- Reference child moved outside of the province: 194 reference children; 5 percent
- Incomplete survey: 66 reference children; 2 percent
- Caregiver refused to participate: 45 reference children; 1 percent of the original sample
- Caregiver could not be found after three home visits and tracking phone calls: 19 reference children; 0.5 percent
- Reference child had passed away: 7 reference children; 0.2 percent of the original sample

[14] Percents are calculates as a share of the total sample that was attempted to be reached: 3711 reference children attempted to be reached combining original sample and replacements used

- Problems in the data programmed into the tablet: 2 reference children; 0.1 percent of the original sample

From here forward, we present all results using the sample collected in the follow-up survey with a sample size of 2,825 households corresponding to a total of 3,765 children living in the house under six years of age.

VI. Balance and Descriptive Statistics

We test balance both using limited baseline data as well as using endline data along characteristics that we do not believe should be affected by the program. We estimate differences across our treatment and control groups (Table 1 and Table 2) and across treatment arms as compared to the control group. At the treatment and control level we test for differences across ten characteristics using the baseline and fifteen characteristics we believe will not change over time using endline data. In the baseline data we find that age of the child is statistically significantly higher in treatment by one month, on average. However, age at endline is no longer statistically significantly different. We believe this difference may be due to measurement error in the enrollment baseline however we include a control for child's age in the regression nonetheless. Using endline data we find that only one characteristic is statistically significantly different at the 10 percent level. Treatment households were 6 percentage points more likely to have had an improved roof. However, when we look at other characteristics of household infrastructure such as having a bathroom, a dirt floor, or public water connectivity as well as indicators of economic status such as poverty or receiving the conditional cash transfer program, we see no statistically significant differences and the sign of these coefficients do not support a hypothesis that the treatment households are financially better off (as could be indicated by the improved roof indicator alone). This leads us to conclude that the difference in improved roof may be due to statistical probability given that we are testing fifteen outcomes. Nonetheless, we do include a control for this characteristic in our regression specification as well.

At the treatment arm level, we also test for differences across fifteen characteristics from endline and find some statistically significant differences. We find that the statistically significant difference observed at the treatment control level is driven by higher rates of improved roofs in T2 and T3. However, there are no differences in other indicators of infrastructure or economic status that would lead us to believe that T2 or T3 are economically better off. We do find that T1 has a higher rate of not having a bathroom, which is statistically significant at the five percent level. We also find that children in T2 and T4 on average are one month older than the comparison group, a difference with potentially important implications for anthropometric measures. Given the number of outcomes that we are testing and a lack of consistency across families of outcomes to tell a consistent story of a lack of balance we do not think these differences pose a threat to the validity of our identification strategy. However, on the treatment arm level we include controls for not having a bathroom, improved roof, and a dummy age groups by year, to control for any differences stemming from these characteristics in our results.

These balance tests support the causal identification using equations one and two presented in the identification strategy section. These tests of balance show that the control group and the treatment groups are similar along almost all characteristics that we tested for in both the ex-anti balance tests and at the time of the household follow-up survey. These tests are strong evidence that the randomization worked in creating balanced groups and that differences observed in outcomes of interest are driven by the program intervention not by alternative factors.

Table 1: Balance at the Treatment and Control level – Baseline data

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	urban	ANY registered HH member completed Secondary School	Age of caregiver1	number of pregnant women registered in HH	number of children under 3 registered in HH	Dummy for household having a child under 1 (at intervention start December 2014)	Age of child in months (at intervention start December 2014)	female child	gestation weeks	duration of gestation estimated by December 10 (weeks)
treat	-0.0450	-0.0477	0.6844	-0.0008	0.0186	0.0011	0.8915*	-0.0072	-4.3165	-3.9340
	(0.0467)	(0.0396)	(0.5728)	(0.0065)	(0.0216)	(0.0066)	(0.4545)	(0.0092)	(3.1895)	(3.8561)
Constant	0.6068***	0.6882***	28.0811***	0.0164***	1.1052***	0.0313***	24.2983***	0.5002***	29.1583***	60.4670***
	(0.0294)	(0.0503)	(0.3598)	(0.0038)	(0.0332)	(0.0096)	(0.8212)	(0.0177)	(3.1119)	(2.8416)
Observations	2,825	1,960	2,002	2,825	2,825	2,825	3,099	2,800	61	61
R-squared	0.3133	0.1751	0.0036	0.0086	0.0127	0.0088	0.0147	0.0048	0.3008	0.3051
Pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control Mean	0.215	0.394	27.93	0.0209	1.114	0.0295	24.23	0.489	29.25	60.20

Robust standard errors in parentheses

Table 2: Balance at the Treatment and Control level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
VARIABLES	Urban	Female child	Female head of HH	Indigenous	Complete secondary at least 1 household member	Number of people in HH	Child's age in months	Per-capita labor income	Poor (US$ 84.4 per capita per month)	BDH	Distance to health center in minutes	Public water access	No bathroom	Improved roof	Dirt floor
Treat	-0.1184	0.0049	-0.0199	0.0764	0.0009	0.0672	0.6739	11.1610	-0.0278	0.0167	4.2940	-0.0410	0.0281	0.0614*	0.0112
	(0.1001)	(0.0087)	(0.0201)	(0.0763)	(0.0333)	(0.1765)	(0.5457)	(10.3249)	(0.0529)	(0.0409)	(6.2948)	(0.0458)	(0.0186)	(0.0348)	(0.0372)
Constant	1.0541***	0.5170***	0.2103***	0.1407**	0.8003***	4.3689***	41.7344***	146.4604***	0.3697***	0.0385	28.0807***	0.9432***	-0.0117	0.8901***	0.0017
	(0.0658)	(0.0098)	(0.0137)	(0.0573)	(0.0336)	(0.1171)	(0.5342)	(8.1449)	(0.0285)	(0.0232)	(4.8397)	(0.0300)	(0.0169)	(0.0312)	(0.0213)
Control Mean	0.5167	0.4993	0.1551	0.4158	0.5385	4.7831	41.583	94.817	0.5521	0.254	40.176	0.6746	0.0571	0.7469	0.1503
Observations	2,825	3,765	2,825	2,825	2,825	2,825	3,751	2,543	2,543	2,822	3,749	2,825	2,824	2,825	2,825
R-squared	0.5689	0.0057	0.0308	0.3750	0.1477	0.1088	0.0144	0.0811	0.1452	0.2156	0.0139	0.3294	0.0845	0.1342	0.1559
Pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses. Clustered at the parroquia level.
*** p<0.01, ** p<0.05, * p<0.1

Table 3: Balance at the Treatment Arm Level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
VARIABLES	Urban	Female child	Female head of HH	Indigenous	Complete secondary at least 1 household member	Number of people in HH	Child's age in months	Per-capita labor income	Poor (US$ 84.4 per capita per month)	BDH	Distance to health center in minutes	Public water access	No bathroom	Improved roof	Dirt floor
t1: health visits	-0.0828	0.0169	-0.0297	0.0543	-0.0430	-0.0623	-0.3118	7.7608	-0.0418	0.0246	8.4345	-0.0756	0.0441**	0.0424	0.0339
	(0.0878)	(0.0172)	(0.0221)	(0.0698)	(0.0292)	(0.1716)	(0.7039)	(8.0635)	(0.0473)	(0.0441)	(9.4890)	(0.0464)	(0.0200)	(0.0325)	(0.0403)
t2: supplements (Chis	-0.1040	0.0134	-0.0192	0.0229	0.0251	-0.0389	1.2238**	7.4514	-0.0293	0.0153	22.3376*	-0.0426	0.0142	0.0688*	0.0267
	(0.0804)	(0.0285)	(0.0242)	(0.0716)	(0.0269)	(0.1959)	(0.6046)	(8.9375)	(0.0475)	(0.0400)	(11.5038)	(0.0441)	(0.0218)	(0.0354)	(0.0369)
t3: complimentary fee	-0.0641	0.0119	-0.0076	0.0428	0.0410	-0.0850	0.6979	16.1063	-0.0778	0.0029	-2.5201	-0.0240	0.0378	0.0542*	-0.0046
	(0.0840)	(0.0276)	(0.0254)	(0.0696)	(0.0378)	(0.1937)	(0.8635)	(10.9463)	(0.0625)	(0.0408)	(6.5629)	(0.0445)	(0.0251)	(0.0309)	(0.0397)
t4: WASH	-0.0775	-0.0302	-0.0137	0.0707	0.0221	0.1592	1.1908*	22.1379	-0.0021	-0.0135	-3.1774	-0.0650	0.0249	0.0466	-0.0042
	(0.0825)	(0.0181)	(0.0283)	(0.0661)	(0.0346)	(0.1689)	(0.6369)	(16.1395)	(0.0499)	(0.0460)	(6.6494)	(0.0434)	(0.0220)	(0.0279)	(0.0374)
t5: mix of content type	-0.0875	0.0086	0.0057	0.0567	0.0029	0.1687	-0.1800	2.5142	0.0091	0.0276	-7.4305	-0.0358	0.0175	0.0463	-0.0210
	(0.0851)	(0.0245)	(0.0183)	(0.0657)	(0.0268)	(0.1819)	(0.7078)	(7.8861)	(0.0491)	(0.0398)	(8.1507)	(0.0436)	(0.0184)	(0.0287)	(0.0384)
Constant	0.3563***	0.5427***	0.0676*	0.6695***	0.6413***	5.0507***	44.6885***	140.8199***	0.3976***	0.1349***	46.4632***	1.0980***	-0.0021	1.0884***	0.1019***
	(0.0962)	(0.0221)	(0.0374)	(0.1321)	(0.0469)	(0.1959)	(1.1129)	(11.3156)	(0.0685)	(0.0387)	(10.3669)	(0.0610)	(0.0219)	(0.0539)	(0.0292)
Control Mean	0.5167	0.4993	0.1551	0.4158	0.5385	4.7831	41.583	94.817	0.5521	0.254	40.176	0.6746	0.0571	0.7469	0.1503
Observations	2,825	3,765	2,825	2,825	2,825	2,825	3,751	2,543	2,543	2,822	3,749	2,825	2,824	2,825	2,825
R-squared	0.6353	0.0068	0.0383	0.4215	0.2668	0.1281	0.0187	0.1049	0.1861	0.2375	0.0177	0.3393	0.0906	0.1460	0.1691
Pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Strata Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

