Utilization of ICDS services and their impact on child health outcomes

Evidence from three East Indian states

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Abstract

The study analyzes a rural household's decision to participate in a public pre-school intervention called the Integrated Child Development Scheme (ICDS), and evaluates its impact on anthropometric outcomes of children in three Indian states namely, Bihar, Jharkhand and Orissa in 2012, almost four decades after the inception of the scheme. Using multinomial logit models, we find that access costs, defined both in physical (distance) and social (caste) terms are the main drivers of ICDS utilization. To estimate the impact of ICDS utilization on anthropometric outcomes, we use matching methods where participants choose to utilize one of the multiple services offered by the ICDS (rather than the binary models of utilization commonly used in the literature). The estimation strategy also accounts for differences in availability and eligibility of various ICDS services. Our results suggest that conditional on utilization, compared to singleton services, utilization of multiple services translates into larger increase in weight-for-age and height-for-age.

I. Introduction

Undernutrition among children is a major global problem. About half of all child mortality can be linked to it (World Health Organization). Also, by adversely affecting health outcomes and educational attainment, it lowers the earnings and productivity in adulthood. It has been shown that malnourished children earn up to twenty percent less than well-nourished children as adults

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(Grantham-McGregor et al. 2007). In the Indian context, the short term economic cost of malnutrition has been estimated to be between 0.8 - 2.5 percent of Gross Domestic Product (GDP), (Stein and Qaim 2007).

Two key indicators of undernutrition are stunting (low height-for-age) and underweight (low weight-for-age).[1] India's progress in reducing the prevalence rates of both these indicators has been dismal, and in 2005-06 these were higher than those in many countries which have much lower per capita GDP than India, including Pakistan, Nepal, Burkina Faso, Ghana, and Somalia. Surveys conducted by National Nutrition Monitoring Bureau (NNMB) in 9 states show that over a period of three decades (1975-2005) the prevalence rates of stunting and underweight have declined by 27 and 22 percentage points, respectively.[2] The nationally representative National Family Health Services survey (NFHS) conducted in 2004-05, gives an even higher estimate of prevalence than NNMB.[3] A recent report published by United Nations shows that the underweight prevalence was 27 percent in 2013-14, decline of only 6 percentage points in almost a decade.

The Integrated Child Development Scheme (ICDS), also known as *Anganwadi Yojana*, is a major preschool intervention by the Government of India. It was launched in 1975 with the aim of reducing malnourishment levels and was targeted at children in age group 0-6 years, and pregnant and lactating mothers. There are various components of the ICDS program – supplementary nutrition, immunization, health check-ups, growth monitoring, and preschool education to children, and nutrition education to mothers. These components may be categorized into two groups (Table 1): the first category is *nutrition* which includes supplementary food or take home rations, while the other services listed above may be included in what we refer to as

[1] A height-for-age and weight-for-age z score below -2 standard deviations from median of reference population is referred to as being stunted and underweight respectively (NFHS-3).

[2] The prevalence rates of stunting and underweight was 52 and 55 percent, respectively in 1975, which reduced to 25 and 33 percent in 2005.

[3] As per NFHS-3, in 2004-05 the prevalence rates of stunting and underweight for children below 5 years were 48 and 42.5 percent, respectively.

health investment category.[4, 5] These services are provided through childcare centres, known as *anganwadi* centres. Each centre is managed by an *anganwadi* worker (AWW) and a helper.

A directive issued by the Supreme Court of India in November, 2001 universalized the supplementary nutrition component of the program (Writ petition (Civil) no. 196 of 2001) and in December, 2006 extended it to universalization of all other services. From only one-third of the villages having at least one ICDS centre in 1992-93 (NFHS-1), coverage increased to 91 percent of all villages in 2004-05 (NFHS-3). Despite the expansion in coverage, relative to the mandated norm of one *anganwadi* centre per 400-800 people in rural/urban areas and per 300-800 people in tribal areas, the Program Evaluation Organization (PEO) of the Planning Commission (PEO 2011) found that there was a shortfall of about 30 percent percent in coverage in 2009.

There has been a steady increase in utilization rates of ICDS services. The NFHS-3 survey data indicate that 35 percent of households utilized at least one ICDS service in 2004-05. More recent data from the Ministry of Women and Child Development (MoWCD) indicate that in 2012, 79 million children were provided with supplementary nutrition (this represents about 50 percent of the population of children aged 6 months to 5 years according to the 2011 census) and 35 million children were provided with preschool education. Thus, utilization figures are far lower than those suggested by the expansion in the coverage of ICDS centres. There are several dimensions to the low utilization rates. First, lack of utilization may reflect lack of availability. The PEO (2011) study, referred to earlier, states that nearly 30 percent of the registered beneficiaries could not benefit from supplementary food as the food was simply not available at the ICDS centre. More generally it was found that it was common for households to utilize a subset of services; to the extent that this reflects supply constraints, it is clearly not a conscious choice by parents to do so. Secondly, parents may voluntarily choose not to avail any or some of the ICDS services for their children. This may, for example, be true of those who are well-off and prefer to avail these

[4] Preschool education to children entails teaching of alphabets, numbers, rhymes etc., along with physical activities for children and imparting basic health education to them. However, our survey conducted at the ICDS centre reveal that the latter activities were not provided at any of the ICDS centres. In this situation, preschool education is not likely to affect health outcomes; it may affect cognitive outcomes. Therefore, for our analysis utilization of this service is not of much consequence and is not considered in the analysis.

[5] The rationale for this two way classification of ICDS services is given in section III.

services through more costly private providers. Also, a household's decision to participate selectively can be affected by various factors, such as distance to centre, opportunity cost of time, and quality of service provided. Additionally, social discrimination based on caste, gender etc. has been identified as an important limiting factor in accessing development programs, and this holds for ICDS participation as well (Mander and Kumaran 2006; and CIRCUS 2006). However, reasons for low and selective participation and relative importance of these factors have not been analysed in the literature.

The first objective of this study is motivated by low utilization of ICDS services despite high availability. We examine the factors that affect a household's decision to utilize none, some, or all of ICDS services.[6] In doing so, we account for the fact that certain services may not be available to certain households (due to actual or perceived lack of supply), and that these households therefore face a smaller choice set.

Apart from understanding the principal drivers of the utilization of various ICDS services, it is equally important to assess whether utilization leads to improvements in child health (measured as anthropometric outcomes). Each of the two key services of the ICDS, supplementary nutrition and health investment, can be expected to improve health outcomes. Health investment services, by improving mother's nutrition knowledge would be expected to lead to improved health outcomes. Similarly, vaccinations enable children to better fight disease and thus be less susceptible to compromised growth. Independent of this, supplementary nutrition can also help ensure that children achieve their growth potential. Thus, the second objective of this study is to assess the impact of utilizing individual or bundled services of the program on health outcomes of participants. We also examine if there is complementarity between various ICDS services in affecting anthropometric outcomes, as these two sets of services when utilized together may have a greater impact on anthropometric outcomes than the utilization of only one set of services. [7]

[6] We estimate the factors that affect the utilization of nutrition and health investment services, and not of each component in these categories. Low sample sizes for each component make it econometrically infeasible to study determinants of each component.

[7] We use the terms health outcomes and anthropometric outcomes interchangeably in rest of the paper.

The analysis is based on 11 villages located in Bihar, Jharkhand and Orissa, states in Eastern India. These states are among the worst performers in terms of health outcomes in the country. Among the 29 states in India in 2004-05, the prevalence rate of stunting in Bihar (55.6%) was higher than all states except one, namely, Uttar Pradesh (NFHS-3). Jharkhand (49.8%) and Orissa (45%) are also among poor performers with a rank of 23 and 19 respectively (NFHS-3). Similarly, the underweight prevalence in Bihar (55.9%) and Jharkhand (56.5%) puts them at 27th and 28th rank respectively, while Orissa is ranked 22nd (40.7%) among the 29 states (NFHS-3).

Perhaps because of this, in the past few years these states are committing large resources to the ICDS program. The number of ICDS centres in Jharkhand and Orissa grew by 71 and 89 percent respectively between 2007 and 2012 (MoWCD), which is higher than the all India growth rate of 54 percent. Jharkhand and Orissa are among the better performing states in ICDS implementation as per PEO (2011); both these states have higher coverage, better delivery of supplementary nutrition component and good infrastructure. Though Bihar's ICDS performance is not at par with the Jharkhand or Orissa, it is spending double the requirement on supplementary nutrition (PEO 2011); however when compared with services provided, it is not clear whether this money is actually reaching beneficiaries. The very low level of health status in these states imply that a program like ICDS, if effective, can make a large and lasting contribution in improving nutritional status. Through this study, we seek to examine if this is in fact the case.

