Training workers and informing mothers to reduce malnutrition: Evidence from a randomized controlled trial

Prakarsh Singh*
August 13, 2015

Abstract

We carry out a randomized controlled trial to test the impact of re-training child caregivers employed by the state government and its interaction with directly supplying mothers with nutritional information for their child. Caregivers are supposed to feed children between ages 2 to 6 years in day care centers and also advise mothers on health and nutrition for their child. The training program was a review of basic health and nutrition rules-of-thumb and introduced better communication strategies with mothers to induce behavioral change at home. We find that on its own, the training has no significant impact on reducing child malnutrition after five months. However, there is a complementarity between training younger caregivers and providing nutritional information to mothers, which helps reduce malnutrition.

1 Introduction

Child malnutrition is a serious and persistent problem that has been shown to decrease immunity towards disease and hamper labor productivity (Behrman et al. 2004; Alderman and Behrman, 2006). Economic development has been associated with widespread declines in malnutrition, but Indian children continue to experience high rates of stunting and wasting. The proportion of underweight children was not much

*Assistant Professor of Economics, Amherst College and Visiting Scholar, Department of Economics, University of Pennsylvania. Email: psingh@amherst.edu. Tel: 413-230-0514. I am grateful to the Department of Social Welfare, Government of Punjab for their co-operation and funding for the project. I am also thankful to Dean of the Faculty, Amherst College for financial support. Thanks also go to Darius Onul, Khishigsuren Jargalsaikhan and Khushy Aggarwal for excellent research assistance, and to Jere Behrman and William Masters for comments.

lower in 2005–06 than in 1992-93 (Drèze and Sen, 2013). In this paper, we evaluate a randomized controlled trial that was designed to assess the impact of re-training government employed child caregivers, and its interaction with direct provision of information to mothers. This was carried out in collaboration with the Punjab government's Social Welfare Department during 2011.

A wide variety of interventions in India aim to improve nutritional outcomes, including the world's largest child development program: the Integrated Child Development Services (ICDS) that began in 1975 across India. ICDS aims to provide health, nutrition and pre-school services through childcare centers. Each center is staffed by a worker (caregiver) who provides meals to children between the ages of two and six years, and is also supposed to counsel mothers on child health and nutrition. The effectiveness of the ICDS program is thus critically dependent on the selection, skill and training of caregivers. However, a World Bank report by Gragnolati et al. (2005) found widespread leakage in the provision of ICDS meals and almost no effective communication between caregivers and mothers. More recently, a household survey in 100 Indian districts found that although 96% of villages are served by an ICDS centers, only 50% of the centers provided food on the day of survey and just 19% of mothers reported that caregivers provided any nutrition counselling (Hungama Report, 2011).

Solutions based purely on improving individual diets through economic growth are of limited effectiveness, as Behrman and Deolalikar (1987) showed that nutrient elasticities with respect to income may be close to zero. There has since been more emphasis on tackling malnutrition through targeted programs on the demand-side including supplementary feeding or supplying information. For example, Maluccio et al. (2009) find positive long-run impacts of a nutritional supplement in Guatemala and Madajewicz et al. (2007) report how information on location of wells with high and low levels of arsenic, influences health behavior in Bangladesh. It is also possible that the solution may lie in equipping households with specific nutritional information that nudges people towards healthier behavior at home (Dupas, 2011). In an experiment conducted in Chandigarh, India, Singh (2015) found no significant health impacts of distributing nutritional information in the form of recipe books to mothers who send their children to the childcare centers. However, when workers were incentivized to improve health outcomes, they were able to bring about behavioral change through home visits to mothers who had recipe books.[1] The complementarity between

[1]Please see Miller and Babiarz (2013) for an excellent review of the role of performance incentives in improving health.

motivated workers and informed mothers resulted in lower malnutrition. In this paper, we test for the impact of giving a similar recipe book along with a training module for workers that was designed to target behavioral change at home through more effective communication with mothers. We find evidence that there is no significant impact of the training-only treatment but the effects of the combined treatment are heterogeneous by age of worker.

There is a large literature on the impact of training health workers on knowledge and communication behavior. Henoch et al. (2013) find that confidence in communication improves significantly for trained caregivers and Moleiro et al. (2011) show that even brief training programs may be effective in changing both awareness and increasing empathy. Simoes et al. (1997) evaluate the performance of primary health workers in Ethiopia after a short training course on integrated management of childhood illness. The course focused on assessment, classification, and treatment of sick children (aged 2 months to 5 years) and on counselling of their mothers. The performance of the health workers improved communication with the mothers of the children over the course of the training. The training sessions that have been evaluated are often very short. Newes-Adeyiemail et al. (2004) report that counseling and communication skills of non-physician health providers can change even after a one day focused training, which highlights the effectiveness of even limited training in improving communication. Pelto et al. (2004) shows that trained providers are more likely to engage in nutrition counseling and to deliver more extensive advice. Mothers who received advice from trained providers had high rates of recalling the messages on specific foods, feeding practice and food preparation recommendations. We use these non-experimental results from the existing literature to design a short one-day program and apply it to caregivers in our context.

Children who are stunted at two years of age usually continue to show nutritional deficits later in life but this is often taken to mean that no catch-up growth is possible (Martorell et al., 1994). This observation has led to the increasing focus of public health organizations on the first 1000 days after birth. Golden (1994) argues that if circumstances of children in developing countries change, almost complete reversal of stunting is possible. A growing body of convincing evidence from Adair (1999), Barham et al. (2013), Crookston et al. (2010), Coly et al. (2006), Outes and Porter (2003), Prentice et al. (2013) and Singh et al. (2014) finds that catch-up at ages beyond the 1000 days window is indeed possible. The relative attractiveness of public policies that can help in catch-up after this threshold is an understudied area of research. Studies rigorously analyzing the impact of training workers on health outcomes have

only focused on children under 2 years of age. Zaman et al. (2008) present results from a cluster-randomized controlled trial that was carried out by distributing a training module regarding feeding practices to health workers who were taking care of children aged 6 to 24 months with the objective of reducing infant and child malnutrition. The communication skills of trained health workers significantly improved and reduced growth faltering especially among children in the age-group of 1 to 2 years. Penny et al. (2005) also find positive effects of an education intervention to caregivers of children under the age of 18 months. However, not all training programs have been so successful. Hamer et al. (2004) show that while nurses in Gambia were trained to identify severe protein-energy malnutrition using WHO training materials, the training did not lead to improvements in terms of under-diagnosis or wrong-diagnosis by nurses.

The Planning Commission report (2011) states that the unspent amount on Supplementary Nutrition Programme (SNP) for Punjab was 56% eclipsed only by the states of Assam, Bihar, and Madhya Pradesh and that a large proportion of the unused funds for SNP was most likely "siphoned off". According to Drèze (2006), "the quality of training of Anganwadi workers needs improvement...in definition, the services of the ICDS scheme also include other interventions such as nutrition and health education activities that foster long-term behavioral change. However, in practice the SNP has come to dominate the ICDS scheme." Prinja et al. (2008) cross-sectionally surveyed 60 Anganwadi centers in Haryana and identified inadequate emphasis on nutritional and health education activities for behavior change and lack of active participation of family members in monitoring the child's nutritional status.

2 Conceptual framework

Child health (W) can be thought of as a function of home and day care center inputs, h and c.

$$W = f(h, c)$$

The inputs can be thought of as promoting health and could include calories, micronutrients and medicine (such as oral rehydration salts that should be available at the centers). The supplementary nutrition obtained in schools has been associated with an improvement in child health (Bhattacharya et al., 2006). The quantity of such inputs at home can depend first, upon the mother's knowledge of the existence of available inputs (k) and second, on her knowledge of the importance of feeding these inputs (i).

Thus,

$$h = g(k, i)$$

Both k and i can be increased by better counseling and monitoring by the worker. For example, the worker can increase her home visits to stress the importance of feeding nutritious recipes. However, she could also improve the knowledge transfer by making the same number of visits as before.

In this paper, we consider two treatments: (1) training workers and (2) training workers and providing recipe books to mothers. We can test if either of these treatments can improve W, which has never been rigorously tested before for the child age group of 2-6 years. Moreover, we can check how training workers impacts mothers' knowledge, k. If W improves, but k does not increase, there may be increases in c or i.

Finally, if we find that training workers has the same impact as training workers and providing recipes to mothers, the two treatments may be thought to be perfect substitutes. However, in that case, training-only would obviously be more cost effective for the policy maker.

If the impact of the second treatment is greater than that of the first, we can conclude that training and recipe books are complements in the child's health production function. This is because we know that recipe books on their own have no significant impact on child health albeit in a different setting (Singh, 2015). Furthermore, it is possible that the complementarity might be heterogeneous depending upon the "type" of worker and mother. For instance, a more motivated worker and mother combination might be able to gain more from the training and recipe treatment. Maternal knowledge and education has been a strong determinant of child health (Guldan et al., Handa, 1999; Sandiford et al., 1995). It will also be possible to understand whether the complementarity results from an increase in k or i. For example, if we do observe trained workers make more visits to mothers who have recipe books, we can check if mother's knowledge of the existence of available inputs improves or not. If k does not improve, the result is likely driven through a change in mother's knowledge of the importance of feeding these inputs, i. These channels are important for unpacking the elements of behavioral change at home, which is often described as an important determinant in the fight against child undernutrition.

