Malnutrition and India's ICDS program: evidence of program impact?

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INTRODUCTION

Established in 1975, India's Integrated Child Development Services program is the world's largest early child development program, and one of the most studied. Yet, the extent to which it has succeeded in attaining one of its primary objectives, namely the reduction in the prevalence of child malnutrition, remains largely uncertain.

We address the question of ICDS's impact on child malnutrition using a new dataset of more than 11,000 children in Kerala, and estimate a series of reduced-form child health demand models to capture the association between access to the program and nutritional status. In addition to examining (i) the effect of the presence of an ICDS village-level program center (*anganwadi* center or AWC) on nutritional status, we are also able to (ii) control for the effect of the length of time that the AWC has been established, and (iii) model the actual participation of children under the age of three.

Our models shows that while the nutritional status of children living in villages with ICDS programs is not significantly better than that of children in villages without the program, there is a clear positive impact of the program on the nutritional status of those young children (under three years) who actually participate regularly. These results suggest that at least some of the services that ICDS provides to children are of sufficient quality to positively influence child nutrition. Strengthening measures to encourage young children to participate in the program is crucial, however, if the ICDS is to have a measurable impact on child malnutrition in the villages in which it is placed.

1. BACKGROUND: INDIA'S INTEGRATED CHILD DEVELOPMENT SERVICES PROGRAM

Originally established in 1975, the Integrated Child Development Services (ICDS) program is the world's largest early child development program. It is a holistic intervention, consisting of health, nutrition and education components, that reaches children under six years of age through a network of community-level *anganwadi* centers and will eventually be universalized across all administrative blocks in India. Over time, the program has grown in its scope, from a pure food supplementation program to a program that adopts a more multi-dimensional approach to child well-being, incorporating health, nutrition and preschool education components. It targets a range of interventions at young children and their mothers, including growth-monitoring, immunization, health check-ups and supplementary feeding, as well as nutrition and health education to improve the childcare and feeding practices that mothers adopt (see Table 1). An additional component focusing on adolescent girls' nutrition, health, awareness, and skills development was added in some blocks in 2000. Preschool education is provided to children between three and six years of age.

Table 1 Range of services offered by ICDS to children under six

	Children under 6	Pregnant women	Lactating women
Health check-ups, and treatment	Health check-ups by AWW, ANM, LHV Treatment of diarrhea Deworming Basic treatment of minor ailments Referral of more severe illnesses	Antenatal check-ups	Postnatal check-ups
Growth-monitoring	Monthly weighing of under-threes Quarterly weighing of 3-6 year olds Weight recorded on growth cards		
Immunization	Immunization against poliomyelitis, diphtheria, pertussis, tetanus, tuberculosis and measles	Tetanus toxoid immunization	
Micronutrient supplementation	IFA supplementation for malnourished children	IFA supplementation	
Health and nutrition education		Advice includes infant feeding practices, child care and development, utilization of health services, family planning and sanitation	Advice includes infant feeding practices, child care and development, utilization of health services, family planning and sanitation
Supplemental nutrition	Hot meal or ready-to-eat snack providing 300 calories and 8-10g protein Double rations for malnourished children	Hot meal or ready-to-eat snack providing 500 calories and 20-25g protein	Hot meal or ready-to-eat snack providing 500 calories and 20-25g protein
Preschool education	Early Childhood Care and Preschool Education (ECCE) consisting of “early stimulation” of under-threes and education “through the medium of play” for children aged 3-6 years		

Source: DWCD 2004

The coverage of the program has expanded rapidly, especially in recent years. From an initial 33 blocks in 1975, the program grew to 4,200 blocks circa 2000, and to over 5,500 by 2003 (DWCD 2003). By 2004, there were almost 600,000 a*nganwadi* workers and an almost equal number of *anganwadi* helpers providing services to beneficiaries throughout the country. The program currently reaches 33.2 million children and 6.2 million pregnant and lactating women (DWCD 2004). In its February 2005 Budget address, the Government of India announced its intention to construct an additional 188,000 *anganwadi* centers and attain universal coverage of the program,

As coverage has expanded, the expenditure on the program has risen. An annual average of 700 million rupees was spent on the program between 1975 and 1992, but between 1992 and 1997 this rose more than six-fold to 4,542 million rupees per year (Government of India 2001). For 1999-2000, the budgetary allocation for the program was over 8,557 million rupees (DWCD 2003) and it has been allocated more than US$400 million under India’s Tenth Five-Year Plan (2002-2007). The program has been supported by several donors, including UNICEF, SIDA, WFP, CARE, NORAD and the World Bank.

2. THE LITERATURE

2.1 Previous ICDS evaluations

There is little consensus on the success of the ICDS scheme in tackling problems of health and nutrition in early childhood, despite it being one of the most studied health and nutrition interventions. However, among these studies there is a paucity of impact evaluations that draw on large samples, include data on treatment and comparison groups and move beyond bivariate analysis to employ more rigorous econometric techniques.

Within the public health literature, there are many small quasi-experimental studies that investigate the effect of ICDS participation on specific health behaviors or conditions, or employ relatively small samples in narrowly defined geographic areas. Among the more recent literature, Bhasin *et al* (2001) use a sample of 1,243 older children (aged 7-13) in Delhi and find that children who attended ICDS in childhood are not at a significantly lower risk of malnutrition than non-participants; Swami *et al* (2001) use a sample of 1,286 preschool children in Chandigarh and find that the prevalence of protein-energy malnutrition (PEM) is significantly *higher* among beneficiaries of ICDS than non-beneficiaries; Trivedi *et al* (1995) use a sample of just over 1,200 children in Madhya Pradesh and find no statistically significant difference in nutritional status between children living in a block with ICDS services and children living children in a block without ICDS services. By contrast, Saiyed and Seshadri (2000) report that increased ICDS service utilization among 0-36 months (n=610) is associated with improved nutritional status. All these studies rely on descriptive statistics to capture ICDS impact.

Larger studies are rare and the few existing ones are not without limitations. The most recent, and perhaps the most well-known, national study (NCAER 2001) monitors program inputs without evaluating impact. The results of another prominent national study (NIPCCD 1992), which does use treatment and control groups to show positive program effect, have since been shown to be statistically insignificant (Das Gupta *et al.* 2004). Other large studies examine ICDS projects that have been modified in some way from the general ICDS program, such as TINP (World Bank 1994), CARE-India's INHP program (Johri 2004) or SIDA's ICDS program in Tamil Nadu (SIDA 2000). Consequently, these results are not generalizable to the national ICDS program.

Among the most rigorous are two recent papers which use National Family Health Survey (NFHS) data to estimate the association between having an *anganwadi* center in a village and the likelihood that a child is underweight. Using the 1992/93 NFHS I data, Deolalikar (World Bank 2004) estimates that, for boys, this is associated with a 5% reduction in the likelihood of being underweight, but that there is no significant association for girls. Using both the 1992/93 and the 1998/99 NFHS II data, Das Gupta *et al.* (2004) initially find that the program appears to have a significant positive effect on nutritional outcomes. However, on more rigorous exploration using propensity score-matching techniques, they find little significant effect when children in the ICDS villages are compared with children with similar characteristics in non-ICDS villages.

In this paper, a large dataset is used in which one can distinguish between children who live in villages with the ICDS program and without the program. In addition, one can control for two potential confounding variables, which are absent in the NFHS data, and the exclusion of which may result in an underestimation of ICDS program effect. First, one can control for the potential confounding effect of the length of time that the AWC has been established in the village. Second, one can capture actual attendance at the ICDS as an explanatory variable of interest. It is the exploration of the effects of these two variables that are of central interest in this paper.

2.2 The determinants of child nutritional status

In the course of evaluating the ICDS program, this paper will contribute to the growing literature that employs a utility-maximizing framework to model the individual, household and community-level correlates of child nutritional status (see the reviews by Behrman and Deolalikar 1998, Strauss and Thomas 1995 and Chamarbagwala *et al.* 2004). While these models are increasingly common, their application to India has been surprisingly limited. Pal (1999) focused on wasting in children under five in 6 villages in rural West Bengal using ordered probit models and Cigno *et al.* (2001) examined the body mass indices (BMI) of children over the age of six.

We estimate the correlates of child nutritional status using both OLS models (of weight-for-age z-scores) and probit models (of the incidence of underweight). Gender-specific and age-specific effects are modeled.

3. THEORETICAL MODEL

The theoretical approach has its origins in Becker's microeconomic models of household production (Becker 1965, 1981) in which households allocate goods and time to the production of commodities that are either sold on the market, consumed at home, or for which there is no market. This work was expanded to the demand for health in the seminal work by Grossman (1972). The later application of this model to children's health status is well-known and discussed in the reviews by Behrman and Deolalikar (1988), Strauss and Thomas (1995) and Currie (2000).

Assuming a simple one-period[1] unitary[2] model of decision-making whereby a household maximizes a **utility function** that depends on the consumption of commodities, such as a composite (market-purchased) household consumption good (X_j), the consumption of leisure by all household members (L_j) and child health (H_{ij}), conditional on a set of household taste and preferences shifters (W_j).

$$U_{jt} = U(X_{jt}, L_{jt}, H_{ijt}; W_{jt}) \qquad (1)$$

This utility function shows that the household does not derive utility from the consumption of health inputs directly, but rather indirectly through their influence on the stock of health (as given by the health production function in (i))

The household faces three sets of constraints:

(i) a health production function representing the technology available to the household to transform available inputs into the health of the child. The production of health is an inherently dynamic process and health status is a stock[3] variable, i.e. the cumulative of current and previous periods' inputs. Thus, the health accumulation process for individual *i* in household *j* in period *t* can be described by a dynamic health production function.

$$\mathrm{H}_{\mathrm{ijt}} = h(M_{jt}, M_{jt-1}, \dots, M_{j1}, M_{j0,} Z_{jt}, Z_{jt-1}, \dots, Z_{j1}, Z_{j0,} V_{jt}, V_{jt-1}, \dots, V_{j1}, V_{j0}; G_{ijt}, F_{jt}) \quad (2)$$

where health depends on M_{jt}, the endogenous material inputs (such as nutrient intake, immunizations and clean water) in consecutive time periods; on Z_{jt}, the exogenous characteristics of the child and household; and on $\mathrm{V}_{\mathrm{ijt}}$, the endogenous child health-related time inputs.

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[1] In a dynamic model, the problem could be formulated as an inter-temporal utility maximization problem, where the household maximizes $U(u_1(X_{j1}, L_{j1}, H_{ij1}; W_j), u_2(X_{j2}, L_{j2}, H_{ij2}; W_j) \dots u_T(X_{jT}, L_{jT}, H_{ijT}; W_j)$ over T time periods.

[2] A unitary model of decision-making stands in contrast to household bargaining models (see, for example, Chiappori (1988) and Browning *et al.* 1994) in which household allocations are the outcome of a bargaining process whereby household members seek to allocate resources over which they have control to goods they have an interest in. In this paper, the unitary model is employed since data do not provide information on individual income, household members' ownership of assets or other indicators of relative bargaining power.

[3] Stock variables can be carried over to future periods for consumption and stand in contrast to flow variables, such as acute morbidity, which are produced as current inputs and "consumed" right away (Federov and Sahn 2004).

Child health is also conditional on two vectors of exogenous child-specific (G_{ijt}) and household/community-specific variables (F_{jt}) that are time-varying or time-invariant indicators of health technology[4]. As such, they influence the choice of health inputs and/or the efficiency with which existing inputs are combined to produce child health, and in so doing affect the shape of the health production function. Exogenous child-specific factors (G_{ijt}) include age and gender. Exogenous endowments at the household level could include the education of the caregiver (typically the mother) who makes health-related decisions that impact on the child's health, and household size[5] to captures scale and congestion effects. At the community level, prevailing cultural norms and the availability of healthcare facilities are examples of F_{ijt} variables.

The household determines the optimal amounts of different inputs in the health production function through the utility-maximizing process.