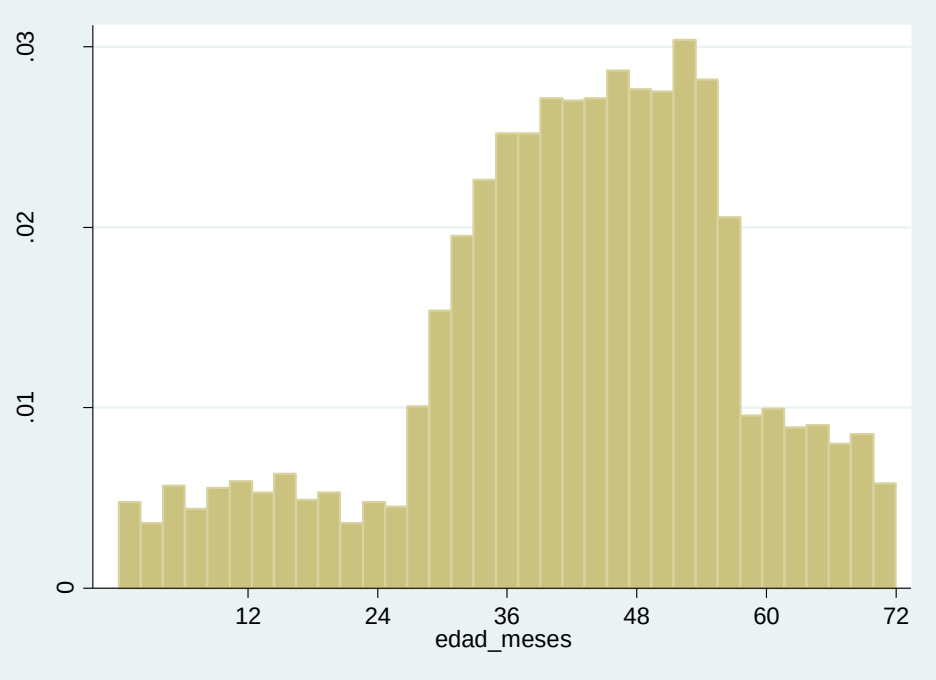
Robust standard errors in parentheses. Clustered at the parroquia level.
*** p<0.01, ** p<0.05, * p<0.1

In these tests, we also learn about the demographic composition of our sample. Just over half of our total sample lived in rural areas (54%). Approximately fifteen percent of our sample households were headed by women. Almost half of our sample (45%) self-identified as indigenous. Fifty-four percent of our sample lives in a household where at least one member had completed secondary school including high school. The average number of household members was 5.

Average total labor income per household was USD $ 431 per month and average per capita labor income was USD $ 100. When we apply the 2014 national poverty line of per capita income of USD $ 84.40 a month and USD $ 47.50 dollars a month for extreme poverty to our sample, we find that 54 percent of our sample households were poor and 30 percent of our sample households were living in extreme poverty. Twenty-six percent of households received the national conditional cash transfer *Bono de Desarrollo Humano* (BDH).

The average age of the children in our sample was 42 months or three and a half years of age. The distribution shows that most of the children in our sample were above the age of two, which is in line with the fact that the program was targeted towards children under three years of age at the time of registration, and the follow-up survey was conducted approximately two years after initial enrollment.

Figure 4: Child Sample age in months



By comparing these characteristics to survey results from national household surveys ECV and ENSANUT, we learn more about how our sample compares to the full Chimborazo population, which the national surveys aim to represent. In Figure 5, we present a comparison of means along each of the demographic characteristics to the ECV and ENSANUT surveys using the Chimborazo province average as the point of comparison for each survey. In the case of the ECV survey the Chimborazo province is comprised of 4,159 observations and, in the case of ENSANUT, it is comprised of 2,172 observations. In both surveys, the samples were designed to be representative at the province level. In the case of ENSANUT, it has a particular focus on representative of the under-five child population rather than the full age range.

For most factors, the sample in our endline survey is quite similar to the Chimborazo sample in the national surveys. The differences that exist are in the average number of household members - in our sample the number of household members is much higher than the national surveys and that the labor income levels of our sample also seem to be much higher. We believe that these two factors are related to the targeting of the program, given its focus on households with young children and households that owned a cell phone at the time of enrollment. It is interesting to note with the rapid expansion of cell phone coverage in 2014 at the time of program enrollment owning a cell phone in this context was an indicator of higher economic status.

Figure 5: Comparative statistics with national household surveys

Variables	Texting for Nutrition	ECV 2014	ENSANUT 2012
Urban	0.4563	0.2674	0.4194
Female head of HH	0.1476	0.2568	0.1298
Indigenous	0.4499	0.4677	0.3108
At least one HH member completed secondary school (including high school) or more	0.5402	0.5905	0.3161
Number of people in HH	4.76	2.84	3.06
Total labor income per HH	430.78	83.68	---
Per capita total labor income	100.47	37.65	---
Connected to the public water network	0.6510	0.6785	0.8849
HH does not have any type of bathroom facility	0.0772	0.1272	0.07
Improved roof	0.7752	0.7165	0.7113
Dirt floor	0.1558	0.1832	0.1262
Cook with charcoal or wood	0.1887	0.2581	0.1008
Own their home	0.5366	0.7461	0.6427

VII. Results

In this section, we present the results for our primary outcomes of interest: anthropometric measures

In this section, we present the results for our primary outcomes of interest: anthropometric measures and other indicators of child health. We present these results using equations 1 and 2. Equation 1 estimates the effect of the intervention at the programmatic level, grouping all treatment arms together. Equation 2 estimates the effects at the treatment arm level, comparing each treatment arm to the control group. For this analysis, we use endline data only.

Anthropometric Indicators

Table 4 shows the estimates of the effects of the Texting for Nutrition program on anthropometric measures. The program on average increased the weight-for-height z-score and the BMI -for-age z-score by .07 standard deviations in the full sample population of children (under six) that had anthropometric measures successfully taken, approximately 3,220 children[15]. These impacts are significant at the 5

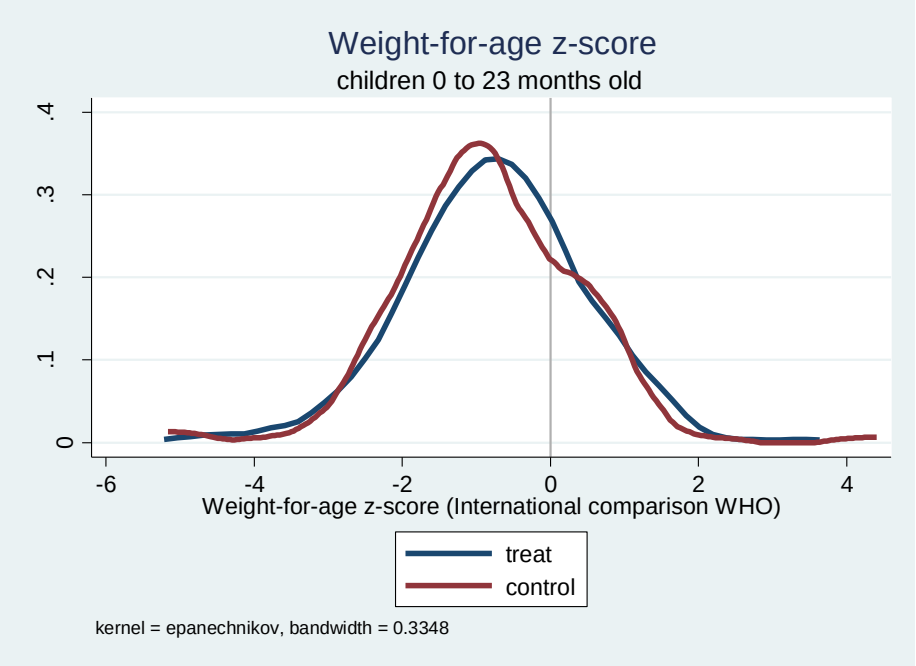
[15] In calculating and reporting the anthropometric measures, we eliminate the extreme values according to WHO recommendations at the 5 or 6 standard deviations from the mean depending on the indicator. This is one reason the sample size of children changes from indicator to indicator in Table 9. Another factor that changes the underlying sample size is successful measurement according to protocol could have been completed successfully in one indicator and not the other.

percent level. However, we also can see that the measurement of weight-for-height z-score in our sample is imprecise as the 95 percent confidence interval is .0022 to .1417. There are no statistically significant changes for weight-for-age z-score, height-for-age z-scores, or stunting[16] for the full sample population.

The impacts in anthropometric measures are larger for the subsample of the population that is under two years of age. For the under two subsample of approximately four hundred children, we observe an increase in weight-for-age z-scores of 0.35 standard deviations, statistically significant at the ten percent level (95% CI: -.0537, .7605). We also observe increases in weight-for-height and BMI-for-age of 0.31 standard deviations for the under two subpopulations, both statistically significant at the 5 percent level (weight-for-height 95% CI: .0737, .5581 and BMI for age 95% CI: .0505, .5679). Again, we see wide confidence intervals indicating these measures are not very precise. Nonetheless, we believe these impacts to be meaningful and almost certainly all positive.

Weight-for-age, weight-for-height, and BMI are all weight-based indicators, for which average increases do not necessarily indicate improved nutrition or health. However, in this case we observe that these changes are affecting children that are between zero and negative three standard deviations below the international norm z-score of zero. This means the increases in weight are positively affecting children, shifting their average weight indicators closer to the healthy levels.