3 Context

Having extremely fertile soil, Punjab has been one of the most prosperous states in India and is known as the "bread basket" of India. However, in recent years, the per capita income has come closer to the national

average as other states have caught up and Punjab's agricultural output has stagnated. The per capita income for Punjab in 2011-12 (Rs. 46,325) was slightly higher than the national per capita income of Rs. 38,048 (Department of Planning, 2013). Despite the state being relatively wealthy, Punjab's ICDS program for children leaves a lot to be desired. The ICDS website states that out of a total of 1.86 million children between the ages of 0-6 years surveyed in Punjab, 24.27% are classified as malnourished. The expenditures on the Anganwadis under the ICDS scheme are split equally between the central and the state governments.

Only 42 percent of the children in the survey register were receiving food from the centers in Punjab suggesting leakages at the grassroots level. Punjab ranked low relative to other Indian states in terms of intended behavioral changes among ICDS beneficiaries (Planning Commission, 2011). Nevertheless, the study correctly points out that effectiveness of behavioral change programs require a more scientific sample design and a much larger sample size to bring out conclusive results. Out of 20 states covered in the report, Punjab ranks an abysmal 18 on the overall infrastructure index. For example, an Anganwadi in Punjab covers only 236 square feet whereas the average area for all centers in India is 315 square feet. 59 percent of the centers did not have a flush system installed in toilets and only a third had functional weighing scales (NCAER ICDS survey, 2009). The workers on average spent 40 minutes feeding, 91 minutes imparting pre-school education and 90 minutes record keeping in Punjab (NCAER ICDS survey, 2009). However, upon inspection of the registers, the study found that only 17 percent of the centers had updated growth charts for their children whereas the national average was 41 percent. Lokshin et al. (2005) and Bredenkamp and Akin (2004) find that children in villages with Anganwadi centers are not less likely to be malnourished or ill than other children.

Kular (2014) investigates the conditions of thirty Anganwadis in a rural district of Punjab and finds that existing training of caregivers needs to be evaluated and their continuous education strengthened. He notes that the problems facing caregivers include work overload, lack of help from community, and inadequate honorarium. However, the workers scored on average less than 25 percent on a quiz related to health and nutrition. He notes, "Nutrition and Health education (NHED) is delivered by Anganwadi workers through inter-personal contacts and discussions at Anganwadi centres...[but] workers have inadequate knowledge about NHED component." Bhandari et al. (2004) paired eight communities from Punjab's neighboring state, Haryana to assign treatment and control. There was a 3-day initial training of health workers in the

intervention groups, and the intervention also included monthly home visits by Anganwadi workers for newborns until the age of 12 months and visits once every 3 months until the age of 2 years. Results demonstrated that there was no significant impact on weight gain and only a small increase in linear growth (0.18 SD) between 6 and 12 months.

4 Methodology

The ICDS operates close to 1.3 million day care centers, each staffed by a caregiver who is paid a fixed government wage. Around 30 preschool children usually attend each center from 9:00 am to noon. Centers are funded to provide each child with a nutritious mid-day meal, and caregivers are initially trained to monitor and advise mothers about the health of their children. The project was undertaken in collaboration with the Social Welfare Department, government of Punjab. The universe of centers in the blocks of Majri and Kharar-2 in the rural district of Mohali were chosen for the study because officials in the Department were especially keen on improving health indicators for Mohali.

Village was chosen as the cluster level to randomize treatments and control so as to reduce the possibility of spillover effects between workers in different centers within a cluster. For instance, if randomization was conducted at the individual center level, a worker may be in the treatment group but her neighbor in the same village may be part of the control group. However, it is very possible that there are nutritional spillovers from providing knowledge rendering the control group contaminated. Table 1 shows the total clusters and centers finally allocated to each group and Figure 1 plots the assignment of villages on a satellite map.[2] The map illustrates that there was no geographic clustering of one type of treatment and villages were randomized through a computer algorithm. The workers in the control group did not have an option to be part of the treatment groups. The total number of clusters for all three groups (two treatments and a control) totalled 76. If we take the first treatment and control group, the total number of clusters were 45. Using the Optimal design software for power calculations, with total number of subjects approximately equal to 2000 and intraclass correlation equal to 0.05, the cluster size is sufficient for obtaining a power greater than 0.8 to detect small-sized effects of 0.2 standard deviation (Cohen, 1988). Figure 2 shows the tradeoff between power and effect size for the sample population.

[2]Following the cluster randomization procedure, it was discovered during fieldwork that centers from two villages in the second treatment and one from the first treatment were no longer operational. These were then removed from our original sample and are not shown on the map.

All workers who were offered the free training session came and sat through the sessions. Overall, 70 workers from 70 centers in 43 villages were given training in one day-long workshops conducted as explained in the next section. They were also handed a set of recipe books in the local language, Punjabi. All mothers associated with 35 of these centers from 21 villages were also given recipe books (the second treatment), thus in these centers the combined treatment of training and recipe was assigned. All mothers who were interviewed at baseline received the recipe book from enumerators in the combined treatment after their interview.

<Table 1 and Figure 1 about here>

The baseline was conducted in July, 2011, followed by the treatment in August, 2011 and endline in December, 2011. A window of five months was chosen for the experiment because it is the average time between two medical check-ups by the local Health Department. The duration was verified to be sufficient for a grade improvement to occur by doctors at the local office of the Health Department, Government of India. At baseline and endline, a team of enumerators (supervised by an assistant and project manager) weighed all children present in the center on a digital weighing machine, interviewed their mothers and the center workers. Previous weights of children (on average two months prior to baseline) were also recorded at baseline from the weight record registers of the workers. These earlier records may have more measurement error than the digital machine recorded weights but they are unlikely to be systematically different across the treatment and control groups. Moreover, we will control for infrastructure at each center and qualifications of caregivers, and that should be a good proxy for capturing any measurement error.

Table 2 shows the sample size of children and mothers in each arm and round. All children between the ages of 2 and 6 years present at the surveyed centers were weighed. This translated to close to 2980 children being weighed at baseline with about 27 children being weighed per center in each group. We also have a high compliance rate for mothers, with a total of 2682 mothers being interviewed, which is a response rate of 90 percent at baseline. At endline too, close to 89 percent of mothers were interviewed for the children weighed at endline. However, 13 percent of children were attrited from the sample because they were not present at the center on the day of the survey.

<Table 2 about here>

The summary statistics in Table 3 show that child characteristics, household-level variables, and worker and center observables, are not significantly different between the two treatment groups and the control group at baseline. Weight-for-age malnutrition is defined as weight-for-age z-scores being more than two standard deviations lower than their sex and age-specific mean from a WHO-specified reference population. At baseline, 31 percent of the children were malnourished (z-score<= -2) and severe malnutrition (z-scores<= -3) was 11 percent. The average child was close to 4 years of age and there was an equal proportion of boys and girls. The mean number of ever born children was 1.9 per family. The monthly income of households was on average Rs. 4730 (or approximately $80 per household) in the control group. This corresponds to just below $1 per day per person. Self-reported food expenditure constitutes about half of the total expenditure, which is in line with other studies on food expenditures of households living in poverty (see Banerjee and Duflo, 2012). The mother was on average relatively young at 28 years and about two-thirds of them were literate as opposed to fathers whose literacy levels are on average 10 percentage points higher. 76 percent of the mothers were housewives, 11 percent worked as housemaids, and 8 percent as laborers. 68 percent of fathers worked as laborers, 11 percent sold eatable items, and 7 percent were engaged in handicrafts.

<Table 3 about here>

In other baseline characteristics, among kitchen assets, 53 percent of households owned a refrigerator, 2 percent used a water filter, 87 percent had a water tap, 86 percent owned a pressure cooker, and 73 percent used cooking gas stoves. Among non-kitchen assets, the proportions were 28 percent for a scooter, 62 percent for a bicycle, 90 percent for a television, 83 percent for a mobile phone and only 6 percent for a radio. Moreover, only 25 percent had a flush system installed in toilets. As the households were in rural areas, 41 percent owned a cow or a goat and 2 percent owned a chicken.

Centers were observed to be inadequately equipped to provide preschool education and early childhood development services. Only 28 percent of the centers had functional electricity on the day of the survey and 23 percent of the centers had blackboard. Similarly, only 24 percent had a toilet. Despite most centers having charts hung up in the classroom, most centers lacked lighting and just half had fans installed despite the maximum average temperature in the month of June being 104 degrees F (40 degrees C). The sample's summary statistics complements the Planning Commission report's (2011) disparaging review of the ICDS centers in Punjab, where they found lack of knowledge among

workers, a lack of infrastructure and "missing" beneficiaries. We also asked for the caregiver's satisfaction with different elements of her work on a 7 point Likert scale. In Appendix Table 1, we show that the workers report high levels of satisfaction at baseline for most characteristics (especially, relations with supervisor and job timings). However, relative to other elements, workers feel dissatisfied by their present salary and potential salary growth. Kapil (2002) argues that there is huge scope for improvement in services as home visits by Anganwadi workers are infrequent.

