ABSTRACT

In the year 1975, the Indian government initiated the Integrated Child Development Services (ICDS), the largest national program in the world targeting long-term nutrition and holistic development of children, to be implemented through the Anganwadi centers (AWC). Combining differences across villages in the year of AWC construction with birth-year of children, we capture the variation in ‘exposure’ to the program, to estimate the impact of the ICDS exposure through access to AWCs on later life health outcomes of children. Our findings suggest that a 10-13 year old cohort fully exposed to the scheme during first three years of life has higher height (by 2.3 cm) and weight (by 1 kg) as compared to the same cohort, not exposed to the services in initial three years. The Z score of height-for-age (ZHFA) and Z score of weight-for-age ZWFA, although not statistically significant, seem to increase as well. The average impacts seem to be as high as 0.74 cm and 0.33 kg for an extra year of exposure, for measures of height and weight respectively. Our findings are robust to changing age cohorts and several specifications. The effects seem to be larger among girls and in *poor* households.

1. Introduction

A child who has been malnourished or suffered from poor health in the initial few years of life (Knudsen, 2004) is found to experience impaired growth through poor lifetime health (Victora et al., 2008), lower ability to learn (Morgane et al., 1993; Martorell, 1997), lower schooling attainment (Alderman et al., 2006), poor employment status (Jurges, 2013) and lesser earnings possibilities (Bleakley, 2010) in the long run. The strong associations between early life health, nutrition status, and later life outcomes raise serious concerns for a developing country like India where more than 160 million children are under the age of six years, and 44.9 percent and 40.4 percent of them are reported to be stunted and underweight respectively (Planning Commission, 2014). In order to combat this problem, the Indian government has launched a scheme known as the Integrated Child Development Services (ICDS) from the year 1975. It is the largest national program in the world, which targets long-term nutrition and holistic development of children by providing a range of services in one platform. The package of services provided by the ICDS includes supplementary nutrition, pre-school education, immunization, health check-up, nutrition and health education, and referral services for children aged 0-6 year old, adolescent girls, pregnant women and nursing mothers (MoWCD, 2017).

With an aim of efficient administration, Anganwadi (or childcare) centers (henceforth, AWC) located within the villages are chosen as the platforms for providing all the services under the scheme. This scheme has seen a rapid expansion after the universalization of the program in the year 2008-09. World's largest mother and child welfare scheme benefitted around 101.06 million children of six months to six years, and pregnant and lactating mothers via the supplementary nutrition component by September, 2016 (MoWCD, 2017). To ensure wider coverage of this scheme, fund allocation has been increased from Rs. 444 billion (equivalent to

US $6.22 billion) in the Eleventh five-year plan (2007-2012) to Rs. 1235.8 billion (equivalent to US $17.3 billion) in the Twelfth five-year plan (2012-2017) (MoWCD, 2017).

In this paper, we estimate the causal impact of the *ICDS exposure through AWC access* in rural areas on children's health outcomes in later years of their lives, when they are not eligible to be the direct beneficiaries of the services anymore. Ideally, we would like to estimate the direct impact of ICDS exposure, but due to unavailability of data on the year of initiation of the ICDS in a village, we use construction of AWC in the village as a proxy to capture the ICDS exposure (see Deolalikar, 2004, which reports a strong association between the ICDS and the AWCs). The outcomes considered are the anthropometric indicators and short-term morbidity indicators in the later lives of children. We focus on estimating the impact on health in later lives because we are interested to test the persistence of positive shocks on health until adolescence. The outcomes are height, weight, Z scores[i] for height-for-age (ZHFA), Z scores for weight-for-age (ZWFA), and short-term morbidity indicators in later lives of children.

To examine the linkage between an ICDS exposure and health outcomes in the later life, we use the intent-to-treat strategy, very similar to the one used by Nandi et al. (2019) in their evaluation of the longer-term impact of an ICDS exposure on schooling attainment. Using the village level survey conducted in 1,410 villages selected from 271 districts (covering 28 states and three union territories) in India, we note the year when Government AWC[ii] was opened in a particular village. We match this information with the birth year of every adolescent of age 10-13 years, whose family has been staying in that village for the last 15 years or more. It helps us to find the number of years (maximum six) a child has been exposed to the ICDS services through AWC after birth. The literature suggests that malnutrition increases at a faster rate until three years of age and becomes stable after that (Bhutta et al., 2008). Therefore, the role of supplementary nutrition in combating the malnutrition is most crucial until initial three years of life (Jain, 2015; Nandi et al., 2019). Hence, in the first model measuring the impact of an ICDS exposure through AWC access, the primary treatment variable, called exposure, is a continuous variable ranging from zero to three. This model helps us to estimate the impact on health outcomes with increasing degree of exposure. In another model, we compare the children exposed to scheme for all initial three years of their life (termed as full exposure) to those who were not at all exposed (no exposure) to the scheme. In order to reduce the selection bias arising from the location-specific time-variant unobservable factors, we consider district-birth year fixed effects model as our preferred specification.[iii] Additionally, to control for possible observable confounding factors, we include the individual and household level covariates in final specifications.

We find that the 10-13 year old cohort fully exposed to the scheme through an AWC access during first three years of life has higher height (by 2.3 cm) and weight (by 1 kg) as compared to the same cohort, not exposed to the services in initial three years. The ZHFA and ZWFA, although not statistically significant, seem to increase. The average impacts for measures of height and weight seem to be as high as 0.74 cm and 0.33 kg respectively, for an extra year of an ICDS exposure through access to the AWCs. Our findings are robust to changing age cohorts and several specifications. The effects seem to be larger among girls and in *poor* households.

Our findings support the existing literature on the benefits of this scheme that plans to cater to the nationwide population via several services at one platform as elaborated in the next section. This paper can be considered as an extension of the literature (Jain, 2015) establishing improvements in anthropometric indicators for the children currently consuming food provided as a part of the ICDS supplementary nutrition program on the daily basis, as compared to their counterparts who were not doing so. Jain (2015) finds that girls in the age group of 0-2 years, receiving food on the daily basis are 1.2 cm taller and have 0.48 standard deviations higher ZHFA relative to the control group.

Earlier, researchers have tried to evaluate the impact of the ICDS supplementary nutrition on children's anthropometric outcomes during the years when they are eligible to use the services (Lokshin et al., 2005; Kandpal, 2011; Jain, 2015) and various health outcomes in later life, such as risk of cardiovascular diseases, bone mass, lean body mass, muscle strength (Kinra et al., 2008; Kulkarni et al., 2014; Matsuzaki et al., 2014 – henceforth mentioned as KKM). While in the next section we discuss a host of existing literature estimating impact of the ICDS on anthropometric outcomes, the only other available work that estimates the impact of the ICDS on later life anthropometric outcomes is done by Kinra et al. (2008) in Hyderabad nutrition Trial, which finds that an exposed child of 13-18 year old on average, is likely to have about 1.4 cm higher height, favorable measures of insulin resistance and arterial stiffness, as compared to the unexposed counterpart. However, that Hyderabad Nutrition trial known as Andhra Pradesh Child and Parents Study (APCAPS) was a small-scale study, conducted in only one district of Andhra Pradesh., with a target 4,338 pregnancies recorded for the trial. The sample attrition led to only 1,446 of them voluntarily participating in the trial till end, which made the study subject to selection bias. The findings of that trial raise concerns on external validity due to difference in the ICDS program placement across states of India (Lokshin, 2005). Moreover, KKM's trial was to estimate the impact of the nutrition component of the ICDS, whereas the ICDS includes several other services. As discussed in the next section, reduction of incidence of morbidity being one of the objectives of the ICDS scheme, it is important to focus on additional health outcomes along with the anthropometric indicators. Ours is the first work that addresses external validity while establishing a long-lasting impact of the ICDS exposure on a comprehensive set of later life health outcomes, through a nationwide impact assessment study, which is analyzed long after the children stop using the services. The estimates of short-term morbidities in later lives also help us to explore if early life intervention that includes nutrition and immunization benefits, help in developing immunity in later life. The other papers closest to our work using national level survey data, estimate the short run impact on anthropometric outcomes during 0-4 years of age of a child, when children continued to be the users (Jain 2015, Kandpal 2011, Lokshin et al. 2005).

The rest of the paper is organized as follows. Section 2 discusses the details of the ICDS scheme and the level of implementation. Section 3 reviews the relevant literature. Section 4 explains the data and potential issues with sample selection. Section 5 elaborates the identification mechanisms, followed by the descriptive statistics. Section 6 discusses the primary findings. Section 7 discusses the possibilities of heterogeneous treatment effects. Section 8 discusses the potential limitations of the study and Section 9 concludes.

2. The ICDS – more than just a nutrition scheme

The erstwhile Planning commission of India chaired by the Late Prime Minister Mrs. Indira Gandhi put child welfare on the first priority among the various schemes of social welfare during the fifth five-year plan. In order to achieve this objective, a National Children's Board was set up in 1974 and a first policy document, National Policy for Children, focusing on the needs and rights of children was formulated in the same year. After recognizing children to be the most important asset of the country in the National Policy for Children, the then Ministry of Education and Social Welfare, Government of India, launched the ICDS Scheme in October, 1975.

ICDS is a multi-dimensional program with the intention of providing a range of services under one umbrella for the collective gain, which is possible only if different services develop in an integrated manner. Moreover, the effectiveness of one service is dependent on how efficiently other services are provided. For operations of the ICDS, the government initiates an ICDS project first, and then under that project, the Anganwadi Centers are developed. Therefore, one ICDS project can have more than one AWC. One Anganwadi worker (AWW) and one helper (AWH) are responsible for running and allocating the services after completion of three months of institutional training and four months of community-based training (Kapur et al., 2016). Over the period, the ICDS has expanded from 33 projects in the year 1975, to 7,073 operational projects with around 1.35 million operational AWCs covering almost all the regions of the country by the year 2016 (MoWCD, 2017). An aggregate of 33 ICDS projects located in rural, urban and tribal regions were launched (Planning Commission, 1982) in 1975 with the particular objectives (MoWCD, 2017) of (1) improving the nutritional and health status of children in the age group 0-6, (2) laying the foundations for the overall development of children, (3) reducing the incidence of mortality, morbidity, malnutrition and school dropout, (4) achieving effective co-ordination of policy and implementation among various departments to promote child development and, (5) enhancing the capability of the mother to look after the normal health and nutritional needs of children through proper nutrition and health education. In order to achieve its objectives, the ICDS scheme offers a combination of six services, that are: i) supplementary nutrition, ii) pre-school non-formal education, iii) nutrition and health education, iv) immunization, v) health check-up and, vi) referral services. The beneficiaries are provided with supplementary nutrition for 300 days in a year i.e. 25 days in a month, with an aim to supplement and not substitute the family food. In addition to this, nutritional norms vary according to the category that a beneficiary belongs to. For example, children in the age group of six months to 72 months are provided food with a minimum energy content of 500 kilocalories (12 to 15 grams of protein per child), whereas severely underweight children lying in the same age group get 800 kilocalories (20 to 25 grams of protein per child). Pregnant and nursing mothers get 600 kilocalories (18 to 20 grams of protein per female). Parents or guardians of younger children aged six months to below three years of age, pregnant and lactating mothers are allowed to take home rations; whereas children of age group three to six year old are fed with cooked meals at the AWC (MoWCD, 2013).

The preschool component of the scheme aims to provide a base for lifelong learning and development by creating a learning environment in the AWC for promotion of social, emotional, cognitive, motor, physical and aesthetic development of the child (MoWCD, 2013). It also helps the children to prepare for the primary schooling. Around 34.54 million children have benefitted by the pre-school education by September, 2016 (MoWCD, 2017). The third component of the scheme provides child care and nutrition counselling to all women belonging to the age group of 15 to 45 years related to breastfeeding, prevailing myths and misconceptions, complementary foods, hygiene, sanitation during feeding, utilization of health services and family planning.

Three major health services namely immunization, health check-up and referral services aim to reduce the incidences of short-term morbidity. They are provided through the public health infrastructure. AWWs and ASHA (Accredited Social Health Activist) workers contribute to cover the target population of pregnant women and infants for their immunization as per the national immunization schedule. All the children under six years of age get benefitted by regular health check-ups, recording of weight, locality based management of malnutrition, treatment of diarrhea, deworming, distribution of iron and folic acid tablets, and medicines for minor illnesses. Every AWC gets a medicine kit which is helpful in controlling short term diseases like fever, cold, cough, worm infestation, etc. Moreover, sick or malnourished children who need immediate medical help are referred to Primary Health Centers by the AWW (MoWCD, 2013).

The cost sharing between central and state governments for supplementary nutrition under the ICDS is different from the general ICDS. Until the year 2005-06, providing supplementary nutrition was the responsibility of the state government and only the complete administrative costs were borne by the central government. The cost of supplementary nutrition remained meagre, with limited coverage across villages and habitations. Many states were not providing any supplementary nutrition due to resources constraints. This led the federal government to revise the structure of financing of the program from the year 2005-06, when central government started supporting states with 50% of their financial norms, or 50% of government expenditures incurred by them for providing supplementary nutrition.

The families willing to receive benefits of the program did not have to bear any direct cost. However, for taking the benefit, either the family had to bring the child to the AWC, or the child would need to come to the AWC for the nutritious meals, which might involve the opportunity costs of the parents' time, particularly if the AWC was not located close to one's home.