Dynamic models of nutritional status, such as (2), could be estimated if panel data over multiple time periods were available. However, only two periods of data are necessary if one assumes that previous period health is a sufficient indicator for all past inputs (Strauss and Thomas 1995)[6]. Then the equation can be simplified such that lagged health on the right hand side absorbs the impact of all exogenous variables occurring in the past. In this way, current health status is modeled as a function of past health status (which is itself a function of health inputs in previous periods) and current endogenous and exogenous inputs.

$$H_{ijt} = h(H_{ijt-1}, M_{jt}, Z_{jt}, V_{jt}; G_{ijt}, F_{jt}) \tag{3}$$

(ii) a **time endowment** reflecting the total available time available to the household ($N_{jt)}$) to allocate between wage labor (T_{jt}), leisure (L_{jt}) and health-related activities (V_{jt})

$$N_{jt} = T_{jt} + L_{jt} + V_{jt} \tag{4}$$

(iii) the **budget constraint** giving the total financial resources, consisting of wage income (w_tT_{jt}), non-wage income ($Y_{jt)}$ and net assets (A_{jt}), available to the household with which to purchase market-produced health-related inputs (M_{jt}) and other consumption goods (X_{jt}) at prices p^M and p^X respectively

$$p_t^X X_{jt} + p_t^M M_{jt} = w_t T_{jt} + Y_{jt} + A_{jt} \tag{5}$$

The budget constraint (5) is combined with the time endowment (4) to yield the **full income constraint**:

$$p_t^X X_{jt} + p_t^M M_{jt} = w_t (N_{jt} - L_{jt} - V_{jt}) + Y_{jt} + A_{jt} \tag{6}$$

Re-arranging the terms so that total consumption, of both goods and time, is subject to the budget constraint including time endowment gives:

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[4] F_{ijt} and G_{ijt} variables can be thought of as exogenous productivity shifters, which may be either permanent or temporary shocks (Currie 2000). Some variables such as child's age and gender can be, and are sometimes, classified as exogenous inputs or exogenous productivity shifters (G_{ijt}) depending on the theoretical perspective.

[5] Household size is only exogenous in the short or medium run.

[6] The appropriateness of this approach depends on the type of health variable being examined. Stunting lends itself well to this approach, for example.

$$p_t^X X_{jt} + p_t^M M_{jt} + w_t L_{jt} + w_t V_{jt} = w_t N_{jt} + Y_{jt} + A_{jt} \tag{7}$$

The left-hand side of (7) represents resource costs or expenditure on goods and services including leisure, which cannot exceed the total resources available to the household. Under the assumption that the utility function is increasing and quasi-concave[7] and the underlying functions have desirable properties so that an internal maximum can be obtained[8], the utility function can be maximized subject to the technology and full income constraint to solve for the optimal amount of material health inputs (M_{jt}*) and health-related time inputs (V_{jt}*), as well as the optimal amount of the household consumption good (X_{jt}*) and leisure time (L_{jt}*) in each time period to obtain the following set of reduced-form demand functions.

$$M_{jt}* = m(H_{ijt-1}, p_t^X, p_t^M, w_t, N_{jt}, Y_{jt}, A_{jt}; G_{ijt}, F_{jt}) \tag{8}$$

$$V_{jt}* = v(H_{ijt-1}, p_t^X, p_t^M, w_t, N_{jt}, Y_{jt}, A_{jt}; G_{ijt}, F_{jt}) \tag{9}$$

$$X_{jt}* = x(H_{ijt-1}, p_t^X, p_t^M, w_t, N_{jt}, Y_{jt}, A_{jt}; G_{ijt}, F_{jt}) \tag{10}$$

$$L_{jt}* = l(H_{ijt-1}, p_t^X, p_t^M, w_t, N_{jt}, Y_{jt}, A_{jt}; G_{ijt}, F_{jt}) \tag{11}$$

The left hand side variables are all endogenous and the right hand side variables are all exogenous variables, i.e. prices, endowments and predetermined wealth.

The health demand function can be derived by substituting equations (8) and (9) into the reduced-form health demand function (3):

$$H_{it} = h\{H_{it-1}, m(H_{it-1}, p_t^X, p_t^M, w_t, N_{jt}, Y_{jt}, A_{jt}; G_i, F_j), Z_{jt}, v(H_{it-1}, p_t^X, p_t^M, w_t, N_{jt}, Y_{jt}, A_{jt}, Z; G_i, F_j); G_i, F_j\}$$

It is characteristic of reduced-form health demand models that all the exogenous prices enter into the determination of each of the endogenous variables, implying that health depends on the prices of *all* goods and not only the prices of health-related input prices. Also, all of the predetermined assets and endowments enter into *all* of the reduced-form relations, implying that the assets and endowments of adults, household and communities all have an effect on the health and nutrient intakes of children in the household. Wages are assumed to be exogenous and can, thus, represent the predetermined opportunity cost of time.

Estimation of the reduced-form relations (both for health and for other choice variables) usually does not provide much information about the structural coefficients, but does provide a consistent framework within which to examine the impact of changes in market prices, endowments and policies on health-related consumption. Government policies and interventions that affect health and nutrition are assumed to operate primarily though prices (e.g. free or subsidized healthcare or food), community endowments (e.g. vector control programs) and unearned or earned income (e.g. public works programs, income transfers or wage policies)

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[7] In a dynamic model, it also needs to be assumed that the utility function *U* is inter-temporally separable and the sub-utility function u_t for each time period is increasing and quasi-concave.

[8] Behrman and Deolaliker (1988) note that in some cases this may be a strong assumption since corner solutions, e.g. zero-values of certain health-related inputs, may occur, complicating estimation.

4. DATA

Data were collected as part of the routine evaluations of World Bank financing of ICDS projects in India in 2000. A household questionnaire, administered to the head of the household, collected basic socioeconomic data on similar items to those contained in the National Family Health Surveys (NFHS surveys). The child questionnaire, administered to the child's mother, elicited information on the child's health status, such as recent incidence of disease; consumption of preventive and curative health services; and aspects of the mother's behavior that are related to children's health, e.g. infant feeding practices. An additional questionnaire specifically addressed the mother's awareness of the ICDS program and the child's utilization of ICDS services. A trained field worker gathered anthropometric data on the child's weight.

The final sample consists of 11,349 children in 21 blocks across 11 districts. Summary statistics can be found in Appendix A.

5. EMPIRICAL ESTIMATION

Empirically, current period health can be estimated as a function of nutritional status in the previous period, a vector of exogenous child-specific characteristics (Z_1) and a vector of exogenous household-specific and/or community-specific characteristics (Z_2); a price vector; and unearned income and/or assets.

In this paper, three types of models are estimated

(i) a reduced-form child health demand function

The cross-sectional data imposes the limitation that lagged child health information is not available. Nor is there information on exogenous prices. Consequently, current period health status (H) is estimated as a function of a vector (X_1) of current period child-specific characteristics (age, gender) and a vector (X_2) of household-specific characteristics (mother's education, mother's age at marriage, the gender of the head of the household, caste, household wealth, water supply and toilet facilities[9]).

Thus, empirical specification of the health demand function (11) is:

$$H = B_0 + B_1 Z_1 + B_2 Z_2 + u \qquad (12)$$

(ii) a reduced-form health demand function which includes the ICDS intervention as a community endowment, i.e. the effect of the availability of ICDS services in the village on nutritional status

(iii) a reduced-form health demand function which models the ICDS intervention as a health input, i.e. examines the effect of children's actual participation in the ICDS program on nutritional status

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[9] Strictly speaking, water supply and toilet facilities are endogenous, but are commonly included in reduced-form models. There is often some exogenous element to them, though, since access to piped water and flush toilets presuppose some exogenous community water and sanitation infrastructure. The availability of this infrastructure may also act as an indicator of the exogenous unobservable level of development of the community.

Strictly speaking, model (iii) is a quasi-reduced form model[10] since nutritional status is posited to be determined by some inputs from the structural production function (namely ICDS nutrition inputs) and some variables from the reduced-form relations (e.g. child characteristics, caregiver's education and assets). As such, the models neither reveal all of the structural parameters nor the total impact of exogenous changes.

5.1 Dependent variables

Nutritional status can be described in terms of anthropometric indices, such as underweight, stunting and wasting. The terms underweight, stunting and wasting are measures of protein-energy undernutrition and are used to describe children who have a weight-for-age, height (or recumbent length)-for-age and weight-for-height measurement that is more than two standard deviations below the median value of the NCHS/WHO 1978 reference group. This is referred to as moderate malnutrition. The terms severe underweight, severe stunting and severe wasting are used when the measurements are more than three standard deviations below the reference median, and mild underweight, stunting and wasting refer to measurements more than one standard deviation below the reference population.

There is some criticism of the use of an international reference group to construct z-scores for Indian children whom, it is argued, may vary genetically from the American children on whom the reference group is based. To overcome this, the Indian Association of Paediatrics (IAP) has developed its own reference group for Indian children. However, two convincing arguments counter the use of country-specific growth standards: first, if one is interested in gender bias in health outcomes, then local standards that are disaggregated by gender and derived from populations in which there is gender bias will lead to the underestimation of obfuscation of gender bias in statistical analysis (Harriss-White 1997). Second, empirical evidence has shown that Indian children of upper socioeconomic strata exhibit remarkably similar growth patterns to children in other countries (Nutrition Foundation of India 1991; Ramalingaswami et al. 1997).

In this paper, age- and sex-standardized weight-for-age z-scores are used. This is a composite measure of the height-for-age and weight-for-height measures, and captures the consequences of both long-term and short-term health status[11]. For example, a child that is stunted due to chronic malnutrition, but currently receiving optimal nutritional inputs, is still likely to have a low weight-age z-score. Likewise, a child whose long-term nutritional status is good, but who has recently suffered a severe episode of diarrhea or whose household is temporarily food-insecure may also have a low weight-for-age z-score. Consequently, one of the limitations of this measure is that is unable to distinguish between chronic and acute malnutrition (Alderman 2000). On the other hand, since ICDS interventions are designed to address the causes of both short and long-term malnutrition (e.g. immunization, supplemental feeding, management of illness, improvements in child-feeding behaviors), weight-for-age z-scores may be the most appropriate measure with which to capture total program effect.

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[10] The most common manifestation of the quasi-reduced form are models in which labor and non-labor income are treated as permanent income and replaced in the estimated relationship by *per capita* household expenditures (Federov and Sahn 2004). Since income is determined by the labor allocation decision in the solution of the utility maximization problem, i.e. health status and income are jointly determined, in a reduced form model income would need to be dropped or instrumented. Models which include *per capita* household expenditures are sometimes referred to as conditional demand or quasi-reduced form models.

[11] Long-term nutritional status is better reflected by a stunting indicator and acute short-term undernutrition is better captured by a wasting indicator.

Child nutritional status is modeled both as a regression of continuous standardized weight-for-age z-scores on a set of explanatory variables, using ordinary least squares regression, and by probit analyses of the incidence of underweight. The latter is interesting since it focuses on a policy-relevant cut-point in the z-score continuum. Unlike the OLS model which highlights factors that cause average improvements in z-scores, the probit model focuses attention on the factors that make a difference in determining whether children are underweight (malnourished) or not.

Table 2 Summary statistics of dependent variables

Dependent variable	Obs	Mean	Std. Dev.	Min	Max
Standardized weight-for-age (z-score)	11,349	-1.00	0.96	-6	5.82
Underweight	11,349	0.11	0.31	0	1

Note: The standard fixed exclusion range for implausible weight-for-age z-scores is <-5.0 and >+5.0 (WHO 1995). However, an examination of the socioeconomics and behavioral characteristics of children in this sample suggests that weight-for-age z-scores with an exclusion range of <-6.0 and >+6.0 are, in fact, plausible for this sample.

5.2 Gender-specific and age-specific models

There are compelling theoretical and statistical reasons to explore separate gender-specific and age-specific specifications in models of child health:

The theoretical rationale is that the relationship between health determinants and health outcomes may differ by age and by gender. Underlying the gender-specific models is a hypothesis of gender discrimination in the allocation of household resources and a curiosity about the extent to which particular distal factors (such as mother's education) and government allocation of resources (for example, through the ICDS program) can mitigate or aggravate the effects of that discrimination. A precedent for age-specific models is found in Sahn and Alderman's (1997) paper on Mozambique in which they argue that the types of nurturing and resources that a child requires changes with age in response to diet and activities and, consequently, they estimate separate models for children under 24 months and over 24 months of age. Taking advantage of the large sample size available for Kerala, this paper will test for age-specific effects during each 12 month age interval.

Descriptive statistics lend some preliminary support to these strategies. Examining weight-for-age z-scores by gender, it can be seen that the variance is much greater for boys than for girls. As children age, the sample mean migrates slowly to the left suggesting increasing growth-faltering. The distribution contracts and the variance falls, and there is increasing evidence of right-skewing.