5 Training

Immediately following the baseline, the training workshop was conducted by a local doctor over three consecutive days to limit the size of each sitting to under 25 workers. The same format was followed in each of the three sessions and is outlined below. The two components of the session consisted of information on child nutrition and hygiene and on communication effectiveness. These are part of the job requirements for a caregiver in the ICDS system. All workers are supposed to undergo a training session before they start work, however it is not clear how effective such trainings are, due to a lack of any rigorous evaluation. The syllabus for the one month training module for Anganwadi workers is available on the ICDS website. This is the first randomized controlled trial trying to understand the role of health worker training with a focus on health information and communication. The training program was designed with the help of a local government nutritionist and on the basis of a previous study which pointed towards the importance of behavioral change through better communication between Anganwadi workers and mothers (Gragnolati et. al., 2005).

The goals of the training capsule included providing information on significance of hygiene and nutrition of children between 2-6 years of age. After motivating the adverse consequences of malnutrition and poor hygiene, hygienic habits were outlined for the workers with examples. These were to ask mothers to help them with teeth cleaning, clipping child's nails, wearing of slippers, washing hands with soap before and after eating, toilet training, drinking clean water, use of spoon for eating, boiling water before cooking, washing fruits and vegetables properly, keeping water and garbage covered and not allowing mosquitoes and fleas to breed in the house by regular cleaning. A group discussion included questions such as: advice to mothers if the child has diarrhea, weak bones or is losing weight.

For improving nutrition, the workers were asked to teach mothers about giving 5-6 small meals every day, and the concept of balanced

meals that includes protein and fat as well as micronutrients from a variety of vegetables and fruits. In order to aid them with specificity of information, a government approved recipe book was distributed to them that enlisted ten nutritious and economical recipes that could be prepared with locally available ingredients in a few easy-to-follow steps. The recipe book was in Punjabi, the local language and it provided the nutritional content of each recipe. The first four pages contained simple rules of hygiene, and gave a list of items rich in calories, protein, vitamin A and iron. This nutritional information would also be examined in a quiz conducted on the trained workers at the end of the workshop. Based on Singh (2015), the ten recipes were taken from the Government's publicly available book on Nutritious Recipes for Complementary Feeding of Young Children. Each recipe could be made at home within a budget of Rs. 4 for 150 gms, as calculated by a Nutritionist, Food and Nutrition Board, Chandigarh. Each recipe had multiple boxes at the bottom which mothers were asked to tick when they prepared that recipe. It also had information on hygiene and good food habits and highlighted food items rich in calories, protein, iron and carotene. The distribution of recipe books also involved discussing four of the recipes in detail. This recipe book was also distributed to all mothers directly in the second treatment. This meant that both the trained workers and the mothers would have the same recipe book in the combined treatment.

Finally, a communication skills handout was distributed to the workers that listed twelve simple rules or "best practices" for effective communication with mothers. This was designed with the help of the officials at the Social Welfare Department. The workers were asked to read these out aloud. These were as follows:

- Explain to the mother the growth and development of the child
- Keep the discussion positive and it should be in a soft and familiar language
- Show the growth chart of the child to the mother with growth curves and the child's progress
- Ask the mother questions about caring practices, listen to the mother and try to ascertain the cause of the problem
- Praise and compliment the mother for all the child care
- Teach the mothers a recipe from the book by asking her the child's food preferences and available ingredients
- Build confidence in the mother and teach her the significance of health and hygiene at home
- Convince the mother to bring the child regularly to the center for key services
- Explain to the mother and the family that feeding, playing and

communicating with children helps them grow and develop well

- Discuss 'developmental milestones' of the child with the mother and the family
- Follow up severely malnourished children and make home visits at a convenient time for the mothers
- Reinforce messages by regular home visits

The last section of the workshop asked them for their feedback and suggestions.

6 Empirical Specification

The main regression specification for finding the average effect of the treatments on weight of a child is as follows:

$$w_{ijt} = \alpha(post)_t + \beta(training)_j + \gamma(training\ \&\ recipe)_j + \eta(post * training)_{jt} + \theta(post * training\ \&\ recipe)_{jt} + X_{ijt} + \varepsilon_{ijt}$$

w_{ijt} is the weight or health indicator of a child i in cluster j at time t. The variable *post* is a dummy that is 0 for baseline and 1 for endline. The variables *training* is a dummy variable that takes a value of 1 if the child is exposed to a worker who is in the training only treatment and 0 otherwise. Similarly, *training & recipe* is 1 if the child is in the combined treatment (training to workers and recipe books provision to mothers) and 0 otherwise. Finally, X_{ijt} are child-level, household-level and center-specific controls. The error term is clustered at the village level, which was the level of randomization.

The variable *post* accounts for the natural increase in weight in three months, all seasonal effects on weight that do not vary by village, regional shocks to food prices and any management changes or unobservables that would impact all groups in the same way. β and γ are the baseline differences between the individual treatments and the control. η and θ give us the difference-in-differences estimates for the effect of each treatment. This interpretation rests on the identification assumption that there are no time varying and group-specific effects that are correlated with the treatments (common trend assumption). As the villages were randomly assigned into one of the three groups, we should not expect there to be differential trends amongst the groups.

Although typically not required for the common trends assumption to be checked with randomization, we do carry out a placebo check to corroborate that pre-trends are similar across all groups. For the placebo check, we define $post = 1$ for baseline and 0 for the weight recorded in

official registers prior to baseline (on average about two months before). There is likely to be greater measurement error in these prior weights because the official weighing scales are not as precise. However, we do not expect the measurement error to be systematically different across the different groups. Running the above regression with this new definition should allow us to test if there are changes in the difference-in-difference estimates from what we had obtained earlier. We should not observe any significant difference-in-difference estimates with the placebo regression for the common trends assumption to hold.

To check for channels, we can replace the dependent variable with a measure of the quantity or quality of interaction between the workers and the mothers.

7 Results

7.1 Main results

The main results in Table 4 show that on average there are no significant effects on child health of the training-only program or the training and recipe treatment. Controls include child-specific, household-level and center-level characteristics at baseline and these are specified in the notes under the table. For column (1), the dependent variable is weight and the controls also include age of child and its square. In Column (2), the dependent variable is the weight-for-age z-score, which has been calculated using the WHO guidelines. Column (3) has malnourished status of the child as the dependent variable. A child is classified as malnourished if her weight-for-age z-score <= -2. We observe that over time weight increased significantly in the control group by on average 394 grams over five months. This is expected although it is lower than the average growth rate for a four year old child, which is about 500 grams over the same time period. We also see that there are no significant differences on average at baseline for the treatment groups relative to the control group. Overall, the treatment effects on weight, z-score and malnutrition are not significant. Thus, we observe no average impact of the treatments on the sample as a whole.

<Table 4 about here>

Note, however, that the difference-in-differences estimate relies on the common trend assumption which may not hold in practice. If there are differential pre-treatment trends in (say) the combined treatment group, we would get spurious coefficients in the main results. These trends may exist, for example, if the government assigns more qualified workers or more infrastructure to the Anganwadi in the training+recipe

treatment before the treatment. Despite conducting randomization, we check if this is the case. We can conduct a simple test where a "Placebo treatment" is applied to the respective treatment groups on weights measured pre-baseline that were recorded in Anganwadi registers (and noted by enumerators).

In Table 5, we see no significant pre-existing differences between the treatments and control and the coefficients on both interaction terms are small and insignificant. The findings from the placebo test validate the common trends assumption in the main specification.

<Table 5 about here>

7.2 Heterogeneous results

7.2.1 Age and gender of child

We split the results for z-score by age categories and gender in Table 6. Although the sample size reduces dramatically (and limits our statistical power), we do find greater catching up for the children aged 2-3 years who are exposed to the combined treatment in Column (1). We find no significant effects for the training-only treatment for all age intervals and there are no gender-differential effects for either treatment.

<Table 6 about here>

7.2.2 Age of worker

Next, we check if the treatment effects are heterogeneous by age of worker in Table 7. Young is defined as a dummy variable for those workers whose age is less than the median worker age at baseline. The median age of workers is 37 years and the mean is 37.9 years and it ranges from 22 to 60 years. Interestingly, there is a significant and negative impact of the combined treatment on the malnourished status for younger workers but not for older workers. Similarly, z-scores increase significantly in the combined treatment for younger workers. A triple differences regression (not shown) also corroborates a significant difference in the impact of the training and recipe treatment for younger versus older workers.[3] The combined treatment's estimate for younger workers is quite imprecise with a standard error of 7.3 percentage points. This implies that although we can convincingly reject the null of zero impact on malnutrition for younger workers, the magnitude of the impact is less certain and has a wide range with the mean estimate of a decline of 17 percentage

[3]However, it can be observed that this impact is not significantly different from the impact of the training-only treatment.

points. This coefficient survives a horse race with heterogeneous effects for mother's age (which does not show a heterogeneous treatment effect). Figure 3 illustrates the difference in the impact on child weight against age of workers in the combined treatment (red line) and control group (green line). The red vertical line is the reference point for the median age of workers at baseline. The figure also shows that the child weight increases are secularly higher for the younger cohort in the combined treatment relative to the control group.

<Table 7 about here>

7.2.3 Other results

We check for interaction of treatments with other observable characteristics of the parents and the worker (these results are available upon request). We find (insignificant) positive effects of the combined treatment on health indicators for literate mothers and fathers that appear to be greater in magnitude than those for illiterate mothers and illiterate fathers respectively. Additionally, there are no significant effects by education level of worker for either treatment. Thus, even though younger workers were better educated than older ones, age seems to be a better predictor of a significant treatment effect than education of worker.[4] Finally, there are no significant treatment effects on child health for younger versus older mothers.