3. Literature on impact of the ICDS

The ICDS being a more than 40-year-old program, there are several studies that have attempted to evaluate it on different outcomes. Positive impacts of the ICDS exposure were found on Intelligent Quotient (Ade et al., 2010), on cognitive ability (Arora et al., 2007), and on schooling outcomes (Nandi et al., 2016) of children in the short run up to the pre-school age, along with educational outcomes (Aggarwal & Kumar, 2000; Hazarika & Viren, 2013) in later life when the beneficiaries enter into adolescence. Jain (2020) finds that childcare services offered under the ICDS narrows gender gap in education.

There are a few studies that have attempted to analyze the impact of the nutritional components of the ICDS through small trial programs at different parts of India, and the findings are mixed.

There is an indication of improvement in maternal weight and birthweight in a trial program in two blocks of Varanasi district of Uttar Pradesh, between the years 1987 to 1993 (Agarwal et al., 2000); whereas, no significant difference could be found in the nutrition status of the 1-6 year old children in the ICDS areas in other parts of the country (Trivedi et al., 1995), or in malnourishment among a small sample of 1,253 children of 7-13 years in East Delhi (Bhasin et al., 2001). Mixed results found by the studies mentioned above on the health outcomes are mostly based on small samples taken from one or two districts of different states, and not specifically designed to ensure the randomness of treatment. The endogenous placement of services in the above-mentioned studies might have biased the results too.

To overcome the concerns with external validity, the studies that have used national level data, studying the sample of children up to pre-school age, report negative association between the ICDS exposure in village and malnutrition among children in short run when they continued to use the services (Deolalikar, 2004 uses NFHS data; Tandon, 1989 uses primary survey data). Lokshin et al. (2005) use both the NFHS-1 of 1992-93 and the NFHS-2 of 1998-99 to find positive association between availability of an ICDS center in the village and anthropometric measures for children aged four years or less. Jain, (2015) evaluates the immediate effects of supplementary nutrition as a component of the ICDS with the help of difference-in-difference estimation. Using the NFHS - 3 of 2004-05, she finds that 0-2 year old cohort of girls receiving the supplementary nutrition on a daily basis is 1.2 cm taller, has 0.48 standard deviation higher ZHFA as compared to their counterpart of 4-5 years not receiving the services.

The few causal estimates of nationwide impact of the ICDS mentioned above is limited by the short run outcomes on children up to pre-school age, when they continue to be the users. Recently, Nandi et al., (2016, 2019) find the impact of the ICDS exposure on schooling attainment, on labor market outcomes (2018) and marriage rates (2020), on age of pregnancy and childbirth of women (2020) in the later life. In our knowledge, the estimates of a nationwide impact of the ICDS having external validity, on a comprehensive set of health outcomes, including short-term morbidity in later life are non-existent in literature.

The study closest to ours that attempts to estimate the long term impacts of the exposure to the ICDS services, when children are not direct beneficiaries anymore, is evaluated by Kinra et. al., (2008) using the APCAPS data for the individuals participated in Hyderabad Nutrition Trial during 1987-1990 across 29 villages in the Ranga Reddy district of Andhra Pradesh (as a part of KKM studies mentioned earlier). They find that children exposed to the ICDS services in the initial years were 1.4 cm taller and faced lesser risk of cardiovascular diseases in their adolescence (13-18 years of age). Similarly, Kandpal, (2011) finds positive impact of existence of an ICDS center in the village on ZHFA using the NFHS-3 of 2004-05. Using propensity score matching, she finds an improvement in ZHFA by 5 percent for the overall sample, 6 percent for boys and 4 percent for girls living in the ICDS villages as compared to their counterparts living in the non-ICDS villages. She further measures this impact for moderately stunted and severely stunted children and finds that both moderately or severely stunted girls benefit more by the presence of an ICDS center in the village.

In the interest of space, we enlist a brief summary of most relevant literature that estimates causal impact of the ICDS on health outcomes in short and long run in Appendix table A1, which should also indicate the difference with our work. The literature estimating impact of the ICDS on other outcomes are listed in Nandi (2019).

4. Data and potential issues with sample selection

We use the publicly available second round of the India Human Development Survey (IHDS-2, 2011-12) data collected jointly by the University of Maryland and the National Council of Applied Economic Research (NCAER), New Delhi during the years 2011-12 (Desai and Vanneman, 2011-12). It is nationally representative multi-topic panel survey covering 42,152 households in 1,420 villages and 1,042 urban blocks across 384 districts[iv], spread over 33 states and union territories in India. It covers all the states and union territories of India except Andaman and Nicobar, and Lakshadweep. This survey captures information related to health, education, employment, economic status, marriage, fertility, gender relations, and social capital for surveyed households.

Detailed information at the village level is available separately. This village questionnaire, which is available for rural areas only, asks every village head about the availability of the AWC in their village. The specific question used is as follows: "Does this village have... Government Anganwadi or other Child Care Centre? How many years ago did it open?" Since the main treatment variable (exposure) relies on this information, our study is limited to the rural areas only. Moreover, this information is not available for seven (0.4 percent) villages out of 1,410 villages, and we exclude households belonging to those seven villages from our analysis. However, the ICDS is mainly focused on rural areas as the prevalence of underweights is far higher in rural areas (50 percent) than in urban areas (38 percent) and the rural-urban gap in terms of malnutrition has increased overtime (Gragnolati et al., 2006). In this study, we restrict our analysis to 6,189 adolescents from rural areas, aged 10-13 year old, who live in these 1,403 villages[v].

Our objective is to estimate the impact on adolescents, who are divided into three stages: early, middle and late adolescence. Rapid growth takes place in the early adolescence (10-13), whereas in the middle age growth slows down; and in the last stage the body is physically mature. So it is unlikely that we see any effects in the last two stages, which are, middle and late adolescence (WHO, 2010).

We combine this village level information with the birth year of 10-13 year old adolescents to find the years of exposure of an adolescent to the ICDS services through the AWC in initial three[vi] years of the child's life. The implementation of the scheme or the 'treatment' through setting up of village level AWC, combined with the exogenous variation of birth year is the basis of our identification strategy. Children born after the setting up of the AWC in the village are expected to gain from the exposure, as compared to the children born before the AWC came in. This heterogeneity helps us to devise our identification strategy in the treatment effect framework. To preserve the precision of our estimates we restrict this analysis to those (6,161) children only, whose household surveys and village surveys are conducted in the same year, i.e. 2011 or 2012.

In order to ensure that children have been living in the same villages since birth, we further restrict our sample to those households only, who have been living in the same villages for at least 15 years[vii], which reduces the sample further to 6,052 adolescents. Few missing observations for the dependent variables reduce the sample further to 5,218 for height, 5,130 for ZHFA, 5,220 for weight, and 5,184 for ZWFA[viii]. The descriptive statistics across different columns of the attrition process as presented in appendix table A2 show that there is no major difference in the covariates originating from the data attrition.

To check the potential selection bias due to the sample attrition, we further use two different approaches as detailed in section 8. As a first strategy, we conduct balancing test of important variables between our sample and the excluded sample, as presented in appendix table A3-A5.

In the second case, following Fitzgerald et al. (1998), we estimate if the likelihood of an observation being included in the sample varies with the value of the main variable of interest ($YOEXP$). In table A6, the dependent variable assumes a value one if the observation is in our final sample, and it assumes a value zero, if the observation is excluded from the final sample in the corresponding outcome equation due to either of the sample attrition phases as explained earlier. Table A6 shows that the coefficients of exposure variable in any of the outcome samples are not statistically significant and indicate that exposure to the ICDS scheme does not seem to have a significant impact on the likelihood of being included in the respective sample.

5. Identification and descriptive statistics

In the first model, the primary independent variable of interest is '$YOEXP$', ranging from 0 to 3 years. To construct this variable, we explore whether a particular adolescent was exposed to the ICDS scheme through village AWC in her initial three years of life, by comparing her birth year with year of AWC construction. The variable capturing the year of ICDS exposure, that is, $YOEXP$ can be defined as follows:

$$\begin{aligned} YOEXP &= 3, && if\ [year\ of\ AWC - birthyear] \leq 0 \\ &= 3 - [year\ of\ AWC - birthyear], && if\ 0 < [year\ of\ AWC - birthyear] \leq 3, \\ &= 0, && if\ [year\ of\ AWC - birthyear] > 3 \ \ldots\ldots \end{aligned} \quad (1)$$

With the help of this variable, we are able to capture variation at both spatial level as well as temporal level. Spatial level variation is exploited by the variation across villages whereas temporal level variation is exploited by the variation between birth year and construction year of AWC in every village. Using the above strategy, we calculate the years of exposure for 6,052 adolescents, of whom 3,636 have been exposed for all three years, 305 for two years, 326 for one year, and 1,785 adolescents had no exposure at all.

This intent-to-treat estimate may differ from the average treatment effect on treated if all the children who could access the ICDS services, would not have actually used it due to some reasons. This could be due to the difference in: i) affordability across households, e.g., some household might be able to provide better nutrition and care at the home; ii) lack of awareness among the marginalized households that could make the malnourished children devoid of these services. In order to cater to these possible differences between target users and the actual users, we estimate our model conditional on several individual level and household level observable variable.

There exists scattered evidence of targeted program placement under the ICDS. National and state governments seem to have targeted the ICDS to reach the regions with poorer development outcomes (Kandpal, 2005), including outcomes of undernutrition. This could cause a systematic difference between the exposed and unexposed groups and this could bias our OLS estimates. The systematic difference could also be time-variant, if the underdeveloped regions kept receiving increasing ICDS funds over time until they attain a certain level of development. We plan to mitigate this bias by controlling for location specific, time-variant factor in our preferred specification. Since our treatment is at village-birth year level, our preferred regression specification is district-birth year fixed effect model as presented below.

$$Y_{id} = \alpha + \beta(YOEXP_{id}) + \gamma I_i + \delta H_h + \theta(Age_i \: X \: District_d) + \varepsilon_{id} \qquad (2)$$

The outcome variables 'Y_{id}' considered in alternate specifications for an individual 'i,' from household 'h,' of district 'd' are: height (in cm), ZHFA, weight (in kg), ZWFA, incidence of short term morbidity (due to fever, cough or diarrhea) in general, and fever and cough in particular. Incidence of short-term morbidity, in general and specific ones, are binary variables; whereas, all others are continuous variables. The ZHFA and ZWFA are calculated using the Centers for Disease

Control and Prevention (CDC) Growth Charts of 2000. It allows us to find standardized values of height (weight) for a cohort of children aged 2-20 (0-20) year old.

One potential criticism could be that the use of anthropometric Z-scores at later ages are somewhat less common for older than for younger children. That is exactly the reason that we do not employ more recent standard WHO measures in this paper. However, Lundeen et al. (2004) use height-for-age in the adulthood, by using the 2007 WHO reference curves. Since we use the Centers for Disease Control and prevention (CDC) Growth Charts of 2000, we also present the estimates for test of robustness (table S2[ix]), where we convert the Z-scores based on the 2007 WHO tables.

In order to construct the general short-term morbidity indicators, we use the following question available in the data set- "In the last 30 days, for how many days an individual was ill?" We consider an individual as ill (Morbidity = 1) if she is reported as ill even for a day in the last 30 days, else we consider her as healthy (Morbidity = 0). For the specific diseases, we have separate questions: "Did an individual have a fever in the last 30 days?" and "Did an individual have a cough in the last 30 days?"

To measure the outcomes in the later life of the children we consider the 10-13 year old cohort at the time of survey. 'I_i,' is a vector of individual specific variables such as, sex and birth order of children, mother's education (binary variable capturing completion of primary education), mother's height. 'H_h' represents the vector of household level observables that could affect outcomes differently, which are: categorical variable denoting primary source of income of the family (from a list of agriculture or allied activities, agriculture wage labor, non-agriculture wage labor, independent or petty shop, business or salary or pension and others), wealth index measured by the number of assets (such as TV, fan, chair etc.) owned by household, dependent ratio in household, ethnicity (Scheduled Cast or SC, Scheduled Tribe or ST, Other Backward Classes or OBC, and others), religion (Hindu or others)[x]. However, it is possible that exposed younger adolescent has poorer outcomes (specifically on anthropometric indicators such as height and weight) as compared to unexposed elder adolescent due to difference in age and not due to the exposure to the ICDS. This effect could be different across locations due to unobserved reasons, including that of preferences in program placements. θ is an indicator for district, interacted with birth-year (age) of children, to control for time-variant district level unobservable. Lastly, ε_{id} is the error term. Standard errors are corrected for heteroscedasticity by clustering them at the village levels[xi].

In the second model (2), we restrict the analysis to those adolescents only, who are exposed to the ICDS for all three years of their initial life in comparison to the adolescents who are not at all exposed. Therefore, with all other specifications remaining same, the primary variable of our interest in second model is a binary variable, called as 'Full exposure ($FULEXP_{id}$),' which assumes a value 1 if years of exposure is three, and zero if years of exposure is zero.

$$Y_{id} = \alpha + \beta(FULEXP_{id}) + \gamma I_i + \delta H_h + \theta(Age_i \, X \, District_d) + \varepsilon_{id} \qquad (3)$$

We argue that the heterogeneity of the birth year of children which is a household level decision, when combined with the timing of foundation of the AWC at the village; conditional on the children's birth year specific and district specific observable and unobservable factors, individual and household level observables, makes our 'exposure' variable exogenous, and helps in the identification of the model. Since this is a nationally representative sample, in all our specifications throughout the paper we use given survey weights.