This paper contributes to the literature in several aspects. First, we explicitly account for difference between supply as defined by service provider and, users' perceptions of availability. There is a need to make this distinction as ultimately it is the perception of supply rather than the actual availability which affects utilization decisions. Even if all services are being made available, the utilization rates may not increase until the users are aware of availability or are willing to use available services. Second, we account for a more comprehensive set of determinants that affects ICDS utilization, and incorporate access cost through caste identities of participants and the ICDS worker, and through distance to ICDS centre. Third, to measure the effectiveness of ICDS program in improving health outcomes, we delve deeper than just a binary

decision of participation, and consider intensity of participation, measured by number of ICDS services used. The paper assesses the impact of individual services of the program, and addresses if there are complementarities in impact. These aspects have received scant attention in the literature thus far. Finally, most of the literature uses data prior to 2005. This paper is among the more recent impact evaluations of the ICDS; more than 50 percent of the expansion in ICDS coverage has happened after 2005, a period which has also seen a restructuring of the ICDS.

The data for this study was collected through a primary survey in rural areas of Bihar, Jharkhand and Orissa in September-October 2012. We model the participation behaviour of the households using a multinomial logit framework and identify the socio-economic characteristics of the households that are most likely to use ICDS services. Thereafter, using propensity score and covariate matching techniques, we examine if utilization of ICDS services has any impact on health outcomes of young children as measured by weight-for-age z-scores (WAZ) and height-for-age z-scores (HAZ) and, which service has the most impact.

The rest of the paper is organized as follows. Section II gives a summary of literature on evaluation of ICDS program, and section III outlines a theoretical model of household decision making. Sampling design and summary statistics are presented in section IV. We discuss empirical estimation strategy and the results for utilization of ICDS and its impact in sections V and VI, respectively. Section VII concludes.

II. Literature Review

Interventions to improve health outcomes of children can be broadly classified in four major groups (Engel et al. 2007; IEG-World Bank 2010). The first set of interventions provides *supplementary food*, either to cover any deficits in energy and protein intakes, or with a specific focus on increasing micronutrient intake. Examples of these include the school meals and take home rations in Burkina Faso, food aid in Ethiopia and milk subsidies in Peru (IEG-World Bank 2010; Stifel and Alderman 2006). The second class of programs aims to improve nutritional outcomes by imparting *nutrition education* to caregivers. One such intervention was implemented in Peru where mothers participated in complementary feeding demonstrations and

growth monitoring sessions; other examples are Integrated Management of Childhood Illness in Brazil and Tanzania (IEG-World Bank 2010). The third category is of *comprehensive programs* and includes programs such as the ICDS, the Bangladesh Integrated Nutrition Project (BINP), the PIDI program in Bolivia and the Community Empowerment and Nutrition Program (CENP) in Vietnam.[8] Such comprehensive interventions provide not only supplementary food and nutrition counseling, but may also provide other services, such as de-worming, vaccination and prenatal services. This category also includes programs where conditional cash transfers, are used as incentive for program participation, as was done through Oportunidades in Mexico. The fourth category is of *unconditional cash transfer* programs, where only money but no services are provided to participants. Such programs have been implemented in Ecuador and South Africa.

In terms of impact on child anthropometric outcomes, there does not seem to be a consensus on which of these intervention designs works best. The IEG-World Bank (2010) study evaluates 46 studies which measure the impact of such health interventions on anthropometric outcomes and do not find conclusive evidence in favour of any one type of intervention; however, from the number of studies that report a positive impact, they infer that food supplementation programs are more likely to affect weight related outcomes, while nutrition education interventions have a higher probability of resulting in taller children. Comprehensive programs are also more likely to affect weight related outcomes but have a higher likelihood of improving height related outcomes as compared to interventions with only a food supplementation component. This is perhaps not surprising since weight related measures are indicators of deprivation in short term that are more amenable to food supplementation, while height related indicators show deprivation over a long period of time, where nutrition education (which is a part of comprehensive programs) is more likely to have impact. Nores and Barnett (2010) do a meta-analysis of early child interventions in developed and developing countries, based on 56 studies that employed experimental or quasi-experimental methods. They cover 31 interventions in 24 countries; among these, of relevance are the comparisons between food supplementation interventions, comprehensive interventions and unconditional cash transfer schemes. They find

[8] Projecto Integral de Desarollo Infantil – Spanish for Integrated Child Development Project

that food only and unconditional cash transfer interventions have a similar mean effect on anthropometric outcomes; and that the impact is higher than for comprehensive interventions. They also find that all types of health interventions have a lower impact in low income countries as compared to developed countries.

Considering only comprehensive programs, the international experience on efficacy of these programs in improving anthropometric outcomes is also mixed. Using matching estimators, Behrman et al. (2004) find that the PIDI program in Bolivia had no impact on weight and height. Similarly in a randomized control design, Hossain et al. (2005) find that the BINP program in Bangladesh had no impact on anthropometric outcomes, though they do find that mothers in treatment group followed better child care practices than the mothers in control group. However, White and Masset (2006) argue that the reason Hossain et al. (2005) have not found any impact is due to small sample size. Using a propensity score matching technique, they find that for children in the age-group of 6-23 months, the program had a positive impact of 0.08 and 0.09 standard deviations on the HAZ and WAZ scores, respectively. The impact is higher for malnourished children. The CENP program in Vietnam, the unique aspect of which was its focus on "positive deviant" families, has also not led to improvement in anthropometric outcomes; however, it positively affected the growth of young children (Schroeder et al. 2002).[9] The program was also able to improve dietary intakes, especially of young and malnourished children. In Haiti, World Vision experimented with two different programs. The first program which was "preventive" in its approach, provided aid to all the children below 2 years of age, and the second called "recuperative", benefited malnourished children below the age of 5 years. Ruel et al. (2008) found that the "preventive" program had higher positive effect on all anthropometric outcomes. The WAZ, HAZ and WHA (weight-for-height) scores of children in "preventive" program were higher by 0.24, 0.14 and 0.24 standard deviations respectively, than the "recuperative" program children. Though not all comprehensive interventions have been effective, the international experience suggests that comprehensive interventions, when effective, are more likely to improve health outcomes of younger children.

[9] Positive deviant families refer to the poor families that had well-nourished children.

Turning next to evaluations of the ICDS in India, the literature may be divided into three broad strands. The first focuses on the operational lacunae in ICDS implementation. National level evaluations, such as those by NIPCCD (1992), NCAER (1998), NIPCCD (2006) and PEO (2011), focus on the availability of infrastructure, coverage of the program and gaps in delivery. For instance, a large proportion of ICDS buildings had inadequate space for indoor activities, storage and cooking (NIPCCD 2006, PEO 2011). Similarly, only 2 out of 5 ICDS buildings have functioning toilets, these have a key role in maintaining a hygienic environment and improving health outcomes (PEO 2011). The situation is worse in the three states considered in this study: 84, 69 and 80 percent of centres in Bihar, Jharkhand and Orissa, respectively, did not have toilet facility. Clean drinking water is the only facility which is available at majority of ICDS centres (NIPCCD 2006); with more than 95 percent of centres in Bihar and Orissa providing this facility. Jharkhand, on the other hand, is amongst the worst performing states in terms of provision of drinking water at ICDS centers, with nearly two-fifth centres not providing clean drinking water.[10]

Although the number of operational ICDS centres has increased by 50 percent during 2007-12 (MoWCD), the coverage is still far from universal, as stated before.[11] Also, the presence of a centre does not imply regular supply of all ICDS services. The PEO (2011) survey suggests that food supplements are provided in almost all centres, while 95 percent centres provide nutrition and health education, 91 percent centres provide immunization services, and 66 percent of ICDS centres have health check-ups (PEO 2011). However, there are huge inter-state differences in the performance. Of our three sample states, Orissa has the highest availability rates, with all services being available at almost all centres. Jharkhand has a lower coverage of immunization (84 percent), while in Bihar health check-ups are done at less than 20 percent of the centres. However, these availability numbers are reported by ICDS workers (service providers) and are not reflected in actual utilization rates of these services, which will also be affected by

[10] At more than 90 percent of centres, water facility is located at a convenient distance of maximum distance of 50 metres PEO (2011)

[11] Though 91 percent of the villages have at least one ICDS centre, it may not be enough to cover all beneficiaries. The gap between number of ICDS centres needed, according to number of beneficiaries, and number of ICDS centres working is 29.3 percent (PEO 2011).

households' perceived availability of and demand for these services. For example, only 22 percent of the surveyed mothers reported receiving any advice on infant feeding and less than half on the children were fully immunized (CIRCUS 2006). A more recent evaluation finds that only 31 percent of eligible children receive supplementary nutrition and it was available only on 16 days, on an average, in a month (PEO 2011). Another explanation for the difference in availability and utilization, apart from choice of the household, could be that availability as perceived by households (users) may be far lower than that of service providers, and this difference in perceptions may have consequences for decisions on utilization.