Figure 1 Distribution of weight-for-age z-scores, by gender

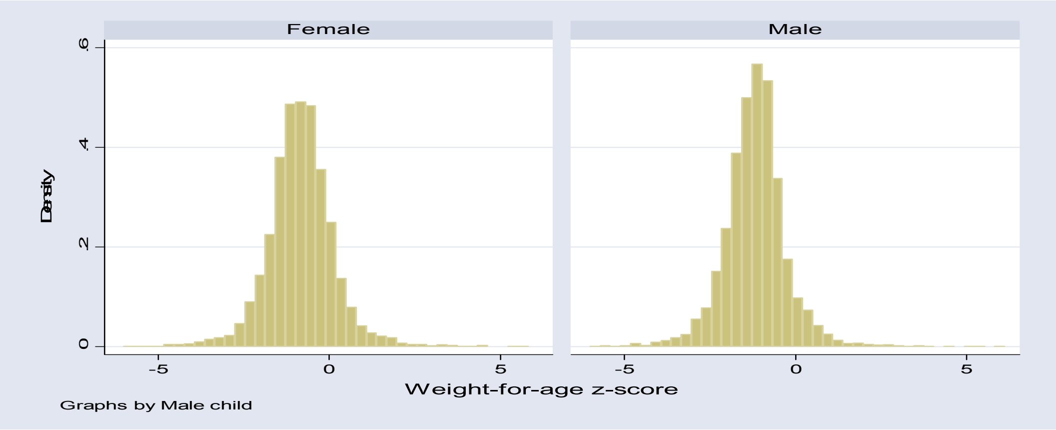
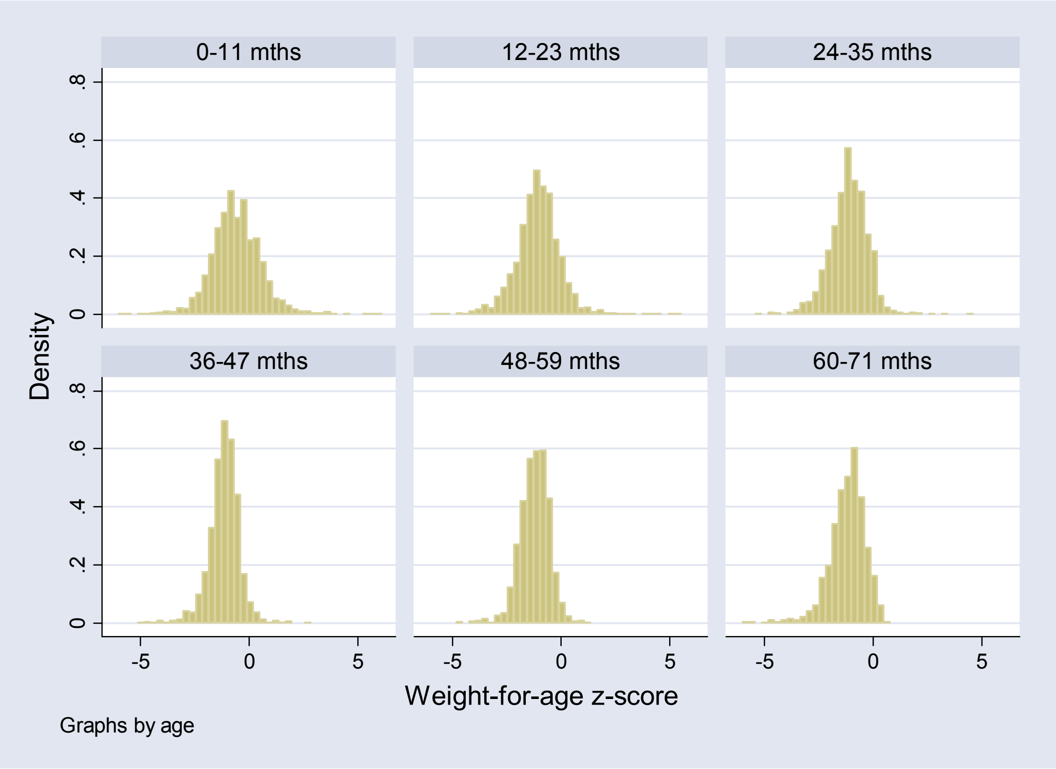


Figure 2 Weight-for-age z-score distribution, by age



6. SOCIOECONOMIC CORRELATES OF CHILD NUTRITIONAL STATUS – LITERATURE REVIEW AND EMPIRICAL RESULTS

In this section, the empirical literature on the socioeconomic correlates of child health is reviewed, and OLS and probit models of the socioeconomic correlates of child nutritional status in Kerala are estimated. In addition to a basic model for all children under six, other models are estimated that explore how the effects of these correlates vary by gender and age.

6.1 The OLS model

The results for the OLS model are presented in Table 3 and discussed below.

Child's age: Children in developing countries tend to follow a growth pattern whereby the mean weight of infants starts to falter at about 3 months of age and declines rapidly until about 12 months, followed by a markedly slower decline until about 18 to 19 months (Shrimpton 2001) and then stays constant or exhibits a slight catch-up. To capture this pattern, z-scores are modeled as a quadratic function of age.

In the OLS model, the age coefficient confirms a rapid deterioration in nutritional status, with each additional month being associated with a 0.03 standard deviation reduction in weight-for-age z-scores. The quadratic term, although highly significant, has a very small value suggesting little recovery from early growth retardation. Gendered models highlight a large male-female differential in child well-being: the deterioration in nutritional status per additional month of life is 1.5 times sharper for girls than for boys.

Gender: The gender effect is large, highly significant, and the strongest predictor in the base model. The coefficient shows that, *ceteris paribus,* being *male* is associated with a 0.35 standard deviations reduction in the weight-for-age z-score. While this result may surprise some, it in line with recent findings in other empirical studies, such as a survey carried out in rural Kerala at approximately the same time as this survey which found that a higher percentage of boys (82.7%) than girls (75.5%) under six are malnourished by the Gomez classification[12] (National Institute of Nutrition 2002: 74). Elsewhere in the South Asia region, Trapp *et al.* (2004) highlight the disappearing sex bias in child health in Bangladesh. Moreover, the sign on the gender coefficient in the economics literature on the determinants of child health in South Asia is not consistently pointed in the same direction. See, for example, Bangladesh (Bairagi 1986, Chauduri 2004), Pakistan (Alderman and Garcia 2004, Hazarika 2000) and Nepal (Martorell *et al* 1984).

While the gender effect is strong and significant across all ages, it appears to be strongest in the first two years of life. Since the mean birth weight of boys (2,930g) is slightly higher than that of girls (2,892g), the apparent male disadvantage can not be attributed to gender differences in birth outcomes. An alternative explanation may be gender differences in the early care behaviors, such as the breastfeeding and weaning practices that mothers adopt, aware or unaware of the consequences of these behaviors for child nutritional status. As children age, and make increasing demands on household resources, the initial advantage of young girls wanes and gender differentials in nutritional status becomes narrower, perhaps indicative of increasing gender discrimination (against girls) in the allocation of household resources[13].

Mother's education: The effect of mother's education on child nutritional status is a key variable of interest in a number of studies of the determinants of child nutritional status (see, for example, Wolfe and Behrman 1987, Thomas *et al* 1991, Glewwe 1999, Handa 1999, Christiaensen and Alderman 2004). One pathway along which mother's education or literacy can be hypothesized to affect child nutritional status is via its effect on household income (either through own income or through positive assortative mating), where higher incomes permit the purchase of more and better health-related inputs. In addition to the impact of education on child health via income,

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[12] The Gomez classification is a weight-for-age measure that classifies children distinguished between children who are "normal" and those who fall into one of four grades of malnutrition. A "moderate" malnutrition classification under the Gomez system reflects a lower weight-for-age than a "moderate" malnutrition classification under the NCHS system.

[13] The gender differential increases again in the 60-71 month age category.

education may also directly influence child health via the direct transfer of health knowledge. In Morocco, Glewwe (1999) finds that it is indeed health knowledge that is crucial for improving child nutritional status, but that this knowledge is typically acquired outside of the formal schooling system, and so unlikely to be captured by a maternal education variable. In Ethiopia, Christiaensen and Alderman (2004), too, find that nutritional knowledge exerts an effect on child nutritional status that operates independently of the effect of adult education and household resources. Schooling is also thought to affect child health by improving women's access to information and enhancing their information-processing skills so that they can make better use of available health and nutrition inputs and more quickly adopt new health technologies and innovations. Glewwe (1999) refers to these pathways as (i) the acquisition of literacy and numeracy skills that enhance the capability to diagnose and treat child health problems, and (ii) increasing familiarity with modern society which may make women more receptive to modern medicine. Another hypothesis, namely that mother's educational attainment may be proxying for the effect of genetic endowment on health status, is lent credence by Wolfe and Behrman's (1987) finding that maternal education is not significantly associated with child height once genetic endowment is controlled for (via fixed effects and maternal childhood characteristics).

In this sample, all three measures of education are strong, positive and significantly associated with improved nutritional status. Relative to the omitted category of children with illiterate mothers, children whose mothers who can read and write (literacy), have high school education or college education all have significantly higher weight-for-age z-scores. After gender, maternal education has more explanatory power than all other variables in the model. The close similarity of the coefficients on being able to read and write (0.233) and the college education variable (0.241) suggests that the returns, in terms of child nutritional status, of getting some college education over and above literacy are small. This lends some credibility to the notion that it is basic information-processing skills, or functional literacy, that is critically important for child health. Strangely, the coefficient on high school education (0.162) is much smaller than the coefficient on the read and write variable. In the gendered models, mother's education, when captured by the literacy variable, appears to have an effect on nutritional status that is of exactly equal magnitude for girls and boys. Having a mother who has a high school education (but not a college education) is significant associated with improved z-scores only for girls and not for boys. On the other hand, the association between having a college-educated mothers and nutritional status is much stronger for boys (0.263) than for girls (0.209) and significant for both. It is also interesting to observe that mother's education is not at all significant in the early years of life, but strongly significant thereafter. This suggests that education influences health behaviors that occur in the later years of childhood, such as feeding patterns and care of children, rather than early inputs like breastfeeding and weaning behaviors or behaviors that are relevant across all ages, such as healthcare utilization. The F tests show that, in almost all models, the education variables are jointly significant.

Mother's age at marriage: There is evidence that in large parts of India women have low autonomy in the household, which diminishes their ability to use household resources to protect their children's health, as well as take decisions to seek healthcare when they feel it may be necessary (Das Gupta 1999). Smith *et al.* (2003), for example, find quantitative evidence that women's status is associated with better child feeding practices, especially early initiation of breastfeeding and the timely introduction of good quality complementary feeding. In the absence of better measures of women's status, the age at which the child's mother was married is included as an indicator of the mother's status within the household and the community. The hypothesis is that the younger the age at marriage, the less power the woman may have to direct household resources towards her children's nutritional health, and she may also have been less likely to lay claim to household resources to meet her own nutritional needs during pregnancy. It is possible that this variable may be picking up some of the negative nutritional consequences of pregnancy at a young age since mother's age at the time of the child's birth cannot be controlled for.

In the base model, there is a small, but significant, effect of age at marriage on the child's nutritional status. In the gendered models, it becomes clear that mother's status is a much more important determinant of girls' nutritional status than of boys': the coefficients on the variable capturing mother's age at marriage, although small, are positively significant for girls (0.012), but insignificant for boys. In households where mothers have more status, girls are likely to be better off. In the age-specific models, mother's age at marriage is only significant for the 12-23 month and 24-35 month age categories. The fact that no significant effect is found in the youngest age category suggests that we should reject our alternative hypothesis that the coefficient on this variable in the base model may, in part, be capturing some of the nutritional consequences of pregnancy at a young age or the ability of the mother to capture resources for herself during pregnancy. Rather, age at marriage is relevant for allocation decisions to children.

Gender of household head: It has been argued that female headship should be treated as endogenous (Handa 1996), since it is affected by a number of the same factors that affect child health directly (for example, the woman's own socioeconomic characteristics) in addition to other factors such as characteristics of the marriage market. However, female headship has been frequently used in reduced form models and shown to be negatively associated with nutritional status in Guatemala (Marini and Gragnolati 2003), Mozambique (Sahn and Alderman 1997) and for the lowest income tertile in Kenya (Kennedy and Haddad 1994). In this Indian sample, however, it is not significant.