Figure 6: Weight-for-age z-scores for children 0 to 23 months



There are some measurement considerations important for interpretation of the results in weight based indicators. Weight based anthropometric measures pick up shorter term changes. Some reasons why the under-two-population may observe larger changes than the average of older and younger populations combined is because the under two population's weight is more quickly affected by small changes in diet and health. The under-two-population, however, is highly determinant of longer-term health and

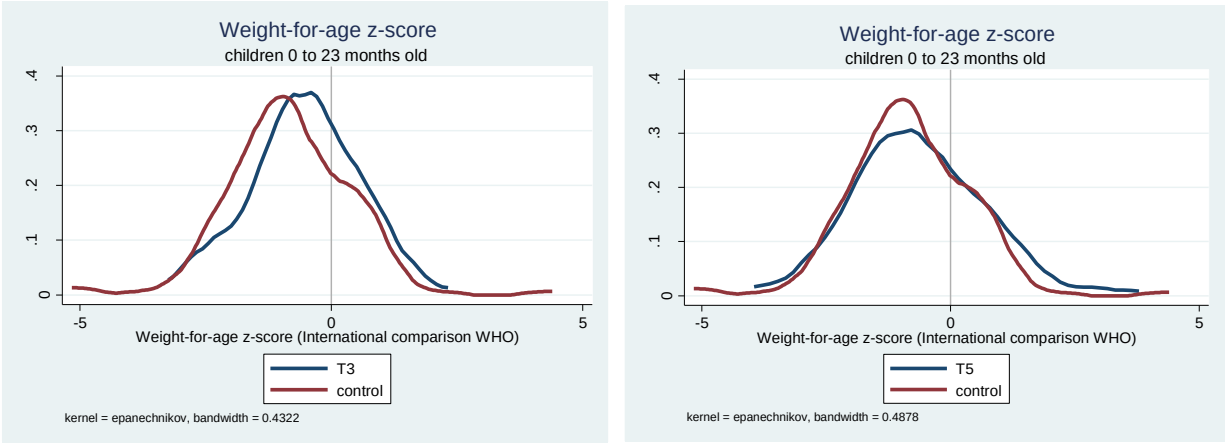
[16] Stunting is defined as having a length for height for age z-score less than 2 standard deviations below the mean using international WHO standard calculations for children under five years of age.

nutrition outcomes, considered part of the "window of opportunity" where nutrition scholars have shown that chronic malnutrition and stunting at this age has long lasting impacts on long term health and development (*reference*). Research has also shown weight-based anthropometric measures to be correlated with longer term indicators of health and nutrition such as stunting (WHO 2010, WHO 1997). For these reasons, improvements in weight-for-height and weight-for-age, while representative of short-term gains, are import indicators for the population in Chimborazo, where stunting is extremely prevalent. In our full sample, we observe an average stunting rate of 46 percent with no statistically significant differences between treatment and control and high levels of negative correlation between weight measures and stunting (higher weights correlated with lower stunting).

In Table 5, we present estimates that compare the effects of the different treatment arms on anthropometric measures to the control group. Here we can see that the average changes we observe in weight-for-height and BMI-for-age in the full child population (under six) at the programmatic level are predominantly being driven by increases in treatment arm 5 (T5: mixed thematic messages) with .10 and .12 standard deviation increases in weight-for-height and BMI for age z-scores respectively.

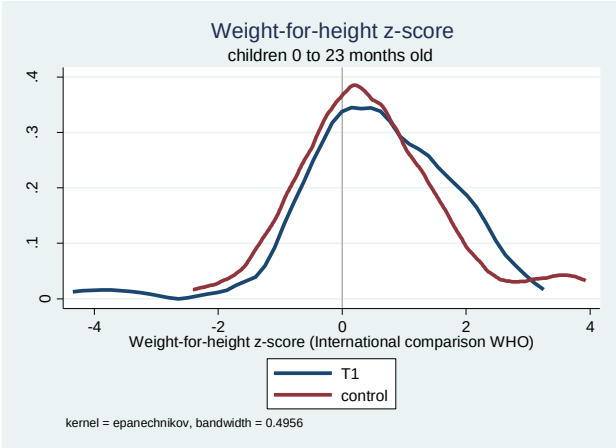
The under two population improvements in weight-for-age, are being driven by treatment arm 3 (T3: diet diversity and on time complementary feeding messages) and treatment arm 5 with a .47 and .41 standard deviation increase respectively as compared to the control mean. The control mean is .84 standard deviations below zero, indicating that average children are almost one standard deviation below the international healthy standard. Improvements in weight for age in T3 and T5 bring these treatment arms' average closer to the international norm of zero and are both statistically significant at the ten percent level.

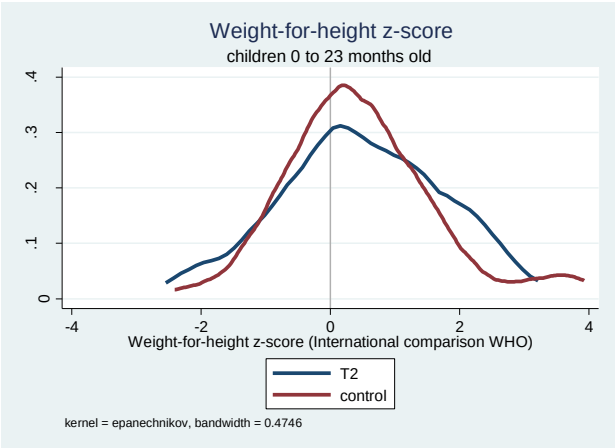
Figure 7: Weight-for-age z-scores - T3 and T5



At the treatment arm level, we also observe statistically significant increases in weight-for-height z-scores for treatment arm one (T1: Regular health checkups), treatment arm two (T2: micronutrient consumption), and T5. For this outcome, in each treatment arm, where statistically significant effects exist, the texting intervention reduces the number of children below the international norm for weight-for-height bringing more children into the normal or positive range. However, for T1 and T2 the increases in weight-for-height are also experienced at the high end of the weight-for-height distribution. In other words, there are also more children in the 1-3 standard deviations above the mean range in T1 and T2 than in control. The effects in BMI-for-age are similar (see **Table 5 : Anthropometric Results Treatment Arm Level Table 5**).

Figure 8: Weight-for-height z-score – T1, T2, and T5





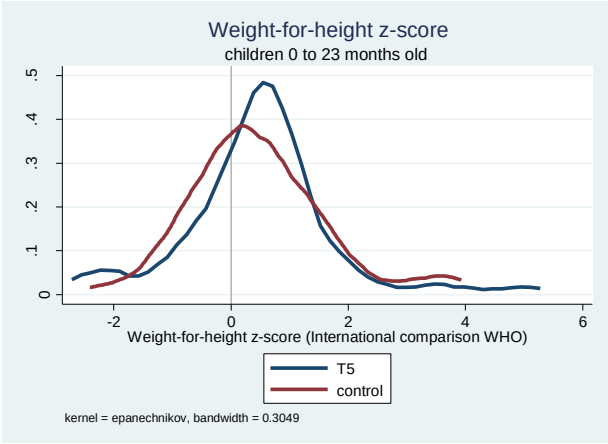


Table 4: Anthropometric Results at the Program Level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
						Under two years of age						
VARIABLES	Weight-for-age z-score	Height-for-age z-score	Weight-for-height z-score	BMI-for-age z-score	Stunting for children under 5 years of age	Weight-for-age z-score (0 - 23 months)	Height-for-age z-score (0 - 23 months)	Weight-for-Height z-score (0 - 23 months)	BMI-for-age z-score (0 - 23 months)	Head circumference-for-age z-score (0 - 23 months)	Stunting for children under 2 years of age	Stunting for FEMALE children under 2 years of age
Treat	0.0103	-0.0719	0.0720**	0.0741**	0.0260	0.3534*	0.2675	0.3159**	0.3092**	0.3180	-0.0552	-0.0708
	(0.0797)	(0.1111)	(0.0348)	(0.0334)	(0.0367)	(0.2020)	(0.2159)	(0.1202)	(0.1284)	(0.2585)	(0.0610)	(0.0918)
Constant	-0.5054***	-1.4517***	0.5038***	0.6232***	0.3134***	-0.7011**	-1.7268***	0.3693	0.4443**	-1.5987***	0.4582***	0.4755***
	(0.0677)	(0.0873)	(0.0395)	(0.0386)	(0.0328)	(0.3351)	(0.3334)	(0.2468)	(0.2083)	(0.4719)	(0.0882)	(0.1248)
Control Mean	-0.6951	-1.858	0.5684	0.7381	0.4491	-0.8414	-2.1299	0.457	0.5935	-0.843	0.5664	0.5733
Observations	3,240	3,233	3,274	3,220	3,207	416	411	412	412	364	411	219
R-squared	0.0450	0.1158	0.0242	0.0348	0.1091	0.1058	0.1277	0.0870	0.0814	0.0843	0.1153	0.2219
Pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unbalanced controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses. Clustered at the parroquia level. All anthropometric measures censored at 5 or 6 standard deviations according to WHO standards.
*** p<0.01, ** p<0.05, * p<0.1