The identification assumption would be violated if the exposure variables ($YOEXP_{id}$ or $FULEXP_{id}$) would be endogenous to the household's choice in place of stay (that is, village). If households caring more for their children's health could ensure the service from the AWC to their children by moving to a village with the AWC center just before birth of their children, then our impacts would be biased upward. However, the data reveals that about 90 percent of households have not moved for more than last 15 years, and our sample includes these households only, taking care of the concerns for possible endogenous exposure[xii].

However, there is still a possibility of endogenous placement of the ICDS across villages within a district, such as, villages with poorer infrastructures would have AWCs placed prior to other villages, which could be systematically associated with the health outcomes. Therefore, as an additional check, we regress the measure of each village level infrastructure and village level average of asset information, as available in the data, on the years of the AWC construction. The estimates as reported in table S3 does not provide any evidence of the endogenous placement of AWCs in the village based on village level infrastructures or assets.

Figure 1 here

The linear fitted graphs in figure 1, for each of the outcomes with respect to birth year indicate that adolescents fully exposed to the ICDS are taller, less stunted, heavier, and less wasted as compared to their counterparts not exposed to the scheme. However, the incidence of morbidity and fever are lower for the adolescents born after 1998 and fully exposed with the ICDS as compared to the unexposed; and the incidence of cough is lower for the adolescents born after 1999 and fully exposed to the ICDS.

Table 1 here

Summary statistics of table 1 indicate that, on average, fully exposed adolescents are younger, have more educated and taller mothers, belonging to wealthier households with Hindu-religious backgrounds, have more agriculture wage labor and less non-agricultural wage labor as major source of income, as compared to the unexposed adolescents. However, the observed differences are very small in magnitudes. E.g., average mother's height in fully exposed sample being 152 cm, it is about 1.1 cm less in unexposed sample; or mothers have 0.11 percentage point higher likelihood of completing primary education in fully exposed sample. The wealth index of fully exposed sample is 14, as compared to 12.32 in unexposed sample. We control for the observed household level factors in all our specifications with the assumption that birth year being random, the households are not supposed to be systematically different between exposed and unexposed samples which could affect the outcomes. If we suspect some other unobservable factors to make the exposed villages different, our district-birth year fixed effect specification should take care of the location specific unobservable to a large extent. Since our treatment is constructed with combination of birth year and village, as an additional check for the village level differences, we also present the estimates of the village level infrastructure facilities on years of AWC construction (that is, how old the AWC is) in table S3, and we do not find a significant association between those. Finally, we would like one to note that comparison of household or higher level covariates between our 'exposed' and 'unexposed' sample may be misleading. It is neither comparison of samples across districts where districts are selected based on exposure, nor comparison across cohorts in a single district where cohorts are selected on the basis of exposure. Our definition of 'exposed' here is a combination of both time and space; where, it is possible that, in the same household one child may be 'exposed' and another may be 'unexposed.'

One criticism of this identification strategy would be the fact we are essentially capturing the impact of access to an AWC, with potential confounder being an ICDS exposure. Since the village level question that has information on year of establishment asks about the AWC, we could not find a better way to design our treatment. However, the ICDS services being primarily delivered through the AWC, a large number of villages having an AWC also report to consume the ICDS components (Deolalikar, 2004). To verify this fact, we use another village level question, which specifically asks whether the village AWC has the following ICDS program components: immunization, health checkup, supplementary nutrition, growth monitoring, pre-school education, and adolescent girls program. A cross tabulation of the AWC access in village and having access to each of the ICDS components at the AWC from the 2004-05 (IHDS 1, Desal and Vanneman 2005) and 2011-12 (IHDS 2) data as presented in table S1, shows that a large percentage of AWC has most of the ICDS program components. However, we could not use this direct question of the ICDS program component, as we do not have the information on year of access to these.

There is still a possibility that a small number of villages may not actually have an AWC, even though they deliver the ICDS components through some other types of village level facilitators. This will make our control group noisy. In that case, our estimate is expected to be a lower bound of the true estimate.

Finally, a village AWC may also provide services other than the ICDS, which can potentially be confounded in our treatment effect. We are unable to decompose that due to data limitations, and we might be capturing the impact of access to the village AWCs and confounding ICDS exposure.

6. Primary findings

Table 2 here

The estimates from the first model are presented in panel A of table 2, where we estimate the impact of the years of exposure, with years ranging from zero to three. Panel B presents estimates with the exposure being binary variables. In both panels, the first columns present the estimates of the naïve specifications, the second columns include district-birth year fixed effects, the third and fourth columns include the individual and household level covariates respectively.

For the anthropometric outcomes in both panels, the difference between the estimates in the naïve specifications of first columns and estimates of second columns are most significant because of importance of district-birth year fixed effects. Without that, we may end up comparing an unexposed elder child to the exposed younger child (among the 10-13 year old adolescents), producing lower estimates of impact (specifically, on height and weight related measures) due to the difference in age and not due to the ICDS exposure through the AWC access. For example, the introduction of district-birth year fixed effects in the second columns significantly increases the impact on heights to 0.72 cm (panel A) and 2.23 cm (panel B) due to exposures of different types. This indicates that increased height in the children is not only visible when they are actually consuming the services (Jain, 2015) but also at the later stage when they are no longer taking benefits of these services. The exposure to the ICDS scheme through the AWC access by an extra year (as shown in panel A) seems to increase height by 0.74 cm and weight by 326 gm. The impacts on ZHFAs and ZWFAs seem to be positive too, and on short-term morbidity seems to be negative, but both remain inconclusive due to the statistically insignificant values.

In the second model (panel B of table 2), when we restrict the sample to the children who are either fully exposed for all three years of initial life or not at all exposed, the former children are likely to have higher height (by 2.31 cm), more weight (by 1.04 kg), lower likelihood of suffering from short term morbidity and fever by 0.04 points in each. However, the estimates from impact on cough do not seem to be statistically significant in most specifications, although impacts seem to work in the expected direction. The complete estimation results are presented in table S6 and S7.

Table 3 here

Even though the initial three years of life is found to be most crucial in a child's later life outcomes, the fact that the ICDS is offered for up to six years of age, encourages us to extend our treatment to six years. Estimates of six years of treatment as presented in table 3 indicates the similar positive impacts on height and weight, as found earlier, but of a lesser strength. Since initial three years are found to be most crucial, the inclusion of additional years as a continuous variable, essentially dilutes the treatment effect, because exposure in fifth or sixth year may not make as much difference as in initial 1000 days.

Table 4 here

Our estimates are robust to increasing the age range. As we keep on increasing the age cohort from 10-13 to 10-18 through columns of table 4, estimates of height and weight are still positive, but reduce in strength for few elder cohorts. However, as argued earlier that the estimates in later years may be confounded with influences of other factors because of adolescence, the higher difference across genders in adolescence, and due to the availability of other schemes (including that of the ICDS) to adolescence girls[xiii].

In order to address the concerns for that fact that age-height relationship could potentially affect our estimates, we also control for age at measurement year in a separate specification as presented in appendix table A8. We do not present this as our primary model, due to the concerns in reporting error of age, where misreporting is identified from mis-match between date of birth and age. However, our estimates seem to be robust to this specification as well.

We also conduct a placebo test separately, where we consider children's birth year to be the year, which is either five years after or before the true year of birth. If we calculate the exposure on the basis of this false year of birth, we do not expect to see any impact of the ICDS exposure, due to the fact that treated groups get diluted with some members from the control group[xiv]. Table 5 supports our a-priori expectation on the placebo test, where none of the estimates are statistically significant, with coefficients of much lesser magnitudes.

Table 5 here

In a separate placebo test, instead of considering the year of AWC construction in the village for generating treatment, we use the year of construction of college in a village. That is, if the child was born after the construction of college in her village and she had access to college in first three years of her life, she was considered to be treated; else, she was assumed to be in control group. Similarly, we also generate the treatment status of a child to calculate the years of exposure. As expected, none of the estimates of column 2 in table 6 is statistically significant, along with high standard errors in most cases. It is expected that, conditional on household level observables and district-birth year fixed effects, years of exposure to college in one's village in first few years of life is not supposed to affect the anthropometric outcomes in later lives of children, as compared to the ones who did not have access to college in first three years of life.

Table 6 here

7. Possibilities of heterogeneous treatment effects

A. Across birth year

Since our primary model captures the average (intention-to-) treatment effect among the 10-13 year cohort, in the next specification, we also check for the possibility of heterogeneous treatment effects among children of different age-cohorts, We estimate the following birth year-specific impact, as this helps in exploring if treatment effects are restricted to any specific age cohort:

$$Y_{id} = \alpha + \beta(Age_i \, X \, FULEXP_{id}) + \gamma I_i + \delta H_h + \theta(Age_i \, X \, District_d) + \varepsilon_{id} \quad (4)$$

Here the primary binary variable of interest '$FULEXP_{id}$' is interacted with birth year indicators. Vector of coefficient β provides the estimate of impact of the exposure for the adolescents born in a particular year.

Figure 2 here

As we plot these regression coefficients connected by a solid line and the corresponding 95 percent confidence intervals connected by the dashed lines, figure 2 shows that adolescents born in 1997, 1998 and 2000 and fully exposed to ICDS scheme have higher height as compared to their not-exposed counterparts born in the same year. We also find higher ZHFA, ZWFA, and weight for the fully exposed adolescents born in 1997. Full exposure seems to increase height, ZHFA, weight, and ZWFA for children born in other years, but the coefficients are not statistically significant. Full exposure seems to reduce the likelihood of suffering from short-term morbidity for adolescents born in 2002.

B. Across gender

Literature has shown that girls in India face discrimination and there exists a gender gap in health investments and outcomes (Jayachandran & Kuziemko, 2011; Oster, 2009). In order to find gender-specific impact of exposure on the outcomes, we estimate equation (2) and (3) separately among male and female (after removing the sex dummy from both specifications).

Table 7 here

Table 7 presents some evidence of impact in height and ZHFA are being seen among the girls and not among boys, which is more pronounced when the treatment specification is full exposure as compared to per year exposure on average. An extra year of exposure seems to increase height by 1.2 cm and ZHFA by 0.08 standard deviation among girls; whereas, increase in height and ZHFA for a fully exposed girl is 3.5 cm and 0.27 standard deviations respectively, as compared to unexposed counterparts. Our study conforms to the existing literature in this area, as Jain (2015) finds that girls of 0-2 years' age receiving daily supplementary nutrition through the ICDS are about 1 cm taller (0.4 standard deviation increase in Z-score) and 140 gm more in weight than girls of same cohort not receiving it. For boys, the impact seems to be about 0.4 cm (and 0.2 standard deviation of Z-score for height increase) that are not statistically significant. Since the objective of our work is to capture the impact of having access to the overall program, rather that impact of particular component of it, we expect a larger impact. Moreover, the cohort that we study are of 10-13 years of age, for whom the change in anthropometric outcomes are expected to be higher.[xv]

8. Discussion on potential limitations

The application of this intent-to treat strategy for evaluating the impact of the ICDS exposure is limited in a sense that we are unable to find the average treatment effect on treated, who would be the actual users of the services. Apart from the fact that we do not have enough information to know more about the children or the households who actually used the services, even if we had that information, the endogeneity of actual usage would bias our estimates. In order to explore if the treatment effects are similar among actual users of the services, and to check robustness of our results, we further restrict the original sample among *poor* households.

We expect the *poor* households to be the users of these services due to unavailability of alternate options to them. It is likely that households which can afford better nutrition and health services will not consume the ICDS services. But there is no specific rule to separate the households in terms of affordability of better nutrition and health services. We try to do this by excluding those adolescents whose households own any of the following items: such as, car, air conditioner, washing machine, microwave oven, laptop, refrigerator, and credit card. We assume that ownership of any of these assets in the rural area is an indicator of high affordability. Hence excluding these households from the sample limits our sample to those who are more likely to consume the ICDS services. We call this restricted sample as the *poor*. As our first check, we use this restricted sample for the regressions based on the final specification of initial two models (2) and (3). The estimates of the average impact of per-year exposure are presented in panel A, and the estimates of full exposure is presented in panel B of table 8.

Table 8 here

Results in the first column of table 8 show that all the coefficients have the same signs as they had in the overall sample (in last column, copied from the last column of table 2).

Barker (1990) points out that the in utero-life of a child is most crucial stage of her development. However, without having information on the month of birth and month of the AWC construction and in want of clean identification strategy, we restrict the ICDS exposure to first three years of life after birth, whereas the true exposure might have been more than that. In our primary strategy, we assume that a child born in a particular year must be exposed to the ICDS through the AWC for initial three years of her life, if the AWC was constructed in the same year. This is true for children born in the first part of the year, as she was not exposed while in-utero. However, in this process, we end up ignoring the children who might be exposed to the ICDS in utero too, and continued to be exposed for first 1000 days, if she was born in last part of the AWC construction year (with an additional assumption that the AWC was constructed at the beginning of the year). In order to relax the restriction of after-birth exposure, in our new strategy, we extend the exposure by another year. Therefore, a child born in the year of AWC construction is assumed to have a total exposure of four years, with additional year of in-utero exposure. This may have diluted our treatment group to an extent, as some of these children may have been born in the beginning of the AWC construction year, thereby losing out in-utero exposure, or the AWC may not have been constructed by the time they were born. The estimates of this new model as presented in table A11 shows that our findings are still robust.