Asset quintile: Household wealth is operationalized as asset quintiles. These were constructed through the application of principal components analysis (Filmer and Pritchett 2001; Pande and Yazbeck 2002) to an index of household assets and housing quality variables similar to those used in the India National Family Health Surveys (NFHS) surveys. Quintile cut-offs obtained from NFHS data were imposed on the ICDS data so that the quintile measures more closely reflect where households rank within (Kerala's) *population* wealth distribution, rather than within the sample. (Appendix B contains more details on the construction of this variable). Relative to the omitted category of children belonging to households in the upper quintile (i.e. quintile 5), children from households in the fourth quintile do not have significantly lower z-scores. However, children belonging to a household in the second and third quintiles have z-scores that are approximately 0.1 standard deviations lower than households in the upper quintile. The relationship is even stronger for children in the lowest quintile who, *ceteris paribus*, have z-scores that are, on average, 0.15 standard deviations below those of the upper quintile. There are clear gender differences in the magnitude of the asset quintile coefficient: being in the lowest quintile, relative to the upper quintile, is associated with a larger reduction in z-scores for girls (-0.17) than for boys (-.14). Also, while being in quintile 1 or 2 has a significant effect on boys' nutritional status, being in quintile 1, 2 or 3, relative to quintile 5, has a significant effect for girls, suggesting that girls' nutritional status responds (negatively) to smaller reductions in economic well-being than boys'.

The strength of the wealth effect is not nearly as strong as was expected and is also smaller in magnitude than maternal education or gender. This suggests that we need to look beyond wealth to uncover the other determinants of malnutrition and also that we need to think more carefully about how we measure wealth or income to capture the aspects of poverty that are most salient for child health

Caste: In the base model, a child from a scheduled caste household has a weight-for-age z-score that is 0.12 standard deviations lower than that of a comparable child belonging to a forward caste. Although it is difficult to be specific about the mechanisms through which caste affects nutritional status, especially since the model controls for wealth and maternal education, it does appear from the model that caste is a very strong predictor of nutritional status. Surprisingly, children of tribal castes or other backward groups do not appear to be significantly worse off than forward caste children. Being of a scheduled caste, rather than a forward caste, is very strongly and significantly associated with poorer nutritional status for boys (-0.155), but not for girls. Thus, there appears to be no disadvantage among girls from scheduled castes, over and above that which may operate through the pathways of household wealth and maternal education. However, after maternal education, caste is the most important determinant boys' nutritional status in the model, possibly suggesting substantial class (caste)-based discrimination outside the household.

Water source: Children who do not have access to a clean source of drinking water are more likely to contract diarrhea (see, for example, CEBU Study Team 1991). In India, Jalan and Ravallion (2003) have shown that the prevalence and duration of diarrhea among children under five in rural India is significantly lower in those households that have access to piped water. Since diarrhea can be responsible for dramatic temporary drops in weight-for-age z-scores, and is also associated with longer term undernutrition, access to piped water is expected to be an important determinant of child nutritional status. Piped water is a significant explanatory variable in this model, but the effect is in the wrong direction. While this result is of some concern, the magnitude of the coefficient is small (0.031) and it is only significant at the 10% level. It is also difficult to explain why access to piped water is negative and significant for boys (at the 5% level), but not for girls.

Toilet facilities: There is a clear theoretical causal link between good toilet facilities and health status. This is especially the case when children, and especially boys, enter the crawling and groping phases of motor development and are more likely to be exposed to any human excrement that is in the immediate environment. In addition, poor human waste disposal attracts flies and other disease-causing agents. In this sample, however, neither children in households with pit-latrines nor children in households with flush toilets have higher weight-for-age z-scores than children with no household toilet facilities. The failure to find an effect of flush toilets may be because it is closely related to the piped water variable, since piped water is a prerequisite for flush toilets. Taken together, the toilet and water variables are jointly significant in the base model and the boys' model.

These models explain a maximum of 10% of the total variation in the sample. An optimistic interpretation is that these exogenous distal factors affecting child nutritional status are far from deterministic.

Table 3 Regression of standardized weight-for-age (z-score) on child, household and community characteristics

	Base model	Boys	Girls	0-11 mths	12-23 mths	24-35 mths	36-47 mths	48-59 mths	60-71 mths
Child's age in months	-0.033	-0.027	-0.04						
	[0.002]***	[0.002]***	[0.002]***						
Child's age squared	0	0	0						
	[0.000]***	[0.000]***	[0.000]***						
Male child	-0.35			-0.424	-0.421	-0.272	-0.246	-0.283	-0.483
	[0.017]***			[0.047]***	[0.044]***	[0.038]***	[0.032]***	[0.033]***	[0.047]***
Mother can read and write	0.233	0.23	0.231	0.034	0.241	0.397	0.239	0.26	0.374
	[0.067]***	[0.091]**	[0.098]**	[0.166]	[0.176]	[0.150]***	[0.129]*	[0.142]*	[0.194]*
Mother has high school education	0.162	0.143	0.176	-0.06	0.124	0.33	0.175	0.162	0.415
	[0.066]**	[0.091]	[0.097]*	[0.164]	[0.175]	[0.149]**	[0.129]	[0.141]	[0.192]**
Mother has college education	0.241	0.263	0.209	0.059	0.217	0.417	0.273	0.196	0.457
	[0.068]***	[0.092]***	[0.100]**	[0.168]	[0.179]	[0.152]***	[0.132]**	[0.144]	[0.196]**
Mother's age at marriage	0.007	0.002	0.012	0.003	0.015	0.012	0.003	0.006	-0.005
	[0.003]**	[0.004]	[0.004]***	[0.008]	[0.008]**	[0.007]*	[0.006]	[0.006]	[0.009]
Male is household head	0.013	0.023	0.007	0.054	-0.051	0.047	-0.023	-0.016	0.053
	[0.025]	[0.034]	[0.035]	[0.065]	[0.062]	[0.057]	[0.046]	[0.049]	[0.072]
Asset quintile 1	-0.153	-0.139	-0.171	-0.189	-0.197	-0.11	-0.043	-0.131	-0.232
	[0.034]***	[0.047]***	[0.050]***	[0.096]**	[0.090]**	[0.076]	[0.065]	[0.066]**	[0.095]**
Asset quintile 2	-0.104	-0.116	-0.089	-0.086	-0.155	-0.063	-0.09	-0.096	-0.087
	[0.026]***	[0.036]***	[0.039]**	[0.072]	[0.069]**	[0.059]	[0.050]*	[0.050]*	[0.070]
Asset quintile 3	-0.09	-0.061	-0.117	-0.071	-0.005	-0.089	-0.158	-0.044	-0.214
	[0.033]***	[0.046]	[0.048]**	[0.088]	[0.088]	[0.078]	[0.061]**	[0.064]	[0.092]**
Asset quintile 4	-0.033	-0.048	-0.016	-0.054	-0.059	0.124	-0.072	-0.052	-0.07
	[0.031]	[0.042]	[0.045]	[0.084]	[0.080]	[0.069]*	[0.059]	[0.059]	[0.082]
Scheduled caste	-0.122	-0.155	-0.086	-0.2	-0.085	-0.13	-0.056	-0.232	-0.009
	[0.035]***	[0.048]***	[0.053]	[0.097]**	[0.088]	[0.085]	[0.067]	[0.070]***	[0.091]
Scheduled tribe	0.001	-0.008	0.011	0.259	-0.2	-0.072	-0.083	0.063	-0.056
	[0.050]	[0.068]	[0.074]	[0.127]**	[0.122]	[0.116]	[0.099]	[0.104]	[0.154]
Other backward groups	0.005	0.015	-0.008	-0.025	0.037	-0.015	0.048	-0.035	-0.001
	[0.019]	[0.026]	[0.028]	[0.052]	[0.049]	[0.043]	[0.035]	[0.037]	[0.052]
Piped water	-0.031	-0.051	-0.004	-0.013	-0.075	-0.081	0.001	-0.018	0.077
	[0.018]*	[0.024]**	[0.026]	[0.049]	[0.047]	[0.040]**	[0.034]	[0.035]	[0.050]
Flush toilet	0.025	0.019	0.034	0.038	-0.037	0.051	0.1	0.075	-0.022
	[0.041]	[0.055]	[0.060]	[0.111]	[0.104]	[0.088]	[0.075]	[0.081]	[0.122]
Pit toilet	0.053	0.075	0.033	0.139	-0.03	0.079	0.1	0.065	-0.052
	[0.036]	[0.049]	[0.053]	[0.099]	[0.093]	[0.079]	[0.066]	[0.072]	[0.111]
Constant	-0.569	-0.91	-0.587	-0.456	-1.135	-1.6	-1.304	-1.312	-1.155
	[0.105]***	[0.141]***	[0.156]***	[0.267]*	[0.259]***	[0.235]***	[0.192]***	[0.212]***	[0.301]***
Observations	11349	5840	5509	2400	2146	2060	1958	1578	1207
R-squared	0.1	0.06	0.08	0.04	0.06	0.04	0.04	0.07	0.1
F (all education variables)	9.31***	8.31***	2.61**	1.74	2.19*	3.44**	3.05***	2.93***	2.02
F (all water and toilet variables)	2.10*	3.21**	0.14	1.55	0.88	1.76	0.77	0.44	0.93

Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

6.2 Probit model

The results of a probit model, predicting whether or not a child is underweight (i.e. weight-for-age z-score <-2.0) are generally consistent with those of the OLS model (see Appendix C, Table 10). However, there are some interesting differences, suggesting that while some of the socioeconomic variables discussed in section 6.1 are associated with improvements in nutritional status, they may not be crucial in determining whether or not children are underweight. For example, in the base probit model, mother' age at marriage, piped water and scheduled caste variables – all of which were significant in the OLS model – are not significant in the probit model. In the gendered probit models, the marginal effects of all three measures of maternal education are much larger for boys than for girls, suggesting that mother's education has a much greater (positive) effect on reducing underweight among boys than among girls.

7. POLICY INTERVENTION: THE EFFECT OF LIVING IN A VILLAGE WITH THE ICDS PROGRAM ON CHILD NUTRITIONAL STATUS

Using the covariates in the above models, we turn to assess the effect of a particular intervention, the Integrated Child Development Services program, on child nutritional status.

The key explanatory variables are measures of access to and participation in the ICDS program.
(i) The first variable captures whether or not the village or ward in which the child resides has an *anganwadi* center (AWC). The effect of this AWC on the child's health may be mediated by the length of time that the AWC has been in the village/ward (i.e. the age of AWC variable).
(ii) A second set of variables captures the frequency of a child's attendance at the AWC, conditional on there being an AWC in the village. Constructed from mothers' categorical responses to the question, "How often do you send your child to the AWC?" one variable is a dummy for children whose mothers responds that they "attend daily" and the other is a dummy that combines children who "attend once a month" and "attend once a week" (see Table 4).
Since attendance data is only measured for children who live in villages with an AWC, and even among these children there are some missing values, the number of observations on the second set of variables is about half the number on the first variable[14].

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[14] It was decided to restrict the sample to those children in villages with AWCs rather than estimate the regression on the whole sample since children who are assigned a zero value for not attending the AWC for the reason that there is not one in the village and children who are assigned a zero value for not attending the AWC may be analytically different.

Table 4 Summary statistics of program variables

Program variable	Obs	Mean	Std. Dev.	Min	Max
ICDS scheme (AWC) in the village	11,349	0.58	0.49	0	1
AWC is less than three years old	11,349	0.03	0.18	0	1
AWC is four to six years old	11,349	0.01	0.12	0	1
AWC is seven to fourteen years old	11,349	0.41	0.49	0	1
AWC is fifteen to twenty-five years old	11,349	0.11	0.31	0	1
Child attends AWC on a daily basis	5,657	0.57	0.5	0	1
Child attends AWC once a month or once a week	5,657	0.05	0.23	0	1
Child never attends the AWC	5,657	0.38	0.49	0	1

Note: Attendance variables are only available for those children who live in a village with an AWC, hence the discrepancy in sample sizes.

7.1 The effect of living in a community with the ICDS program on weight-for-age z-scores and underweight

To examine the effect of living in a village/ward with an AWC on child nutritional status, OLS and probit models are estimated. Covariates are similar to the OLS and probit models in section 6.1, but also include a program variable indicating whether there or not there is an AWC in the village/ward.

In both the base OLS model and the gender-specific OLS models (in Table 5), living in a village/ward with an AWC is not significantly associated with an improvement in standardized weight-for-age z-scores. Some significant effects emerge in the models that are run separately for different age categories, though, where a coefficient that is significant at the 10% level is observed on the AWC variable for children aged 60-71 months, suggesting that having an AWC in the village/ward is associated with an (0.1 standard deviations) increase in the weight-for-age z-score for this age group. While we do not want to attach too much importance to significance in only one age group, the significant coefficient in the 60-71 months category makes theoretical sense: first, attendance rates at the AWC are 4-5 times higher in the upper three age categories than in the lower two categories (see Figure 3, section 8), and second, the impact of the program on nutritional status may only be felt after some years of exposure to the program.