Table 5 : Anthropometric Results Treatment Arm Level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
						Under two years of age						
VARIABLES	Weight-for-age z-score	Height-for-age z-score	Weight-for-height z-score	BMI-for-age z-score	Stunting for children under 5 years of age	Weight-for-age z-score (0 - 23 months)	Height-for-age z-score (0 - 23 months)	Weight-for-Height z-score (0 - 23 months)	BMI-for-age z-score (0 - 23 months)	Head circumference-for-age z-score (0 - 23 months)	Stunting for children under 2 years of age	Stunting for FEMALE children under 2 years of age
t1: health visits	0.0092	-0.1052	0.0766	0.0825	0.0316	0.1563	-0.1090	0.3712***	0.3880***	-0.4571	0.0325	-0.0878
	(0.0682)	(0.0958)	(0.0515)	(0.0508)	(0.0359)	(0.2101)	(0.2368)	(0.1300)	(0.1396)	(0.4107)	(0.0662)	(0.1042)
t2: supplements (Chispas)	0.0146	-0.0469	0.0516	0.0680	0.0147	0.3171	0.2373	0.2545*	0.3935**	0.7646**	-0.0406	0.0834
	(0.0721)	(0.0977)	(0.0563)	(0.0568)	(0.0323)	(0.2147)	(0.2671)	(0.1332)	(0.1507)	(0.3327)	(0.0744)	(0.1184)
t3: complimentary feeding	0.0952	0.0641	0.0586	0.0495	-0.0197	0.4686*	0.3933	0.2757	0.2450	0.2994	-0.0919	-0.1359
	(0.0722)	(0.0871)	(0.0565)	(0.0561)	(0.0318)	(0.2431)	(0.2775)	(0.1832)	(0.1699)	(0.4308)	(0.0800)	(0.1081)
t4: WASH	-0.0095	-0.0513	0.0557	0.0699	0.0211	0.0552	0.0201	0.0987	0.1591	0.2352	0.0154	-0.0311
	(0.0945)	(0.1056)	(0.0598)	(0.0522)	(0.0337)	(0.2310)	(0.2380)	(0.1475)	(0.1626)	(0.3826)	(0.0634)	(0.1207)
t5: mix of content types	0.0408	-0.0703	0.0997*	0.1217**	0.0319	0.4158*	0.3841	0.2803*	0.3597*	0.5351*	-0.0829	-0.1190
	(0.0822)	(0.0874)	(0.0547)	(0.0501)	(0.0290)	(0.2357)	(0.2767)	(0.1655)	(0.1988)	(0.2900)	(0.0659)	(0.0953)
Constant	-0.5155***	-1.5310***	0.9082***	0.5297***	0.4322***	-0.5285	-1.5469***	0.7837***	0.4580*	-1.3311*	0.5288***	0.8114***
	(0.1791)	(0.2134)	(0.1555)	(0.1787)	(0.0677)	(0.3600)	(0.3519)	(0.2740)	(0.2650)	(0.7398)	(0.1180)	(0.2454)
Control Mean	-0.6951	-1.858	0.5684	0.7381	0.4491	-0.8414	-2.1299	0.457	0.5935	-0.843	0.5664	0.5733
Observations	3,240	3,233	3,222	3,220	3,207	416	411	412	412	364	411	219
R-squared	0.0695	0.1681	0.0455	0.0556	0.1416	0.1651	0.2190	0.1595	0.1275	0.1166	0.1925	0.3766
Pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Child Age FE (year)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Strata Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unbalanced controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses. Clustered at the parroquia level. All anthropometric measures censored at 5 or 6 standard deviations according to WHO standards.
*** p<0.01, ** p<0.05, * p<0.1

Child Health

Results of the Texting for Nutrition program on indicators of health and nutrition for children provide additional evidence that the program had significant impacts on improving the health and nutrition of children in the treatment group. The program reduced the experience of respiratory illness for children under six years of age by 9 percentage points. The program also led to a statistically significant 9 percentage point reduction in the frequency by which caregivers reported that their children experienced at least one of nine possible illnesses in the last two weeks. These effects are large representing a 29 percent and 23 percent reduction as compared to the control group, respectively. These estimates are statistically significant at the one percent level and presented for the total child population consisting of a sample of 3,765 children in Table 6.

Table 6: Health and Nutrition Indicators (Equation 1, clustered at the parroquia level)

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Diarrhea in the last two weeks	Coughing, a cold, difficulty breathing in the last two weeks	Fever in the last two weeks	Child was sick in the last two weeks (9 possible illnesses)	Child was hospitalized in the last 12 months
Treat	-0.0151	-0.0920***	-0.0193	-0.0937***	-0.0079
	(0.0098)	(0.0231)	(0.0116)	(0.0256)	(0.0078)
Constant	0.1105***	0.3445***	0.1005***	0.4643***	0.0749***
	(0.0164)	(0.0340)	(0.0164)	(0.0290)	(0.0109)
Control Mean	0.1148	0.3121	0.1019	0.4075	0.0445
Observations	3,763	3,765	3,763	3,765	3,765
R-squared	0.0232	0.0431	0.0185	0.0437	0.0129
Pair FE	Yes	Yes	Yes	Yes	Yes
Unbalanced controls	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses. Clustered at the parroquia level.
*** p<0.01, ** p<0.05, * p<0.1

Assessing the impacts on health and nutrition indicators by treatment arm, in Assessing the impacts on health and nutrition indicators by treatment arm, in **Table 7**, we observe that the program led to statistically significant reductions in respiratory illness in all of the treatment arms (T1, T2, T3, T4 and T5) effects ranging in size from 9-12 percentage point reductions. These effects are large, they represent a reduction in the frequency of respiratory illness by one third as compared to the control group where 31 percent of the sample children reported experiencing respiratory illness such as coughing, a cold, or difficulty breathing.

Program participants in T2, T4, and T5 experienced statistically significant 2.9-3.5 percentage point reductions in the experience of fever. Once again, these changes are large because the prevalence rate of fever is low, 10 percent in the control group, therefore a 3 percentage point reduction reduces the average experience of fever by approximately 30 percent.

Program participants in T1, T2, T4, and T5 experienced 8.3-10.8 percentage point reductions in caregiver reports of children having experienced at least one of nine possible illnesses in the last two weeks. The largest reduction was experienced for children in T5, for whom 30 percent of the sample reported having

experienced one of the nine possible illnesses as compared to the control group where 41 percent of the sample reported having such experience.

T3 and T4 program participants also show statistically significant reductions in the rates of reported hospitalizations in the past twelve months. Declines were small in absolute terms: 2 percentage point reductions, however, these declines represent an approximately 40 percent decline in the hospitalization rate for these treatment arms as compared to the control group mean of 4 percent.

Table 7: Health and Nutrition Indicators (Equation 2, clustered at the parroquia level)

VARIABLES	(1) Diarrhea in the last two weeks	(2) Coughing, a cold, difficulty breathing in the last two weeks	(3) Fever in the last two weeks	(4) Child was sick in the last two weeks (9 possible illnesses)	(5) Child was hospitalized in the last 12 months
t1: health visits	-0.0162	-0.0860**	0.0031	-0.0872**	0.0015
	(0.0148)	(0.0333)	(0.0142)	(0.0355)	(0.0110)
t2: supplements (Chispas)	-0.0256	-0.0864***	-0.0294*	-0.0831***	-0.0052
	(0.0164)	(0.0268)	(0.0150)	(0.0300)	(0.0093)
t3: complimentary feeding	0.0054	-0.0522*	0.0202	-0.0514	-0.0183**
	(0.0195)	(0.0309)	(0.0200)	(0.0341)	(0.0088)
t4: WASH	-0.0280	-0.0926***	-0.0351**	-0.1042***	-0.0193*
	(0.0173)	(0.0304)	(0.0164)	(0.0350)	(0.0099)
t5: mix of content types	-0.0063	-0.1182***	-0.0346**	-0.1077***	-0.0027
	(0.0166)	(0.0272)	(0.0144)	(0.0348)	(0.0114)
Constant	0.0798*	0.2673***	0.0268	0.3402***	0.1208***
	(0.0404)	(0.0579)	(0.0266)	(0.0482)	(0.0219)
Control Mean	0.1148	0.3121	0.1019	0.4075	0.0445
Observations	3,710	3,712	3,710	3,712	3,712
R-squared	0.0547	0.0490	0.0272	0.0516	0.0164
Pair FE	Yes	Yes	Yes	Yes	Yes
Child Age FE (year)	Yes	Yes	Yes	Yes	Yes
Strata Controls	Yes	Yes	Yes	Yes	Yes
Unbalanced controls	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses. Clustered at the parroquia level.
*** p<0.01, ** p<0.05, * p<0.1

Impacts on Behavioral Outcomes

We also explored impacts of the Texting for Nutrition program on all eight behavioral outcomes of interest including:

(1) Timely caregiver visits to the local health centers with their children for check-ups;
(2) Consumption of nutritional supplements with a particular focus on the locally available iron supplement Chispas;
(3) Consumption of a greater variety of nutritious, readily available (locally grown) foods;
(4) Timely integration of solid foods for children;
(5) Frequency and timing of hand washing by caregivers (prior to preparing food, after defecation, and prior to interacting with infants);

(6) Consumption of clean potable water; and
(7) Maintaining clean cooking and food preparation spaces;
(8) Exclusive breastfeeding from birth through 6 months of age.

However, we do not observe any consistent and statistically significant impacts. Because we are testing multiple hypotheses we were not only looking for statistical significance but also for "consistent" findings. We define consistent as being observed over multiple variables measuring similar concepts or supportive evidence based on directionality within a family of variables. For instance, for outcome 6 the frequency and timing of hand washing by caregivers is tested using self-reported frequency of washing hands in the last seven days, self-reports of using soap when washing hands, and observational data on enumerators observing soap in the hand washing areas during a walk through the house. In this case, we looked for directionality, economic importance, and statistical significance to identify a causal relationship.

Contrary to our hypothesis, we do not observe impacts of the program on the behavioral outcomes we measure. We expected that each treatment arm would affect the anthropometric measures and health and nutrition indicators through the behaviors they encouraged through the text messages; however, we do not observe evidence of this in our measures of behavior change. This finding could be driven by many explanations including measurement error, and warrants additional exploration in future work.