The second strand of literature pertains to the determinants of utilization of ICDS services, although it is relatively limited. These determinants tend to focus on demand side factors, and have typically not accounted for the fact that low utilization may simply reflect low perceptions of availability (even if actual availability was not a constraint). Jain (2015) finds that utilization of supplementary food service of the ICDS is affected by child's age, mother's education, her health status, head's education and caste category of the household. ICDS participants are more likely to belong to backward caste and, landless or marginal households (NIPCCD 2006). PEO (2011) reports that (as expected) non-beneficiaries of ICDS program are more educated, have a higher probability of belonging to salaried class and higher monthly per capita expenditure than the beneficiaries. The proximity to ICDS centre also affects the probability of participation in the program. The probability of a child going regularly to ICDS centre increases by 35 percent if the centre is located in the same hamlet as the child resides in (CIRCUS 2006). Time taken to visit the centre providing services has also been noted to affect utilization in Bangladesh (White and Masset 2006). Though a determinant in itself, Mander and Kumaran (2006) argue that distance to ICDS centre often disguises social discrimination. As the decision regarding location of ICDS centre is taken by politically strong members of the village, who often belong to upper caste, the placement of centres itself could exclude or make it difficult for children from lower caste to access centres. In none of their sample villages was a centre located in schedule caste (SC) and schedule tribe (ST) hamlets.[12] Similarly, for 70 and 75 percent of ST and Muslim households, ICDS centre was located at a distance of more than 100 metres from the hamlet, while for 34

[12] This, however, is not the case in our sample villages.

percent of Hindu upper caste the centre was situated within the hamlet (CIRCUS 2006). Another factor through which caste discrimination manifests is the attitude of the ICDS worker. Mander and Kumaran (2006) find that discriminatory behavior of ICDS worker towards the children of different and lower caste dissuades them to participate in the program. Gragnolati et al. (2005) also find that caste of the ICDS worker positively influences the attendance of children from the same caste. Apart from caste, there is also evidence of discrimination against girls and disabled children (Mander and Kumaran 2006; CIRCUS 2006). Therefore, the children who may be in most need of the program may be getting excluded from the program. Apart from the supply side factors, demographic characteristics such as mother's age and number of children in the house are the other variables that have been found to affect utilization of programs similar to ICDS (White and Masset 2006, Behrman et al. 2004).

The third strand of studies focuses on the effect of ICDS participation on various anthropometric outcomes. This can further be subdivided into two segments. First, there are studies that analyse the *association* between ICDS participation and anthropometric outcomes. Deolalikar (2004) uses NFHS-1 data to evaluate the association between availability of an ICDS centre in the village and probability of being underweight. Using a probit regression, he concludes that presence of an ICDS centre reduces the probability of being underweight by 5 percent. However, this effect is only noticed for boys. In a state level analysis, the PEO (2011) study finds that ICDS had a positive impact on nutritional status of only moderately malnourished children. A few of the studies delve deeper to study the relationship between attending an ICDS centre, (as against presence of centre in village) and anthropometric outcomes. Bredankamp and Akin (2004) find that for the state of Kerala, attending an ICDS centre is positively associated with better nutritional outcomes. Bhasin et al. (2001) and Bhalani and Kotecha (2002) evaluate the effect of ICDS utilization on the prevalence of malnourishment over time. While Bhalani and Kotecha (2002) find that despite participating in the ICDS program for two years, there was no change in the malnutrition status of children in Vadodara city. Bhasin et al. (2001) find that impact of ICDS does not persist after exiting the program. They find that attending AWC centre is not associated with lower risk of being malnourished after leaving the program. These studies

therefore indicate that the gains from ICDS are probably not long lasting and reversible, but these studies were conducted at a time when its scale of operation was far more limited.

The second sub-class of studies, which examine the *causal* relationship between ICDS participation and health outcomes, have focused on whether the presence (as against utilization) of an ICDS centre in the village has a beneficial impact on children's heights and weights. These studies are based on larger surveys and typically found limited impact. Lokshin et al. (2005) compare the anthropometric outcomes of children in villages which have an ICDS centre with the ones that don't, using NFHS-1 data. After accounting for selective placement of ICDS centres, they do not find any difference in WAZ scores, but a positive impact of 0.15 standard deviations on HAZ scores of boys in the age group 0-4 years. They found no impact for older boys or girls. Kandpal (2011) extends their analysis and finds that even though the mean impact is insignificant, ICDS had a positive impact on the worst-off children. Presence of an AWC improved the HAZ score of severely and moderately stunted boys by 0.22 and 0.03 standard deviations, respectively during the first two rounds of NFHS in 1992-93 and 1998-99, respectively. In the third round in 2004-05, however, she finds improvement in both the mean and at the lower end of the distribution. The mean HAZ score in villages with AWC centre was higher by 0.09 standard deviations. She finds a lower impact at the tails than the mean; however, there was a shift in trend with higher improvements for girls. All these studies have focused on 'availability' of ICDS centre at the village level, and do not consider utilization by the household. The need to differentiate between 'availability' and 'utilization' is highlighted by Jain (2015). She finds no impact of availability of ICDS but a positive impact of utilization. Jain (2015) considers the impact of utilizing only one of the ICDS services namely supplementary nutrition and finds that children who receive supplementary nutrition every day are about 1 cm taller than those who do not receive supplementary nutrition. The impact estimates from these studies by gender and age-group are summarized in Table 2.

The complementarities between various ICDS services may require use of all services together to have any impact on health outcomes. Thus not just participation, but the intensity of participation (measured by number of services used) may also matter. Fewer still are studies that look at the

impact of ICDS by intensity of ICDS utilization. One such study that considers the differential impact of partial and full ICDS utilization is Saiyed and Seshadri (2000). Using data for urban areas for preschool children, they find that compared to partial utilization of ICDS services, complete utilization of ICDS services has a positive effect on anthropometric outcomes. An unconditional comparison of mean z-scores of "full" users with "partial" users showed that z-scores of "full" users were 0.7 standard deviations higher than "partial users" for HAZ scores. The difference for WAZ score was higher than 1 standard deviation.

III. Conceptual Framework

To understand the decision of a household to participate in the ICDS program, we outline a simple model of household decision-making, building on the framework used by, among others, Becker (1991) and Pitt and Rosenzweig (1986). We assume a household with parents (p) and a child (c). Parents, treated as a single entity, are the decision makers in the house and derive utility from consumption of food (F_p), non-food goods (G_p) and their health status (H_p). We assume that parents are altruistic towards the child; their utility therefore also depends on child's utility (W^c), which in turn, has similar arguments as parents' utility, namely, consumption of food and non-food and health status. The *household utility function* (W), which depends on parents' utility, can then be written as:

$$W = W(F^p, G^p, H^p, W^c(F^c, G^c, H^c)) \quad \ldots(1)$$

We assume the utility function to be concave, double differentiable and increasing in all four arguments. Utility is maximized subject to health production function and income constraint.

The health production function of the parents is given by (Rosenzweig and Schultz 1983):

$$H^p = H^p(F^p, IH^p, \eta^p, \Omega|X) \quad \ldots(2)$$

There are two major inputs that affect health outcomes. The first is food intake (F) which has a positive effect on health outcomes. Food intake therefore affects the utility of the household directly and also through health outcomes. The second is health investments (IH) which comprises of inputs such as medicines, micronutrient supplements and vaccines, which

complement food intake. Consumption of these health investment inputs depends on the nutrition knowledge of parents. These health inputs have no direct effect on utility of the household, unlike food intake. A third factor that affects health outcomes is the innate healthiness (η) of the individual. It represents individual specific health endowments such as genetic makeup. Apart from these factors, health outcomes are also affected by the environment (Ω) one lives in. For example, unhygienic environment with higher prevalence of diseases increases the risk of gastro-intestinal infection and thus adversely affects health outcomes. Factors such as economic status and parent's education also have a bearing on health outcomes. These work by influencing affordability, health seeking behavior and allocation of resources. Such household controls are included in vector X.

The child's health production function takes an additional argument, U_j^c representing utilization of ICDS service (where *j* refers to the ICDS service utilized from the set of available ICDS services). Both the services provided by ICDS – nutrition and health investment – can complement or substitute consumption of food (F) and health investments (IH) which are provided through private resources. The child's *health production function* is therefore given by equation 2'.

$$H^c = H\left(F^c, IH^c, U_j^c, \eta^c, \Omega | X\right) \qquad \dots (2')$$

The family is assumed to earn a fixed income I, which is spent on food (F), non-food goods (G), health investments (IH) and utilization of ICDS service (U_j). The *budget constraint* can be written as:

$$I = P_G \sum_{i=p,c} G_i + P_F \sum_{i=p,c} F_i + P_{IH} \sum_{i=p,c} IH_i + C_j U_j^c \qquad \dots (3)$$

In the above equation, P_G, P_F and P_{IH} are the prices associated with non-food goods, food and health investments respectively. G, F and IH represent the total consumption of these goods by all three household members. C_j is the cost of utilization of j^{th} ICDS service. Though the services are available free of cost at the ICDS centre, the household may incur certain other costs in using these services. Such costs include transportation cost and opportunity cost of the time spent in

visiting the centre. We term these as access costs. These may also include social costs, as discussed earlier. A household will utilize ICDS services only if the utility gains from utilization are at least as high as access costs.