7.3 Potential mechanism: Quantity or quality of interaction

The young workers can influence child weight through two channels: providing greater food at the center and creating behavioral change within the child's home through home visits to counsel and monitor the mother. As the training program focused on communication with the mothers, the second channel is likely to be more salient. Moreover, it was not possible within the project budget to collect data on the distribution of food to each child at every center. However, we asked all mothers about the number of home visits in the last month by the worker and the number of visits by the mother to the center (Table 8, Panel A). Mothers were also asked whether the worker spoke with them in the past three months about their child's diet, about consequences of child malnutrition, or showed them their child's growth chart (Panel B).

[4] A horse race between the interactive effects of higher education and young worker with the combined treatment yields significant effects on health for the young worker and insignificant effects for the higher educated worker.

Overall, it appears that even in the training-only treatment, a young worker's effort increases and she makes more visits to home. However, the child's weight does not show a significant increase perhaps because the number of visits are not high enough to induce behavioral change or the lack of a recipe book at home makes the visit ineffective for the worker. The young worker (as opposed to the older worker) appears to respond to training, but it does not help improve health outcomes, implying that the effort of the trained worker alone is not effective to change behavior. In the combined treatment, not only do workers' visits increase relative to the training-only treatment but also the mothers increase their visits to the center. This implies that providing the recipe book to the mother encourages not only greater home visits by the worker but also more visits to the center by the mother. This may lead to an increase in food provision to the children and may signal that empowering mothers with nutritional information can lead to an increase in their voice to reduce leakages.

The increase in workers' visits is unproductive in the training-only treatment perhaps because there is no specific information relayed to the mother and she also does not have the recipe book to refer to once the worker leaves. Gragnolati et al. (2005) remark in the context of an Anganwadi worker in India: "Although communication for behavior change through the worker is a crucial weapon in the fight against malnutrition, the information the worker is conveying to the mothers is not being communicated effectively enough to positively affect mothers' behavior." However, the combination of training younger workers and information to mothers appears to reduce significantly malnutrition by triggering greater communication between the worker and the mother. This communication does not seem to change the content (quality) significantly but stems from an increase in the quantity of interaction. Younger workers may be able to reinforce the importance of nutritious recipes by increasing home visits. Relating to the conceptual framework, it is i (knowledge of the importance of feeding these inputs) instead of k (knowledge of the existence of available inputs) that trained young workers focus on and they are able to do so more successfully when the mother has a recipe book.

<Table 8 about here>

7.4 Knowledge of workers and mothers

Another piece of evidence that neither training nor recipes led to an improvement in the knowledge of mothers is that there are no significant effects on the nutritional quiz score for the mothers measured at

endline and baseline. Quiz score is out of 20 which consists of recipe and non-recipe scores: 13 and 7 respectively. The recipe score accounts for questions related directly to information in the recipe book and non-recipe score is "out-of-book". Appendix Table 2 shows that there was no impact on knowledge acquisition of the mothers after five months in either treatment (Panel A). Surprisingly, even the workers seem to revert back to their old scores five months after their training (Panel B). The training did increase the worker's baseline scores by 1.8 points to 15 out of 20 in a quiz conducted after the training session. However, at endline the quiz scores are not significantly different from baseline for the two treatments. Thus, knowledge acquisition (as measured by the quiz) is temporary and knowledge does not transfer to the mothers in the long-term. The results on knowledge are consistent with the interpretation that it was either i or c rather than k that caused a reduction in malnutrition through either behavioral change at home or the mother reducing leakage in the center by increasing her visits. Further research is required to understand how the informational treatment on the demand-side can act to complement supply-side training. It may do so by first, simply making the mother more aware, second, facilitating more effective communication with the worker or third, empowering the mother to monitor the worker. We find evidence to reject the first channel but distinguishing between second and third channels is also likely to be important for designing training programs and informational campaigns.

The results are in line with Hamer et al. (2004) that found no effects of a training-only treatment. Finally, the complementarity can be related to the results from Zaman et al. (2008) and Penny et al. (2005) where the sample population may be more aware when training was implemented. It may also be the case that children between 2-6 years of age need a more intensive treatment to have a shift in their health development paths relative to children under 2 years. We believe that apart from the contribution of the paper towards finding no effects of the training-only treatment and heterogeneous effects of the combined treatment, this is the first paper studying experimentally the impact of a training program on the supply-side for children over two years of age. The significant effects for children exposed to younger caregivers in the combined treatment is consistent with the recent empirical literature that finds catch-up effects after two years.

8 Conclusion

We carry out a randomized controlled trial to test the impact of re-training child caregivers employed by the state government. Caregivers are supposed to feed children between ages 2 to 6 years in day care

centers and also advise mothers on health and nutrition for their child. Moreover, we predict that behavioral change at home can happen by either an increase in the knowledge of the mothers about the inputs or through an increase in the knowledge about the importance of the inputs. The training program introduced more effective communication strategies with mothers to induce behavioral change at home. We find that on its own, the training has no significant impact on reducing child malnutrition after five months. However, there is a complementarity between training younger workers and providing nutritional information to mothers, which helps reduce malnutrition. This appears to be driven by an increase in the knowledge about the importance of the inputs as the younger workers make more visits to homes of mothers who have recipe books. Similarly, these mothers also increase their visits to the day care centers.

The 2014-15 budget for Punjab allocates $1.2 billion to health expenditures (Department of Planning, 2013). There are currently 26,408 Anganwadi workers and over 434,586 children between the ages of 2-6 years (ICDS, 2014). All workers undergo health, nutrition and pre-school training when they start working but there was no systematic evidence on the impact of refresher training modules for these workers focusing on counseling to mothers. This is the first attempt through a randomized controlled trial at understanding whether it is beneficial to target state's scarce resources towards training programs. The training program costs only about $4 per worker but the cost effectiveness may be high if it significantly improves child health. We find that only introducing supply-side training without empowering the mothers does not improve child health. This may indeed be a case of wasteful spending. Training workers and providing recipe books to mothers may work to reduce child malnutrition but this only happens if the worker is relatively young. However, the precise nature of behavioral change at home and reduction in leakages at the centers that lead to a decline in malnutrition are topics for further research.

References

[1] Adair, L. S., "Filipino children exhibit catch-up growth from age 2 to 12 years", The Journal of Nutrition (1999), 129(6), 1140-1148.

[2] Adhikari, Saroj K., and Caryn Bredenkamp. "Monitoring for Nutrition Results in ICDS: Translating Vision into Action." IDS Bulletin 40, no. 4 (2009): 70–77. doi:10.1111/j.1759-5436.2009.00061.x.

[3] Alderman, Harold, and Jere R. Behrman. "Reducing the Incidence of Low Birth Weight in Low-Income Countries Has Substantial Economic Benefits." The World Bank Research Observer 21, no.

1 (March 20, 2006): 25–48. doi:10.1093/wbro/lkj001.

[4] Alderman, Harold, John Hoddinott, and Bill Kinsey. "Long Term Consequences of Early Childhood Malnutrition." Oxford Economic Papers 58, no. 3 (July 1, 2006): 450–74. doi:10.1093/oep/gpl008.

[5] Barham, T., K. Macours, & John A. Maluccio. "Boys' Cognitive Skill Formation and Physical Growth: Long-Term Experimental Evidence on Critical Ages for Early Childhood Interventions", The American Economic Review (2013),103(3), 467-471.

[6] Bhattacharya, Jayanta, Janet Currie, and Steven J. Haider. "Breakfast of Champions?: The School Breakfast Program and the Nutrition of Children and Families." Journal of Human Resources (June 20, 2006), XLI:445-466;

[7] Behrman, Jere, Harold Alderman, and John Hoddinott. "Malnutrition and Hunger." In Global Crisis, Global Solutions, 2nd ed., 363–420. Cambridge, UK: Cambridge University Press, 2004.

[8] Behrman, Jere R., and Anil B. Deolalikar. "Will Developing Country Nutrition Improve with Income? A Case Study for Rural South India." Journal of Political Economy 95, no. 3 (June 1, 1987): 492–507.

[9] Bhandari, Nita, Sarmila Mazumder, Rajiv Bahl, Jose Martines, Robert E. Black, and Maharaj K. Bhan. "An Educational Intervention to Promote Appropriate Complementary Feeding Practices and Physical Growth in Infants and Young Children in Rural Haryana, India." The Journal of Nutrition 134, no. 9 (September 1, 2004): 2342–48.

[10] Cohen, J. *Statistical power analysis for the behavioral sciences* (2nd ed.), 1988. Hillsdale, NJ: Lawrence Earlbaum Associates.

[11] Coly, A., J. Milet, A. Diallo, T. Ndiaye, E. Bénéfice, F. Simondon, S. Wade, and K. Simondon, "Preschool stunting, adolescent migration, catch-up growth, and adult height in young Senegalese men and women of rural origin", The Journal of Nutrition (2006), 136.9: 2412-2420.

[12] Crookston, Benjamin T., Mary E. Penny, Stephen C. Alder, Ty T. Dickerson, Ray M. Merrill, Joseph B. Stanford, Christina A. Porucznik, and Kirk A. Dearden, "Children who recover from early stunting and children who are not stunted demonstrate similar levels of cognition", The Journal of Nutrition (2010), 140, no. 11: 1996-2001.