VIII. Conclusions

The results of the Texting for Nutrition randomized control trial provide robust evidence that receiving text messages that encouraged caregiver behavior change improved the health and nutrition of children under six. We observe large impacts on the experience of illness - reductions in experience of respiratory illnesses, fevers, and an index compiling nine symptoms. We also observe important improvements in anthropometric measures including increases in z-scores for weight-for-height, weight-for-age, and BMI-for-age. These impacts are all statistically significant.

The consistency of our findings provides robust evidence of a causal relationship between the text messages and health outcomes for children. In doing so, these results provide an important contribution to the mHealth literature by expanding the evidence base on the thematic areas where mobile phone text messaging interventions can be effective. These findings also contribute to the behavioral economics literature providing evidence that overcoming behavioral barriers for caregivers through reminders, new information, using social norms language, and positive encouragement can be effective in improving nutrition and health outcomes for children.

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External datasets used for primary research and analysis:

Encuesta de Condiciones de Vida (ECV) 2013-2014

Encuesta Nacional de Salud y Nutrición (ENSANUT) 2012-2013

Tecnologías para Decisiones Informados (TDI) rounds 1-6 Chimborazo

Figures and Annexes

Annex 1: Behavioral Outcomes Results
Table 8: Health Checkups (Equation 2)

VARIABLES	(18) Do you have a health record card for your child?	(19) Do you have a vaccination card for your child?	(20) Age in days the child attended a health center for the first time	(21) Age in days the child attended a regular health checkup for the first time	(22) Average number of health center visits conducted by age of child	(23) Average number of regular health checkups conducted by age of child	(24) Satisfies the recommended number of health checkups by age
t1: health visits	-0.0362	-0.0482	2.0159	2.1005	-0.0277	-0.0570	-0.0843
	(0.0542)	(0.0358)	(1.4758)	(1.5183)	(0.0383)	(0.0485)	(0.0667)
t2: supplements (Chispas)	-0.0161	0.0022	1.9408	1.9058	0.1139*	0.0981*	-0.0038
	(0.0541)	(0.0365)	(1.4387)	(1.4433)	(0.0670)	(0.0556)	(0.0616)
t3: complimentary feeding	-0.0623	-0.0301	1.5582	1.4250	-0.0008	-0.0152	-0.0090
	(0.0637)	(0.0461)	(1.4084)	(1.4216)	(0.0311)	(0.0492)	(0.0689)
t4: WASH	-0.0259	-0.0010	2.1555	2.0573	0.0056	0.0128	0.0133
	(0.0506)	(0.0340)	(1.7259)	(1.7317)	(0.0382)	(0.0463)	(0.0482)
t5: mix of content types	-0.0022	-0.0074	0.9569	0.7594	0.0701	0.0601	0.0703
	(0.0576)	(0.0434)	(1.5039)	(1.4935)	(0.0706)	(0.0787)	(0.0439)
Constant	0.8203***	0.8016***	9.9523***	9.3504***	2.0921***	2.0348***	0.9477***
	(0.0905)	(0.0841)	(2.5998)	(2.6587)	(0.5095)	(0.4660)	(0.1053)
Control Mean	0.5409	0.556	14.9239	14.7723	0.522	0.6253	0.8345
Observations	3,712	3,712	3,615	3,474	3,366	3,482	416
R-squared	0.0673	0.0925	0.0825	0.0859	0.1150	0.0737	0.0608
Pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Child Age FE (year)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Strata Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unbalanced controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses. Clustered at the parroquia level.
*** p<0.01, ** p<0.05, * p<0.1

Table 9: Micronutrients (Equation 2)

VARIABLES	(25) In the past year received or purchased micronutrients Chispas for child	(26) In the past year received or purchased Vitamin A for child	(27) In the last 7 days has the child consumed any type of nutritional supplement?
t1: health visits	0.0460	0.0274	-0.0038
	(0.0321)	(0.0367)	(0.0178)
t2: supplements (Chispas)	0.0634**	0.0303	-0.0242
	(0.0275)	(0.0408)	(0.0145)
t3: complimentary feeding	0.0598	0.0553	-0.0210
	(0.0363)	(0.0480)	(0.0143)
t4: WASH	0.0052	-0.0173	-0.0176
	(0.0274)	(0.0396)	(0.0119)
t5: mix of content types	0.0437	0.0174	-0.0205**
	(0.0287)	(0.0354)	(0.0099)
Constant	-0.0419	0.1380	-0.0576*
	(0.0496)	(0.0957)	(0.0343)
Control Mean	0.1768	0.2406	0.0552
Observations	3,686	3,673	3,712
R-squared	0.0809	0.0962	0.0536
Pair FE	Yes	Yes	Yes
Child Age FE (year)	Yes	Yes	Yes
Strata Controls	Yes	Yes	Yes
Unbalanced controls	Yes	Yes	Yes

Robust standard errors in parentheses. Clustered at the parroquia level.
*** p<0.01, ** p<0.05, * p<0.1

Table 10: Diet Diversity (Equation 2)

VARIABLES	(28) Total number of food groups consumed yesterday	(29) WHO indicator of diverse diet (children 6 to 23 months old)	(30) WHO indicator of diverse diet (children 6 to 23 months old) THAT DO NOT BREASTFEED	(31) Child consumed iron rich food yesterday (children 6 to 23 months old)
t1: health visits	-0.2117*	-0.0800	-0.0800	0.1035
	(0.1218)	(0.1193)	(0.1193)	(0.1070)
t2: supplements (Chispas)	-0.0960	-0.0646	-0.0646	-0.0727
	(0.1110)	(0.0681)	(0.0681)	(0.0699)
t3: complimentary feeding	-0.1759	-0.1263	-0.1263	0.0252
	(0.1390)	(0.0842)	(0.0842)	(0.0934)
t4: WASH	-0.2534**	-0.0336	-0.0336	-0.1306
	(0.1182)	(0.0946)	(0.0946)	(0.0901)
t5: mix of content types	-0.2012*	0.0495	0.0495	-0.0389
	(0.1118)	(0.0794)	(0.0794)	(0.0801)
Constant	1.4777**	0.8698***	0.8698***	0.7599***
	(0.7118)	(0.1508)	(0.1508)	(0.1302)
Control Mean	4.0836	0.4836	0.4836	0.5328
Observations	3,582	340	340	340
R-squared	0.1579	0.1878	0.1878	0.1887
Pair FE	Yes	Yes	Yes	Yes
Child Age FE (year)	Yes	Yes	Yes	Yes
Strata Controls	Yes	Yes	Yes	Yes
Unbalanced controls	Yes	Yes	Yes	Yes

Robust standard errors in parentheses. Clustered at the parroquia level.
*** p<0.01, ** p<0.05, * p<0.1

Table 11: Breastfeeding (Equation 2)

VARIABLES	(32) Ever breastfed (children 0 to 23 months)	(33) Early initiation of breastfeeding	(34) continued breastfeeding at 1 year (children 12 to 15.9 months)	(35) Continued breastfeeding at 2 years (children 20 to 23 months)	(36) Exclusive breastfeeding for 6 months exactly (children over 6 months)	(37) Exclusive breastfeeding (children under 6 months)	(38) Duration of exclusive breastfeeding (days, children over 6 months)
t1: health visits	-0.0154	0.0223	0.0402	0.1419	-0.0102	0.1040	-4.9379
	(0.0177)	(0.0484)	(0.0956)	(0.3073)	(0.0332)	(0.1192)	(3.7063)
t2: supplements (Chispas)	-0.0133	-0.0160	-0.2773**	0.1052	0.0267	-0.1332	-1.4762
	(0.0167)	(0.0493)	(0.1327)	(0.3490)	(0.0273)	(0.1401)	(3.5911)
t3: complimentary feeding	-0.0167	-0.0879	-0.3307	-0.0381	0.0256	-0.1065	-4.5172
	(0.0237)	(0.0576)	(0.2199)	(0.2911)	(0.0285)	(0.1468)	(4.3307)
t4: WASH	-0.0108	-0.0014	-0.2404	0.6632	0.0413	-0.1039	3.5723
	(0.0093)	(0.0535)	(0.1448)	(0.4163)	(0.0315)	(0.1557)	(5.2859)
t5: mix of content types	-0.0193	-0.0405	-0.1433	0.0731	0.0044	-0.0485	-4.6889
	(0.0229)	(0.0580)	(0.1078)	(0.2994)	(0.0345)	(0.1181)	(4.9448)
Constant	1.0462***	0.9422***	0.6721*	1.0545***	0.4291***	0.2282	229.0003***
	(0.0294)	(0.0748)	(0.3591)	(0.3387)	(0.0780)	(0.1994)	(14.4436)
Control Mean	0.9805	0.8506	0.9063	0.4286	0.6804	0.8485	186.6459
Observations	439	440	90	62	3,560	101	3,560
R-squared	0.1043	0.1040	0.5359	0.4564	0.0441	0.2898	0.0709
Pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Child Age FE (year)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Strata Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unbalanced controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses. Clustered at the parroquia level.
*** p<0.01, ** p<0.05, * p<0.1

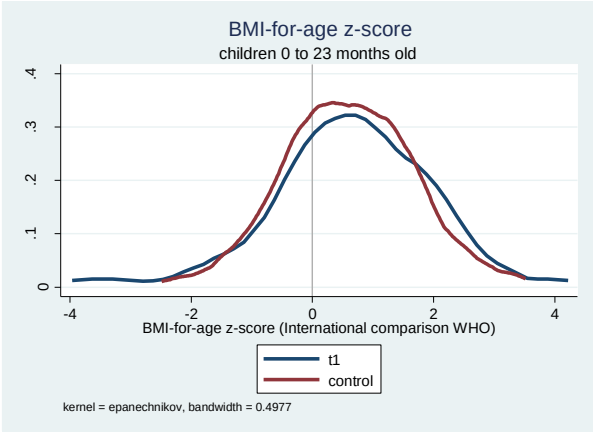
Table 12: Hand Washing (Equation 2)