ICDS offers many services to its beneficiaries and they may choose to utilize none, some or all of the services. As noted earlier, these services may be categorized into two groups – nutrition and health investment. The rationale for such a classification is that each of these services is distinct and may be viewed differently by households. That better food translates in better health outcomes is common knowledge, and so it may be easier to convince parents to participate. The contribution of vaccines and nutrition education to health outcomes is indirect and therefore, may not be perceived as valuable, and thus have fewer takers. A household thus has four choices – it can decide not to participate, or to choose only nutrition services, or to choose only health investment services, or it can choose both nutrition and health investment services. We call the fourth alternative as the *comprehensive* alternative. U therefore is a discreet variable, $U \in \{0, \ldots, 3\}$, representing the alternative chosen by the household (0 is for non-participation). The subscript *j* refers to the alternative chosen.[13]

The number of ICDS services offered varies by the age of child; therefore children of all age groups are not eligible for all the alternatives. Children below 6 months of age are eligible only for health investment component and therefore have 2 alternatives to choose from. Children above 6 months of age are eligible for all ICDS services and therefore face full choice set of 4 alternatives. Another factor that can cause difference in the number of choices available across households is lack of supply – both actual and perceived. This means some services (alternatives) are in effect not in the household's choice set. If M is the number of alternatives an individual is eligible for and K is the number of eligible alternatives that are not available to a household, then M – K is the number of eligible alternatives actually available. Thus, the choice set faced by a household varies by eligibility and availability.

The household maximizes utility function (eq. (1)) subject to health production function ((eq. (2) and (2')) and income constraint (eq. (3)). Household makes decision with respect to level of

[13] We use the words service, component and alternative interchangeably.

consumption of food, non-food and health investments, and which ICDS service to utilize. Other variables such as innate healthiness, general environment and prices are assumed exogenous.

As the model outlined above has a discrete variable, U_j, standard maximization cannot yield demand functions. The utility maximizing choice can be arrived at by comparing the utility derived from each of the alternatives in the utilization choice set. For each of the alternatives, the conditional utility function (on utilization) can be defined as:

$$W_{U_j^c} = W\left(F^p, G^p, H^p, W^c(F^c, G^c, H^c) |\, U_j^c\right) \quad \ldots.(4)$$

where j refers to j^{th} alternative in the choice set. The above function is maximized subject to constraints. This exercise yields the following demand functions for food and non-food consumption, and health investments-

$$F_{i|U_j^c} = F\left(I - C_j, P_F, P_G, P_{IH}, X, \eta, \Omega \middle| U_j^c\right), \qquad i = p, c$$

$$IH_{i|U_j^c} = IH\left(I - C_j, P_F, P_G, P_{IH}, X, \eta, \Omega \middle| U_j^c\right), \qquad i = p, c$$

$$G_{i|U_j^c} = G\left(I - C_j, P_F, P_G, P_{IH}, X, \eta, \Omega \middle| U_j^c\right), \qquad i = p, c$$

The utility level can then be derived for each of the j alternatives in the choice set. If $W'_{U_j^c}$represents utility at utilization level j, then the chosen level of utilization (J) is such that utility is maximized ($W^*_{U_j^c}$).

$$W^*_{U_j^c} = max.(W'_{U_j^c})$$

The derived demand function for utilization of a given ICDS service then is given by:

$$U_J{}^* = U\left(I, C_j, P_F, P_G, P_{IH}, X, \eta, \Omega\right) \quad J \in \{0, \ldots, M - K\} \quad \ldots(5)$$

The reduced form of health outcome (anthropometric) equation, conditional on the utilization of the j^{th} service can then be written as

$$H_{i|U_j^c} = H\left(I - C_j, P_F, P_G, P_{IH}, \eta, \Omega \middle| U_j^c, X\right), \qquad i = p, c \qquad \ldots (6)$$

We empirically estimate the utilization demand function and health outcome equation in the next section.

IV. Sampling design and summary statistics

IV.1 Sampling Design and Analysis Sample

Data for this study was collected through a special-purpose survey administered as an additional module to the main Village Dynamics of South Asia (VDSA) survey of International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), which was conducted in 11 villages of 3 East Indian states – Bihar, Jharkhand and Orissa, in September-October, 2012. The additional module was funded by the Research Fellowship Grant of the VDSA project, ICRISAT.

VDSA employs a multi-stage stratification design. All districts in each state were ranked based on developmental indicators. Based on this, districts were then divided into 2 categories according to level of development – high and low. A district was then randomly chosen from each of the two categories. Within each chosen district, a block, and then 2 villages from each chosen block were randomly selected.[14] Households in the villages were then divided into 4 strata based on land size owned – landless, marginal, medium and large landholders. Ten households were randomly selected from each land category.

The survey for this study was conducted in a subset of the VDSA sample households — comprising households which had children in the age group 0-6 years. All the children in the reference age group in a household were surveyed. Thus, this survey canvassed information for 304 children belonging to 200 households of the 440 surveyed households in 11 villages. The distribution of all VDSA sample households and VDSA sample households with young children across land category is nearly identical. This is also true for distribution of all households and households with young children in the population. In other words, the ratio of sampled

[14] 12 villages were initially selected for survey purposes of which one village in Orissa was dropped due to logistical issues.

households to total number of households in each land category is nearly identical for VDSA sample households and VDSA sample households with children. Thus the sub-sample of VDSA households with young children is representative of households with young children in the village, drawing equal number of households from each land category.

Since the survey was restricted to a sub-sample of the VDSA sample, it is important to ask whether the subsample was powered to detect differences in anthropometric outcomes. It turns out that our sample is sufficient to detect a difference of 0.5 standard deviations in WAZ and HAZ scores with the probability of a type 1 error being 10 percent.

In addition to household level survey, we also collected data from all 34 ICDS centres in these villages on the services available at these centres, frequency of availability and reasons for non-availability.

After excluding children who were surveyed but are not permanent residents of the village (11 children out of a total of 304 children surveyed), and observations with large amounts of missing information (10 children out of a total of 304 children surveyed), the analysis of the ICDS utilization decision was done on a sample of 283 children.

Apart from 21 observations (out of 304 surveyed) that were not included in the analysis (due to non-permanent residence in village and missing data), a few more observations had to be excluded while estimating the impact of ICDS utilization on anthropometric outcomes as heights and weights could not be measured for an additional 47 and 12 children, respectively (these include outliers as well). These children were either not available or it was not possible to take measurement despite repeated visits. This leads to concern about whether children for whom weight and height measurements have been taken are a biased subsample of all children and is discussed in next section (IV.2.c).

IV.2 Summary statistics

IV.2.a Households' perception of availability in contrast to centre reported availability of ICDS services

A precondition to the decision of participating in the program and choosing which ICDS services to utilize is their availability. The limited availability of some or all of these services to a household could be due to many reasons. First is the absence of an ICDS centre in the area. To check if this is the case for our sample households, we calculate the number of ICDS centres that should be operational in the sample villages using the population norm for each of the three survey states from PEO (2011) and find that there are state level differences. While all villages in Jharkhand have more than required number of working ICDS centres, one and three villages in Orissa and Bihar, respectively, were short by a centre each.

Another factor that limits availability of ICDS services to a household, even if there are adequate ICDS centres present in the area, is the exclusion by the service provider due to design of the program. Apart from differences in eligibility by age, certain services may not be made available to all children in the eligible age-group, as even though Supreme Court has universalized the program, the population norms for placing an ICDS centre are yet to be changed. While health services are available to all, the supplementary feeding is provided to a maximum of 80 children per centre. On an average, an ICDS centre is placed per 800 people. With the share of children below 6 years in the total population at about 13 percent (Census 2011), it implies that on an average there are about 104 children in the catchment area of an ICDS centre. Thus, the design of the program excludes 25 children from supplementary nutrition.

Since an ICDS centre cannot provide services to all children in its catchment area, in such cases, there appears to be an unsaid mandate of the program to target children who are under nourished and/or belong to less well-off households. For instance, in Bihar, where 3 out of 4 villages were one short of prescribed number of centres,[15] using the registers maintained by the ICDS worker we find that 41 of the 109 sample children in Bihar (38 percent) were neither registered nor availed the facility of supplementary nutrition. Of these 41 unregistered children, 45 percent belonged to landed households (medium or large), and therefore, probably were excluded in favour of poorer households. Thus, in Bihar, roughly 20 percent of the children were excluded

[15] In the one village in Orissa that had inadequate number of centres, only 2 out of 20 sampled children did not avail any ICDS services.

from the supplementary food component either due to the design or lack of adequate number of ICDS centres.

However, the existence of an ICDS centre need not imply that all services are provided. Using the data collected from ICDS centres we find that except for health investment services at one of the 34 centres, both nutrition and health investment component were available at all centres.[16] Since it is plausible that ICDS workers might have over-reported availability, we use household responses to validate the data provided by centres. We define a service as being available at a centre if there are at least 2 households which report availing that service from the centre. Using this alternative definition, we find that all alternatives were available at all centres, with the exception of health investment alternative at one centre.

An equally important reason that affects utilization of ICDS services/alternatives is the perception of availability. A household can only choose to consume an alternative from the set of choices that it perceives to be available, even if de facto a larger set is available at the centre. One of the explanations for the gap between perceived availability and actual availability is lack of awareness about the availability and/or entitlement. PEO (2011) finds that awareness about the program is low among households: two-thirds of the households did not know of their entitlements. In our sample, 12 percent of the households who did not participate in the ICDS program report that they are not aware about the program.

Another factor that may affect perception of availability is social discrimination. CIRCUS (2006) finds that ICDS workers often deliberately leave out lower caste households during door-to-door visits,[17] and thus such households will not be aware of their entitlements. The other way in which this may affect perceptions of discriminated households is through their belief of functional availability; if certain types of households face discrimination in access to development

[16] The centre not providing health investment services was in Bihar.