[13] Department of Planning, Government of Punjab. GSDP/NSDP (2004-05) - Statewise Data (2004-05 to 2013-14), 2014. http://pbplanning.gov.in/pdf/state%20wise%20data%202014.pdf.

[14] "District Wise Geographical Area in Punjab." Census 2011, n.d.

http://www.punjabstat.com/

[15] Drèze, Jean. "Universalisation with Quality: ICDS in a Rights Perspective." Economic and Political Weekly 41, no. 34 (August 26, 2006): 3706–15.

[16] Dreze, Jean, and Amartya Sen. An Uncertain Glory: India and Its Contradictions. Princeton University Press, 2013.

[17] Dupas, Pascaline. "Health Behavior in Developing Countries." Annual Review of Economics 3, no. 1 (2011): 425–49. doi:10.1146/annurev-economics-111809-125029.

[18] Evaluation Report on Integrated Child Development Services. Program Evaluation Organization, Planning Commission, March 2011. http://planningcommission.gov.in/reports/peoreport/peo/peo_icds_vol1.pdf.

[19] "Funds Released and Expenditure Reported under Integrated Child Development Schemes (ICDS) General SNP and Training in Punjab." Indiastat, 2014. http://www.indiastat.com/

[20] Golden, M. H., "Is complete catch-up possible for stunted malnourished children?", European Journal of Clinical Nutrition (1994), 48, S58-70.

[21] Gragnolati, M., C. Bredenkamp, M. Shekar, M. Das Gupta, and Yi-K. Lee. "India's Undernourished Children: A Call for Reform and Action." World Bank Washington, 2005.

[22] Guldan, Georgia S., Marian F. Zeitlin, Alexa S. Beiser, Charles M. Super, Stanley N. Gershoff, and Sabita Datta. "Maternal Education and Child Feeding Practices in Rural Bangladesh." Social Science & Medicine 36, no. 7 (April 1993): 925–35. doi:10.1016/0277-9536(93)90084-H.

[23] Hamer, C., K. Kvatum, D. Jeffries, and S. Allen. "Detection of Severe Protein-Energy Malnutrition by Nurses in The Gambia." Archives of Disease in Childhood 89, no. 2 (February 1, 2004): 181–84. doi:10.1136/adc.2002.022715.

[24] Handa, Sudhanshu. "Maternal Education and Child Height." Economic Development and Cultural Change 47, no. 2 (January 1, 1999): 421–39. doi:10.1086/452408.

[25] "Integrated Child Development Scheme." Directorate of Social Security, Government of Punjab, http://www.pbsocialsecurity.gov.in/html/icds.html.

[26] "Integrated Child Development Services." Ministry of Women and Child Development, Government of India, http://wcd.nic.in/icds/icds.aspx.

[27] "Integrated Child Development Services (ICDS) Scheme." Ministry of Women and Child Development, Government of India, 2011. http://wcd.nic.in/icds.htm.

[28] Kapil, Umesh. "Integrated Child Development Services (ICDS) Scheme: A Program for Holistic Development of Children in India." The Indian Journal of Pediatrics 69, no. 7 (July 1, 2002): 597–601. doi:10.1007/BF02722688.

[29] Kular, Sarbjit Singh. "A Study on Anganwadi Workers in Rural ICDS Blocks of Punjab." International Journal of Humanities and Social Science Invention 3, no. 9 (September 2014): 1–4.

[30] ———. "Evaluation of Nutrition and Health Education Programme of ICDS Scheme in Barnala District of Punjab." Dynamics of Public Administration 31, no. 2 (2014): 234. doi:10.5958/0976-0733.2014.00799.8.

[31] Madajewicz, Malgosia, Alexander Pfaff, Alexander van Geen, Joseph Graziano, Iftikhar Hussein, Hasina Momotaj, Roksana Sylvi, and Habibul Ahsan. "Can Information Alone Change Behavior? Response to Arsenic Contamination of Groundwater in Bangladesh." Journal of Development Economics 84, no. 2 (November 2007): 731–54. doi:10.1016/j.jdeveco.2006.12.002.

[32] Maluccio, John A., John Hoddinott, Jere R. Behrman, Reynaldo Martorell, Agnes R. Quisumbing, and Aryeh D. Stein. "The Impact of Improving Nutrition During Early Childhood on Education among Guatemalan Adults." The Economic Journal 119, no. 537 (2009): 734–63. doi:10.1111/j.1468-0297.2009.02220.x.

[33] Martorell, R., Khan, L. K., & Schroeder, D. G., "Reversibility of stunting: epidemiological findings in children from developing countries", European Journal of Clinical Nutrition (1994), 48, S45-57.

[34] Michaelsen, Kim F., Camilla Hoppe, Nanna Roos, Pernille Kaestel, Maria Stougaard, Lotte Lauritzen, Christian Molgaard, Tsinuel Girma, and Henrik Friis. "Choice of Foods and Ingredients for Moderately Malnourished Children 6 Months to 5 Years of Age." Food & Nutrition Bulletin 30, no. 3 (2009): S343.

[35] Miller, G., and K.S. Babiarz, "Pay-for-performance incentives in low-and middle-income country health programs." NBER Working Paper No. 18932 (2013).

[36] Moleiro, Carla, Susana Marques, and Pedro Pacheco. "Cultural Diversity Competencies in Child and Youth Care Services in Portugal: Development of Two Measures and a Brief Training Program." Children and Youth Services Review 33, no. 5 (May 2011): 767–73. doi:10.1016/j.childyouth.2010.11.022.

[37] Newes-Adeyi, Gabriella, Deborah L. Helitzer, Debra Roter, and Laura E. Caulfield. "Improving Client–provider Communication: Evaluation of a Training Program for Women, Infants and Children (WIC) Professionals in New York State." Patient Educa-

tion and Counseling 55, no. 2 (November 1, 2004): 210–17. doi:10.1016/j.pec.2003.05.001.

[38] Outes, I., & Porter, C., "Catching up from early nutritional deficits? Evidence from rural Ethiopia", Economics & Human Biology (2013), 11(2), 148-163.

[39] Onyango, Adelheid W, Steven A Esrey, and Michael S Kramer. "Continued Breastfeeding and Child Growth in the Second Year of Life: A Prospective Cohort Study in Western Kenya." The Lancet 354, no. 9195 (December 11, 1999): 2041–45. doi:10.1016/S0140-6736(99)02168-6.

[40] Pelto, Gretel H., Iná Santos, Helen Gonçalves, Cesar Victora, José Martines, and Jean-Pierre Habicht. "Nutrition Counseling Training Changes Physician Behavior and Improves Caregiver Knowledge Acquisition." The Journal of Nutrition 134, no. 2 (February 1, 2004): 357–62.

[41] Penny, Mary E, Hilary M Creed-Kanashiro, Rebecca C Robert, M Rocio Narro, Laura E Caulfield, and Robert E Black. "Effectiveness of an Educational Intervention Delivered through the Health Services to Improve Nutrition in Young Children: A Cluster-Randomised Controlled Trial." The Lancet 365, no. 9474 (June 3, 2005): 1863–72. doi:10.1016/S0140-6736(05)66426-4.

[42] Prentice, A. M., Ward, K. A., Goldberg, G. R., Jarjou, L. M., Moore, S. E., Fulford, A. J., & Prentice, A., "Critical windows for nutritional interventions against stunting", The American Journal of Clinical Nutrition (2013), 97(5), 911.

[43] Prinja, Shankar, Ramesh Verma, and Sunder Lal. "Role of ICDS Program in Delivery of Nutritional Services and Functional Integration between Anganwadi and Health Worker in North India." The Internet Journal of Nutrition and Wellness 5, no. 2 (2008). http://ispub.com/IJNW/5/2/4072.

[44] Ramachandran, Nira. Persisting Undernutrition in India: Causes, Consequences and Possible Solutions. Springer Science & Business, 2014.

[45] Sandiford, P., J. Cassel, M. Montenegro, and G. Sanchez. "The Impact of Women's Literacy on Child Health and Its Interaction with Access to Health Services." Population Studies 49, no. 1 (March 1, 1995): 5–17.

[46] Sengupta, Paramita, Nina Philip, and A. I. Benjamin. "Epidemiological Correlates of under-Nutrition in under-5 Years Children in an Urban Slum of Ludhiana." Health and Population: Perspectives and Issues 33, no. 1 (2010): 1–9.

[47] Simoes, E. A., T. Desta, T. Tessema, T. Gerbresellassie, M. Dag-

new, and S. Gove. "Performance of Health Workers after Training in Integrated Management of Childhood Illness in Gondar, Ethiopia." Bulletin of the World Health Organization 75 Suppl 1 (1997): 43–53.

[48] Singh, Abhijeet, Park, Albert and Stefan Dercon, "School Meals as a Safety Net: An Evaluation of the Midday Meal Scheme in India", Economic Development and Cultural Change (2014), University of Chicago Press, vol. 62(2), pages 275 - 306.

[49] Singh, Prakarsh. "Performance Pay and Information: Reducing Child Undernutrition in India." Journal of Economic Behavior & Organization Forthcoming. 2015.

[50] Status Report on ICDS Scheme - Data Tables. India: Ministry of Women and Child Development, 2014 2008. http://wcd.nic.in/icds/icdsdatatables.aspx.