In the probit models, no significant effects of the AWC program are observed in the base or gender-specific models, nor in any age-specific model (see Appendix C, Table 11).

Table 5 OLS model of effect of living in a village/ward with AWC on weight-for-age z-scores

	Base model	Boys	Girls	0-11 mths	12-23 mths	24-35 mths	36-47 mths	48-59 mths	60-71 mths
Child's age in months	-0.033	-0.027	-0.04						
	[0.002]***	[0.002]***	[0.002]***						
Child's age squared	0	0	0						
	[0.000]***	[0.000]***	[0.000]***						
Male child	-0.35			-0.425	-0.423	-0.273	-0.246	-0.284	-0.487
	[0.017]***			[0.047]***	[0.045]***	[0.039]***	[0.032]***	[0.033]***	[0.047]***
Mother can read and write	0.234	0.234	0.229	0.025	0.246	0.395	0.238	0.275	0.395
	[0.067]***	[0.091]**	[0.098]**	[0.166]	[0.177]	[0.150]***	[0.129]*	[0.142]*	[0.194]**
Mother has high school education	0.163	0.147	0.173	-0.072	0.13	0.328	0.175	0.175	0.439
	[0.067]**	[0.091]	[0.098]*	[0.164]	[0.176]	[0.149]**	[0.129]	[0.142]	[0.192]**
Mother has college education	0.241	0.268	0.206	0.046	0.224	0.415	0.272	0.215	0.482
	[0.068]***	[0.093]***	[0.100]**	[0.168]	[0.179]	[0.153]***	[0.132]**	[0.145]	[0.196]**
Mother's age at marriage	0.007	0.002	0.012	0.003	0.015	0.012	0.003	0.006	-0.005
	[0.003]**	[0.004]	[0.004]***	[0.008]	[0.008]*	[0.007]*	[0.006]	[0.006]	[0.009]
Male is household head	0.013	0.023	0.006	0.052	-0.051	0.047	-0.023	-0.015	0.055
	[0.025]	[0.034]	[0.035]	[0.065]	[0.062]	[0.057]	[0.046]	[0.049]	[0.072]
Asset quintile 1	-0.153	-0.138	-0.172	-0.194	-0.194	-0.11	-0.043	-0.126	-0.215
	[0.035]***	[0.047]***	[0.050]***	[0.096]**	[0.090]**	[0.076]	[0.065]	[0.066]*	[0.095]**
Asset quintile 2	-0.104	-0.115	-0.09	-0.09	-0.153	-0.063	-0.09	-0.092	-0.081
	[0.026]***	[0.036]***	[0.039]**	[0.073]	[0.070]**	[0.059]	[0.050]*	[0.051]*	[0.070]
Asset quintile 3	-0.09	-0.06	-0.118	-0.074	-0.003	-0.089	-0.158	-0.042	-0.204
	[0.033]***	[0.046]	[0.048]**	[0.088]	[0.088]	[0.078]	[0.061]**	[0.064]	[0.092]**
Asset quintile 4	-0.033	-0.047	-0.016	-0.059	-0.058	0.124	-0.072	-0.051	-0.067
	[0.031]	[0.042]	[0.045]	[0.085]	[0.080]	[0.069]*	[0.059]	[0.059]	[0.082]
Scheduled caste	-0.122	-0.155	-0.086	-0.205	-0.085	-0.13	-0.056	-0.229	-0.023
	[0.035]***	[0.048]***	[0.053]	[0.097]**	[0.088]	[0.085]	[0.067]	[0.070]***	[0.091]
Scheduled tribe	0.001	-0.008	0.011	0.264	-0.2	-0.071	-0.083	0.068	-0.077
	[0.050]	[0.068]	[0.074]	[0.127]**	[0.122]	[0.116]	[0.099]	[0.104]	[0.154]
Other backward groups	0.005	0.014	-0.007	-0.024	0.036	-0.014	0.048	-0.036	-0.007
	[0.019]	[0.026]	[0.028]	[0.052]	[0.049]	[0.043]	[0.035]	[0.037]	[0.052]
Piped water	-0.032	-0.057	0	0.006	-0.086	-0.079	0.001	-0.039	0.042
	[0.019]	[0.027]**	[0.029]	[0.052]	[0.051]*	[0.044]*	[0.037]	[0.038]	[0.053]
Flush toilet	0.025	0.018	0.034	0.037	-0.036	0.052	0.1	0.069	-0.03
	[0.041]	[0.055]	[0.060]	[0.111]	[0.104]	[0.088]	[0.075]	[0.081]	[0.122]
Pit toilet	0.053	0.076	0.031	0.134	-0.026	0.078	0.1	0.066	-0.049
	[0.036]	[0.049]	[0.053]	[0.099]	[0.093]	[0.079]	[0.066]	[0.072]	[0.111]
Child's village has an AWC	**0.002**	**0.015**	**-0.011**	**-0.049**	**0.027**	**-0.006**	**-0.001**	**0.049**	**0.095**
	[0.019]	**[0.026]**	**[0.028]**	**[0.052]**	**[0.050]**	**[0.044]**	**[0.036]**	**[0.037]**	**[0.052]***
Constant	-0.571	-0.923	-0.578	-0.413	-1.156	-1.594	-1.304	-1.352	-1.216
	[0.106]***	[0.142]***	[0.157]***	[0.271]	[0.262]***	[0.238]***	[0.194]***	[0.214]***	[0.303]***
Observations	11349	5840	5509	2400	2146	2060	1958	1578	1207
R-squared	0.1	0.06	0.08	0.04	0.06	0.04	0.04	0.07	0.1

Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Not only is there no significant association between the presence of an ICDS program and improved child nutritional status, but ICDS also does not appear to be associated with improvements in the care and feeding behaviors that are proximate determinants of child nutritional status, and which ICDS is designed to improve. Only in the case of deworming do we observe that health behaviors are better in villages with AWCs than in villages without AWCs. Indeed, almost all other behaviors – including most breastfeeding practices and micronutrient consumption - are statistically better in villages *without* AWCs.

Table 6 Comparison of intermediate health outcomes and behaviors across children living in villages with and without an AWC

	In villages:	**Kerala**
Percentage over 6 mths receiving Vitamin A supplementation	Without AWCs	81.2
	With AWCs	78.3***
Percentage older than 12 months dewormed	Without AWCs	61.1
	With AWCs	**66.3*****
Percentage over 6 mths consuming Vitamin A-rich food	Without AWCs	78.1
	With AWCs	72.0***
Percentage breastfed within 1 hour of delivery	Without AWCs	85.6
	With AWCs	80.0***
Percentage consuming colostrums	Without AWCs	98
	With AWCs	96.9***
Percentage under 6 mths who are exclusively breastfed	Without AWCs	67.1
	With AWCs	58.2***
Percentage aged 6-9 mths consuming complementary food	Without AWCs	84.1
	With AWCs	87.7
Mean duration of breastfeeding, among children who have been weaned	Without AWCs	13.4 mths
	With AWCs	12.5 mths***

Notes: * statistically significant at the 10% level; ** statistically significant at the 5% level; *** statistically significant at the 1% level; **Boldface** indicates where outcomes are significantly *better* in villages with AWCs

7.2 Exploring endogenous program placement as an explanation for "no program effect"

The failure to find a positive effect of the presence of an AWC on nutritional status may be because the estimations are plagued by the endogeneity of the key explanatory variable. If the placement of AWCs in villages is endogenous, then $\text{corr}(X_{AWC},\varepsilon_i)\neq 0$ and β_{AWC} would be biased. Specifically, if AWCs are placed in those villages with the poorest nutrition indicators, the effect of the AWC on reducing malnutrition will be underestimated. It may appear to be insignificant (as in this case), or even positively associated with malnutrition, when the lack of correlation (or positive correlation) in fact reflects appropriate targeting of public investments. In addition, nutritional status and the placement of an AWC in a village may be determined contemporaneously by common unobservable factors, resulting in simultaneity bias.

In the absence of pre- and post-program data on treatment and control groups, the standard solution for this endogeneity is two-stage estimation, first estimating AWC presence and then using the predicted values of AWC presence to estimate nutritional status. However, we not have appropriate instrumental variable(s) that satisfy the exclusion restrictions. For example, there are no data on village size, access to paved roads, political affiliations etc. Observable factors that may influence whether a village or block has an AWC, in addition to nutritional status of village, include village wealth and caste composition, but these are all correlated with nutritional status.

Although two-stage estimation is not feasible, village-level regressions of AWC presence on village wealth (which is assumed to be correlated with nutritional status) can shed light on the possible direction of the bias on β_{AWC}. A simple probit model reveals that the presence of an AWC in the village is significantly and *positively* correlated with the wealth of the village (as captured by the mean quintile of the inhabitants) (See Table 13, Appendix C). Thus, there is no clear support for the hypothesis that the lack of program effect found in the models can be attributed to a negative bias on β_{AWC} induced by the ICDS being placed in poorer (and thus more nutritionally deprived) villages.

7.3 Exploring the potential confounding effect of the length of time that the AWC/program has been established in a particular village/ward as an explanation for "no program effect"

Another possible explanation for the observed lack of program effect is a failure to control for the length of time that the AWC has been established in a village/ward. This may be an important confounding variable, and there are a number of pathways by which its exclusion can be hypothesized to bias the initially observed effect of the AWC. First, it takes time for information about the activities of the AWC and its potential benefits to diffuse through the community. Second, older centers may function better since they are likely to have more experienced AWWs, well-established facilities, and a history of community and local government support of activities. Third, the maximum potential length of exposure of children to the program is shorter in the subset of centers that are less than 6 years old than in the other centers. All these hypotheses suggest that failure to include the age of the AWC as a potential confounding variable may bias the coefficient downwards, underestimating program effect; one expects to observe a stronger effect of the AWC in those villages in which the program has been established for a longer time.

The most theoretically plausible operationalization of the age of AWC variable, i.e. the one that most closely captures the hypotheses about the relationship between the age of the AWC and its effectiveness, is one where separate dummy variables are constructed for AWCs that are less than or equal to three years old (3.4 % of sample), AWCs that are four to six years old (1.4 % of sample), AWCs that are 7 to 14 years old (10.6% of sample) and AWCs that are 15 to 25 years old (41.3% of sample), with an excluded category of villages with no center (42.3% of sample)[15].

In Table 7, we see that that in villages with the newest AWCs (i.e. less than 4 years old), children tend to have significantly better nutritional status than children in villages without AWCs. This result is observed in all models: the base model, gendered models and most age-specific models. By contrast, children who live in villages that have had AWCs for 4-6 years, 7 to 14 years or 15 to 25 years do not have significantly better weight-for-age z-scores than children who live in villages without AWCs. Not only are the coefficients insignificant, but they are not even in the hypothesized direction. The probit model (see Appendix C, Table 14) reveals the same strong relationship for the youngest set of ICDS programs: children living in villages with a recently-established ICDS program, but not in villages with older ICDS programs, are less likely to be underweight than children living in villages without the program. Unlike in the OLS model, a significant effect is also observed in the base model for the oldest AWCs (15 to 25 years old), as well as in the age-specific models for the under 12 month and 60-71 month age categories.

In general, the relationship between the age of the AWC and nutritional status is the opposite of what was originally hypothesized[16]. There may be something about the new AWCs that is positive for child nutrition. Perhaps new AWCs have better equipment, supplies that are not yet depleted and AWWs who have undergone training in the more recent growth promotion methodologies. However, this may also be an anomalous result.

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[15] Other operationalizations of the "age of AWC" variable were experimented with, including a continuous (interval) measure and different categorizations of the variable, but did not yield any significant results.

[16] These results also do not seem to reflect endogenous program placement. Village-level regressions that model some factors that might affect how long an AWC has been established in a village find no significant associations with socioeconomic variables, such as village wealth, village caste composition or the percentage of mothers in the village that have completed secondary education, that might be associated with program age, and lead one to under- or overestimate program effect (see Table 12 in Appendix C).