[17] These visits are meant to spread awareness about the program and its components. The ICDS worker is supposed to inform households about the services being offered and persuade them to participate in the program. Services like vaccination and health check-ups are provided in collaboration with other government health personnel like ANM and are available only on particular days. During door-to-door visits, ICDS worker also inform households about the day and time at which these services shall be made available at the centre.

programs, then it is possible that they might believe that ICDS services would not be made available to them by the service provider, even if they want to avail of them.

We therefore use data from two different sources to define availability. The first, termed as "centre level availability", is from the perspective of ICDS worker and is based on the survey of all 34 centres. The second, termed as "household perceived availability", is generated from the household questionnaire, wherein, we canvassed a module on utilization of each of the ICDS services and the reasons for not utilizing them. Using these responses, a service is said to be unavailable if the household reports non-availability as the reason for non-utilization.[18]

It is clear that going by the ICDS worker's perceptions, as captured in "centre level availability", there is adequate supply of ICDS services (Table 3). The nutrition component is available to all the survey households and health investment component is not available to only 1 percent of them (after accounting for differences due to age-specific eligibility).

However, this is not true for "household perceived availability" with 9 percent of the households reporting no access to both nutrition and health investment services (Table 3). Among the remaining 91 percent, 9 percent did not have access to nutrition component, and health investment alternative was not available to 11 percent of the sample. For the parents of these children, the lack of utilization of ICDS services can hardly be a matter of choice. A comparison of households which perceive that they have fewer services available to them with the ones which perceive full availability shows that households with perception of no or limited supply are located near to ICDS centres, are more likely to be SC and landless (Table 4). This is indicative of social exclusion in access to ICDS services, which we also find to be an important factor determining level of participation in ICDS program (discussed in section V)

IV.2.b Utilization of ICDS services

Though at least one alternative is perceived to be available by 91 percent of the sample, a little less than 60 percent choose to participate in the program, with almost equal distribution across

[18] The 20 percent households that were excluded from supplementary nutrition due to inadequate number of centres are included in this.

three alternatives (Table 3). Among the households that perceive availability of both ICDS services, less than half (45%) utilize both the services. About a quarter choose to participate partially, while 31 percent did not participate at all, suggesting that utilization of ICDS is affected by not only supply factors but demand factors also play an important role.

One such factor is access costs. Although the ICDS services are freely provided to users, accessing them may nonetheless involve costs. For example, households located farther away from the *anganwadi* centre are likely to face higher access costs than those living closer. In our sample, the average distance to the centre is 350 metres (Table 5) but range between a minimum of 10 metres to a maximum of 2 kilometres. More than 90 per cent lives within one kilometre; a higher figure than that noted in earlier report (NIPCCD 2006) which found that only two-thirds of the households in rural Bihar did so. Though it seems to convey that therefore distance should not affect ICDS utilization, but it is possible that a young child who may have to walk alone to the centre may find a distance of 500 metres too long.

A second component of access costs could be the opportunity costs of the labour income foregone by mothers/parents bringing their children to the ICDS centre. Although, ICDS centre can also facilitate mother's labour force participation by providing day care services and making health services available in the village to such mothers. In our sample, however, mothers of very young children typically did not work outside the home; the labour force participation rate of mothers was only 15 percent (Table 5). Nonetheless, a significantly higher percentage of working mothers choose not to participate in the program, suggesting that high opportunity cost of time leads to lower ICDS participation rates.

A third aspect of costs is social; in that there may be perceived barriers to participation in the ICDS program of households belonging to lower castes. Literature has shown that beneficiaries from low caste category are often discriminated in access to social programs; 30 percent of SC children report facing some form of caste based discrimination in Mid-Day Meal Scheme (Sabharwal et al. 2014a) and SC mothers have lower access to health services provided under Janani Suraksha Yojana as compared to upper caste mothers (Sabharwal et al. 2014b). Social exclusion is not just reflected in low participation rates but also in the location of ICDS centres,

as mentioned earlier. However, we find no evidence of discrimination in placement of ICDS centres (lower caste category hamlets are as likely as upper caste hamlets to have ICDS centres) in our sample, and the percentage of SC and ST households among ICDS participants is higher than their share in population.[19] The proportion of ST households that utilize ICDS services is significantly higher than the ones who do not, and might lead one to believe that lower castes are not getting excluded from ICDS utilization (Table 5). However, if we compare across caste categories, then we find that the highest non-participation rates are among the SC households (53 percent) (Table 6). Among the participating households, a higher percentage of SC households choose to utilize only nutrition services, while a higher proportion of all the other three caste categories utilize comprehensive alterative. As mentioned before, SC households are also more likely to perceive lower availability of services.

Another way in which caste discrimination may affect ICDS participation is the caste of the *anganwadi* worker (AWW); households may not be able to send their children to a centre which is run by an upper caste AWW. In the context of other interventions such as the Public Distribution System, the literature suggests that belonging to the same caste as the shop owner was a significant predictor of independent uptake (Thorat et al. 2008). There is evidence to suggest that similar social access costs may be at work in the ICDS as well. In our sample about 70 percent of the households participating in the ICDS program belonged to the same caste as AWW.[20]

It, therefore, seems belonging to same caste as ICDS worker is an important driver in utilizing ICDS services. However, there are wide differences in having access to centre with same caste ICDS worker by caste category. While 92 percent of ST households were catered by centres which had a ST AWW,[21] the percentage was lower for SC (64 percent) and OBC (67 percent).[22]

[19] We classify households in four caste categories – upper caste, schedule caste (SC), schedule tribe (ST) and other backward castes (OBC).

[20] About a fifth of the households were attached to ICDS centres that had AWW below their own caste category.

[21] This is due to the fact that our villages in Jharkhand were inhabited by mostly ST households.

[22] There are wide state level differences. In Bihar, 55 percent of the households belonged to the same caste as AWW, of which highest percentage were from SC caste category. In Orissa, only 34 percent of the households belonged to the same category as AWW, with almost all of them belonging to OBC category. In Jharkhand, the highest representation is of ST households.

Only 10 percent of upper caste households belonged to centres managed by upper caste AWW.[23] However, on the whole it is possible that SC households are discriminated against as they are less likely to believe services to be available, less likely to be attached to a centre with SC worker and also less likely to participate and utilize all ICDS services.

In addition to the economic and social costs (which this analysis incorporates explicitly, unlike much of the literature) there are other factors influencing uptake. These may include gender of the child (boys may be favoured in ICDS participation), mother's education (more educated women more likely to participate) and household wealth (more wealthy parents may be less likely to utilize ICDS services). In these respects, the summary statistics indicate no significant differences between ICDS participants and non-participants (Table 5). Other variables such as number of children, mother's health status (measured by mother's height), mother's age and father's education, which have also been found to affect participation in comprehensive programs elsewhere, were also not significantly different among participants and non-participants.

IV.2.c Missing data on anthropometric outcomes

As discussed before, we could not get heights and weights data for 47 and 12 children, respectively, which may bias our sample. A comparison of means reveals that children with missing anthropometric data are different from the rest in some respects (Table 7). Children with missing data on weight have more educated parents, belong to richer families, more likely to belong to backward caste (OBC) households and less likely to belong to landless class. For child height, the children with missing data are on an average younger by 13 months, have more educated mothers, have younger parents and more likely to belong to OBC households. We also

[23]These numbers might suggest that the ST households are actually being favoured in ICDS participation. However, it is due to the fact that 94 percent of all sampled ST households are from Jharkhand which is a better performing state in ICDS implementation and performance (PEO 2011). Rest are from Orissa, which is also a good performing state in terms of performance and infrastructure (PEO 2011).

estimate a probit model to analyse the characteristics of children with missing data.[24] The results from unconditional difference in means are corroborated by probit estimates. In addition to characteristics discussed above, the probit analysis also suggests that children with missing weight data are also more likely to be older and have higher birth order; while father's education is no longer significant. For child height, we find that children with missing height data are also more likely to be boys, have higher birth order and not have fallen sick in past one month. The probit analysis reveals that children with missing data are more likely to be healthier and belong to wealthier families. Thus our sample consists of children who are weaker than average (have lower than average z-scores). This might lead to higher estimates of impact. Since these data are clearly not missing at random (Cameron and Trivedi 2005), the entire analysis of section VI is repeated on the full sample, making the assumption that all the children with missing anthropometric data had a z-score of -1, -0.5 and 0 (as they are more likely to be healthy) and find that our results do not change much, both in sign and magnitude.

IV.2.d Summary statistics on anthropometric outcomes

There is high prevalence of malnourishment in our sample, with 51 percent of children being underweight, and 48 percent being stunted (Table 5). Hungama (2011) reports a lower underweight prevalence of 42 percent, but a higher prevalence of stunting (59 percent). There is no significant difference in WAZ and HAZ scores, and prevalence rates of underweight and stunting between ICDS participants and non-participants. However, on comparing the prevalence rates for each bundle, we find that the prevalence rate of underweight is significantly lower among the households that choose to utilize all ICDS services (comprehensive alternative) (36%). Similarly, stunting rates are higher among the households that utilize only health investment services (65%), though there is no difference in the HAZ scores across alternatives.