Another cautionary note should be on the interpretation of findings that points to the early life exposure, to the extent it is possible that current activities of the program might be influencing those fully exposed in early life. For example, if the children exposed in early life are more likely to have younger siblings benefiting, then they may indirectly benefit as well. In order to reduce the bias in our estimates arising from such influences, we do include several individual and household specific controls in different specifications, including birth order, number of children and household size[xvi], but our findings do not change. Additionally, in order to understand if our estimates are confounded by significant spillover impacts on younger siblings, we restrict the same model among the first-born children only. As reported in column (2) of table A10, it reduces our sample size drastically, but the magnitudes of the heights and weights related coefficients seems to be higher among the first born, which conforms to the literature.

Table 9 here

We also use another question, where the woman in the household is asked whether her last-born child, born within last seven years, had consumed any of the six ICDS components. Assuming, the consumption of any of the ICDS components for the last born child as an indicator of the fact that the elder child received extra benefit in later life because of her younger sibling using the ICDS component, we use that variable as an additional control in a different specification. However, the information being limited to households giving birth in the last seven years, our sample size reduces significantly. The estimates as presented in table 9 support the same findings as earlier, but estimates seem to be higher compared to our full sample.

One potential criticism could be about using asset indicators of households from the period much later than when the exposure was happening. This could make the heterogeneity tests by wealth problematic. In order to address this issue, we control for the time-invariant indicators capturing socio-economic conditions of households, such as, castes and religions in all our final specifications. Additionally, in appendix table A9, we also present estimates using asset indicators from the IHDS-1 data of 2004-05, but our estimates are robust to that specification too.

Finally, one might worry about the possibility of selection bias due to sample attrition at different stages. The construction of the main variable of interest requires the information on year of construction of the AWC in the village and the birth year of the adolescent. Along with that, as shown in table A2, the missing observations in several stages have caused sample attrition. We use two different approaches to see whether this sample attrition can be a potential problem of selection bias.

In the first approach, we compare the mean values of the covariates and the outcome variables used in the regression analysis between the samples included in the analysis and the excluded ones as presented in table A3 to table A5. The outcomes Morbidity, Fever and Cough in samples of table A3, Height in table A4, and Weight in table A5 do not seem to be significantly different, but the outcomes ZHFA and ZWFA presented in table A4 and table A5 respectively, seem to differ. The excluded samples in almost all tables seem to be better off in terms of years of exposure, mother's education, and wealth index, which means, our estimates may be a lower bound of the impact.

As a second method, we use a modified approach[xvii] from Fitzgerald et al., (1998) to see whether exposure variable affects the likelihood of being included in the sample. We construct a new variable 'included' which takes a value one for an adolescent who has been included in the analysis and zero otherwise. This variable is constructed for five different samples that are, short-term morbidity, height, ZHFA, weight and ZWFA. Each variable is regressed on the exposure variable (that is, years of exposure) to check whether exposure variable has a significant impact on the probability of being included. The location specific time variant factors are controlled by using district-birth year fixed effects. Results in table A6 show that the exposure variable is not statistically significant and indicate that exposure to the ICDS scheme does not have a significant impact on the likelihood of being included in the respective sample.

9. Conclusion

In this study, we aim to evaluate the impact of a nationwide early life intervention, that is, the ICDS exposure through access to the AWCs on later life health outcomes of children when they are not using the services anymore. However, in order to evaluate these later life health impacts, we select the cohort of adolescents who were 10-13 year old at the time of survey. Since children under the age of six can take advantage of the ICDS scheme, our selected cohort was no longer eligible for the program. Using second round of the IHDS data, we find that the potential impact of the ICDS scheme through access to village level AWCs, on health outcomes is not only limited to younger age (Jain, 2015) but it is also visible in the later age.

Estimates show that children exposed to the ICDS scheme through the AWC access have higher heights and weights than the children who are not exposed to these services. The mixed impacts on short term morbidities, fever and cough partially conforms to Jain (2015)’s findings, where the author could not find significant effect on daily exposure to the ICDS supplementary nutrition on incidence of short term diseases such as fever and cough for children aged 0-2 year old, while they had been using the daily services. The estimates for weight are not expected to be significant in later life from an early life nutrition shocks (positive or negative) as it can be affected by the deficiency in both current as well as past energy status (Sahu et al., 2015); whereas, height is a measure of long term nutrition and the deficiency that is very difficult to overcome beyond a specific age (Hoddinott & Kinsey, 2001). Even though we find positive impact on weights as well, the impact varies from as small as 326 gm for per year exposure to 1.04 kg in case of full exposure, which is not significantly high estimate for a 10-13 year old cohort. In principle, it is possible that our estimates still confound the impact due to the fact that villages with the ICDS are better villages in general with better healthcare infrastructures, better nutritional resources. However, if we assume that with a district-time control, villages may not be left with large variations, then the bias, if there is any, would be small. In addition, there is a possibility that children who received the ICDS nutrition in early life may be selectively given more nutrition through their life by their parents. Without having any meaningful covariates at the baseline level, we are unable to address this issue[xviii]. However, our estimates being robust to a large number of household level covariates, we address this concern to some extent.

Further, we show that the results are not driven by the cohort of children born in particular birth year. Our estimates are robust to different age groups until adolescence, and treatment duration of initial six years. We also find higher impact for the female cohort as compared to the males, conforming to Jain's findings (2015).

The ICDS offers a composition of six services which includes supplementary nutrition, pre-school non-formal education, nutrition & health education, immunization, health check-up and referral services. However, the intensity of different components is not same, and food nutrition has been given the prime importance as compared to the other components of the scheme, but there is no way to segregate out the impact of the different components of the scheme. Given these limitations, we find that ICDS exposure has not only immediate returns as found by Jain (2015) but also has long-term returns. Even though we are unable to measure the direct impact of the ICDS exposure, but the overwhelming support towards a strong association of the AWC access and the ICDS exposure (see Jain, 2015 and Lokshin, 2005) indicates that the impact of the ICDS stays in later lives. It may work not only through the direct nutritional channels of users, but it can potentially generate other externalities to the child or the household, entangling which could be the scope of a future work. In a country like India where more than half of the children under age of five year are moderately or severely malnourished (Planning Commission, 2002), it is important to further strengthen the scheme by eliminating the hurdles (Gragnolati et al., 2006) in the successful operation of the scheme across all communities.

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[i] Z-score are evaluated by standardizing a child's anthropometric indicators such as height or weight conditioned on age and sex against an international standard of reference population of children.

[ii] Platform for providing major ICDS services.

[iii] Our preferred specification would have been the inclusion of village-birth year fixed effects, but our identification strategy based on AWC construction at the village level in a particular birth year prevents us.

[iv] However, the village level data is available for 1,410 villages only, and the district level data is available for 373 districts only.

[v] The fact that children aged 10 to 13 in 2012 (2011) should have birth year in the range of 1998 to 2002 (1997 to 2001) helps us to detect serious reporting errors in age. So, in all our final specifications, we use the sample where age and birth year seem to be consistent.

[vi] The estimates based on six years of exposure are presented in table 3 for robustness.

[vii] Approximately 90 percent of the surveyed households in the sample have been living in the same village.

[viii] The initial sample of 6,189 cohort of 10-13 year old drops to 6,052 for the morbidity outcomes due to attrition in two stages: One, in which the households are matched with village surveys; two, we want the household to reside in same village for last 15 years. Since questions related to the morbidity of the children are answered by the eligible women or any other representative and presence of the specific child is not required, sample attrition is not an issue at this stage. However, a significant sample attrition happened at the stage of anthropometric data collection because it required the presence of the child. Unavailability of the child for the data collection exercise is likely to be a cause the missing data on anthropometric outcomes.

[ix] All tables with prefix ‘S’ are in online supplementary file.

[x] To check for robustness, we also include few more covariates in different specifications, but our findings do not change. The additional covariates used are, mother’s age, household size, number of children in 0-14 year cohort in household, household head’s education (in lieu of data on father’s education), household indicator capturing open defecation, regular hand wash, piped drinking water and per-capita household expenditures. These additional results are available from authors on request.

[xi] Tables S4 and S5 show that our estimates are robust to clustering standard errors at the district-birth year level and district levels respectively.

[xii] However, our findings are robust to removal of this restriction of staying on the same village for last 15 years, as presented in appendix table A7.

[xiii] In a different specification, not presented with this text, we use years of exposure as a categorical variable for the model (1), with zero exposure being the reference category. The results are very similar to that of panel A of table 2. The results are available with authors on request.

[xiv] Consider a village where AWC was constructed in 1990. Say, a child in that village was actually born in 1986, so she should be in the control group. However, if we increase his birth year falsely by 5 years, we assume that he is born in 1991, then he becomes treated falsely. Similarly, if a child in same village is born in 1991, he should be exposed to ICDS for all 3 years. But if we reduce his birth year by 5, then his false birth year becomes 1986 and he is not considered as treated anymore, where as in reality he should have been.

[xv] We also include the single regression estimate in table S8, where we estimate the interaction of treatment with gender (girl).

[xvi] The results from some of these specifications not presented with text are available on request.

[xvii] We follow a similar approach as also used by Bundervoet et al., (2009) in their study.

[xviii] We do not have direct data on per capita food expenditure in the household. Therefore, we have calculated some estimates of this variable at the survey year, and included this covariate as a control for robustness check of estimates of weight in different specification, not presented in text. It reduces sample size significantly, from 5220 to 4644 in case of YOEXP, and from 4667 to 4154 in case of FULEXP, because of missing data on some of the variables used to calculate food expenditure. Even with that specification, we see a positive impact on weight, as the magnitude changes marginally, from 0.326 kg (1.039 kg) to 0.312 kg (0.909 kg) in case of YOEXP (FULEXP).

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Table 1: Difference in means of variables between samples exposed for all three years and sample not at all exposed

Panel A: Covariates	Exposed	Unexposed	Overall	Difference	Standard Error of Difference
Female	0.46	0.46	0.46	-0.00	(0.01)
Birth order	2.53	2.93	2.66	-0.41***	(0.05)
Age	11.45	11.68	11.52	-0.23***	(0.03)
Mother completed Primary education	0.48	0.37	0.44	0.11***	(0.01)
Mother’s Height	152.06	150.95	151.70	1.11***	(0.22)
<u>*Household level Covariates*</u>					
Religion(Hindu)	0.87	0.79	0.84	0.10***	(0.01)
Ethnicity (Schedule Tribe)	0.12	0.09	0.11	0.03***	(0.01)
Ethnicity (Backward Caste)	0.42	0.42	0.42	-0.00	(0.01)
Ethnicity (Schedule Caste)	0.23	0.28	0.25	-0.05***	(0.01)
Wealth index	14.00	12.32	13.45	1.67***	(0.17)
Dependent ratio	50.69	51.26	50.87	-0.57	(0.45)
Income source(agriculture or allied activities)	0.37	0.39	0.38	-0.01	(0.01)
Income source(agriculture wage labor)	0.14	0.11	0.13	0.03***	(0.01)
Income source(non-agriculture wage labor)	0.23	0.27	0.24	-0.04***	(0.01)
Income source(independent/petty shop)	0.10	0.09	0.10	0.01	(0.01)
Income source(business/salary/pension)	0.14	0.13	0.13	0.00	(0.01)
Income source(others)	0.02	0.02	0.02	0.00	(0.00)
Observations: Sample of non-missing covariates	3,636	1,785	5,421	5,421	
Panel B: Outcomes (Observations in parentheses)	Exposed	Unexposed	Overall	Difference	Standard Error of Difference
Height (4666)	136.98	137.65	137.21	-0.67	(0.41)
ZHFA (4586)	-1.30	-1.32	-1.31	0.03	(0.04)
Weight (4667)	30.08	30.79	30.32	-0.71***	(0.24)
ZWFA (4637)	-1.68	-1.64	-1.67	-0.05	(0.04)
Morbidity (5421)	0.18	0.24	0.20	-0.06***	(0.01)
Fever (5421)	0.16	0.22	0.18	-0.06***	(0.01)
Cough (5421)	0.12	0.15	0.13	-0.04***	(0.01)

*** p<0.01, ** p<0.05, * p<0.1

Table 2: OLS estimates of health and morbidity outcomes on exposure to ICDS with years of exposure from 0-3

Outcome Variables	(1)	(2)	(3)	(4)	Observations
Panel A: Exposure is defined as continuous variable of years of exposure ranging from 0 to 3					
Height	-0.061	0.716***	0.775***	0.741***	5,218
	[0.35]	[0.24]	[0.23]	[0.22]	
ZHFA	0.031	0.033	0.035	0.031	5,130
	[0.04]	[0.03]	[0.03]	[0.02]	
Weight	-0.126	0.301**	0.330***	0.326***	5,220
	[0.22]	[0.13]	[0.13]	[0.12]	
ZWFA	0.008	0.028	0.034	0.033	5,184
	[0.04]	[0.03]	[0.02]	[0.02]	
Morbidity	-0.020**	-0.008	-0.008	-0.008	6,052
	[0.01]	[0.01]	[0.01]	[0.01]	
Fever	-0.022***	-0.010	-0.009	-0.010	6,052
	[0.01]	[0.01]	[0.01]	[0.01]	
Cough	-0.005	-0.003	-0.003	-0.004	6,052
	[0.01]	[0.01]	[0.01]	[0.01]	
Panel B: Exposure is a binary variable of full exposure (3 years) against no exposure (0 years)					
Height	-0.029	2.227***	2.392***	2.307***	4,666
	[1.06]	[0.74]	[0.74]	[0.71]	
ZHFA	0.104	0.104	0.113	0.105	4,586
	[0.12]	[0.08]	[0.08]	[0.08]	
Weight	-0.329	0.976**	1.043***	1.039***	4,667
	[0.68]	[0.40]	[0.39]	[0.38]	
ZWFA	0.027	0.102	0.120	0.119	4,637
	[0.13]	[0.08]	[0.08]	[0.07]	
Morbidity	-0.060***	-0.038*	-0.038*	-0.037*	5,421
	[0.02]	[0.02]	[0.02]	[0.02]	
Fever	-0.068***	-0.040*	-0.040*	-0.040*	5,421
	[0.02]	[0.02]	[0.02]	[0.02]	
Cough	-0.017	-0.017	-0.017	-0.016	5,421
	[0.02]	[0.02]	[0.02]	[0.02]	
District-Birth Year FE	NO	YES	YES	YES	
Individual Covariates	NO	NO	YES	YES	
Household Covariates	NO	NO	NO	YES	

*** p<0.01, ** p<0.05, * p<0.1;
Note: Height is in cm, ZHFA lying in [-6,6], weight is in kg., ZWFA lying in [-6,6].
Individual characteristics include birth order, sex, mother's education and mother's height; household characteristics include dependent ratio, income source, wealth index, ethnicity and religion; Robust standard errors clustered at the village levels are shown in parentheses.