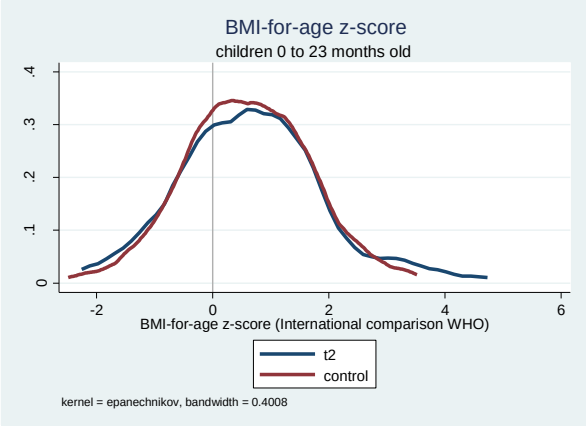
VARIABLES	(39) In the past 7 days always or almost always wash hands before eating	(40) In the past 7 days always or almost always wash hands after using the bathroom	(41) In the past 7 days always or almost always use soap to wash hands	(42) report using a towel to try hands after washing	(43) OBSERVATION: soap in hand washing area used when preparing food	(44) OBSERVATION: soap in hand washing area used after using the bathroom	(45) soap observed within the house during observation, including when asked	(46) Number of critical handwashing moments listed spontaneously	(47) Hand washing importance self-assessed scale 0-3	(48) You agree "Not washing hands with water and soap causes diarrhea"	(49) Reported that the best way to wash hands is with water and soap (open-ended question format)
t1: health visits	0.0193	-0.0061	-0.0242	-0.0591**	-0.0331	-0.0114	-0.0492	0.1849*	0.0011	-0.0023	-0.0002
	(0.0466)	(0.0441)	(0.0369)	(0.0279)	(0.0373)	(0.0704)	(0.0319)	(0.1004)	(0.0093)	(0.0178)	(0.0258)
t2: supplements (Chispas)	0.0388	0.0425	-0.0007	-0.0342	-0.0061	0.0157	-0.0297	0.1548	-0.0160	0.0039	0.0236
	(0.0462)	(0.0456)	(0.0310)	(0.0290)	(0.0447)	(0.0577)	(0.0392)	(0.1108)	(0.0135)	(0.0207)	(0.0213)
t3: complimentary feeding	0.0786*	0.0389	0.0406	-0.0367	-0.0244	0.0281	-0.0496	0.0995	-0.0037	0.0036	0.0309
	(0.0462)	(0.0442)	(0.0328)	(0.0292)	(0.0429)	(0.0566)	(0.0301)	(0.1050)	(0.0092)	(0.0200)	(0.0211)
t4: WASH	0.0410	0.0149	0.0088	-0.0515*	-0.0168	-0.0496	-0.0462	0.1659*	0.0084	0.0107	0.0043
	(0.0422)	(0.0398)	(0.0261)	(0.0273)	(0.0415)	(0.0732)	(0.0287)	(0.0981)	(0.0079)	(0.0155)	(0.0199)
t5: mix of content types	0.0093	0.0058	-0.0665*	-0.0568*	-0.0155	-0.0325	-0.0427	0.1510	-0.0044	0.0070	-0.0214
	(0.0518)	(0.0535)	(0.0355)	(0.0322)	(0.0364)	(0.0626)	(0.0283)	(0.1144)	(0.0072)	(0.0131)	(0.0322)
Constant	0.7354***	0.8055***	0.7484***	0.8696***	0.4495***	0.2033	0.6413***	2.1114***	2.9260***	0.9768***	0.9637***
	(0.1112)	(0.0803)	(0.0774)	(0.0326)	(0.0752)	(0.1357)	(0.0685)	(0.2842)	(0.0243)	(0.0352)	(0.0498)
Control Mean	0.7269	0.7631	0.7174	0.8552	0.6488	0.6919	0.7427	2.1874	2.9767	0.9148	0.8589
Observations	2,824	2,824	2,824	2,816	2,236	958	2,378	2,824	2,675	2,771	2,822
R-squared	0.1007	0.1059	0.1030	0.1105	0.1031	0.1680	0.1195	0.1639	0.0260	0.0136	0.0765
Pair FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Child Age FE (year)	No	No	No	No	No	No	No	No	No	No	No
Strata Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Unbalanced controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses. Clustered at the parroquia level.
*** p<0.01, ** p<0.05, * p<0.1

Annex 2: Additional figures

Figure 9: BMI-for-age z-scores - T1, T2, and T5





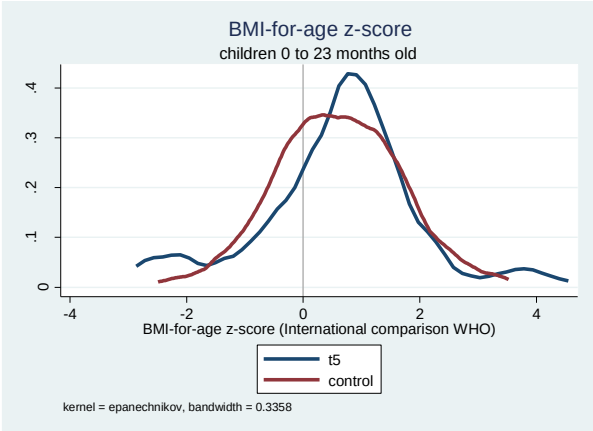


Table 13: Types of Text Messages and Channels of Change

	Types of SMS - and Channels of change			
	Outcome	**Channel**	**Mechanism**	**Type of SMS**
1	Timely visits to health centers	Change the value that mothers or families place on visits themselves	Norms	Potential SMS could target the long-held attitudes/cultural perceptions towards health centers.
			Efficiency of investment of time	Information about the timing of when vaccines will be available to limit visit inefficiencies.
			Efficiency of investment of time	Information that may reduce their wait time.
		Thinking about visits more frequently	Reminders - top of mind	Reminders of when ppl should do visits
2	Consumption of nutritional supplements chispas	Change in knowledge about usage	Correct Usage	Messages to clearly articulate correct usage of supplements
		Change in perceptions of negative side effects	Reduce negative perception and suspicion	Side effects: dispelling suspicion or explaining when they may make children sick as well as discuss the adjustment period for children, but this is normal.
		Increasing how often mothers think to use chispas	Reminders - top of mind	Remind mothers to use chispas. The other content messages may also function as reminders.
		Change in level of access to chispas	Reminders - top of mind	Remind mothers to ask for chispas and other supplements at their next clinic visit and that they are available for free
3	Consumption of clean/potable water (this is especially important for children between 6-24 months)	Increase the regular practice of boiling water prior to drinking for 0-24.	Value placed on boiling water	Text message noting that if giving water to children between 0-24 especially, it is important to boil water to prevent illness.
		Change in community level water treatment	Empower community members on the issue of water treatment	Text message to explain the chlorine issue, to perhaps mobilize families to demand proper treatment of water.
4	Consumption of a greater variety of nutritious foods	Increase the variety of nutritious foods prepared and increase the time investment in cooking fresh food rather than purchasing prepared food	Generate new ideas on **what** to prepare and encourage investment of time in the preparation of nutritious foods	Recipes
		Increase nutritional content of regularly prepared foods	Generate new ideas on **how** to prepare food	Information regarding food preparation - tricks of things to add to increase nutritional benefits.
		Increase purchase or preparation of nutritious foods	Value placed on eating meats and a variety of nutritious foods	SMS on importance of eating meats and a variety of nutritious foods
5	Exclusive breastfeeding from 0-6 months, Breastfeeding frequency	Increase in milk production and breastfeeding frequency	Encourage mothers to raise their liquid intake levels (especially in first 6 months) to facilitate milk production.	Information about how much liquid lactating mothers should be consuming
		Increase in milk production and breastfeeding frequency	Reminders - top of mind	Reminders to mothers to consume more liquids
		Increase breastfeeding frequency	Improve detection of when to feed	Information about how to identify early hunger before crying. (this was something mentioned at the health centers as malnutrition babies may not have the energy to cry)
		Increase durration of breast feeding	Knowledge about health benefits to maintenance up to six months	Information about health benefits for children that breastfeed exclusively for the first six months.
		Increase durration of breast feeding	Positive encouragement	
6	Timely integration of solid foods for children	Increase in on-time introduction of semi-solid and solid foods for children	Information	Information about when to integrate solid foods, which solid foods should be used to start, how to identify when it's the right time.
7	Frequency and timing of hand washing by caregivers (prior to preparing food, after defecation, and prior to interacting with infants)	Increase frequency of washing hands	Value placed on washing hands	Information about the importance of washing hands before and after preparing food
		Increase frequency of washing hands	Reminders - top of mind	Reminder to wash hands
8	Healthy food preparation and hygienic practices	Increase separation of animal raising spaces from food preparation spaces	Knowledge about risks of fecal contamination	Information about the dangers of animal raising in food preparation areas