[51] The Hungama Survey Report 2011. Naandi Foundation. Accessed January 25, 2015. http://www.naandi.org/wp-content/uploads/2013/12/HUNGaMA-Report-One-Pager.pdf.

[52] Udo, C., C. Melin-Johansson, I. Henoch, B. Axelsson, and E. Danielson. "Surgical Nurses' Attitudes towards Caring for Patients Dying of Cancer – a Pilot Study of an Educational Intervention on Existential Issues." European Journal of Cancer Care 23, no. 4 (2014): 426–40. doi:10.1111/ecc.12142.

[53] Zaman, Shakila, Rifat N. Ashraf, and José Martines. "Training in Complementary Feeding Counselling of Healthcare Workers and Its Influence on Maternal Behaviours and Child Growth: A Cluster-Randomized Controlled Trial in Lahore, Pakistan." Journal of Health, Population, and Nutrition 26, no. 2 (June 2008): 210–22.

Part I

Figures and Tables

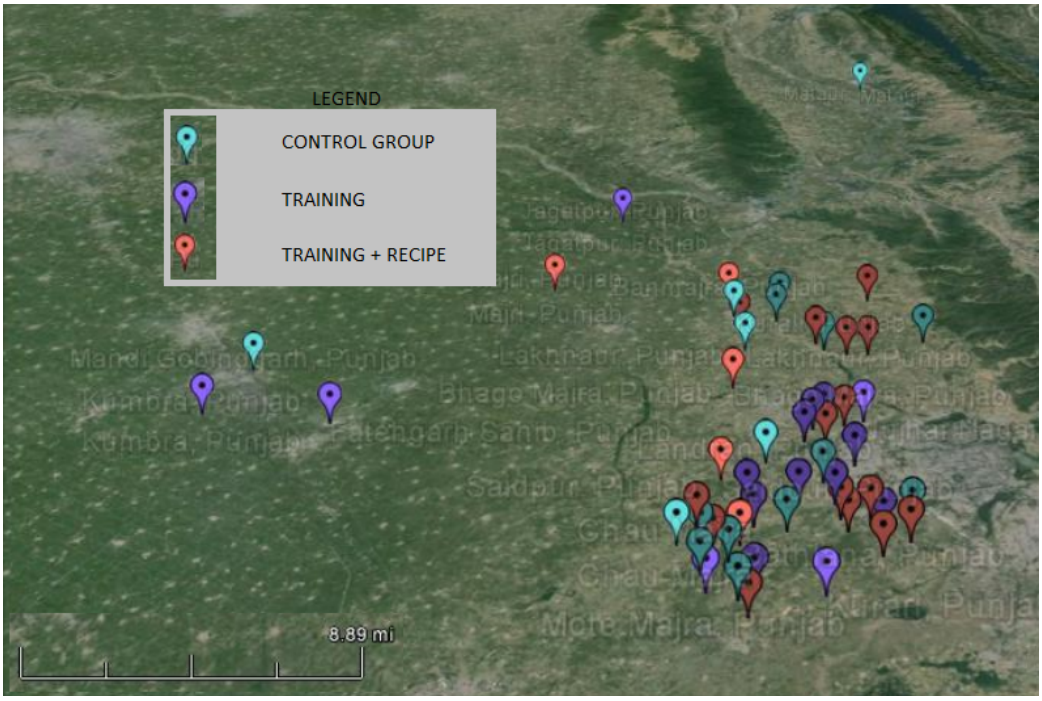

Figure 1: Map showing distribution of villages in rural Punjab assigned to treatments and control

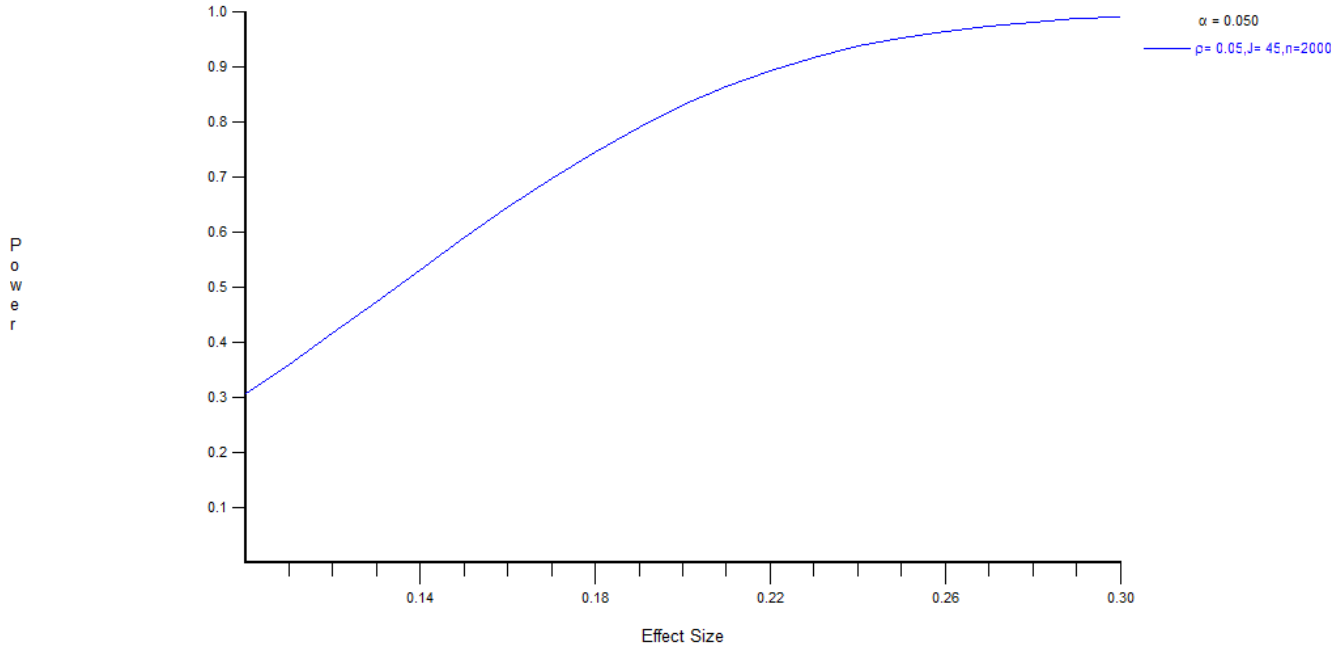

Figure 2: Graph showing the tradeoff of power with effect size in a cluster randomized trial with number of clusters = 45, number of subjects equal to 45 and intra-class correlation equal to 0.05. Generated through Optimal design software.

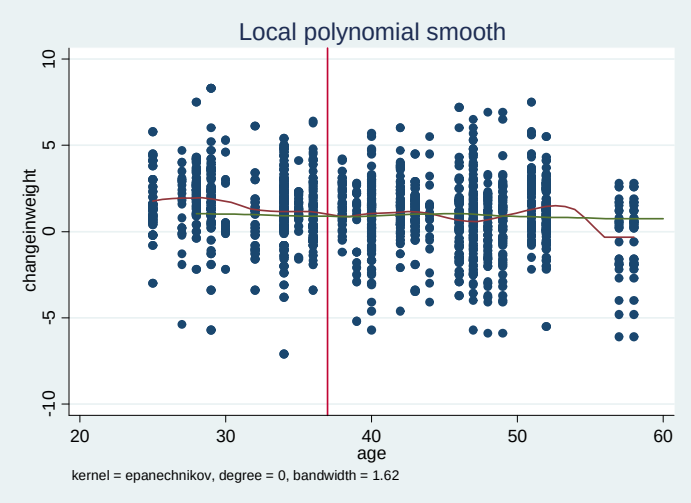

Figure 3: Graph showing a local polynomial smoothing function for the change in weight for each child against age of worker. Green line represents the control group and red line represents the combined treatment (training + recipe).

Table 1: Number of Centers and Villages by Treatment

	Number of Villages	Number of Centers
Control	23	39
Training	22	35
Training+Recipe	21	35

Table 2: Compliance and Attrition Rates

		Training	Training + Recipe	Control
Round 1	children weighed	955	965	1060
	children whose mothers were quizzed	871	871	940
	% of children whose mothers were quizzed	91%	90%	89%
Round 2	children weighed	807	887	913
	children whose mothers were quizzed	711	767	845
	% of children whose mothers were quizzed	88.10%	86.47%	92.55%
	% of children weighed again	84.50%	91.92%	86.13%
	%mothers quizzed again	81.63%	88.06%	89.89%