The summary statistics discussed in section *IV.2.b* indicate that the participation in ICDS program is not random, and is dependent on individual and household characteristics. These characteristics not only affect participation decision but can also affect health outcomes. Therefore, a simple comparison of outcomes of participants and non-participants will give biased

[24] Appendix Table A.1

estimates of the impact of program participation. Also, if there are other factors that independently affect health outcomes, but not participation, then not accounting for such factors will also confound our impact estimates of ICDS utilization on WAZ and HAZ. We compare other such factors that may affect health outcomes. We consider birth order, a hedonic ranking of size at birth, morbidity, dietary diversity score which is an indicator for dietary quality, number of vaccinations taken, household size, sanitation and drinking water facility available at home, and type of fuel used.[25] However, we do not find any significant difference apart from number of vaccinations received and access to safe drinking water. Participants have received higher number of vaccinations as compared to non-participants but since vaccination is a part of the ICDS program, it is not unexpected. The differences in the factors that affect ICDS utilization (leading to self-selection in the program) and health outcomes (independent of ICDS utilization) need to be accounted for while estimating the impact of ICDS utilization on health outcomes.

V. Utilization of ICDS services

Despite availability of ICDS services, the uptake is low. It is therefore important to examine the factors that affect uptake of these services. To model the choice of a household regarding the decision and level of participation in ICDS program, we estimate equation 5.

V.1 Estimation Method

The participation decision is best modeled as a discrete choice among the four alternatives with the underlying assumption being that an individual derives utility from each of the alternative, and chooses the alternative that gives him/her most utility. This framework is most appropriate in our context, as there was practically no difference in the frequency of utilization, conditional on use.[26]

[25] Appendix Table A.2

[26] The vast majority of households used a service at same frequency as required by the program. For children above 3 years, more than three-fourth of the utilizers availed of nutrition services, i.e. cooked meal, every day. Another 15 percent availed it at least once every week. Similarly for children below 3 years, who get take home rations and

These choices may be modeled using Multinomial Logit Model (MNL).[27] However, the standard version of the model assumes that the same choice set is available to all individuals. Since in our case the number of choices available to an individual varies depending on age-specific eligibility, supply and perception, we therefore estimate the utilization decision using a varying choice set MNL proposed by Yamamoto (2012). If S_{im} is the set of alternatives available to an individual *i* from all alternatives, then the probability of choosing an alternative *j* by an individual *i* can then be written as

$$\Pr(U_{ij}) = \frac{\exp(V_{ij})}{\sum_{m \in S_{im}} \exp(V_{im})}$$

where V_{ij} is the observed systematic component of the utility derived from consuming alternative *j* and depends on the characteristics of alternative *j* and of individual *i*. The above expression is arrived at by assuming that the stochastic component of the utility derived from consumption of alternative *j* follows a logistic distribution. The above equation is same as a standard MNL model, the only difference being in the denominator. While in a MNL model, the summation is over all choices and remains same for all the households, in the above expression, the summation is over choices that the household is eligible for and perceives as being available. In the sample, a tenth of the households are not included in the estimates as they do not perceive that they have access to any ICDS service and therefore have no choice of participating. And one fifth of the household have only two choices in their choice set as at least one of the nutrition or health investment alternative is not available (after accounting for differences in eligibility).

The systematic component of the utility from the j^{th} choice to individual *i* (V_{ij}) is modelled as

$$V_{ij} = \alpha_j + \beta_j X_{ij}$$

where α_j is the alternative specific constant and X_{ij} is a vector of child and household specific covariates. Following the preceding discussion, X_{ij} includes measures of economic access

are distributed once a month, 95 percent of the households report getting these rations at the before mentioned frequency. Weighing and health check-ups were availed once a month by 80 and 90 percent of the users, respectively. Therefore, we do not include the variance in intensity in modeling utilization decision.

[27] Explained in Appendix A.1

(distance from household *i* to the ICDS centre and whether the mother works outside the home), social access (dummy for caste categories and a dummy variable taking value 1 if the household belongs to same caste as AWW worker), child characteristics (age, dummy for boys and birth order), parental characteristics (age and education), and household characteristics (number of children in the household and an index for number of assets owned by a household constructed using Principal Component Analysis). We also control for state fixed effects.[28,29]

V.2 Results

Results from multinomial estimation of utilization decision using household perceived availability are presented in Table 8 (marginal effects). [30] Marginal effects measure the change in probability of choosing a particular alternative for a unit change in covariate.[31]

First, consider the effect of economic cost of utilizing ICDS services on household's choice of participating in the program. Our results suggest that longer distances make it costly for the household to participate in ICDS program and therefore reduce the probability of participation across all alternatives. The highest marginal effect is observed for the comprehensive alternative, where a 100 metres increase in distance to the centre reduces the probability of utilizing this alternative by 2.3 percentage points.

Working mothers have relatively a higher opportunity cost of time. However, we observed that in many instances it was not the mother, but the ICDS helper who accompanied children. Thus, availing ICDS services does not compete with mother's time spent in labour market. Therefore it is not surprising that working mothers are more likely to participate in the program with the

[28]We do not include prices of food, non-food goods and health investments as there was not much variation in these variables at the village level. Also, the village dummies were highly correlated with other covariates and therefore are not included in our model.

[29] Estimation of a MNL model requires including variables that vary by alternative. Since the variables considered in this model are not alternative, but individual and household specific, we multiply each variable with alternative specific constant.

[30] These are computed as the average of marginal effects for each individual. Beta coefficients are presented in Appendix Table A.1.

[31] The sum of marginal effects, across all alternatives, for a covariate is zero.

highest uptake for health investment alternative, as it provides a convenient alternative to visiting nearest public health care centre to avail these services.

The effect of social cost on probability of participating outweighs that of economic cost. Compared to upper caste households, SC households are 31 percent more likely to not participate in the program. This is true for ST households as well, who are also more likely to not use any services. In terms of ICDS utilization, SC households are least likely to utilize the comprehensive alternative, while for ST households the probability is lowest for health investment alternative. OBC households fare better; though this caste group is also less likely to avail of ICDS services as compared to upper caste, the probability (14.7) is not as high as for SC and ST households. Also among all ICDS alternatives, OBC households have a positive probability of choosing the comprehensive alternative. Thus this caste group, when it chooses to participate, it is more likely to use all services of ICDS.

Another variable capturing social costs is whether the household belongs to same caste category as ICDS worker. These coefficients are also indicative of high social access costs to the program. If both the household and AWW belong to same caste category, then it increases the probability of participating in ICDS by 7.4 percentage points. Households belonging to same caste as ICDS worker are more likely to utilize nutrient alternative (compared to health investment or comprehensive alternative) in comparison with household who do belong to a different caste than that of ICDS worker. Caste discrimination may well be more pronounced in ICDS services which include food distribution, as this requires direct contact with the AWW, therefore high and positive effect of AWW's caste category on uptake of supplementary food component is not unexpected.[32].

[32]One may argue that the caste dummies and same caste dummy are both capturing aspects of discrimination. We therefore estimate two alternative models, dropping one of the two variables at a time. The marginal effects from these alternative models are presented in Appendix Table A.2. (The marginal effects for other variables and the beta coefficients for these alterative models are not provided here. These can be made available on request). Dropping the indicator variable for same caste as AWW worker, changes the direction of results for the nutrition component for ST households, these households are more likely to choose nutrition component among all 3 alternatives. All other results are same. Dropping caste dummies also does not change the direction of results. Thus, it seems that the social factors ease up the constraint of using the nutrition bundle, but more so for ST households. A more robust test of this claim would have been to include a dummy for belonging to same caste as

Another important factor that adversely affects ICDS utilization is the economic status of the household, measured by number of assets owned. Improvement in economic status of the household reduces the probability of participating in ICDS program by 2.4 percentage points. This is as expected. However among participants, owning greater number of assets translates into a higher probability of selecting the nutrition component. This is not expected and may imply some crowding out of less wealthier households, especially as the number of households that can avail of nutrition component from an ICDS centre is fixed. Taken together the coefficients on social costs and assets suggest that the ICDS program has not been able to attract/cover the socially and economically marginalized households.

The estimated coefficient on the gender dummy suggests that girls are more likely to participate than boys. However, girls are more likely to choose either nutrition or health investment alternative, while there is no difference in the uptake of comprehensive alternative. This suggests that girls are more likely to utilize ICDS services. Older children (above 3 years) are more likely to avail of comprehensive bundle. This is expected as these children are also eligible to avail preschool services from the ICDS centre and they spend 4 hours at the centre every day. This reduces the access cost to avail other services and makes it easier to avail all components of the program. Higher birth order children, i.e. those born later, are less likely to participate in the program and if they do, they are more likely to choose comprehensive alternative.

State dummies capture high participation rates in Jharkhand and Orissa; these states also have higher rates of full utilization of all ICDS services.