Figure 10: Project and Data Collection Timeline

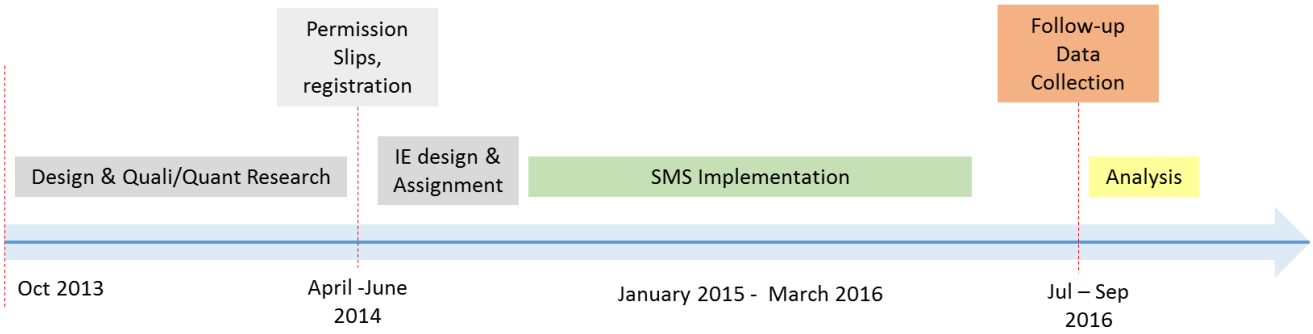
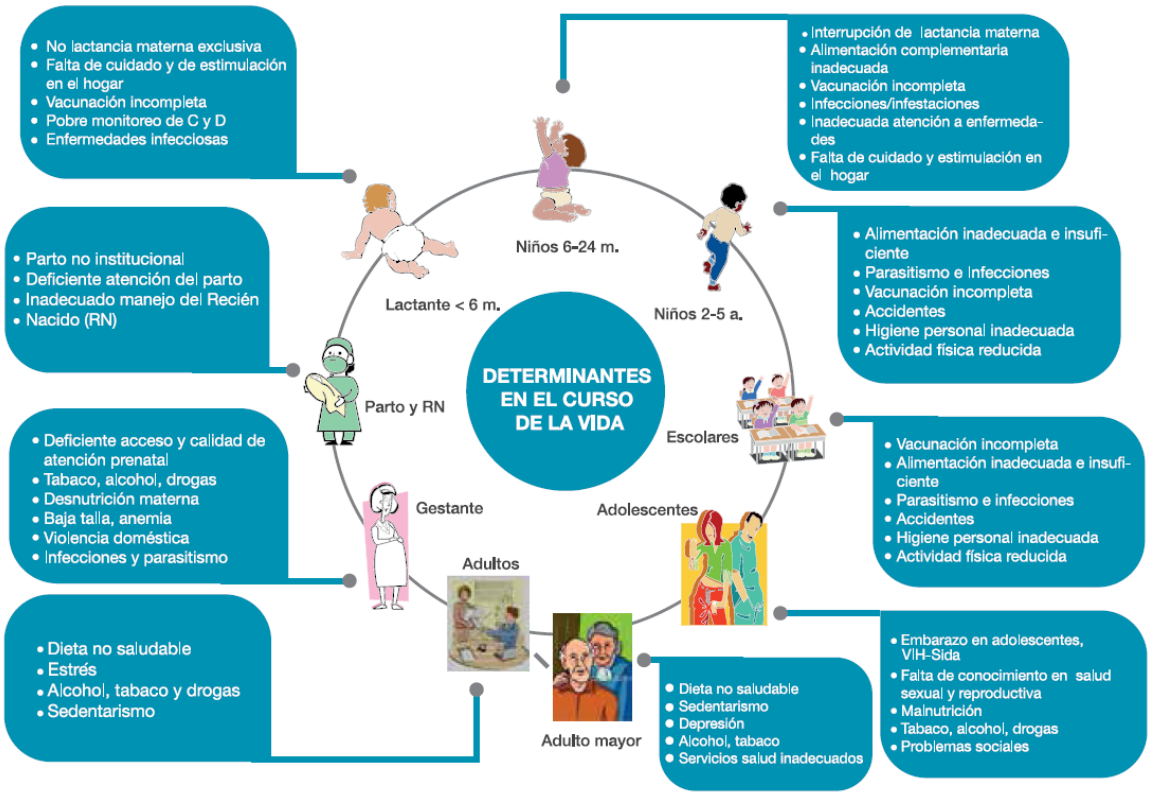


Figure 11: Determinants of Nutrition throughout the life cycle



Fuente: Peña M. 2011. Alianza para la Nutrición y el Desarrollo; Adaptado por Freire, W.; Diseño por Herrera, D.

Source: ENSANUT 2012

Figure 12: Chispas

Annex 3: Power Calculations

Table 14: Programmatic Level Clustered Power Calculation

Thematic Area	Outcome Variable		m1	m2	sd	n	n2	Percent change	alpha	power	icc	clusters
Health Checkups	control_emb	chimborazo rural	0.904	0.994	0.297	282	282	0.10	0.05	0.90	0.02	45
		national	0.925	1.018	0.263	199	199	0.10	0.05	0.90	0.02	45
	control_emb_f	chimborazo rural	4.060	4.466	2.733	1,909	1,909	0.10	0.05	0.80	0.02	45
		national	4.974	5.472	3.254	1,640	1,640	0.10	0.05	0.80	0.02	45
	control_emb_nunca	chimborazo rural	Not possible with number of clusters, power between .8-.9 and interclass correlation of .02 and percent change of 10%									
		national										
	postpart	chimborazo rural	Not possible with number of clusters, power between .8-.9 and interclass correlation of .02 and percent change of 10%									
		national										
	prenat	chimborazo rural	0.886	0.975	0.318	353	353	0.10	0.05	0.90	0.02	45
		national	0.950	1.044	0.219	124	124	0.10	0.05	0.90	0.02	45
	prenat_total	chimborazo rural	5.650	6.215	2.515	651	651	0.10	0.05	0.90	0.02	45
		national	7.033	7.736	2.865	503	503	0.10	0.05	0.90	0.02	45
	prenat1_mes	chimborazo rural	2.798	2.518	1.559	850	850	0.10	0.05	0.80	0.02	45
		national										
	control1	chimborazo rural	variable initial mean 96% so high that difficult to change									
		national	variable initial mean 98% so high that difficult to change									
	control1_dias	chimborazo rural	23.537	20.006	16.918	831	831	0.15	0.05	0.90	0.02	45
		national	20.724	16.579	22.839	821	821	0.20	0.05	0.80	0.02	45
	control1_mes1	chimborazo rural	0.903	0.993	0.297	283	283	0.10	0.05	0.90	0.02	45
		national	0.923	1.016	0.266	207	207	0.10	0.05	0.90	0.02	45
Exclusive Breast Feeding	exclusiva	chimborazo rural	0.857	0.943	0.356	532	532	0.10	0.05	0.90	0.02	45
		national	0.923	1.016	0.266	207	207	0.10	0.05	0.90	0.02	45
	dur_exclusiva	chimborazo rural	4.740	5.214	2.641	850	850	0.10	0.05	0.80	0.02	45
		national	3.300	3.795	3.111	1,367	1,367	0.15	0.05	0.80	0.02	45
	exclusiva3days	chimborazo rural	0.803	0.883	0.399	957	957	0.10	0.05	0.90	0.02	45
		national										
	lacayer	chimborazo rural	0.577	0.664	0.496	938	938	0.15	0.05	0.80	0.02	45
		national	0.623	0.717	0.485	667	667	0.15	0.05	0.80	0.02	45
	seno	chimborazo rural	variable initial mean 100%									
		national										
	seno_6mes	chimborazo rural	0.902	0.992	0.298	286	286	0.10	0.05	0.90	0.02	45
		national	0.816	0.898	0.388	808	808	0.10	0.05	0.90	0.02	45
	seno_dia	chimborazo rural	429.350	472.285	216.530	1,006	1,006	0.10	0.05	0.90	0.02	45
		national	367.732	404.505	225.983	1,234	1,234	0.10	0.05	0.80	0.02	45
	seno_edad	chimborazo rural	14.179	15.597	7.135	1,003	1,003	0.10	0.05	0.90	0.02	45
		national	12.162	13.378	7.462	1,230	1,230	0.10	0.05	0.80	0.02	45
chispas			no data									
WASH	cocina	chimborazo rural	0.900	0.990	0.301	292	292	0.10	0.05	0.90	0.02	45
		nacional	0.835	0.919	0.371	649	649	0.10	0.05	0.90	0.02	45
	toman	chimborazo rural	0.727	0.655	0.446	1,230	1,230	0.10	0.05	0.80	0.02	45
		nacional	0.385	0.308	0.487	1,395	1,395	0.20	0.05	0.80	0.02	45
	tratado	chimborazo rural	Not possible with number of clusters, power between .8-.9 and interclass correlation of .02 and percent change of 10%									
		national	0.581	0.668	0.493	899	899	0.15	0.05	0.80	0.02	45
	lavar_acom	chimborazo rural	0.572	0.658	0.496	963	963	0.15	0.05	0.80	0.02	45
		nacional	0.678	0.779	0.467	730	730	0.15	0.05	0.90	0.02	45
	lavar_dban	chimborazo rural	0.683	0.786	0.466	449	449	0.15	0.05	0.80	0.02	45
		nacional	0.828	0.911	0.377	707	707	0.10	0.05	0.90	0.02	45
	lavar_jab	chimborazo rural	0.572	0.658	0.496	963	963	0.15	0.05	0.80	0.02	45
		nacional	0.707	0.813	0.455	582	582	0.15	0.05	0.90	0.02	45
General Health and Nutrition	diarrea	chimborazo rural	initial mean too small (10%); sample size needed to observe change is very large									
	vivo	chimborazo rural	variable initial mean 100% so high that difficult to change									
	retardo en talla		no data									
	bajo peso para la talla		no data									
	bajo peso para la edad		no data									
	sobrepeso para la talla		no data									
	sobrepeso para la edad		no data									