Table 3: Robustness (OLS estimates) of health and morbidity outcomes with years of exposure from 0-6

Outcome Variables	(1)	(2)	(3)	(4)	Observations
Panel A: Exposure is defined as continuous variable of years of exposure ranging from 0 to 6					
Height	-0.074	0.406***	0.412***	0.396***	5,218
	[0.23]	[0.13]	[0.13]	[0.12]	
ZHFA	0.021	0.021	0.021	0.019	5,130
	[0.03]	[0.02]	[0.01]	[0.01]	
Weight	-0.110	0.143**	0.156**	0.155**	5,220
	[0.15]	[0.07]	[0.07]	[0.07]	
ZWFA	0.002	0.011	0.014	0.013	5,184
	[0.03]	[0.01]	[0.01]	[0.01]	
Morbidity	-0.008*	-0.002	-0.001	-0.002	6,052
	[0.00]	[0.00]	[0.00]	[0.00]	
Fever	-0.010**	-0.003	-0.003	-0.003	6,052
	[0.00]	[0.00]	[0.00]	[0.00]	
Cough	-0.001	-0.002	-0.002	-0.002	6,052
	[0.00]	[0.00]	[0.00]	[0.00]	
Panel B: Exposure is a binary variable of full exposure (6 years) against no exposure (0 years)					
Height	-0.964	2.455***	2.135***	2.058***	3,958
	[1.66]	[0.79]	[0.74]	[0.71]	
ZHFA	0.143	0.219*	0.193*	0.182*	3,899
	[0.18]	[0.11]	[0.11]	[0.10]	
Weight	-1.021	0.844*	0.861*	0.860*	3,958
	[1.11]	[0.51]	[0.50]	[0.49]	
ZWFA	-0.001	0.084	0.088	0.087	3,940
	[0.20]	[0.10]	[0.10]	[0.09]	
Morbidity	-0.023	0.018	0.022	0.020	4,611
	[0.03]	[0.02]	[0.02]	[0.02]	
Fever	-0.035	0.013	0.016	0.013	4,611
	[0.03]	[0.02]	[0.02]	[0.02]	
Cough	0.011	-0.002	-0.000	-0.002	4,611
	[0.02]	[0.02]	[0.02]	[0.02]	
District-Birth Year FE	NO	YES	YES	YES	
Individual Covariates	NO	NO	YES	YES	
Household Covariates	NO	NO	NO	YES	

*** p<0.01, ** p<0.05, * p<0.1;

Note: Height is in cm, ZHFA lying in [-6,6], Weight is in kg., ZWFA lying in [-6,6].

Individual characteristics include birth order, sex, mother's education and mother's height; household characteristics include dependent ratio, income source, wealth index, ethnicity and religion. Robust standard errors clustered at the village level are shown in parentheses.

Table 4: Robustness (OLS estimates) of health and morbidity outcomes on exposure to ICDS with extended age cohorts

Age Cohort	10-13 (1)	N	10-14 (2)	N	10-15 (3)	N	10-16 (4)	N	10-17 (5)	N	10-18 (6)	N
Panel A: Exposure is defined as continuous variable of years of exposure ranging from 0 to 3												
Height	0.741***	5,218	0.546***	6,684	0.493***	7,919	0.384**	9,109	0.383**	9,196	0.384**	9,216
	[0.22]		[0.19]		[0.18]		[0.17]		[0.17]		[0.17]	
ZHFA	0.031	5,130	0.019	6,578	0.021	7,802	0.010	8,984	0.010	9,072	0.010	9,092
	[0.02]		[0.02]		[0.02]		[0.02]		[0.02]		[0.02]	
Weight	0.326***	5,220	0.292***	6,686	0.256**	7,922	0.228**	9111	0.224**	9,198	0.225**	9,218
	[0.12]		[0.11]		[0.10]		[0.10]		[0.10]		[0.10]	
ZWFA	0.033	5,184	0.033	6,638	0.032*	7,860	0.028	9,035	0.027	9,123	0.027	9,142
	[0.02]		[0.02]		[0.02]		[0.02]		[0.02]		[0.02]	
Morbidity	-0.008	6,052	-0.006	7,797	-0.007	9,216	-0.006	10,578	-0.006	10,679	-0.006	10,703
	[0.01]		[0.01]		[0.01]		[0.01]		[0.00]		[0.00]	
Fever	-0.010	6,052	-0.008	7,797	-0.008	9,216	-0.006	10,578	-0.007	10,679	-0.007	10,703
	[0.01]		[0.01]		[0.01]		[0.00]		[0.00]		[0.00]	
Cough	-0.004	6,052	-0.004	7,797	-0.005	9,216	-0.006	10,578	-0.005	10,679	-0.005	10,703
	[0.01]		[0.00]		[0.00]		[0.00]		[0.00]		[0.00]	
Panel B: Exposure is a binary variable of full exposure (3 years) against no exposure (0 years)												
Height	2.307***	4,666	1.685***	6,073	1.547***	7,186	1.213**	8,156	1.210**	8,237	1.212**	8,257
	[0.71]		[0.60]		[0.56]		[0.53]		[0.53]		[0.53]	
ZHFA	0.105	4,586	0.063	5,978	0.068	7,080	0.033	8,042	0.035	8,123	0.035	8143
	[0.08]		[0.06]		[0.06]		[0.06]		[0.06]		[0.06]	
Weight	1.039***	4,667	0.938***	6,074	0.815***	7,188	0.695**	8,157	0.684**	8,238	0.687**	8,258
	[0.38]		[0.33]		[0.31]		[0.30]		[0.30]		[0.31]	
ZWFA	0.119	4,637	0.116*	6,034	0.112*	7,135	0.094*	8,092	0.092	8,173	0.093	8,192
	[0.07]		[0.06]		[0.06]		[0.06]		[0.06]		[0.06]	
Morbidity	-0.037*	5,421	-0.026	7,093	-0.027*	8,374	-0.023	9,492	-0.024	9,586	-0.024	9,610
	[0.02]		[0.02]		[0.02]		[0.01]		[0.01]		[0.01]	
Fever	-0.040*	5,421	-0.030*	7,093	-0.030**	8,374	-0.024*	9,492	-0.025*	9,586	-0.025*	9,610
	[0.02]		[0.02]		[0.02]		[0.01]		[0.01]		[0.01]	
Cough	-0.016	5,421	-0.013	7,093	-0.018	8,374	-0.014	9,492	-0.015	9,586	-0.015	9,610
	[0.02]		[0.02]		[0.01]		[0.01]		[0.01]		[0.01]	

*** p<0.01, ** p<0.05, * p<0.1;

Note: Height is in cm, ZHFA lying in [-6,6], weight is in kg., ZWFA lying in [-6,6]. Column (1) has the adolescents in the age group of 10 to 13 years with correct birth year information. In the subsequent columns one extra age cohort is added. Individual characteristics include birth order, sex, mother's education and mother's height; household characteristics include dependent ratio, income source, wealth index, ethnicity and religion; In addition to District-Birth year fixed effects, all the regressions control for individual and household level characteristics. Robust standard errors clustered at the village level are shown in parentheses.

Table 5: Placebo test using exposure variable based on false birth year

Age Cohort	Born 5 years before the actual birth year (1)	N	Born 5 years after the actual birth year (2)	N
Panel A: Exposure is defined as continuous variable of years of exposure ranging from 0 to 3				
Height	0.329	5,218	0.245	5,218
	[0.22]		[0.27]	
ZHFA	0.007	5,130	-0.001	5,130
	[0.03]		[0.04]	
Weight	0.170	5,220	-0.091	5,220
	[0.11]		[0.16]	
ZWFA	0.011	5,184	-0.044	5,184
	[0.02]		[0.03]	
Morbidity	-0.012*	6,052	0.020**	6,052
	[0.01]		[0.01]	
Fever	-0.014**	6,052	0.014	6,052
	[0.01]		[0.01]	
Cough	-0.004	6,052	0.001	6,052
	[0.01]		[0.01]	
Panel B: Exposure is a binary variable of full exposure (3 years) against no exposure (0 years)				
Height	0.851	4,711	0.360	4,841
	[0.68]		[0.79]	
ZHFA	0.019	4,629	-0.031	4,757
	[0.08]		[0.11]	
Weight	0.471	4,713	0.063	4,843
	[0.36]		[0.47]	
ZWFA	0.034	4,678	-0.077	4,812
	[0.07]		[0.09]	
Morbidity	-0.046**	5,476	0.023	5,620
	[0.02]		[0.03]	
Fever	-0.051**	5,476	0.008	5,620
	[0.02]		[0.03]	
Cough	-0.021	5,476	-0.010	5,620
	[0.02]		[0.03]	

*** p<0.01, ** p<0.05, * p<0.1;

Note: Column (1) indicates the results when we falsely assume that the child is born five years before the actual year of birth and column 2 indicates estimates when we falsely assume that child is born five years after actual birth year. Height is in cm, ZHFA lying in [-6,6], weight is in kg., ZWFA lying in [-6,6]. All columns include district-birth year fixed effects, individual and household covariates. All are full model specifications similar to the last column of table 2. Robust standard errors clustered at the village levels are shown in parentheses.

Table 6: Placebo Test using construction year of the college in the village instead of construction year of the AWC

	Overall (1)	N	Based on the construction year of college (2)	N
Panel A: Exposure is defined as continuous variable of years of exposure ranging from 0 to 3				
Height	0.740***	5,214	0.434	5,214
	[0.22]		[0.65]	
ZHFA	0.031	5,126	0.094	5,126
	[0.02]		[0.06]	
Weight	0.325***	5,216	0.195	5,216
	[0.12]		[0.26]	
ZWFA	0.033	5,180	0.033	5,180
	[0.02]		[0.06]	
Morbidity	-0.008	6,048	-0.000	6,048
	[0.01]		[0.03]	
Fever	-0.010	6,048	-0.014	6,048
	[0.01]		[0.03]	
Cough	-0.004	6,048	-0.010	6,048
	[0.01]		[0.02]	
Panel B: Exposure is a binary variable of full exposure (3 years) against no exposure (0 years)				
Height	2.306***	4,657	0.972	4,657
	[0.71]		[2.73]	
ZHFA	0.104	4,577	0.348	4,577
	[0.08]		[0.22]	
Weight	1.039***	4,658	-0.010	4,658
	[0.38]		[0.97]	
ZWFA	0.119	4,628	0.018	4,628
	[0.07]		[0.21]	
Morbidity	-0.037*	5,411	-0.000	5,411
	[0.02]		[0.11]	
Fever	-0.040*	5,411	-0.016	5,411
	[0.02]		[0.10]	
Cough	-0.016	5,411	-0.029	5,411
	[0.02]		[0.09]	
District-Birth FE	YES		YES	
Individual Covariates	YES		YES	
Household Covariates	YES		YES	

*** p<0.01, ** p<0.05, * p<0.1;

Note: Height is in cm, ZHFA lying in [-6,6], Weight is in kg., ZWFA lying in [-6,6].

Individual characteristics include birth order, sex, mother's education and mother's height; household characteristics include dependent ratio, income source, wealth index, ethnicity and religion. Robust standard errors clustered at the village level are shown in parentheses. The Specific village level question asked was: "Does this village have College? If yes then how many years ago did it open?"