AWW for each caste category. However none of the SC households that are catered by SC AWW opted for the comprehensive alternative, and thus leads to identification problem. We therefore estimate two other alternatives. Model 4 includes a dummy for belonging to same caste as AWW but only for lower castes (SC, ST and OBC). The coefficient for this variable is higher than when we include all caste categories. In model 5, we include an indicator variable if both AWW and household are ST and another for rest of the caste categories[32]. The marginal effects show that while belonging to same caste as AWW worker has a positive effect on uptake of nutrition alternative for all castes, for ST households it also increases the chances of utilizing comprehensive alternative. However, since state dummies had to be dropped in this specification due to multicollinearity (all ST households are from Jharkhand), this could just be state effect.

The analysis thus far is based on choices made from among the set that household perceives to be available to them. How might results change if availability were defined based on what the centre reports? As discussed earlier, using the latter definition translates into virtually all services being available to everyone. Table 9 reports results from the MNL based on centre-reported availability. There are some changes in direction of signs of some coefficients. For example, the effect of belonging to same caste as AWW is opposite of the ones we get from household perceived availability suggesting that the program is at least able to attract the marginalized caste groups to participate in the health investment component, if not in all services. Thus, not accounting for household perception of availability seems to under-estimate the role of social barriers. Similarly, marginal effects of economic status show high probability of participating in the nutrition component by the economically weaker section. Also, compared to results from household perceived availability, the probability of richer households participating in any of the ICDS services is lower. Thus, not accounting for household perceptions gives an impression that the program's performance in targeting economically weak households is not as bad and marginalized caste categories are not being left out. There are differences in the signs of marginal effects for other covariates (such as age of child and parents' characteristics) as well. Therefore, it is important to account for differences between centre reported and household perceived availability to be able to channelize efforts in right direction. For example, results from centre reported availability suggests that targeting non-working will increase participation rate in the program, which is opposite of the results we get when using household perceived availability.

From a statistical perspective, the two definitions of availability may be seen as two competing, but non-nested models. Using Vuong test for non-nested models (Greene 2002) suggests that the household-perceived availability fits the data better.[33] Therefore, we estimate the impact of ICDS participation on anthropometric outcomes in the next section using "household perceived availability" only.

VI. Impact of utilization on anthropometric outcomes

[33] The Vuong statistics for the non-nested hypothesis of household perceived availability vs. centre reported availability was 4.34, implying that model 1, that is, model with household perceived is favoured.

Now, we turn to our second objective of the paper which is to estimate the impact of utilizing ICDS services on anthropometric outcomes. The services provided by ICDS are the key inputs in health outcomes. It provides 500-800 kcal calories and 15-20 grams of protein per day through supplementary nutrition to beneficiary children. This constitutes more than 50 percent of the daily calorie requirement and more than 80 percent of protein requirement of these children. If there is no substitution away of food allocated at home to the beneficiaries with food provided at ICDS and the program is implemented effectively, then ICDS can have a large and sustained effect on levels of protein-energy malnutrition. However, if the pattern of household allocation of food changes in response to ICDS participation, this component of ICDS will fail to make any impact. Other ICDS services ensure that the child's growth does not lag behind. Some components reduce the susceptibility to diseases, while others ensure that growth faltering is detected at an early stage so that corrective measure can be taken. Timely and regular uptake of these services is essential for these to make any impact.

The results from section V indicate that the participation in ICDS program is not random, and is dependent on individual and household characteristics. These characteristics not only affect participation decision but can also affect health outcomes. Therefore, a simple comparison of outcomes of participants and non-participants will give biased estimates of the impact of program participation. Since there is self-selection in the program, it needs to be accounted for while estimating the impact of ICDS utilization on health outcomes.

IV.1 Covariate and Propensity Score Matching

The standard evaluation problem in attributing the impact of ICDS on heights and weights of children arises since ICDS participation is endogenous. When program participation is non-random, as is the case here, matching methods may be appropriate to use to estimate impact, provided the selection into the ICDS is based on observable characteristics. Matching methods create a counterfactual for each participant from the pool of non-participants. If we can observe

all the characteristics that differentiate participants from non-participants, we can match the participants with those non-participants who are similar to participants on those observables. The difference in outcomes of this matched counterfactual group and participants can give us the impact of ICDS on health outcomes.

There are various ways one can use to match the participants with non-participants. To create a group of counterfactuals, matching can be done on all covariates that distinguish participants from non-participants; this method is known as covariate matching (CVM). However, having a large number of covariates can lead to a problem of too many combinations and inability to find exact matches. This is called the "curse of dimensionality". Abadie and Imbens (2002) proposed a matching technique that resolves this problem. They suggest that instead of matching on all covariates, one can match on the distance between the covariates. The weighted average of a fixed number of closest neighbours, in terms of distance, is used as a counterfactual.

Another approach to matching is the propensity score matching (PSM) proposed by Rubin (1977), where matching is done on the propensity scores or the probability of participation. The estimated propensity score contains all the information of the covariates and reduces the problem of matching to a single dimension. The conditional independence assumption (CIA), that is treatment participation and treatment outcome are independent of each other, conditional on the covariate vector X, is required to identify the treatment effect in both CVM and PSM methods.[34]

There is no consensus in literature about the performance of alternative matching methods. Busso et al. (2014) compare the performance of various matching estimators for finite samples using simulations. They show that efficiency of covariate matching is conditional on number of neighbors specified and parametres chosen. It can be efficient if the number of neighbors used to match is not too large, and it is as biased as propensity score matching.[35] Bias correction in propensity score matching (nearest neighbor) reduces the bias but increases the variance. They

[34]CVM by Abadie and Imbens (2002) additionally assume that the conditional mean and variance function (conditional on treatment) is continuous. Also, the fourth moment of conditional distribution of Y (conditional on treatment and covariate) exists and is bounded.

[35] The bias term arises due to matching discrepancy, i.e. due to inexact matching.

recommend that one should use various approaches to check robustness of results. Therefore, we present results using both PSM and CVM.

However, both these techniques were proposed to assess the impact of a single treatment. In our case, the interest is in examining the impact of each of the three alternatives. This can be addressed using the framework proposed by Imbens (2000) and Lechner (2001), who extended the PSM method proposed by Rubin (1977) to a multiple treatment framework (more than two alternatives). The identifiability assumption in multiple treatment case requires that outcomes in all treatments should be independent of treatment assignment, given certain observables X. In other words, conditional on a vector of observables X, anthropometric outcomes should be orthogonal to utilization of any of the ICDS components. If H represents health outcome and $U \in \{0, \ldots., 3\}$represents participation in a particular treatment,[36] then the CIA can be written as:

$$H^0, H^1, \ldots., H^3 \perp U|X$$

The average treatment effect on treated (ATT) of alternative m relative to alternative j (θ^{mj}) is given by the following equation.

$$\theta^{mj} = E\left(H^m - H^j \middle| U = m\right) = E(H^m|U = m) - E(H^j|U = m)$$

The expression $E(H^j|U = m)$ is the counterfactual which is not observed and is created by matching.

$$\theta^{mj} = E(H^m|U = m) - E_{P^{j|mj}(X)}(E(H^j|P^{j|mj}(X), U = j)|U = m)$$

$$where \qquad P^{j|mj}(X) = P^{j|mj}(U = j|U = j \text{ or } m, X) \qquad \ldots(a)$$

Equation (a) gives the probability of choosing alternative *j*, if *m* and *j* are the two choices available. It is similar to a two treatment case.

Lechner (2001) suggests that the propensity scores which are used to generate the counterfactual could be estimated either using an MNL, or a series of bivariate logistical regressions. Using

[36] 0 refers to not choosing any component, i.e. not participating in the ICDS program

estimates of propensity score from MNL has the advantage that it incorporates the interdependence of probabilities across different alternatives. Lechner (2002) compares these two alternatives approaches to estimating the propensity score and finds that empirically the results from the two approaches are same.

Since there is no such multiple treatment extension for covariate matching, we report results for bivariate comparisons for both matching methods. Since matching methods such as nearest neighbour matching are discontinuous functions, standard asymptotic expansions cannot be used to derive the variance of these estimators.[37]Abadie and Imbens (2008) show that due to this reason bootstrapped standard errors are also not correct for such matching methods. Abadie and Imbens (2006) provide an estimator for the analytical standard error for the asymptotic variance of matching estimators which is consistent. These are used here.

To create the counterfactual group, whether by PSM or CVM, the covariates we use include various child-specific (age, gender, order, size at birth, whether the child was ill in last one month), parents-specific (age, education, mother's health status and occupation status) and household-specific characteristics (distance to ICDS centre, whether the household belongs to same caste as ICDS worker, household size, economic status, caste category, access to clean drinking water, access to hygienic sanitation facility and type of fuel used for cooking). We also use state fixed effects.

To assess whether the counterfactual group thus created results in comparable sets of participants and non-participants we use several tests. First we use a two sample t-test for differences in means for all covariates; after matching there should not be significant difference in means of the control and treatment group. Since there are a large number of such comparisons, Table 10 presents differences in the means of all covariates, for one such comparison where the treatment group refers to utilizing any ICDS services, and control group refers to not participating in ICDS at all, relegating the remaining comparisons to Appendix Tables A.5 – A.7. For many of the

[37]Abadie and Imbens (2006) note that despite being very commonly used to evaluate the impact of treatment, large sample properties of matching estimators have not been established. They show that nearest neighbour matching estimator is not root n consistent due to the bias term mentioned above.

covariates considered, while there are statistically significant differences in the means of unmatched covariates, these differences lose significance when matched means are compared.