Table 15: Individual Treatment Arm Power Calculation

Thematic Area	Outcome Variable		m1	m2	sd	n	Percent change	alpha	power
Health Checkups	control_emb	chimborazo rural	0.904	0.994	0.297	227	0.10	0.05	0.90
		national	0.925	1.018	0.263	171	0.10	0.05	0.90
	control_emb_f	chimborazo rural	4.060	4.466	2.733	712	0.10	0.05	0.80
		national	4.974	5.472	3.254	672	0.10	0.05	0.80
	control_emb_nunca	chimborazo rural	initial mean too small (10%); sample size needed to observe change is very large						
		national	initial mean too small (7%); sample size needed to observe change is very large						
	postpart	chimborazo rural	0.319	0.351	0.467	3,370	0.10	0.05	0.80
		national	0.477	0.525	0.500	1,721	0.10	0.05	0.80
	prenat	chimborazo rural	0.886	0.975	0.318	271	0.10	0.05	0.90
		national	0.950	1.044	0.219	112	0.10	0.05	0.90
	prenat_total	chimborazo rural	5.650	6.215	2.515	417	0.10	0.05	0.90
		national	7.033	7.736	2.865	349	0.10	0.05	0.90
	prenat1_mes	chimborazo rural	2.798	2.518	1.559	488	0.10	0.05	0.80
		national	2.256	2.031	1.432	633	0.10	0.05	0.80
	control1	chimborazo rural	variable initial mean 96% so high that difficult to change						
		national	variable initial mean 98% so high that difficult to change						
	control1_dias	chimborazo rural	23.537	21.183	16.918	812	0.10	0.05	0.80
		national	20.724	18.652	22.839	1,907	0.10	0.05	0.80
	control1_mes1	chimborazo rural	0.903	0.993	0.297	228	0.10	0.05	0.90
		national	0.923	1.016	0.266	131	0.10	0.05	0.80
Exclusive Breast Feeding	exclusiva	chimborazo rural	0.857	0.943	0.356	364	0.10	0.05	0.90
		national	0.618	0.679	0.486	1,303	0.10	0.05	0.90
	dur_exclusiva	chimborazo rural	4.740	5.214	2.641	488	0.10	0.05	0.80
		national	3.300	3.630	3.111	1,396	0.10	0.05	0.80
	exclusiva3days	chimborazo rural	0.803	0.883	0.399	389	0.10	0.05	0.80
		national	0.623	0.686	0.485	1,271	0.10	0.05	0.90
	lacayer	chimborazo rural	0.577	0.635	0.496	1,157	0.10	0.05	0.80
		national	0.517	0.568	0.500	1,470	0.10	0.05	0.80
	seno	chimborazo rural	variable initial mean 100%						
		national							
	seno_6mes	chimborazo rural	0.902	0.992	0.298	230	0.10	0.05	0.90
		national	0.816	0.898	0.388	475	0.10	0.05	0.90
	seno_dia	chimborazo rural	429.350	472.285	216.530	400	0.10	0.05	0.80
		national	367.732	404.505	225.983	593	0.10	0.05	0.80
	seno_edad	chimborazo rural	14.179	15.597	7.135	398	0.10	0.05	0.80
		national	12.162	13.378	7.462	591	0.10	0.05	0.80
chispas			no data						
WASH	cocina	chimborazo rural	0.900	0.990	0.301	235	0.10	0.05	0.90
		nacional	0.835	0.919	0.371	416	0.10	0.05	0.90
	toman	chimborazo rural	0.727	0.655	0.446	591	0.10	0.05	0.80
		nacional	0.385	0.346	0.487	2,509	0.10	0.05	0.80
	tratado	chimborazo rural	needed sample size too large						
		national	0.581	0.639	0.493	1,135	0.10	0.05	0.80
	lavar_acom	chimborazo rural	needed sample size too large						
		nacional	0.678	0.745	0.467	747	0.10	0.05	0.80
	lavar_dban	chimborazo rural	0.683	0.751	0.466	731	0.10	0.05	0.80
		nacional	0.828	0.911	0.377	326	0.10	0.05	0.80
	lavar_jab	chimborazo rural	0.572	0.630	0.496	1,177	0.10	0.05	0.80
		nacional	0.707	0.778	0.455	651	0.10	0.05	0.80
General Health and Nutrition	diarrea	chimborazo rural	initial mean too small (10%); sample size needed to observe change is very large						
	vivo	chimborazo rural	variable initial mean 100% so high that difficult to change						
	retardo en talla		no data						
	bajo peso para la talla		no data						
	bajo peso para la edad		no data						
	sobrepeso para la talla		no data						
	sobrepeso para la edad		no data						

Annex 4: Key findings from Text Message Focus Groups

Six qualitative focus group discussions were conducted in March of 2014 to explore potential text message interventions. Five focus groups were held with pregnant women and mothers of children under three years of age, each with approximately 9 women, organized according to key characteristics (reside in urban or rural area, indigenous or mestizo, and pregnant or with children). Focus group participants came from all 10 cantons of the Chimborazo Province. One additional focus group was conducted with TDI nutritionists and health promoters from the Chimborazo Provincial Government as key informants on the barriers caregivers face in achieving the desired outcomes of the program.

The purpose of the exercise was to determine whether mothers would be receptive to text messages with reminders and/or information on good health practices for their children and further understand the knowledge, attitudes, and practices in nutrition, diet, and access to health services for caregivers and their children. The focus groups explored what types of messages to send (top of mind or informational), and what type of framing would be most effective (positive, negative, encouraging, social norms, etc.) The focus groups also explored preferred frequency (weekly or twice a week) and preferred delivery days in each canton. Because of the large indigenous population and the provincial government's focus on including Quichua in public discourse, the focus groups also explored the preferred language to receive text messages: Spanish (Castilian) or Quichua and in what form (text or audio).

The research revealed key trends that were used in conjunction with the aforementioned quantitative data to create the intervention design and determine outcome variables. Highlights from the findings are as follows:

- **Maternal nutrition during pregnancy:** Mothers believe it is important to eat healthy during the pregnancy to improve the health of their child, this includes eating fruits, vegetables, *machica,* quinoa, and for urban mothers this also meant consumption of vitamins provided at public health centers.
- **Exclusive Breast Feeding 0-6 months:** Mothers in the focus groups - mestiza, indigenous, living in rural and urban areas – all agree that breastfeeding for the first six months is very important. They report knowing and following good breastfeeding practices (including recommended daily frequency of feeding and length of exclusive feeding). However due to concerns on biases of the sample (towards caregivers with improved nutrition knowledge as compared to the general population), the interviewers also asked about other mothers in their communities. Participants explained that when thinking about other mothers in the community it is common for them to breastfeed exclusively for 4-6 months, but it is also common to introduce other liquids. In some cases, women are unable to breastfeed due to insufficient milk production.
- **Children's diet:** Children's meals generally consist of soup with noodles or flours, *coladas*, and *la machica*. Children receive the same types of food as the rest of the family. It is difficult to provide meat and protein because these foods are expensive. Mothers are the primary person that feeds children, when children refuse to eat mothers usually use games to get them to eat. If children are sick, mothers do not suspend providing breast milk, but usually supplement the breast milk with medicinal waters/beverages.
- **Health Checkups:** All caregivers aware of the need to bring their child to health checkups, however the frequency and timing of visits depends on the characteristics of the caregivers. Mothers in rural areas perceived that health checkups should be continued until two years of age whereas mothers in urban areas thought regular health checkups were only necessary for the first year of life of the child. However, mothers reported variable quality care at local health centers – listing long wait times, absenteeism, high turnover of health center staff, and negative attitudes, and a lack of empathy as primary complaints.

- **Potential project interventions:** When asked about whether mothers would like to receive specific training or technical advice on nutrition, women explained that they do not receive training on nutrition topics, but are keen to receive more information, specifically on topics like healthy meal preparation practices and recipes.
- **Focus group with local Health workers:** The focus group with technical health workers attributed high rates of child malnutrition in the area to 1) a lack of knowledge and 2) a failure to follow advice given by health center workers.
- **Cell phone usage:** Cell phone ownership is higher in urban areas and among *mestizo* mothers. However, in rural areas if mothers don't own cell phones their husbands do with higher frequency, however they are often work outside of the home or community for long periods of time. Caregivers that had cell phones use them primarily to receive phone calls from their family or husbands. All mothers agree that they prefer to make phone calls than send text messages, they usually only send messages if they have run out of cell phone credit. Voice mail is not used, because they can't save the messages and are not sure how to access them.
- **Language:** Indigenous mothers prefer to receive text messages in Spanish (Castellano). Language should not be mixed, the word "guagua" should not be used for children. Language should be simple and positive such as "niño sano", "combinación de alimentos", "vivir sanos y fuertes", "salud y nutrición". Technical language and negative language generated rejection among mothers.
- **Identified sender**: Mothers requested that the name of the sender be identified within the text message so that they know which institution is sending the text messages, and preferably that it comes from the same telephone number.
- **Timing and frequency**: Mothers wanted to receive short ad concise messages, sent in the afternoon between 4pm and 7pm. They would like to receive 2 messages per week and their preferred days depend on when they have markets as their cell phone service is improved on those days of the week.
- **Thematic areas**: Mothers encouraged text messages in the areas of nutrition, diet, breast feeding, complementary feeding, care for children, and health checkups for children. Mothers were particularly interested in receiving messages on how to prepare specific healthy foods, and suggestions on what to do if children are ill.

Primarily, women acknowledged that they would be happy to receive messages about health, nutrition and food. In particular, they welcome messages about the preparation and use of food, food combination techniques (recipes), and primary care for sick children.

*Annex 5: Description of the Growing with our Children (*Creciendo con Nuestras Guaguas*) Program*

The objectives of the overarching JSDF project Growing with our Children are:

To contribute to the reduction of chronic malnutrition in children under five years in the ten cantons of the province of Chimborazo by

1. Raising parental understanding and expectations regarding adequate child growth;
2. Encouraging take-up of primary health and nutrition-related services; and
3. Empowering parents to put pressure on health services to improve the quality and intensity of nutritional monitoring and counseling.

The Growing with our Children Program has five key components through which it aims to achieve its program objectives:

1. Community-based growth promotion system;
2. Training plan to improve the provision of health and nutrition services;
3. Culturally appropriate, participatory communication strategy;
4. Strengthening of the Provincial Health Council and Nutrition Committee; and
5. Monitoring and Evaluation (Quantitative Evaluation).