Table 7 OLS model of the effect of living in a village/ward with AWC on weight-for-age z-scores, controlling for AWC age

	Base model	Boys	Girls	0-11 mths	12-23 mths	24-35 mths	36-47 mths	48-59 mths	60-71 mths
No AWC in village [excluded]									
AWC is less than 4 years old	0.237	0.218	0.257	0.396	0.298	0.065	0.284	0.182	0.067
	[0.048]***	[0.065]***	[0.072]***	[0.131]***	[0.116]***	[0.111]	[0.090]***	[0.100]*	[0.148]
AWC is 4 to 6 years old	-0.051	0.093	-0.175	0.078	-0.153	0.06	-0.195	0.158	-0.048
	[0.076]	[0.111]	[0.104]*	[0.204]	[0.173]	[0.180]	[0.138]	[0.173]	[0.231]
AWC is 7 to 14 years old	-0.019	-0.001	-0.036	-0.125	0.016	0.001	-0.002	0.034	0.054
	[0.021]	[0.029]	[0.031]	[0.057]**	[0.056]	[0.048]	[0.039]	[0.040]	[0.057]
AWC is 15 to 25 years old	-0.046	-0.031	-0.061	-0.04	-0.016	-0.068	-0.094	-0.04	0.135
	[0.030]	[0.041]	[0.044]	[0.081]	[0.077]	[0.069]	[0.055]*	[0.059]	[0.082]*
Constant	-0.536	-0.915	-0.509	-0.386	-1.108	-1.589	-1.248	-1.322	-1.203
	[0.106]***	[0.142]***	[0.158]***	[0.272]	[0.262]***	[0.239]***	[0.194]***	[0.215]***	[0.303]***
Observations	11349	5840	5509	2400	2146	2060	1958	1578	1207
R-squared	0.1	0.06	0.08	0.05	0.06	0.04	0.05	0.07	0.1
F(two younger AWC variables)	12.38***	5.87***	8.02***	4.59**	3.86**	0.22	6.23***	2.01	0.13
F(two older AWC variables)	1.27	0.32	1.24	2.46*	0.1	0.57	1.67	0.89	1.44

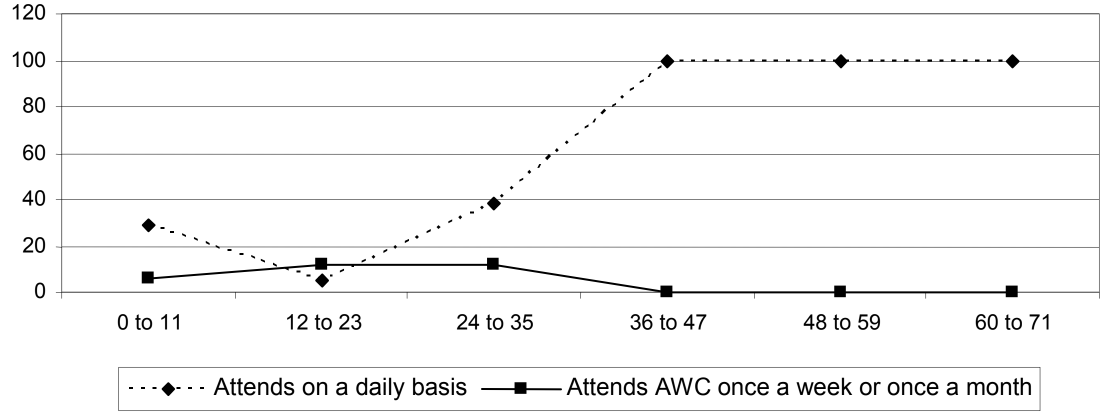
Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Note: Other covariates have been suppressed. These covariates are the same as in Table 3 and include child's age, child's age squared, child's gender, mother's education, mother's age of marriage, gender of household head, asset quintile, caste, piped water, and type of toilet.

8. THE EFFECT OF ACTUAL PARTICIPATION IN THE ICDS PROGRAM ON CHILD NUTRITIONAL STATUS

One reason why the original OLS models failed to find much evidence of program effect may be that children who live in villages with AWCs do not attend the AWC frequently enough to benefit from its interventions. Indeed, attendance rates are very low among children under 36 months of age, something that is of particular concern in light of the evidence that most growth faltering occurs during the first two years of life (Shrimpton 2001). By contrast, in the upper age group, all mothers interviewed in villages with AWCs claim that their children attend the AWC on a daily basis.

Figure 3 Percentage children attending, by child's age (mths), in villages with AWCs



Although there may be some upward bias on the attendance figures, since they are based on mothers' self-reports, the large gap in the attendance of under-threes and three to six year olds has been observed in other states, and other studies of ICDS too. The reason for this is that, in its practical implementation, the ICDS program's main focus has gradually become food supplementation and preschool education for 3 to 6 year olds, to the neglect of the interventions related to children under 3, especially those aged 6 to 24 months (Measham and Chatterjee 1999). This is aggravated by community perceptions that ICDS is first and foremost a preschool education program (indeed, even the name *anganwadi* means "courtyard for playing") and thereafter a universal food supplementation program, with little awareness of the nutrition and health promotion functions.

To examine the hypothesis that poor attendance may be driving the lack of observed program effect, this section will compare the nutritional status of children who attend the AWC on a regular basis to those who never attend. To capture the effect of attendance on nutritional outcomes, three intensities of participation are examined: those children whose mothers report that they currently attend the AWC on a daily basis, those whose mothers report that they currently attend once a week or once a month and those who do not currently attend. All these variables are constructed conditional on their being an AWC in the village/ward. The analysis is restricted to children under the age of three years that live in villages with AWCs. Age-specific models cannot be estimated for the older age categories since there is no variation in the attendance of children aged between 36 and 71 months.

A major methodological concern is the potential endogeneity of program participation. One potential source of bias is the inability to control for the *mother's perception of the child's nutritional status*. Mothers who consider their children to be of low nutritional status may be more likely to send their children to the AWC resulting in a reverse causality that leads to an underestimation of the impact of attendance on nutritional status. However, since all women in this sample report that their children are experiencing "normal growth" there is insufficient variation on this variable to provide any information. The mother's perception of her child's nutritional status is, thus, unobservable. Another potential source of bias arises if there is *explicit targeting of malnourished children.* Indeed, in the interests of efficient targeting of resources, AWWs are supposed to encourage the participation of malnourished children. This is an additional potential source of endogeneity: if malnourished children are more likely to attend the program, there will be a downward bias on the program variable of interest, and an underestimation of program effect. Once again, appropriate instruments for a two-stage approach[17] to this issue, such as distance to the AWC or the attendance of siblings, are not available in the dataset.

In the base model (Table 8), it is found that children under three who attend the AWC once a month or once a week have weight-for-age z-scores that are 0.11 standard deviations higher than children who do not attend, but there is no significant effect for daily attendees. Nor does participation in the ICDS scheme appear to affect nutritional status in the gendered models. In age-specific models, however, important AWC effects are observed for particular age categories. While no significance is found for children under 12 months, the growth effects of attending the AWC on a daily basis are very strong and highly significant for children older than 12 months. Indeed, in the 12-23 month age category, children who attend the AWC every day have weight-for-age z-scores that are 0.33 standard deviations higher than children who do not attend the

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[17] Such an approach would entail predicting program participation (frequency of attendance) using an instrumental variable in the first stage and then examining how nutritional status varies with predicted participation in the second stage.

AWC and children aged 24-35 months have z-scores that are 0.22 standard deviations higher than children who do not attend. It is noteworthy that, in these age categories, there appear to be no nutritional gains from less frequent attendance.

Table 8 OLS model of the effect of varying frequencies of attendance at the AWC on weight-for-age z-scores

	Base model	Boys	Girls	0-11 mths	12-23 mths	24-35 mths
Child's age in months	-0.07	-0.075	-0.065			
	[0.009]***	[0.012]***	[0.012]***			
Child's age squared	0.001	0.002	0.001			
	[0.000]***	[0.000]***	[0.000]***			
Male child	-0.355			-0.388	-0.375	-0.323
	[0.034]***			[0.067]***	[0.060]***	[0.051]***
Mother can read and write	0.276	0.273	0.287	0.266	0.198	0.425
	[0.113]**	[0.160]*	[0.161]*	[0.206]	[0.209]	[0.173]**
Mother has high school education	0.249	0.271	0.229	0.281	0.135	0.361
	[0.112]**	[0.159]*	[0.160]	[0.204]	[0.209]	[0.171]**
Mother has college education	0.372	0.388	0.36	0.366	0.299	0.521
	[0.116]***	[0.163]**	[0.166]**	[0.211]*	[0.215]	[0.176]***
Mother's age at marriage	0.01	0	0.021	0.004	0.006	0.018
	[0.006]*	[0.008]	[0.009]**	[0.011]	[0.010]	[0.009]*
Male is household head	-0.015	-0.026	-0.012	0.054	-0.121	0.027
	[0.048]	[0.070]	[0.067]	[0.093]	[0.082]	[0.075]
Asset quintile 1	-0.207	-0.185	-0.246	-0.17	-0.239	-0.182
	[0.069]***	[0.095]**	[0.103]**	[0.138]	[0.120]**	[0.103]*
Asset quintile 2	-0.105	-0.068	-0.145	-0.04	-0.143	-0.109
	[0.051]**	[0.070]	[0.074]**	[0.101]	[0.089]	[0.074]
Asset quintile 3	-0.06	-0.033	-0.087	-0.127	-0.032	-0.054
	[0.065]	[0.090]	[0.094]	[0.120]	[0.116]	[0.101]
Asset quintile 4	0.054	0.033	0.081	0.068	-0.036	0.107
	[0.059]	[0.082]	[0.087]	[0.118]	[0.104]	[0.087]
Scheduled caste	-0.119	-0.126	-0.101	-0.309	0.139	-0.326
	[0.075]	[0.101]	[0.113]	[0.157]**	[0.120]	[0.119]***
Scheduled tribe	-0.097	-0.145	-0.044	0.322	-0.516	-0.23
	[0.100]	[0.143]	[0.141]	[0.183]*	[0.183]***	[0.154]
Other backward groups	-0.007	-0.012	-0.001	-0.025	0.071	-0.075
	[0.038]	[0.052]	[0.056]	[0.075]	[0.066]	[0.058]
Piped water	-0.081	-0.137	-0.015	-0.037	-0.143	-0.076
	[0.036]**	[0.049]***	[0.052]	[0.070]	[0.062]**	[0.053]
Flush toilet	-0.101	-0.047	-0.171	-0.158	-0.034	-0.069
	[0.079]	[0.109]	[0.116]	[0.172]	[0.133]	[0.114]
Pit toilet	-0.041	0.047	-0.143	-0.095	-0.026	0.003
	[0.072]	[0.100]	[0.104]	[0.158]	[0.120]	[0.105]
Child never attends the AWC [excluded]						
Child attends the AWC once a week or once a month	**0.11**	**0.111**	**0.114**	**0.219**	**0.045**	**0.124**
	[0.060]*	**[0.082]**	**[0.088]**	**[0.147]**	**[0.096]**	**[0.085]**
Child attends the AWC every day	**0.082**	**0.084**	**0.091**	**0.092**	**0.33**	**0.216**
	[0.052]	**[0.073]**	**[0.075]**	**[0.078]**	**[0.147]****	**[0.055]*****
Constant	-0.395	-0.59	-0.567	-0.672	-0.933	-1.654
	[0.199]**	[0.275]**	[0.289]*	[0.368]*	[0.329]***	[0.291]***
Observations	3192	1631	1561	1011	1133	1048
R-squared	0.11	0.08	0.09	0.05	0.07	0.09
F test for joint significance of attendance variables	2.54*	1.36	1.38	1.56	2.56*	7.91***

Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

The results of the probit model (see Appendix C, Table 15) highlight, one again, the importance of looking at the effect of attendance at a particular health and policy-relevant cut-point rather than at average increases in z-scores across the entire z-score distribution. They show that while there was no overall significant increase in z-scores as a result of attendance, daily attendance at the AWC does appear to play a significant role in reducing the likelihood of a child being underweight. In the base model, the probability of being underweight falls by 4.1 percentage points if a child attends the AWC on a daily basis. In the gendered models, it can be seen that attendance benefits girls rather than boys: the probability of being underweight falls by 4.8 percentage points for girls who attend the AWC on a daily basis, but no significant effect is observed for boys. In the age-specific models, only among children in the 24-35 month age category is daily attendance associated with a (large) reduction in the probability of underweight (marginal effect of 0.089). As in the OLS model, it appears that less frequent attendance (once a month or once a week) is not sufficient to effect significant changes in nutritional status. Only in the 0-11 month age category is a significant reduction in underweight observed for less frequent attendance.