Table 7: Heterogeneous treatment effects across gender – Full model specification

Outcomes	(1) Height	(2) ZHFA	(3) Weight	(4) ZWFA	(5) Morbidity	(6) Fever	(7) Cough
Panel A: Exposure is defined as continuous variable of years of exposure ranging from 0 to 3							
			Boys				
YOEXP	0.246	0.005	0.289*	0.042	0.004	0.002	0.005
	[0.31]	[0.03]	[0.15]	[0.03]	[0.01]	[0.01]	[0.01]
Observations	2,781	2,729	2,780	2,760	3,251	3,251	3,251
R-squared	0.639	0.535	0.595	0.527	0.474	0.472	0.441
			Girls				
YOEXP	1.199***	0.084**	0.291	0.027	-0.017	-0.015	-0.005
	[0.33]	[0.04]	[0.19]	[0.04]	[0.01]	[0.01]	[0.01]
Observations	2,437	2,401	2,440	2,424	2,801	2,801	2,801
R-squared	0.676	0.574	0.667	0.558	0.446	0.434	0.420
Panel B: Exposure is a binary variable of full exposure (3 years) against no exposure (0 years)							
			Boys				
FULEXP	0.222	-0.036	0.494	0.066	0.005	-0.003	0.020
	[1.00]	[0.10]	[0.49]	[0.09]	[0.03]	[0.03]	[0.03]
Observations	2,507	2,459	2,505	2,488	2,933	2,933	2,933
R-squared	0.668	0.550	0.611	0.550	0.504	0.503	0.462
			Girls				
FULEXP	3.464***	0.267**	1.105*	0.129	-0.066*	-0.054	-0.036
	[1.08]	[0.13]	[0.63]	[0.12]	[0.04]	[0.03]	[0.03]
Observations	2,159	2,127	2,162	2,149	2,488	2,488	2,488
R-squared	0.700	0.601	0.679	0.575	0.480	0.467	0.458
District-Birth Year FE	YES	YES	YES	YES	YES	YES	YES
Individual Covariate	YES	YES	YES	YES	YES	YES	YES
Household Covariates	YES	YES	YES	YES	YES	YES	YES

*** p<0.01, ** p<0.05, * p<0.1; Individual characteristic includes birth order, mother's education and mother's height; household characteristics include dependent ratio, income source, wealth index, ethnicity and religion. Robust standard errors clustered at the village level are shown in parentheses.

Table 8: Treatment effects on prospective users

	(1) Poor		(2) Overall	
Outcome Variables	Coefficient	Observations	Coefficient	Observations
Panel A: Exposure is a continuous variable (0-3 years)				
Height	0.839***	4,233	0.741***	5,218
	[0.26]		[0.22]	
ZHFA	0.042	4,162	0.031	5,130
	[0.03]		[0.02]	
Weight	0.314**	4,237	0.326***	5,220
	[0.13]		[0.12]	
ZWFA	0.036	4,207	0.033	5,184
	[0.03]		[0.02]	
Morbidity	-0.007	4,916	-0.008	6,052
	[0.01]		[0.01]	
Fever	-0.010	4,916	-0.010	6,052
	[0.01]		[0.01]	
Cough	-0.004	4,916	-0.004	6,052
	[0.01]		[0.01]	
Panel B: Exposure is a binary variable of Full exposure (3 years), No exposure (0 year)				
Height	2.573***	3,779	2.307***	4,666
	[0.83]		[0.71]	
ZHFA	0.136	3,715	0.105	4,586
	[0.09]		[0.08]	
Weight	1.060**	3,782	1.039***	4,667
	[0.42]		[0.38]	
ZWFA	0.138*	3,758	0.119	4,637
	[0.08]		[0.07]	
Morbidity	-0.037	4,398	-0.037*	5,421
	[0.02]		[0.02]	
Fever	-0.044*	4,398	-0.040*	5,421
	[0.02]		[0.02]	
Cough	-0.017	4,398	-0.016	5,421
	[0.02]		[0.02]	

*** p<0.01, ** p<0.05, * p<0.1;

First column restricts the sample to those households which do not own any of the following assets: car, air conditioner, washing machine, microwave oven, laptop, refrigerator, credit card. Second column copies full sample results from the last column of table 2. All the regressions include district-birth year fixed effects, individual characteristics and household characteristics. Individual characteristics include birth order, sex, mother's education and mother's height; household characteristics include dependent ratio, income source, wealth index, ethnicity and religion. Robust standard errors clustered at the village level are shown in parentheses.

Table 9: OLS estimates on exposure - conditional on consumption status of other family members

	Original Sample (1)	N	Sample with available information on the consumption status of other members (2)	N
Panel A: Exposure is defined as continuous variable of years of exposure ranging from 0 to 3				
Height	0.741***	5,218	1.112**	1,652
	[0.22]		[0.45]	
ZHFA	0.031	5,130	0.095*	1,619
	[0.02]		[0.05]	
Weight	0.326***	5,220	0.700***	1,654
	[0.12]		[0.21]	
ZWFA	0.033	5,184	0.101**	1,638
	[0.02]		[0.05]	
Morbidity	-0.008	6,052	-0.009	1,874
	[0.01]		[0.02]	
Fever	-0.010	6,052	-0.010	1,874
	[0.01]		[0.02]	
Cough	-0.004	6,052	-0.005	1,874
	[0.01]		[0.01]	
Panel B: Exposure is a binary variable of full exposure (3 years) against no exposure (0 years)				
Height	2.307***	4,666	2.902**	1,474
	[0.71]		[1.46]	
ZHFA	0.105	4,586	0.241	1,443
	[0.08]		[0.17]	
Weight	1.039***	4,667	1.799***	1,475
	[0.38]		[0.67]	
ZWFA	0.119	4,637	0.280*	1,461
	[0.07]		[0.15]	
Morbidity	-0.037*	5,421	-0.048	1,674
	[0.02]		[0.05]	
Fever	-0.040*	5,421	-0.048	1,674
	[0.02]		[0.05]	
Cough	-0.016	5,421	-0.035	1,674
	[0.02]		[0.04]	
Control for the consumption status of the other members	NO		YES	

*** p<0.01, ** p<0.05, * p<0.1;

Note: Height is in cm, ZHFA lying in [-6,6], weight is in kg., ZWFA lying in [-6,6].

Individual characteristics include birth order, sex, mother's education and mother's height; household characteristics include dependent ratio, income source, wealth index, ethnicity and religion.

All the regressions control for District-Birth year fixed effects, individual characteristics and household characteristics. In addition to this, Column (2) controls for the consumption status of other family members who reported to consume any of the ICDS services after 2005. Since this information was available for those households where the mothers or their last-born child has consumed any of the ICDS services it reduces the sample size in the column (2)

Robust standard errors clustered at the village level are shown in parentheses.

Figure 1: Fitted lines of outcomes for fully exposed and unexposed adolescents against birth year

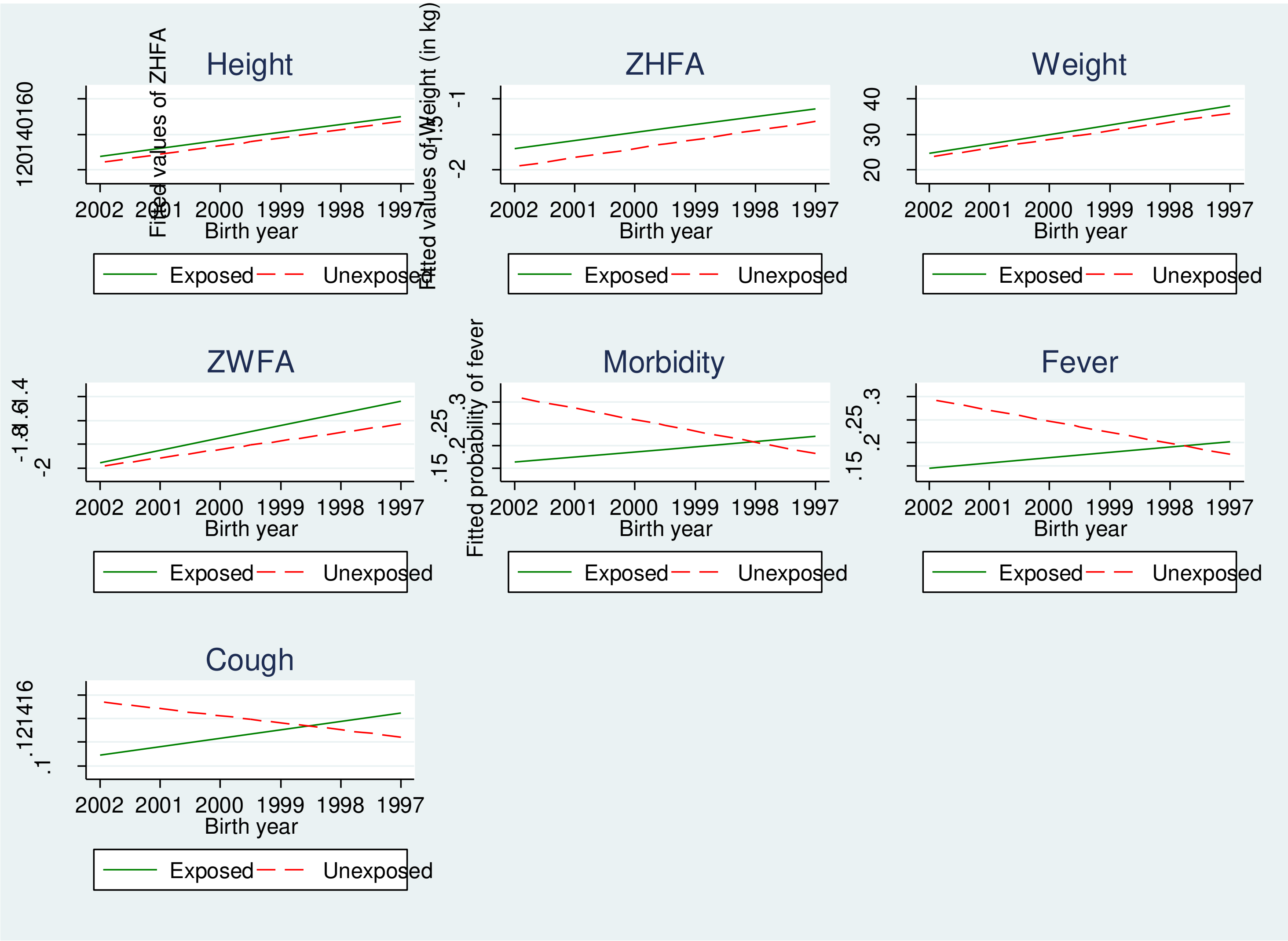
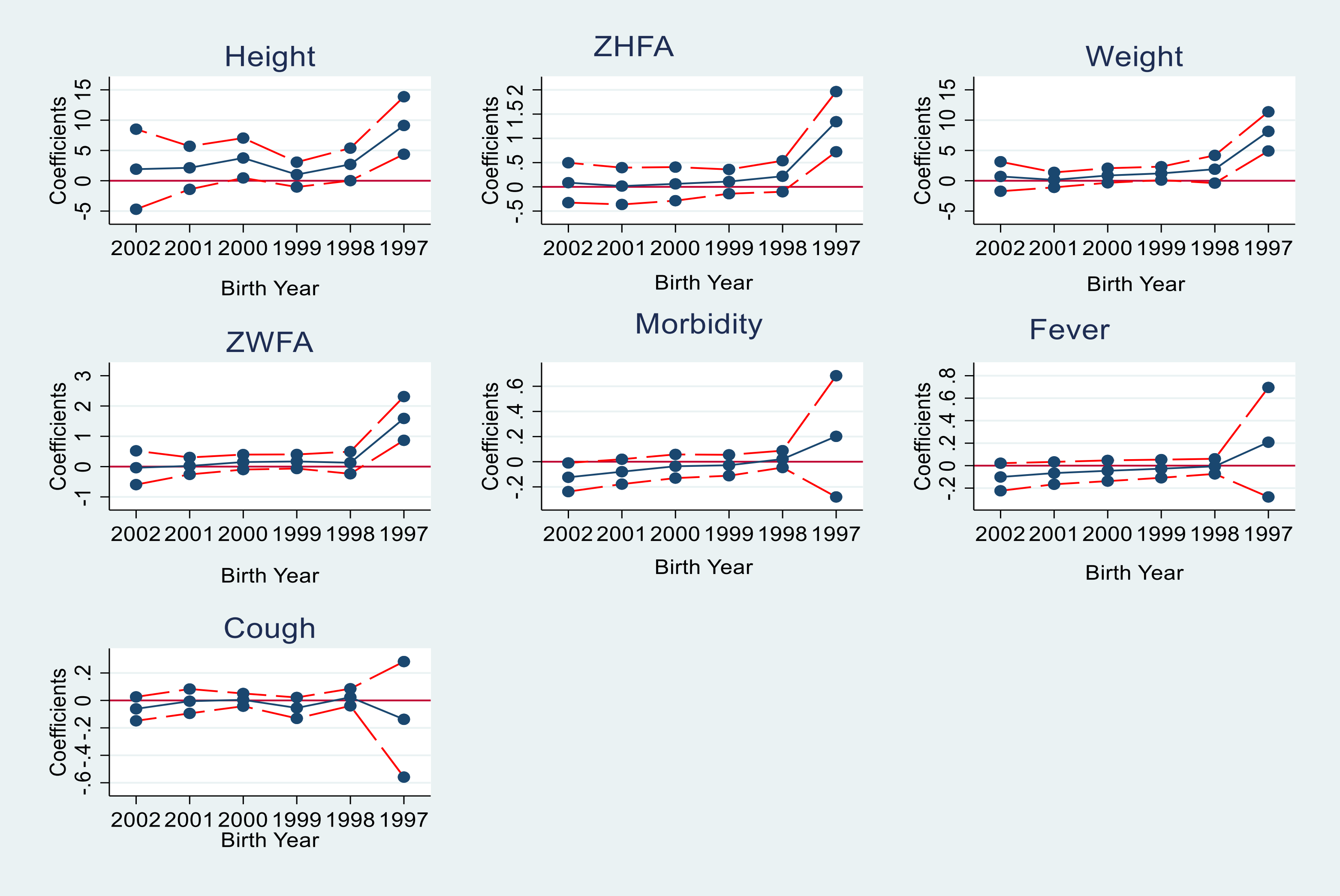


Figure 2: Coefficients from interactions of birth year and full exposure variable for different outcomes



Note: The OLS estimation is done using the full model specification with all individual, household covariates, district-birth year fixed effects. The sample is same as in full model of table 2. The dotted lines represent 95% confidence intervals.