Second method uses the standardized bias (Caliendo and Kopeinig 2005). Standardized bias is the ratio of difference in means of two groups to the square root of average variance of these two groups. Difference between the standardized bias before and after matching gives the reduction in standardized bias. A 3-5 percent reduction in bias is considered to be indicative of good quality matching. In all the binary comparisons we consider in this study, the reduction in bias was more than 5 percent (Table 10). Both these measures compare balancing for each covariate separately.

The third measure that we use tests the joint significance of all covariates (Caliendo and Kopeinig 2005). This is done by re-estimating the propensity score equation for matched sample only and then comparing the Pseudo-R^2before and after matching. The last column of Table 10 reports the Pseudo-R^2, before and after matching; the post matching Pseudo R^2 is low and insignificant, which is indicative of good matching quality. Thus, using all three criteria, we find that the distribution of observables is balanced after matching for each of our binary comparisons (of treatments).

VI.2 Impact on Anthropometric Outcomes using PSM and CVM

The impact of utilization of ICDS services on WAZ scores as estimated by both PSM and CVM is presented in Table 11 (upper panel). We first consider the impact of utilizing any of the ICDS services as compared to non-utilization. The unmatched differences suggest that there is no significant effect of utilization. However, results from both PSM and CVM method suggest a significant positive impact of approximately 0.5 standard deviations on WAZ. This implies an increase of 500 grams for an 18 month old child and 1000 grams for a 39 month old child. This would also translate into a reduction in prevalence of underweight by 13 percentage points.

The increase in WAZ scores, estimated above, due to ICDS participation is not expected to be uniform for all children, as the number and type of services availed varies by households. To examine if impact estimates vary when intensity of participation is accounted for, Table 11 also

presents the impact of utilizing both services, separately from the impact of utilizing any one[38] (but not both) of the ICDS services. The impact of utilizing both services remains as before, at 0.5 standard deviations, using both matching methods. However, using only one of the services results in an impact of 0.15 standard deviations using PSM, but the CVM suggests no impact. A 0.15 improvement in WAZ scores translates into an approximately 6 percent reduction in prevalence of underweight, a far lower magnitude than 13 percentage point reduction seen when both services are availed. These magnitudes suggest that there are complementarities in the use of ICDS services – as using both services seems to have greater impact than using only one service (in either case, comparison is with children who do not participate at all). To verify if this is the case, we compute impact estimates using household who use both services as the treatment group, and those who use only one of the two services as the comparison group. If there were no complementarities in utilization, we would expect these impact estimates to be insignificant. The results presented in Table 11 however suggest that this is far from the case. Using an additional service has a higher impact (0.41-0.75 standard deviations), than just using one service on WAZ scores. This suggests that there are some thresholds effects in ICDS utilization, and in order to realize the full potential of the program, all services must be utilized.

The results for HAZ scores are similar when PSM is used to estimate impact; all the CVM impact estimates are insignificant. The PSM results suggest that utilization of any ICDS service leads to an increase of 0.34 standard deviations in HAZ scores which is equivalent to reduction in the prevalence of stunting by 6 percent. In contrast, children who utilize both services experience a 0.43 standard deviations improvement in HAZ, compared to those who did not participate at all. This corresponds to a 6 percent reduction in the prevalence of stunting and a 1.7 cm increase in height on average. This is once again suggestive of complementarities in utilization. A comparison of impact between those who use both services and those who do not, suggests that this is indeed the case, with children utilizing both services being 0.34 standard deviations taller than those who only use one service. Thus, qualitatively these results are similar

[38]The sub-sample to evaluate the impact of each of nutrition and health investments alternatives independently were too small to permit estimation.

to those for WAZ; but are not as robust, as the HAZ impact estimates using CVM as noted above are insignificant.

As mentioned in section IV, we could not collect data for weights and heights of some children, who are likely to be healthier. Since our sample comprises of children with poorer health outcomes, this may bias our results on impact. To test the robustness of our results, we re-estimated all our results including these children with missing data by assigning them a z-score of -1. A z-score of -2 or below indicates poor nutritional outcomes; since these children are likely to be healthier we assume that they have a z-score of -1. We find that our results are similar to those we obtained without including these children, in sign and magnitude,[39] and therefore our results are not biased due to missing data.

VII. Summary and Conclusions

The ICDS, which provides both supplementary nutrition and health inputs to young children, is believed to be the single-largest pre-school intervention in the world. Since its universalization in 2006, the number of ICDS centers has increased by more than 50 percent to cover more than 96 percent of villages by 2010.Yet at the same time, the expansion in utilization of all its services has not been commensurate. This provides the motivation for the first of our objectives, which is to analyze the determinants of ICDS utilization. Our second objective is to quantify the impact of ICDS utilization on child anthropometric outcomes. Though there have been several other evaluations of ICDS impact that account for attribution, most of these rely on the National Family Health Surveys, the latest survey of which was in 2005/6. This study attempts to address the question of its impact after the expansion in coverage, although the analysis is based on a relatively small region of (11 villages in) three states in eastern India.

For the first objective, our analysis explicitly accounts for the facts that (a) the presence of an ICDS center need not imply that all its services are available and (b) that perceptions of availability of services among users may be significantly at variance from what the centers report as being available, and it is the former that matters to decisions on utilization. About 10 percent

[39] We also test the robustness of our results by assuming a z-score of -0.5 and 0 for these children and find that our results do not change. These results are presented in Appendix Table A.8.

of the sample did not perceive that they were eligible for any of the ICDS services, another 20 percent of the sample believed that they were eligible to receive one (but not both) of the services. Another 30 percent did not use any service despite believing themselves to be eligible, indicating that demand factors are also important in determining utilization. Our multinomial logit analysis of the drivers of the use of various ICDS services, also confirms that it is important to account for the fact that each household in effect faces a different choice set of services available to them. This is one aspect that sets this study apart from the rest of the literature.

We find that the primary drivers of utilization are access costs, defined both in physical (distance) and social terms. Scheduled caste and tribe households are less likely to participate and when they do, are less likely to use all ICDS services. Similarly, belonging to the same caste as the ICDS worker increases the probability of participation, and in particular of using the supplementary nutrition service. This is perhaps not unexpected, as caste discrimination often translates into taboos regarding the serving of food.

To address the second objective, we use propensity score and covariate matching techniques to assess the impact of ICDS utilization on child weights and heights. In doing so, we consider the impact of ICDS services separately, and try to address if there are complementarities in the use of both rather than a single services. We find that in eastern Indian villages considered here, the ICDS has translated into a 13 percentage points decline in the prevalence of being underweight, a result that is robust across both matching techniques. Similarly it has also translated into a 6 percentage points decline in the prevalence of stunting, but this result is not robust across methods. That there is stronger evidence of impact on underweight is not surprising, given the greater focus of the ICDS on supplementary nutrition. This is somewhat in contrast with the literature that shows some impact on heights, but is more ambiguous about impacts on weights. There is also evidence of complementarities in impact, with children who utilize both sets of services showing greater weights (and heights) than those who utilize only one service.

The contributions of this paper thus lie in (a) providing more recent evidence of impact, after the considerable scale-up that has taken place since 2006; (b) explicitly accounting for household

perceptions of availability in utilization decisions; and (c) addressing potential complementarities in utilization of the two ICDS services.

Our results imply that it is important to improve awareness of entitlements, so that perceptions of lack of availability do not pose a constraint to utilization. It is also necessary to reduce access costs; and while this may be easier to do in terms of ensuring a greater density of ICDS centers, caste-barriers are entrenched, although ensuring that there a greater number of ICDS workers from scheduled caste/tribe groups and sensitization campaigns may help improve participation. Our results on the complementarities from utilization of all services suggest that any imbalance in centers in terms of the composition of services provided be redressed; supplementary nutrition is clearly important, but so are the other vaccination, health-checkup and nutrition education components in improving child nutrition outcomes.

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Appendix A.1

Multinomial Logistic model

The utility/benefit (B) from each alternative can be divided into two components. The systematic component V_{ij} is a function of observable characteristics of the alternatives and those of the respondent. ν_{ij} is the stochastic element and captures the unobserved characteristics that affect utility.

$$B_{ij} = V_{ij} + \nu_{ij}$$

If an individual i faces m choices, then the probability of selecting alternative j is given by

$$\Pr(U_{ij}) = \Pr(B_{ij} > B_{im} \; \forall \; m \neq j)$$

$$\Pr(U_{ij}) = \Pr(V_{ij} + \nu_{ij} > V_{im} + \nu_{im} \; \forall \; m \neq j)$$

$$\Pr(U_{ij}) = \Pr(\nu_{im} - \nu_{ij} < V_{ij} - V_{im} \; \forall \; m \neq j)$$

The probability function can be derived from the cumulative distribution of ν. We assume that ν follows an extreme value distribution and therefore the probability of choosing alternative j is given by the following expression and is called Multinomial Logit Model (Train 2009).

$$\Pr(U_{ij}) = \frac{\exp(V_{ij})}{\sum_{\mathrm{m}} \exp(V_{im})}$$