9. SUMMARY OF FINDINGS

9.1 Socioeconomic correlates of nutritional status

While the covariates included in the series of reduced-form child health models in the first part of the paper are similar to those employed in previous studies, the attempt to examine their gender-specific and age-specific effects is less common and yields some interesting results, especially with respect to maternal education. The findings show that if one is interested in improving the nutritional status of young girls, programs that improve the status of mothers and alleviate poverty may help: mother's status is positively associated with girls' nutritional status, but not with boys, and being in the lowest wealth quintile has a much larger (negative) effect on girls' status than on boys'. On the other hand, although both girls and boys appear to benefit from improvements in literacy, boys seem more likely to benefit from improvements in mothers' schooling attainment: in OLS models, maternal literacy has an effect that is of equal magnitude on both girls' and boys' nutritional status, but college education has a larger (positive) effect on boys' nutritional status than on girls'; in probit models, maternal education also has a much larger mitigating effect on the probability that boys are underweight than it has on the probability that girls are underweight. Belonging to a scheduled caste household has a negative effect on boys' nutritional status, but not on girls. The age-specific models show that maternal education is significant in later childhood, but fail to find any effect in the first two years of life.

The other interesting finding that emerges from the socioeconomic correlates models is that, in Kerala, girls appear to have better nutritional status than boys. This result holds across all age categories and is robust to both OLS and probit specifications. Although in line with some other findings in the region (see section 6), it contradicts conventional wisdom on gender and malnutrition in India and South Asia. It also highlights the need for state-specific research into the socioeconomic determinants of child nutritional status in India, and cautions against using results obtained at the national level to make policy recommendations at the state level.

9.2 Impact of ICDS on nutritional status

In the second part of the paper, examining the effect of the ICDS program on nutritional status, initial models fail to find evidence of impact.

One possible explanation for the lack of significance is that program placement is endogenous, specifically that *anganwadi* centers are more likely to be placed in the villages with the poorest nutritional status. However, village-level regressions show that it is in fact the *wealthier* villages (which one expects to also have the best nutritional status) that are more likely to have the program.

Another possible explanation for the lack of program effect in the initial models may be a failure to adjust models to allow for the possibility that the effect of the ICDS program may vary by the length of time that the AWC has been established in the village. When the age of the AWC is included as an explanatory variable, the results are mixed. While there do appear to be positive effects of ICDS for the newest AWCs in both the OLS and the probit models, this effect is contrary to our theoretical hypothesis that one would observe more impact in villages where centers have been established for a longer time, and is probably an anomalous result.

The third part of the paper, which captures the effect of young children's program participation on their nutritional status, suggests that the program does have some impact on the nutritional status of those children who actually attend. Results from the probit base model show that daily (but not less frequent) attendance at the AWC does appear to play a significant role in reducing the likelihood of a child being underweight. The probit model also provides evidence of a gendered effect: daily attendance reduced the probability of underweight for girls but not for boys. In the age-specific models, a significant effect is only found for the oldest age category, 24-35 months. Moreover, since we cannot overcome any potential endogeneity bias arising from over-participation among the more malnourished children – indicative of good targeting – these results may underestimate the true extent of program impact.

Taken together, these findings suggest that poor attendance is an important factor driving the effectiveness of the program, and may explain why the original models (where the presence of *anganwadi* center was the key explanatory variable, section 7.1) failed to find an impact of the program. Simply having a program in the village does not seem to be enough to effect statistically measurable changes in nutritional status.

10. CONCLUSION

ICDS tends to reach 3 to 6 year olds more easily than younger children, possibly because of the popularity of its preschool component. Children under 3 are brought less regularly to the AWC and, so, the ICDS intervention tends to miss much of its most critical nutrition target group. Failing to reach young children is of great concern: most growth faltering occurs during the first two years of life and it negatively affects children's development all through their lives. This paper shows that ICDS can indeed have a measurable impact on the nutritional status of young children who attend; children under three who participate in the ICDS program are less likely to be malnourished than those who do not attend. Consequently, a more concerted effort needs to be made to recruit young children into the program. Perhaps this can occur through reaching out to women effectively while they are still pregnant or at birth. Succeeding in this effort would produce a shift towards preventing malnutrition instead of just treating older malnourished children - when it is often already too late to recover their growth trajectory.

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APPENDIX A Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Dependent variables					
Standardized weight-for-age (z-score)	11,349	-1.00	0.96	-6	5.82
Underweight	11,349	0.11	0.31	0	1
Child characteristics					
Age (mths)	11,349	31.13	19.74	0	71
Age is less than 12 mths	11,349	0.21	0.41	0	1
Age is 12 months to less than 24 mths	11,349	0.19	0.39	0	1
Age is 24 months to less than 36 mths	11,349	0.18	0.39	0	1
Age is 36 months to less than 48 mths	11,349	0.17	0.38	0	1
Age is 48 months to less than 60 mths	11,349	0.14	0.35	0	1
Age is 60 months to less than 72 mths	11,349	0.11	0.31	0	1
Gender (male=1)	11,349	0.51	0.50	0	1
Mother's characteristics					
Mother is illiterate	11,349	0.02	0.14	0	1
Mother can read and write	11,349	0.27	0.44	0	1
Mother has high school education	11,349	0.45	0.5	0	1
Mother has college education	11,349	0.26	0.44	0	1
Age at marriage	11,349	21.69	2.90	16	35
Father is head of household (yes=1)	11,349	0.86	0.35	0	1
Household wealth					
Asset quintile 1	11,349	0.16	0.36	0	1
Asset quintile 2	11,349	0.39	0.49	0	1
Asset quintile 3	11,349	0.10	0.30	0	1
Asset quintile 4	11,349	0.13	0.33	0	1
Asset quintile 5	11,349	0.22	0.41	0	1
Household caste					
Scheduled caste	11,349	0.07	0.26	0	1
Scheduled tribe	11,349	0.04	0.18	0	1
Other backward group	11,349	0.54	0.50	0	1
Forward caste	11,349	0.35	0.48	0	1
Water supply					
Piped water	11,349	0.39	0.49	0	1
Toilet facilities					
Flush toilet	11,349	0.34	0.47	0	1
Pit toilet	11,349	0.58	0.49	0	1
No toilet	11,349	0.08	0.27	0	1
Program variables					
ICDS scheme (AWC) in the village	11,349	0.58	0.49	0	1
AWC is less than three years old	11,349	0.03	0.18	0	1
AWC is four to six years old	11,349	0.01	0.12	0	1
AWC is seven to fourteen years old	11,349	0.41	0.49	0	1
AWC is fifteen to twenty-five years old	11,349	0.11	0.31	0	1
Child attends AWC on a daily basis	5,657	0.57	0.5	0	1
Child attends AWC once a month or once a week	5,657	0.05	0.23	0	1
Child never attends the AWC	5,657	0.38	0.49	0	1

APPENDIX B Construction of asset/wealth quintiles using principal components analysis

Asset/wealth quintiles for each state were constructed through the application of principal components analysis, in two steps, following the methodology employed by Filmer and Pritchett (2001) and Pande and Yazbek (2002).

The questionnaire included a number questions related to the household's housing features and possession of assets, similar to those includes in the NFHS surveys. These items include: (i) Assets: Radio, television, bullock-cart, bicycle, motorcycle, tractor/thresher/power tiller, car, livestock (ii) Housing features: home ownership, building materials (kutcha/semi-pucca/pucca), fuel (wood, coal, kerosene, electricity, LP gas, other), lighting (electricity, kerosene, LP gas, oil, none), drinking water (piped, well, surface, other), toilet (flush, pit, nothing). Since these questions are a subset of the asset questions asked in NFHS II, the corresponding set of asset questions from NFHS II could be used to obtain quintile cut-offs (based on principal components f-score) for the NFHS data. These cut-offs were then applied to the f score generated, also by principal components analysis, for the ICDS data to obtain the ICDS quintiles.

Consequently, the ICDS quintile measure captures where the household would rank within the (randomly sampled) NFHS II sample, not its ranking within the ICDS data set. This methodology enables statements to be made about ICDS households that are generalizable to households from the corresponding quintiles in the state, even if sampling of ICDS respondents was not altogether random. Indeed, the fact that the sampled ICDS households fall rather disproportionately into the upper quintiles suggests that those households that were recruited into the ICDS study are not fully representative of the state, at least in terms of asset ownership.

Table 9 Percentage observations falling within each "quintile"

	Quintile 1	**Quintile 2**	**Quintile 3**	**Quintile 4**	**Quintile 5**
	15.8%	39.1%	10.2%	12.8%	22.1%

APPENDIX C Probit models

Table 10 Probit model of socioeconomic correlates of underweight

Dependant variable: Child is underweight (weight-for-age z-score <-2)

	Base model	**Boys**	**Girls**	**0-11 mths**	**12-23 mths**	**24-35 mths**	**36-47 mths**	**48-59 mths**	**60-71 mths**
Child's age in months	0.002	0.001	0.002						
	[0.001]***	[0.001]	[0.001]***						
Child's age squared	0	0	0						
	[0.000]***	[0.000]	[0.000]***						
Male child	0.052			0.027	0.08	0.051	0.025	0.043	0.11
	[0.006]***			[0.010]***	[0.015]***	[0.014]***	[0.013]**	[0.015]***	[0.018]***
Mother can read and write	-0.059	-0.072	-0.047	0.019	-0.091	-0.078	-0.066	-0.068	-0.12
	[0.016]***	[0.025]***	[0.019]**	[0.040]	[0.040]**	[0.038]**	[0.034]*	[0.046]	[0.040]***
Mother has high school education	-0.047	-0.056	-0.038	0.018	-0.082	-0.067	-0.053	-0.032	-0.152
	[0.019]**	[0.030]*	[0.023]*	[0.036]	[0.049]*	[0.048]	[0.041]	[0.054]	[0.059]***
Mother has college education	-0.056	-0.073	-0.04	-0.005	-0.084	-0.076	-0.067	-0.034	-0.122
	[0.016]***	[0.026]***	[0.020]**	[0.036]	[0.043]*	[0.039]*	[0.029]**	[0.048]	[0.040]***
Mother's age at marriage	-0.001	-0.001	-0.002	0.001	-0.004	-0.004	0	-0.003	0.001
	[0.001]	[0.002]	[0.001]	[0.002]	[0.003]	[0.003]	[0.002]	[0.003]	[0.003]
Male is household head	0.01	0.007	0.014	0.005	0.013	0.028	0.013	0.017	-0.018
	[0.008]	[0.013]	[0.010]	[0.014]	[0.020]	[0.020]	[0.017]	[0.020]	[0.030]
Asset quintile 1	0.064	0.071	0.057	0.021	0.056	0.101	-0.011	0.086	0.18
	[0.015]***	[0.022]***	[0.019]***	[0.024]	[0.035]	[0.037]***	[0.024]	[0.042]**	[0.060]***
Asset quintile 2	0.034	0.026	0.043	-0.003	0.031	0.046	0.018	0.052	0.084
	[0.009]***	[0.014]*	[0.013]***	[0.016]	[0.024]	[0.024]*	[0.020]	[0.026]**	[0.032]***
Asset quintile 3	0.008	-0.009	0.025	-0.005	-0.045	0.024	0.036	0.013	0.048
	[0.012]	[0.018]	[0.017]	[0.019]	[0.026]*	[0.033]	[0.029]	[0.034]	[0.047]
Asset quintile 4	0.014	0.008	0.019	0.007	-0.011	-0.022	0.015	0.048	0.066
	[0.011]	[0.017]	[0.016]	[0.020]	[0.027]	[0.025]	[0.026]	[0.035]	[0.043]
Scheduled caste	0.017	0.013	0.02	0.031	-0.009	0.034	-0.026	0.066	0.022
	[0.012]	[0.018]	[0.016]	[0.025]	[0.028]	[0.034]	[0.021]	[0.039]*	[0.037]
Scheduled tribe	0.022	0.016	0.027	-0.016	0.13	-0.009	0.015	0.02	0.023
	[0.018]	[0.027]	[0.024]	[0.024]	[0.053]**	[0.040]	[0.041]	[0.051]	[0.065]
Other backward groups	-0.008	-0.014	-0.003	-0.004	-0.01	-0.004	-0.018	0.005	-0.021
	[0.006]	[0.010]	[0.008]	[0.012]	[0.016]	[0.016]	[0.014]	[0.017]	[0.020]
Piped water	0	0.008	-0.008	-0.004	0.008	-0.004	0.008	0.016	-0.048
	[0.006]	[0.009]	[0.008]	[0.011]	[0.016]	[0.015]	[0.013]	[0.016]	[0.018]***
Flush toilet	0.016	0.026	0.006	-0.025	0.074	0.036	-0.032	0.002	0.056
	[0.013]	[0.021]	[0.016]	[0.021]	[0.039]*	[0.034]	[0.025]	[0.034]	[0.049]
Pit toilet	-0.015	-0.015	-0.014	-0.051	0.051	-0.015	-0.05	-0.019	-0.008
	[0.012]	[0.018]	[0.015]	[0.021]**	[0.031]*	[0.029]	[0.026]*	[0.030]	[0.041]
Observations	11349	5840	5509	2400	2146	2060	1958	1578	1207
F (add education variables)	16.9***	11.62***	6.18	3.5	4.5	4.5	6.05	6.84*	6.69*
F (all water and toilet variables)	18.68***	13.72***	7.08*	8.92**	4.05	8.07**	4.9	2.47	15.85***

Standard errors in brackets

Interpretation: Change in the probability for an infinitesimal change in each independent, continuous variable; discrete change in the probability for dummy variables (marginal effects).