Appendix

Table A1: Summary of relevant literature evaluating impact of ICDS on health outcomes

Study	Data	Research Question	Strategy	Results	Concerns and comparison with our findings
Early life Impact on health when one is a current user					
Jain (2015)	DHS data (NFHS-3) of 2005-06	She measures the impact of daily supplementary feeding on 0-2 year old. She uses the information on whether the child received supplementary feeding and how intensely: daily, weekly, monthly or less.	Impact of ICDS through average treatment effects on treated. Children up to 3 year of age get 'take-home' rations of food, including designated components of protein and energy needs. For 3-6 year of children, there was on-the-spot feeding arrangements to ensure that the food is consumed by the targeted beneficiary. She uses several methods, including PSM, covariates matching and difference in difference.	Impact was 1 cm higher height for girls of 0-2 year age when they were users of the benefits. She finds that having older sibling going to the ICDS centre increases the likelihood of younger one receiving supplementary feeding daily (pg 75).	Even after using different methods, the unobservable and uncommon difference across cohorts remains confounded in the treatment effects, because, PSM or covariate matching can take care of observable difference, and Difference-in difference can take care of only the common difference across cohorts. This paper measures only the impact of supplying nutritious food daily to children, whereas ICDS has bigger prospects, including immunisation, health check-up and pre-school services and providing information related services on health. Our paper estimates the intention to treatment effect of having access to ICDS centre in the village through AWC and we look at the long run impact, when children are not using the services anymore.
Kandpal (2011)	DHS data (NFHS-3) of 2005-06	It estimates treatment effects of ICDS on worst-off children and Average treatment effect on treated for the whole sample. Measures impact on Height for Age Z (HAZ)	She takes into account that program placement effectively targets vulnerable population. Uses PSM to control for issues with endogenous program placement, measuring the impacts of ICDS on HAZ score. Uses Probit and beta regressions to examine the placement of ICDS in villages as a function of	ICDS increases average HAZ scores by 6%. Program placement fails to target villages with most needs, such as villages with more educated mothers get ICDS.	Her results are in contrast to Lokshin et al. (2005), who do not find significant impact of ICDS because they use data from 1992-93 and 1998-99. Kandpal explains that there have been improvement in program design in next 5 years, hence she gets positive impact on HAZ score by using 2005-06 data. Their sample are children until 5 years of age, who are current users. HAZ scores as a measure of chronic malnutrition is found to have least impact of early life nutrition program worldwide. Hence, that is not our

		scores for children below age 5.	observable factors affecting placement decisions.		primary outcome of interest. We use 2011-12 data, therefore interested in long run impact, as our cohort were born in 1998-2001. This is right before the period of suggested ICDS program re-design post 2000.
Lokshin et al. (2005)	NHFS - (1992-93) and NFHS -2 (1998-99)	Measures Average Treatment Effect of ICDS on Treated (ATT) for children of 0-4 (NFHS-1) or 0-3 (NFHS-2) years. The outcomes are Height for Age and Weight for Age.	They use PSM and matching techniques to compare the children in ICDS village to another child of same observable characteristics in a non-ICDS village.	They find ICDS fails to increase HAZ scores. The states with highest malnutrition had the lowest coverage of ICDS, which they explain to be the main reasons of no impacts.	PSM only controls for observable differences across villages. However, if there were unobservable differences across villages which could affect program placement, then the treatment effect would confound the difference across villages which is not due to ICDS. They measure impact on Z score of children of 0-4 years of age, while they were using the program. We measure the impact for 10-13 years old.
Later Life impact when discontinued the usage					
Kinra et al. (2008)	Hyderabad (India) Nutrition Trial (APCAPS study - first follow up in 2002-03), 1,165 adolescents aged 13-18 years.	Whether nutritional supplementation with other public health programmes in early life reduces the risk of cardiovascular diseases in undernourished populations. Outcomes: Height, adiposity, blood pressures, lipids, insulin resistance (homoeostasis model assessment (HOMA) score),	Approximately 15 years' follow-up of participants. in APCAPS study, 4,338 pregnancies recorded for the trial. Birthweights were available for 68% (2,964) children. Only 2,601 children were eligible for follow up, whose records could be successfully traced back to the previous records of baseline (born between 1987-90 and still alive). Only 1,492 (57%) had existing information available on clinical dataset, and invited for trial. A total of 1,165 (which is only 45% of all eligible births) participated in clinics. 654 were	The participants from the intervention villages were 1.4 cm taller than controls but had similar body composition. The participants from the intervention villages had more favourable measures of insulin resistance and arterial stiffness.	The study may have been underpowered due to significant sample attrition till end. The sample may have high potential bias (page 5) due to non-randomisation of the villages in a baseline study, losses to follow up, and non-availability of data on current diet plan and physical activity.

		and arterial stiffness.	from intervention area and 511 from control area.		
Kulkarni et al. (2014)	Hyderabad (India) Nutrition Trial (APCAPS study - second follow up in 2009-10): A total of 1,446 children of 18-23 years,	Examined the associations of early nutrition with adult lean body mass (LBM) and muscle strength in a birth cohort that was established to assess the long-term impact of a nutrition program.	Providing freshly cooked nutritious meals to pregnant and lactating mothers and children less than 6 years of age and measure heights, weights and body-mass index in adulthood (18-23years born in 1987-90). 29 villages from 1987-90 were selected, out of which 15 were treatment villages. 738 in the intervention area and 708 in the control area, with a total of 56% response rate.	No difference found in the anthropometric measures between children of treated and control villages.	One, potential problem due to non-randomisation of villages. Two, non-adherence and non-availability of precise estimates on rates of adherence. Three, mothers in intervention area were assumed to have taken the supplements. However, in reality, it could have been shared by other family members. Therefore, the dosage of nutritional supplement may have been too modest for persistent effects on children's development. A large proportion of women were lost to follow up. Our sample size being very large covering the country, the treatment of consumption of nutritious supplement can safely be assumed to have random distribution and chances of selection bias due to drop out from study is less.
Matsuzaki et al. (2014)	Hyderabad (India) Nutrition Trial: 29 villages from 1987-90 were selected, out of which 15 were treatment villages. A total of 1,446 children.	Investigates the combined effects of early-life undernutrition and urbanized lifestyles in later life on bone mass accrual in young adults of 18-23 years.	Balanced protein calorie supplements were provided to pregnant mothers and pre-school children up to 6 years. Follow up survey was done in 2009-10. Total observation were 1,446 children who became 18-23 years in the follow up survey.	Did not find any positive association between bone mass and early-life nutritional supplementation, rather, there was weak evidence of an inverse association between the two.	Same as Kinra et el. (2008) and Kulkarni et al. (2014), as these are parts of same APCAPS experiment.

Table A2: Sample attrition at each stage and corresponding descriptive statistics

	Initial sample of 10-13 year with birth year (1)	Matched household and village survey year (2)	Final Sample -Living in same place for last 15 years (3)
Variable	Mean (N = 6,189)	Mean (N = 6,161)	Mean (N = 6052)
Female	0.46	0.46	0.46
Birth order	2.67	2.67	2.68
Age	11.52	11.52	11.52
Primary education completed by the mother	0.44	0.44	0.43
Mother’s Height (in cm)	151.73	151.73	151.74
Ethnicity (Schedule Caste)	0.23	0.23	0.23
Ethnicity (Schedule Tribe)	0.10	0.10	0.10
Ethnicity (Backward Caste)	0.42	0.42	0.42
Ethnicity (Other Caste)	0.25	0.25	0.25
Wealth index	13.47	13.47	13.41
Dependent Ratio	50.87	50.85	50.87
Income source(agriculture or allied activity)	0.37	0.37	0.38
Income source(agriculture wage labor)	0.14	0.13	0.13
Income source(non-agriculture wage labor)	0.24	0.24	0.24
Income source(independent/petty shop)	0.09	0.09	0.09
Income source(business/salary/pension)	0.14	0.14	0.14
Income source(others)	0.02	0.02	0.02
Religion(Hindu)	0.84	0.84	0.84

Note: First column of 6,189 adolescents consist of 10-13 year old adolescents having birth year information. Second column of 6,161 adolescents belong to the households for whom the household and village surveys are done in the same year i.e. 2011 or 2012. Third column includes 6,052 adolescents whose families have been staying in the same place from last 15 years, which is our final sample for the analysis of morbidity outcomes. However, for all other outcomes, the final sample reduces further (marginally, as found in table A3-A4) due to few more missing observations for the dependent variables.

Table A3: Difference in means between final sample and excluded sample for Morbidity outcome

Short Term Morbidity Outcome Sample	Final sample (1)		Excluded sample (2)		Difference (3)
Variables	N	Mean	N	Mean	Mean
Independent Variables					
Years of ICDS exposure	6052	1.96	137	2.24	-0.28***
Female	6052	0.46	137	0.50	-0.04
Birth order	6052	2.68	137	2.22	0.46***
Age	6052	11.52	137	11.56	-0.04
Primary education completed by the mother	6052	0.43	137	0.61	-0.17***
Mother’s Height	6052	151.74	137	151.29	0.45
Ethnicity (Schedule Caste)	6052	0.23	137	0.16	0.07**
Ethnicity (Schedule Tribe)	6052	0.10	137	0.08	0.02
Ethnicity (Backward Caste)	6052	0.42	137	0.47	-0.05
Ethnicity (Other Caste)	6052	0.25	137	0.29	-0.05
Wealth index	6052	13.41	137	16.26	-2.85***
Dependent Ratio	6052	50.87	137	51.05	-0.18
Income source(agriculture or allied activities)	6052	0.38	137	0.18	0.19***
Income source(agriculture wage labor)	6052	0.13	137	0.15	-0.02
Income source(non-agriculture wage labor)	6052	0.24	137	0.16	0.08***
Income source(independent/petty shop)	6052	0.09	137	0.12	-0.02
Income source(business/salary/pension)	6052	0.14	137	0.32	-0.19***
Income source(others)	6052	0.02	137	0.07	-0.05**
Religion(Hindu)	6052	0.84	137	0.77	0.08**
Dependent Variables					
Morbidity	6052	0.20	136	0.22	-0.02
Fever	6052	0.18	136	0.19	-0.01
Cough	6052	0.13	136	0.14	-0.01

*** p<0.01, ** p<0.05, * p<0.1;

Table A4: Difference in means between final sample and excluded sample for Height and ZHFA outcome variables.

	Height					ZHFA				
	Final Sample (1)		Excluded Sample (2)		Difference (3)	Final Sample (4)		Excluded Sample (5)		Difference (6)
Variables	N	Mean	N	Mean	Mean	N	Mean	N	Mean	Mean
Independent Variables										
Years of ICDS exposure	5218	1.95	971	2.03	-0.08*	5130	1.95	1059	2.02	-0.07*
Female	5218	0.47	971	0.45	0.02	5130	0.47	1059	0.44	0.03
Birth order	5218	2.70	971	2.53	0.17***	5130	2.71	1059	2.49	0.21***
Age	5218	11.50	971	11.64	-0.15***	5130	11.50	1059	11.60	-0.10***
Primary education completed by the mother	5218	0.43	971	0.48	-0.05***	5130	0.43	1059	0.49	-0.06***
Mother's Height	5218	151.77	971	151.51	0.27	5130	151.83	1059	151.24	0.59*
Ethnicity (Schedule Caste)	5218	0.24	971	0.18	0.06***	5130	0.24	1059	0.18	0.05***
Ethnicity (Schedule Tribe)	5218	0.10	971	0.13	-0.03***	5130	0.10	1059	0.13	-0.03***
Ethnicity (Backward Caste)	5218	0.41	971	0.44	-0.03	5130	0.42	1059	0.43	-0.01
Ethnicity (Other Caste)	5218	0.25	971	0.24	0.00	5130	0.25	1059	0.26	-0.01
Wealth index	5218	13.35	971	14.12	-0.77***	5130	13.33	1059	14.12	-0.79***
Dependent Ratio	5218	50.92	971	50.63	0.29	5130	50.90	1059	50.73	0.17
Income source(agriculture or allied activities)	5218	0.38	971	0.36	0.02	5130	0.38	1059	0.35	0.02
Income source(agriculture wage labor)	5218	0.13	971	0.17	-0.04***	5130	0.13	1059	0.17	-0.04***
Income source(non-agriculture wage labor)	5218	0.25	971	0.20	0.04***	5130	0.25	1059	0.20	0.04***
Income source(independent/petty shop)	5218	0.09	971	0.09	0.00	5130	0.09	1059	0.09	0.00
Income source(business/salary/pension)	5218	0.14	971	0.16	-0.02*	5130	0.13	1059	0.17	-0.03***
Income source(others)	5218	0.02	971	0.02	0.00	5130	0.02	1059	0.02	0.00
Religion(Hindu)	5218	0.85	971	0.79	0.06***	5130	0.85	1059	0.79	0.06***
Dependent Variables										
Height	5218	137.18	119	134.74	2.44					
ZHFA						5130	-1.31	207	-4.85	3.55***

*** p<0.01, ** p<0.05, * p<0.1

Table A5: Difference in means between final sample and excluded sample for Weight and ZWFA outcome variables.