Table 3: Summary statistics from the baseline

				Differences	
VARIABLES	Training	Training+Recipe	Control	Training	Training+Recipe
Panel A: Children characteristics					
Malnutrition rate	0.245	0.287	0.244	0.00	0.04
	[0.44]	[0.45]	[0.43]	(0.62)	(0.62)
Weight of child	12.79	12.87	12.83	-0.04	0.04
	[2.21]	[2.23]	[2.18]	(3.10)	(3.12)
z-score	-1.336	-1.421	-1.452	0.12	0.03
	[1.07]	[1.05]	[1.03]	(1.49)	(1.47)
Age of child	3.74	3.85	3.81	-0.07	0.04
	[0.95]	[0.96]	[0.99]	(1.37)	(1.38)
Fraction male	0.5	0.52	0.51	-0.01	0.01
	[0.50]	[0.50]	[0.50]	(0.71)	(0.71)
Panel B: Household characteristics					
Monthly income	4982.11	4389.48	4730.41	251.70	-340.93
	[1935.69]	[1922.97]	[1991.08]	(2776.92)	(2768.07)
Weekly Expenditures	831.07	927.30	956.37	-125.30	-29.07
	[394.81]	[534.43]	[508.24]	(643.57)	(737.51)
Food expenditures	448.08	556.58	538.93	-90.85	17.65
	[275.52]	[379.72]	[323.54]	(424.96)	(498.86)
Number of rooms	2.03	2.11	2.35	-0.32	-0.24
	[1.17]	[1.27]	[1.24]	(1.70)	(1.77)
Mother's age	27.67	28.06	28.08	-0.41	-0.02
	[4.01]	[3.88]	[4.52]	(6.04)	(5.96)
Mother can read	0.62	0.65	0.74	-0.12	-0.09
	[0.49]	[0.48]	[0.44]	(0.66)	(0.65)
Father can read	0.75	0.81	0.84	-0.09	-0.03
	[0.43]	[0.39]	[0.37]	(0.57)	(0.54)
Housewife mother	0.51	0.77	0.69	-0.18	0.08
	[0.50]	[0.42]	[0.46]	(0.68)	(0.62)
Panel C: Worker and center characteristics					
Worker's Age	38.11	41.32	40.8	-2.69	0.52
	[7.64]	[8.68]	[8.98]	(11.79)	(12.49)
Educated worker	0.29	0.39	0.17	0.12	0.22
	[0.46]	[0.49]	[0.37]	(0.59)	(0.61)
Proportion kitchen goods	0.54	0.58	0.61	-0.07	-0.03
	[0.25]	[0.23]	[0.26]	(0.36)	(0.35)
Proportion non-kitchen goods	0.61	0.58	0.63	-0.02	-0.05
	[0.22]	[0.20]	[0.22]	(0.31)	(0.30)
Electricity in AWC	0.29	0.35	0.28	0.01	0.07
	[0.45]	[0.48]	[0.45]	(0.64)	(0.66)
Fan in AWC	0.41	0.35	0.53	-0.12	-0.18
	[0.49]	[0.48]	[0.50]	(0.70)	(0.69)
Helper in AWC	1	1	0.97	0.03	0.03
	[0.00]	[0.00]	[0.18]	(0.18)	(0.18)
Chart in AWC	0.82	0.94	0.89	-0.07	0.05
	[0.38]	[0.65]	[0.32]	(0.50)	(0.50)
Blackboard in AWC	0.19	0.32	0.23	-0.04	0.09
	[0.40]	[0.47]	[0.42]	(0.58)	(0.63)
Drinking water in AWC	0.3	0.57	0.36	-0.06	0.21
	[0.46]	[0.50]	[0.48]	(0.66)	(0.69)
Toilet in AWC	0.35	0.25	0.24	0.11	0.01
	[0.48]	[0.43]	[0.43]	(0.64)	(0.61)

Notes: Standard deviations in parentheses. Expenditures are in Rupees. Proportion kitchen means proportion of kitchen assets owned. Kitchen assets are fridge, water filter, water tap, cooking gas and pressure cooker. Non-kitchen assets are mobile, television, scooter, radio and a flush toilet. Infrastructural variables for AWC (Anganwadi Center) are dummy variables.

Table 4: Impact of treatments on health outcomes

VARIABLES	**Weight**	**z-score**	**Malnourished**
	(1)	(2)	(3)
Post	0.394**	0.0477	-0.0502
	(0.172)	(0.0930)	(0.0358)
Training	-0.169	-0.0724	0.0338
	(0.239)	(0.133)	(0.0432)
Training+Recipe	-0.225	-0.130	0.0541
	(0.243)	(0.135)	(0.0408)
Post*Training	0.232	0.134	-0.0509
	(0.198)	(0.108)	(0.0413)
Post*(Training+Recipe)	0.0680	0.0840	-0.0247
	(0.234)	(0.131)	(0.0540)
Age of child	1.925***		
	(0.326)		
Age of child squared	-0.113***		
	(0.0402)		
Other controls	**Yes**	**Yes**	**Yes**
Constant	6.643***	-0.835*	0.242*
	(0.946)	(0.496)	(0.142)
Observations	3164	3164	3164
R-squared	0.326	0.059	0.044

Notes: Robust standard errors in parentheses clustered at the village level. Weight-for-age z-score for each child is calculated by the following formula from WHO Reference (2007):
(observed weight – median weight-for-age from reference population)/(Std. deviation of weight-for-age from reference population).
Malnourished status is a dummy which takes value 1 if child is malnourished according to WHO classification (if z-score < = -2). Age of child and the square of the age of child are used to capture potential non-linear impact of the child's age. Other controls include: Age of mother, Proportion kitchen, Proportion non-kitchen, Household Income, Age of worker, and the following dummy variables: Gender of child, Mother housewife, Mother is Hindu, High quiz score worker (if quiz score is higher than median in the baseline), High quiz score mother, High experienced worker (if experience of the worker is more than the median experience), Literate mother (if the mother can read and write), Literate father, Educated worker (completion of secondary schooling), Electricity in Anganwadi, Fan in Anganwadi, Blackboard in Anganwadi, Drinking water in Anganwadi, Helper in Anganwadi, Weight chart in Anganwadi. Proportion kitchen means proportion of kitchen assets owned. Kitchen assets are fridge, water filter, water tap, cooking gas and pressure cooker. Non-kitchen assets are mobile, television, scooter, radio and a flush toilet. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Placebo check on health outcomes

VARIABLES	**Weight**	**z-score**	**Malnourished**
	(1)	(2)	(3)
Placebo Post	0.201**	0.0948	-0.0432**
	(0.0992)	(0.0615)	(0.0207)
Training	-0.0393	0.0201	-0.0190
	(0.292)	(0.156)	(0.0547)
Training+Recipe	-0.166	-0.0924	0.0316
	(0.289)	(0.162)	(0.0544)
Placebo Post*Training	-0.0241	-0.0156	0.0192
	(0.151)	(0.0867)	(0.0282)
Placebo Post*			
(Training+Recipe)	-0.000708	0.00170	0.0282
	(0.125)	(0.0732)	(0.0300)
Age of child	2.060***		
	(0.406)		
Age of child squared	-0.140***		
	(0.0474)		
Other controls	**Yes**	**Yes**	**Yes**
Constant	5.750***	-1.472***	0.426**
	(1.103)	(0.423)	(0.162)
Observations	3571	3571	3571
R-squared	0.249	0.036	0.030

Notes: Placebo Post=1 at baseline and 0 two months prior to baseline. Robust standard errors in parentheses clustered at the village level. Weight-for-age z-score for each child is calculated by the following formula from WHO Reference (2007):
(observed weight – median weight-for-age from reference population)/(Std. deviation of weight-for-age from reference population).
Malnourished status is a dummy which takes value 1 if child is malnourished according to WHO classification (if z-score < = -2). Age of child and the square of the age of child are used to capture potential non-linear impact of the child's age. Other controls include: Age of mother, Proportion kitchen, Proportion non-kitchen, Household Income, Age of worker, and the following dummy variables: Gender of child, Mother housewife, Mother is Hindu, High quiz score worker (if quiz score is higher than median in the baseline), High quiz score mother, High experienced worker (if experience of the worker is more than the median experience), Literate mother (if the mother can read and write), Literate father, Educated worker (completion of secondary schooling), Electricity in Anganwadi, Fan in Anganwadi, Blackboard in Anganwadi, Drinking water in Anganwadi, Helper in Anganwadi, Weight chart in Anganwadi. Proportion kitchen means proportion of kitchen assets owned. Kitchen assets are fridge, water filter, water tap, cooking gas and pressure cooker. Non-kitchen assets are mobile, television, scooter, radio and a flush toilet. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Results on z-score disaggregated by age and gender

VARIABLES	Panel A: By age				Panel B: By gender	
	Age 2 to 3	**Age 3 to 4**	**Age 4 to 5**	**Age 5 to 6**	**Girls**	**Boys**
	(1)	(2)	(3)	(4)	(5)	(6)
Post	-0.155	0.0217	0.0629	0.128	-0.0329	0.152
	(0.157)	(0.121)	(0.128)	(0.167)	(0.0976)	(0.108)
Training	-0.115	-0.124	-0.142	0.332*	-0.0820	-0.0451
	(0.232)	(0.160)	(0.139)	(0.181)	(0.143)	(0.138)
Training+Recipe	-0.396*	0.00549	-0.119	0.0410	-0.197	-0.0272
	(0.200)	(0.163)	(0.150)	(0.160)	(0.149)	(0.146)
Post*Training	0.134	0.211	0.149	-0.149	0.132	0.113
	(0.218)	(0.143)	(0.140)	(0.148)	(0.128)	(0.120)
Post*(Training+Recipe)	0.478**	0.0304	-0.100	-0.167	0.0846	0.0460
	(0.204)	(0.159)	(0.170)	(0.223)	(0.146)	(0.148)
Other controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Constant	-0.333	-1.872***	-2.018***	-2.778***	-0.606	-1.143**
	(0.705)	(0.496)	(0.562)	(0.598)	(0.551)	(0.558)
Observations	737	1038	897	382	1575	1589
R-squared	0.081	0.096	0.101	0.156	0.076	0.065