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 11 Probit model of the effect of living in a village/ward with an AWC on underweight

Dependant variable: Child is underweight (weight-for-age z-score <-2)

	Base model	**Boys**	**Girls**	**0-11 mths**	**12-23 mths**	**24-35 mths**	**36-47 mths**	**48-59 mths**	**60-71 mths**
Child's age in months	0.002	0.001	0.002						
	[0.001]***	[0.001]	[0.001]***						
Child's age squared	0	0	0						
	[0.000]***	[0.000]	[0.000]***						
Male child	0.052			0.027	0.08	0.05	0.025	0.043	0.111
	[0.006]***			[0.010]**	[0.015]***	[0.014]***	[0.013]**	[0.015]***	[0.018]***
Mother can read and write	-0.061	-0.075	-0.048	0.015	-0.093	-0.082	-0.068	-0.069	-0.122
	[0.016]***	[0.025]***	[0.019]**	[0.039]	[0.040]**	[0.037]**	[0.034]**	[0.046]	[0.039]***
Mother has high school education	-0.05	-0.061	-0.04	0.014	-0.085	-0.073	-0.055	-0.034	-0.157
	[0.019]***	[0.030]**	[0.023]*	[0.036]	[0.049]*	[0.049]	[0.041]	[0.054]	[0.059]***
Mother has college education	-0.059	-0.077	-0.042	-0.01	-0.087	-0.08	-0.069	-0.036	-0.124
	[0.016]***	[0.025]***	[0.020]**	[0.035]	[0.043]**	[0.039]**	[0.029]**	[0.048]	[0.039]***
Mother's age at marriage	-0.001	-0.001	-0.002	0.001	-0.004	-0.004	0	-0.003	0.001
	[0.001]	[0.002]	[0.001]	[0.002]	[0.003]	[0.003]	[0.002]	[0.003]	[0.003]
Male is household head	0.01	0.007	0.013	0.005	0.012	0.027	0.013	0.017	-0.018
	[0.008]	[0.013]	[0.010]	[0.014]	[0.020]	[0.020]	[0.017]	[0.020]	[0.029]
Asset quintile 1	0.062	0.07	0.056	0.018	0.054	0.1	-0.012	0.085	0.176
	[0.014]***	[0.022]***	[0.019]***	[0.024]	[0.035]	[0.037]***	[0.024]	[0.042]**	[0.059]***
Asset quintile 2	0.034	0.025	0.042	-0.005	0.03	0.046	0.017	0.051	0.083
	[0.009]***	[0.014]*	[0.013]***	[0.016]	[0.024]	[0.024]*	[0.020]	[0.026]**	[0.032]**
Asset quintile 3	0.007	-0.01	0.025	-0.006	-0.045	0.023	0.036	0.012	0.046
	[0.012]	[0.017]	[0.017]	[0.019]	[0.026]*	[0.033]	[0.029]	[0.034]	[0.046]
Asset quintile 4	0.013	0.007	0.019	0.005	-0.012	-0.022	0.014	0.047	0.065
	[0.011]	[0.017]	[0.016]	[0.020]	[0.027]	[0.025]	[0.026]	[0.034]	[0.043]
Scheduled caste	0.016	0.013	0.02	0.029	-0.009	0.035	-0.026	0.065	0.025
	[0.012]	[0.018]	[0.016]	[0.025]	[0.028]	[0.035]	[0.021]	[0.039]*	[0.038]
Scheduled tribe	0.022	0.016	0.027	-0.014	0.13	-0.007	0.015	0.02	0.027
	[0.018]	[0.027]	[0.024]	[0.024]	[0.053]**	[0.041]	[0.041]	[0.051]	[0.067]
Other backward groups	-0.008	-0.013	-0.003	-0.004	-0.01	-0.002	-0.017	0.005	-0.02
	[0.006]	[0.010]	[0.008]	[0.012]	[0.017]	[0.016]	[0.014]	[0.017]	[0.020]
Piped water	0.004	0.014	-0.005	0.001	0.014	0.003	0.011	0.018	-0.042
	[0.007]	[0.010]	[0.008]	[0.012]	[0.017]	[0.017]	[0.015]	[0.017]	[0.020]**
Flush toilet	0.016	0.028	0.006	-0.025	0.073	0.037	-0.031	0.003	0.058
	[0.013]	[0.021]	[0.016]	[0.021]	[0.039]*	[0.034]	[0.025]	[0.034]	[0.049]
Pit toilet	-0.016	-0.016	-0.015	-0.053	0.049	-0.018	-0.05	-0.019	-0.009
	[0.012]	[0.018]	[0.015]	[0.021]**	[0.031]	[0.029]	[0.026]*	[0.030]	[0.041]
Child's village has an AWC	-0.01	-0.015	-0.007	-0.014	-0.015	-0.017	-0.006	-0.005	-0.018
	[0.006]	[0.010]	[0.008]	[0.012]	[0.017]	[0.017]	[0.014]	[0.016]	[0.020]
Observations	11349	5840	5509	2400	2146	2060	1958	1578	1207

Standard errors in brackets

Interpretation: Change in the probability for an infinitesimal change in each independent, continuous variable; discrete change in the probability for dummy variables (marginal effects).

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 12 Village-level OLS model of the correlates of the timing of AWC presence

Dependent variable: Years that AWC has been present in village	
Mean wealth quintile	0.42
	[0.771]
Share of village population that is of forward caste	-1.57
	[2.094]
Share of mothers with a high school education or more	-3.17
	[2.717]
Constant	17.29
	[2.152]
Observations	89
R-squared	0.0247

Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 13 Village-level probit model of the correlates of AWC presence

Dependent variable: AWC in the village/ward	
Mean wealth quintile	0.171
	[0.072]**
Share of village population that is of forward caste	-0.230.
	[0.154]
Mean education of mothers	-0.382
	[0.232]
Constant	
Observations	89

Standard errors in brackets
Interpretation: Change in the probability for an infinitesimal change in each independent, continuous variable; discrete change in the probability for dummy variables (marginal effects).
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 14 Probit model of the effect of living in a village/ward with AWC on underweight, controlling for AWC age

Dependant variable: Child is underweight (weight-for-age z-score <-2)

	Base model	**Boys**	**Girls**	**0-11 mths**	**12-23 mths**	**24-35 mths**	**36-47 mths**	**48-59 mths**	**60-71 mths**
AWC is less than 4 years old	-0.035	-0.054	-0.017	-0.015	-0.07	-0.023	-0.069	-0.011	0.018
	[0.014]***	[0.020]***	[0.019]	[0.026]	[0.029]**	[0.039]	[0.016]***	[0.043]	[0.062]
AWC is 4 to 6 years old	0.007	-0.018	0.023		0.063	-0.026	0.154		-0.017
	[0.025]	[0.038]	[0.032]		[0.066]	[0.057]	[0.086]*		[0.078]
AWC is 7 to 14 years old	-0.002	-0.006	0	-0.003	-0.005	-0.015	-0.003	-0.003	0.006
	[0.007]	[0.011]	[0.009]	[0.013]	[0.018]	[0.018]	[0.015]	[0.018]	[0.022]
AWC is 15 to 25 years old	-0.016	-0.015	-0.016	-0.026	-0.018	-0.006	-0.007	0.002	-0.063
	[0.009]*	[0.015]	[0.011]	[0.015]*	[0.024]	[0.025]	[0.020]	[0.026]	[0.023]***
Observations	11349	5840	5509	2366	2146	2060	1958	1563	1207

Standard errors in brackets
Interpretation: Change in the probability for an infinitesimal change in each independent, continuous variable; discrete change in the probability for dummy variables (marginal effects).
* significant at 10%; ** significant at 5%; *** significant at 1%
In models 4 and 8, variable "AWC is 15 to 25 years old" dropped due to perfect prediction in two models

Note: Other covariates have been suppressed. These covariates are the same as in Table 5 and include child's age, child's age squared, child's gender, mother's education, mother's age of marriage, gender of household head, asset quintile, caste, piped water, and type of toilet.

Table 15 Probit model of the effect of different frequencies of attendance at the AWC on underweight

	Base model	**Boys**	**Girls**	**0-11 mths**	**12-23 mths**	**24-35 mths**
Dependant variable: Child is underweight (weight-for-age z-score <-2)						
Child's age in months	0.012	0.019	0.007			
	[0.003]***	[0.005]***	[0.004]*			
Child's age squared	0	0	0			
	[0.000]***	[0.000]***	[0.000]			
Male child	0.048			0.016	0.067	0.063
	[0.011]***			[0.015]	[0.020]***	[0.019]***
Mother can read and write	-0.043	-0.037	-0.047	0.025	-0.074	-0.078
	[0.026]*	[0.045]	[0.028]*	[0.048]	[0.053]	[0.037]**
Mother has high school education	-0.046	-0.032	-0.056	-0.013	-0.058	-0.078
	[0.031]	[0.050]	[0.036]	[0.040]	[0.063]	[0.053]
Mother has college education	-0.067	-0.053	-0.074	-0.03	-0.078	-0.105
	[0.025]***	[0.046]	[0.026]***	[0.034]	[0.055]	[0.036]***
Mother's age at marriage	-0.001	-0.002	0	0.004	-0.002	-0.004
	[0.002]	[0.003]	[0.002]	[0.002]	[0.004]	[0.003]
Male is household head	0.02	0.035	0.01	0.028	0.034	-0.001
	[0.014]	[0.022]	[0.017]	[0.016]*	[0.026]	[0.028]
Asset quintile 1	0.062	0.092	0.032	0.022	0.049	0.098
	[0.027]**	[0.041]**	[0.034]	[0.034]	[0.048]	[0.052]*
Asset quintile 2	0.027	0.015	0.039	-0.022	0.04	0.05
	[0.017]	[0.025]	[0.023]*	[0.021]	[0.033]	[0.030]
Asset quintile 3	0.001	-0.021	0.023	0.011	-0.006	0.005
	[0.021]	[0.030]	[0.031]	[0.029]	[0.041]	[0.040]
Asset quintile 4	-0.011	-0.035	0.009	0.026	-0.016	-0.047
	[0.019]	[0.026]	[0.027]	[0.031]	[0.036]	[0.028]*
Scheduled caste	0.001	-0.02	0.023	0.068	-0.091	0.105
	[0.023]	[0.032]	[0.035]	[0.050]	[0.027]***	[0.062]*
Scheduled tribe	0.088	0.085	0.09	-0.025	0.26	0.093
	[0.041]**	[0.063]	[0.053]*	[0.026]	[0.093]***	[0.076]
Other backward groups	0.006	0.013	-0.001	-0.005	-0.013	0.037
	[0.012]	[0.018]	[0.016]	[0.017]	[0.023]	[0.021]*
Piped water	0.021	0.044	0	0.014	0.046	0.006
	[0.011]*	[0.017]**	[0.014]	[0.015]	[0.021]**	[0.020]
Flush toilet	0.023	0.015	0.028	-0.033	0.051	0.031
	[0.024]	[0.037]	[0.033]	[0.031]	[0.050]	[0.042]
Pit toilet	0.01	-0.009	0.023	-0.031	0.042	0.011
	[0.021]	[0.033]	[0.028]	[0.031]	[0.042]	[0.036]
Child never attends the AWC [excluded]						
Child attends the AWC once a week or once a month	**-0.018**	**-0.036**	**-0.006**	**-0.034**	**-0.03**	**-0.005**
	[0.016]	[0.023]	[0.021]	[0.021]*	[0.030]	[0.028]
Child attends the AWC every day	**-0.041**	**-0.034**	**-0.048**	**-0.009**	**-0.034**	**-0.089**
	[0.015]***	**[0.024]**	**[0.017]*****	**[0.016]**	**[0.043]**	**[0.018]*****
Observations	3192	1631	1561	1011	1133	1048
F test for joint significance of attendance variables	7.03**	3.21	5.74*	1.58	1.26	20.24***

Interpretation: Change in the probability for an infinitesimal change in each independent, continuous variable; discrete change in the probability for dummy variables (marginal effects).

Standard errors in brackets

* significant at 10%; ** significant at 5%; *** significant at 1%