	Weight					ZWFA				
	Final Sample (1)		Excluded Sample (2)		Difference (3)	Final Sample (4)		Excluded Sample (5)		Difference (6)
Variables	N	Mean	N	Mean	Mean	N	Mean	N	Mean	Mean
Independent Variables										
Years of ICDS exposure	5220	1.95	969	2.04	-0.09*	5184	1.95	1005	2.01	-0.06
Female	5220	0.47	969	0.44	0.02	5184	0.47	1005	0.44	0.02
Birth order	5220	2.70	969	2.52	0.17***	5184	2.70	1005	2.51	0.19***
Age	5220	11.50	969	11.64	-0.15***	5184	11.50	1005	11.63	-0.14***
Primary education completed by the mother	5220	0.43	969	0.49	-0.06***	5184	0.43	1005	0.48	-0.05***
Mother's Height	5220	151.77	969	151.54	0.23	5184	151.76	1005	151.59	0.16
Ethnicity (Schedule Caste)	5220	0.24	969	0.18	0.05***	5184	0.24	1005	0.19	0.05***
Ethnicity (Schedule Tribe)	5220	0.10	969	0.13	-0.03***	5184	0.10	1005	0.13	-0.03***
Ethnicity (Backward Caste)	5220	0.41	969	0.44	-0.03	5184	0.42	1005	0.43	-0.02
Ethnicity (Other Caste)	5220	0.25	969	0.24	0.01	5184	0.25	1005	0.25	0.00
Wealth index	5220	13.34	969	14.15	-0.80***	5184	13.35	1005	14.09	-0.74***
Dependent Ratio	5220	50.93	969	50.59	0.34	5184	50.91	1005	50.66	0.25
Income source(agriculture or allied activities)	5220	0.38	969	0.36	0.02	5184	0.38	1005	0.35	0.03
Income source(agriculture wage labor)	5220	0.13	969	0.17	-0.04***	5184	0.13	1005	0.17	-0.04***
Income source(non-agriculture wage labor)	5220	0.25	969	0.20	0.04***	5184	0.25	1005	0.20	0.04***
Income source(independent/petty shop)	5220	0.09	969	0.09	-0.00	5184	0.09	1005	0.09	-0.00
Income source(business/salary/pension)	5220	0.14	969	0.16	-0.02*	5184	0.13	1005	0.16	-0.03**
Income source(others)	5220	0.02	969	0.02	0.00	5184	0.02	1005	0.02	0.00
Religion(Hindu)	5220	0.85	969	0.79	0.06***	5184	0.85	1005	0.80	0.06***
Dependent Variables										
Weight	5220	30.27	119	30.68	-0.41					
ZWFA						5184	-1.67	155	-3.44	1.77***

*** p<0.01, ** p<0.05, * p<0.1

Table A6: Likelihood of being included in the sample based on exposure status

	Probability of being included in the sample				
Sample	(1) Short-term Morbidity	(2) Height	(3) ZHFA	(4) Weight	(5) ZWFA
YOEXP	-0.002	0.003	0.006	0.003	0.006
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Observations	6,189	6,189	6,189	6,189	6,189
District-Birth Year FE	YES	YES	YES	YES	YES

*** p<0.01, ** p<0.05, * p<0.1

Table A7: OLS results of health and morbidity outcomes on exposure to ICDS for different samples

Sample	Sample after excluding reporting error in the birth year with no missing covariates (1)	N	Sample excluding reporting error in birth year, with household and village survey done in same year and no missing covariates (2)	N	Final Sample excluding reporting error in birth year, with household and village survey done in same year, households not moving in last 15 years and no missing covariates (3)	N
Panel A: Exposure is defined as continuous variable of years of exposure ranging from 0 to 3						
Height	0.671***	5,337	0.654***	5,311	0.741***	5,218
	[0.23]		[0.23]		[0.22]	
ZHFA	0.029	5,246	0.028	5,220	0.031	5,130
	[0.02]		[0.02]		[0.02]	
Weight	0.323***	5,339	0.310***	5,313	0.326***	5,220
	[0.12]		[0.12]		[0.12]	
ZWFA	0.032	5,300	0.030	5,274	0.033	5,184
	[0.02]		[0.02]		[0.02]	
Morbidity	-0.008	6,189	-0.007	6,161	-0.008	6,052
	[0.01]		[0.01]		[0.01]	
Fever	-0.009	6,189	-0.009	6,161	-0.010	6,052
	[0.01]		[0.01]		[0.01]	
Cough	-0.003	6,189	-0.003	6,161	-0.004	6,052
	[0.01]		[0.01]		[0.01]	
Panel B: Exposure is a binary variable of full exposure (3 years) against no exposure (0 years)						
Height	2.029***	4,771	2.034***	4,750	2.307***	4,666
	[0.73]		[0.73]		[0.71]	
ZHFA	0.095	4,689	0.096	4,668	0.105	4,586
	[0.08]		[0.08]		[0.08]	
Weight	0.968**	4,772	0.967**	4,751	1.039***	4,667
	[0.38]		[0.38]		[0.38]	
ZWFA	0.105	4,739	0.105	4,718	0.119	4,637
	[0.07]		[0.07]		[0.07]	
Morbidity	-0.034	5,542	-0.034	5,519	-0.037*	5,421
	[0.02]		[0.02]		[0.02]	
Fever	-0.037*	5,542	-0.037*	5,519	-0.040*	5,421
	[0.02]		[0.02]		[0.02]	
Cough	-0.016	5,542	-0.015	5,519	-0.016	5,421
	[0.02]		[0.02]		[0.02]	
District-Birth FE	YES		YES		YES	
Individual Covariates	YES		YES		YES	
Household Covariates	YES		YES		YES	

*** p<0.01, ** p<0.05, * p<0.1;

All specifications are same as in final column of table 2.

Table A8: OLS estimates of Height and Weight outcomes on exposure to ICDS with additional control Age

Age Cohort	Including age as an additional control (1)	N	Excluding age as an additional control (2)	N
Panel A: Exposure is defined as continuous variable of years of exposure ranging from 0 to 3				
Height	0.661***	5,218	0.741***	5,218
	[0.22]		[0.22]	
Weight	0.279**	5,220	0.326***	5,220
	[0.12]		[0.12]	
Panel B: Exposure is a binary variable of full exposure (3 years) against no exposure (0 years)				
Height	2.059***	4,666	2.307***	4,666
	[0.68]		[0.71]	
Weight	0.890**	4,667	1.039***	4,667
	[0.37]		[0.38]	
District Birth FE	YES		YES	
Individual Covariates	YES		YES	
Household Covariates	YES		YES	
Age as an additional control	YES		NO	

*** p<0.01, ** p<0.05, * p<0.1;

Note: Height is in cm, Weight is in kg.

Individual characteristics include birth order, sex, mother's education and mother's height; household characteristics include dependent ratio, income source, wealth index, ethnicity and religion.

Robust standard errors clustered at the village level are shown in parentheses.

Table A9: OLS estimates of health and morbidity outcomes on exposure to ICDS on prospective users – using asset information from 2004-05 data (IHDS 1 round)

Age Cohort	Non-Rich (1)	N	Overall (2)	N
Panel A: Exposure is defined as continuous variable of years of exposure ranging from 0 to 3				
Height	0.621***	4,038	0.741***	5,218
	[0.23]		[0.22]	
ZHFA	0.038	3,976	0.031	5,130
	[0.03]		[0.02]	
Weight	0.296**	4,041	0.326***	5,220
	[0.13]		[0.12]	
ZWFA	0.033	4,014	0.033	5,184
	[0.03]		[0.02]	
Morbidity	-0.009	4,664	-0.008	6,052
	[0.01]		[0.01]	
Fever	-0.013*	4,664	-0.010	6,052
	[0.01]		[0.01]	
Cough	-0.004	4,664	-0.004	6,052
	[0.01]		[0.01]	
Panel B: Exposure is a binary variable of full exposure (3 years) against no exposure (0 years)				
Height	1.875**	3,605	2.307***	4,666
	[0.75]		[0.71]	
ZHFA	0.113	3,549	0.105	4,586
	[0.09]		[0.08]	
Weight	1.019**	3,608	1.039***	4,667
	[0.42]		[0.38]	
ZWFA	0.131	3,586	0.119	4,637
	[0.08]		[0.07]	
Morbidity	-0.042	4,174	-0.037*	5,421
	[0.03]		[0.02]	
Fever	-0.052**	4,174	-0.040*	5,421
	[0.02]		[0.02]	
Cough	-0.017	4,174	-0.016	5,421
	[0.02]		[0.02]	
District-Birth FE	YES		YES	
Individual Covariates	YES		YES	
Household Covariates	YES		YES	

*** p<0.01, ** p<0.05, * p<0.1;

Note: Height is in cm, ZHFA lying in [-6, 6], weight is in kg., ZWFA lying in [-6, 6].

Individual characteristics include birth order, sex, mother's education and mother's height; household characteristics include dependent ratio, income source, wealth index, ethnicity and religion.

Following a similar approach of column (1) in table 4, we restrict the sample in column (1) to those households which have reported that they do not own any of the following assets: car, air conditioner, washing machine, refrigerator, credit card in IHDS 1 of 2004-05.

Robust standard errors clustered at the village level are shown in parentheses.

Table A10: Robustness of OLS estimates on exposure to ICDS when the sample is restricted to first-born children

Age Cohort	Overall (1)	N	First-Born (2)	N
Panel A: Exposure is defined as continuous variable of years of exposure ranging from 0 to 3				
Height	0.741***	5,218	1.347**	1,525
	[0.22]		[0.62]	
ZHFA	0.031	5,130	0.071	1,491
	[0.02]		[0.06]	
Weight	0.326***	5,215	0.475	1,526
	[0.12]		[0.31]	
ZWFA	0.033	5,184	0.089*	1,513
	[0.02]		[0.05]	
Morbidity	-0.008	6,052	-0.014	1,775
	[0.01]		[0.02]	
Fever	-0.01	6,052	-0.014	1,775
	[0.01]		[0.02]	
Cough	-0.004	6,052	-0.001	1,775
	[0.01]		[0.02]	
Panel B: Exposure is a binary variable of full exposure (3 years) against no exposure (0 years)				
Height	2.307***	4,666	4.342**	1,375
	[0.71]		[2.14]	
ZHFA	0.105	4,586	0.250	1,346
	[0.08]		[0.20]	
Weight	1.039***	4,667	1.437*	1,376
	[0.38]		[0.87]	
ZWFA	0.119	4,637	0.300**	1,365
	[0.07]		[0.15]	
Morbidity	-0.037*	5,421	-0.072	1,599
	[0.02]		[0.07]	
Fever	-0.040*	5,421	-0.064	1,599
	[0.02]		[0.06]	
Cough	-0.016	5,421	-0.024	1,599
	[0.02]		[0.05]	
District-Birth FE	YES		YES	
Individual Covariates	YES		YES	
Household Covariates	YES		YES	

*** p<0.01, ** p<0.05, * p<0.1; Column (1) indicates the results for the original sample. In column (2), sample is limited to those children who are reported to be first born child. Height is in cm, ZHFA lying in [-6,6], weight is in kg., ZWFA lying in [-6,6]. Individual characteristics include sex, mother's education and mother's height; household characteristics include dependent ratio, income source, wealth index, ethnicity, dependent ratio and religion. Robust standard errors clustered at the village levels are shown in parentheses.

Table A11: Robustness of OLS estimates on continuous exposure to ICDS including in-utero exposure

Age Cohort	Including in utero exposure with a total of 4 year of exposure (cohort in utero till 3 years after birth) (1)	N	Excluding in utero exposure with a total of 3 year of exposure (cohort from birth till 3 year) (2)	N
Height	0.554***	5,218	0.741***	5,218
	[0.17]		[0.22]	
ZHFA	0.024	5,130	0.031	5,130
	[0.02]		[0.02]	
Weight	0.255***	5,220	0.326***	5,220
	[0.09]		[0.12]	
ZWFA	0.027	5,184	0.033	5,184
	[0.02]		[0.02]	
Morbidity	-0.006	6,052	-0.008	6,052
	[0.01]		[0.01]	
Fever	-0.007	6,052	-0.010	6,052
	[0.01]		[0.01]	
Cough	-0.002	6,052	-0.004	6,052
	[0.00]		[0.01]	
District-Birth FE	YES		YES	
Individual Covariates	YES		YES	
Household Covariates	YES		YES	

***p<0.01, ** p<0.05, * p<0.1;

Note: In column (1), exposure variable includes the exposure in-utero and ranges from 0 (no exposure) to 4 years (including in-utero and 3 years after birth). Column (2) indicates the results for the original sample where exposure variable does not include the exposure in-utero and ranges from 0 to 3 year.

Height is in cm, ZHFA lying in [-6,6], weight is in kg., ZWFA lying in [-6,6].

Individual characteristics include birth order and sex; household characteristics include mother's education, mother's height, income source, wealth index, ethnicity, dependent ratio and religion. Robust standard errors clustered at the village levels are shown in parentheses.