Notes: Robust standard errors in parentheses clustered at the village level. Weight-for-age z-score for each child is calculated by the following formula from WHO Reference (2007):
(observed weight – median weight-for-age from reference population)/(Std. deviation of weight-for-age from reference population).
Other controls include: Age of mother, Proportion kitchen, Proportion non-kitchen, Household Income, Age of worker, and the following dummy variables: Mother housewife, Mother is Hindu, High quiz score worker (if quiz score is higher than median in the baseline), High quiz score mother, High experienced worker (if experience of the worker is more than the median experience), Literate mother (if the mother can read and write), Literate father, Educated worker (at least till A-level), Electricity in Anganwadi, Fan in Anganwadi, Blackboard in Anganwadi, Drinking water in Anganwadi, Helper in Anganwadi, Weight chart in Anganwadi. Proportion kitchen means proportion of kitchen assets owned. Kitchen assets are fridge, water filter, water tap, cooking gas and pressure cooker. Non-kitchen assets are mobile, television, scooter, radio and a flush toilet. *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Impact of treatments on health outcomes for younger versus older workers

	Panel A: Young workers			Panel B: Old Workers		
VARIABLES	**Weight**	**z-score**	**Malnourished**	**Weight**	**z-score**	**Malnourished**
	(1)	(2)	(3)	(4)	(5)	(6)
Post	0.873**	-0.0454	0.0310	0.673**	0.0335	-0.0795*
	(0.385)	(0.177)	(0.0659)	(0.294)	(0.115)	(0.0434)
Training	-0.258	-0.147	0.0874	-0.495	-0.0329	-0.0225
	(0.447)	(0.183)	(0.0638)	(0.400)	(0.176)	(0.0510)
Training+Recipe	-0.179	-0.250	0.102	-0.367	-0.00508	-0.0100
	(0.426)	(0.159)	(0.0613)	(0.442)	(0.188)	(0.0529)
Post*Training	0.0315	0.165	-0.110	0.293	0.0777	0.0263
	(0.411)	(0.176)	(0.0694)	(0.294)	(0.144)	(0.0555)
Post*(Training+Recipe)	0.258	0.366**	-0.174***	-0.132	-0.121	0.0780
	(0.389)	(0.151)	(0.0573)	(0.349)	(0.155)	(0.0617)
Other controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Constant	10.65***	-0.672	0.198	11.51***	-1.050**	0.320**
	(0.983)	(0.420)	(0.163)	(0.727)	(0.414)	(0.124)
Observations	1311	1311	1311	1909	1909	1909
R-squared	0.121	0.080	0.077	0.102	0.066	0.047

Notes: Young is defined as a dummy variable for those workers whose age is less than or equal to the median worker age (37 years). Robust standard errors in parentheses clustered at the village level. Weight-for-age z-score for each child is calculated by the following formula from WHO Reference (2007): (observed weight – median weight-for-age from reference population)/(Std. deviation of weight-for-age from reference population).

Malnourished status is a dummy which takes value 1 if child is malnourished according to WHO classification (if z-score < = -2). Age of child and the square of the age of child are used to capture potential non-linear impact of the child's age. Other controls include: Age of mother, Proportion kitchen, Proportion non-kitchen, Household Income, and the following dummy variables: Gender of child, Mother housewife, Mother is Hindu, High quiz score worker (if quiz score is higher than median in the baseline), High quiz score mother, Literate father, Electricity in Anganwadi, Fan in Anganwadi, Blackboard in Anganwadi, Drinking water in Anganwadi, Helper in Anganwadi, Weight chart in Anganwadi. Proportion kitchen means proportion of kitchen assets owned. Kitchen assets are fridge, water filter, water tap, cooking gas and pressure cooker. Non-kitchen assets are mobile, television, scooter, radio and a flush toilet. *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Heterogeneity of Social Interaction by age of worker

	Panel A: Quantity of interaction		Panel B: Quality of interaction		
VARIABLES	**Worker visits** Reported by Mother	**Mother visits** Reported by Mother	**Talked about Diet**	**Talked about Medicine**	**Showed Growth Chart**
	(1)	(2)	(5)	(6)	(7)
Post	0.581	0.545	0.0943*	0.118	0.346**
	(0.696)	(0.388)	(0.0557)	(0.0858)	(0.137)
Post*Training	0.583	-0.0283	-0.00541	-0.141	-0.322
	(0.994)	(0.491)	(0.0568)	(0.114)	(0.220)
Post*(Training+Recipe)	-1.845**	-1.166**	-0.0191	-0.0261	-0.0818
	(0.873)	(0.483)	(0.0822)	(0.132)	(0.177)
Post*Young* Training	2.207*	1.660***	-0.0567	0.141	0.227
	(1.210)	(0.601)	(0.0999)	(0.134)	(0.237)
Post*Young*(Training+Recipe)	3.471**	2.249***	-0.103	0.0787	0.153
	(1.345)	(0.656)	(0.124)	(0.175)	(0.265)
Other controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Constant	3.517***	0.866	1.007***	0.870***	0.793***
	(1.174)	(0.640)	(0.0799)	(0.124)	(0.177)
Observations	3058	3097	3164	3164	3164
R-squared	0.136	0.164	0.055	0.050	0.166

Notes: Young is a dummy variable that takes the value 1 if the worker's age in the center is less than or equal to the median age of all workers at baseline. Number of Worker visits and Mother visits in the previous month in columns (1) and (2) are reported by the mother in both rounds. Total visits reported by mother is equal to the sum of Worker visits and Mother visits, both reported by the mother. The dependent variables in Panel B are all dummy variables that take value 1 if the worker talked to the mother in the past 3 months on these topics as reported by the mother. Other controls include: Age of mother, Proportion kitchen, Proportion non-kitchen, Household Income, and the following dummy variables: Gender of child, Mother housewife, Mother is Hindu, High quiz score worker (if quiz score is higher than median in the baseline), High quiz score mother, High experienced worker (if experience of the worker is more than the median experience), Literate mother (if the mother can read and write), Literate father, Educated worker (at least till A-level), Electricity in Anganwadi, Fan in Anganwadi, Blackboard in Anganwadi, Drinking water in Anganwadi, Helper in Anganwadi, Weight chart in Anganwadi. *** p<0.01, ** p<0.05, * p<0.1.

9 Appendix

Appendix Table 1: How satisfied are you with the following work characteristics? (1=min, 7 =max)

	Observations	Average	Std. dev.	Min	Max
Salary growth potential	4579	4.917668	2.435268	1	7
Present salary	4560	3.777632	2.572678	1	7
Relations with supervisor	4604	6.387272	1.526825	1	7
Job security	4588	6.073888	1.686321	1	7
Own capability	4558	6.215226	1.656466	1	7
Own work	4604	6.109036	1.72654	1	7
Job timings	4579	6.572614	1.30585	1	7
Overall job satisfaction	4539	5.789381	1.972746	1	7

Appendix Table 2: Mother and Worker knowledge

	Panel A: Mother knowledge			Panel B: Worker knowledge		
VARIABLES	**Quiz Score**	**Recipe Score**	**Non-recipe Score**	**Quiz Score**	**Recipe Score**	**Non-recipe Score**
	(1)	(2)	(3)	(4)	(5)	(6)
Post	0.888	0.212	0.565***	0.543	0.0805	-0.167
	(0.536)	(0.394)	(0.199)	(0.499)	(0.706)	(0.409)
Training	-0.630	-0.620	-0.156	-0.0987	0.0735	-0.0230
	(0.571)	(0.422)	(0.233)	(0.468)	(0.396)	(0.224)
Training+Recipe	-0.352	-0.113	-0.325	0.191	0.167	-0.107
	(0.614)	(0.432)	(0.227)	(0.483)	(0.424)	(0.269)
Post*Training	1.183	1.072	0.301	0.0376	-0.137	0.614
	(0.851)	(0.650)	(0.304)	(0.692)	(0.725)	(0.394)
Post*(Training+Recipe)	0.00809	-0.309	-0.236	-1.032	-0.202	-0.228
	(0.637)	(0.512)	(0.283)	(0.831)	(0.838)	(0.486)
Other controls	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Constant	12.522***	7.501***	5.021***	13.283***	7.993***	5.290***
	(0.205)	(0.140)	(0.096)	(0.652)	(0.498)	(0.260)
Observations	8824	8824	8824	7335	7335	7335
R-squared	0.066	0.079	0.025	0.083	0.101	0.040

Notes: Robust standard errors in parentheses clustered at the village level. Quiz score is out of 20 where recipe and non-recipe scores are out of 13 and 7 respectively. The recipe score accounts for questions related directly to information in the recipe book. Other controls include: Age of mother, Proportion kitchen, Proportion non-kitchen, Household Income, Age of worker, and the following dummy variables: Gender of child, Mother housewife, Mother is Hindu, High experienced worker (if experience of the worker is more than the median experience), Literate mother (if the mother can read and write), Literate father, Educated worker (at least till A-level), Electricity in Anganwadi, Fan in Anganwadi, Blackboard in Anganwadi, Drinking water in Anganwadi, Helper in Anganwadi, Weight chart in Anganwadi. Proportion kitchen means proportion of kitchen assets owned. Kitchen assets are fridge, water filter, water tap, cooking gas and pressure cooker. Non-kitchen assets are mobile, television, scooter, radio and a flush toilet. *** p<0.01, ** p<0.05, * p<0.1.