



Who Benefits from Public Nutrition Programmes? Caste and Region-Based Heterogeneity in the Effectiveness of ICDS in India

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Abstract. This study examines the differential impact of the Supplementary Nutrition Programme (SNP), delivered under Integrated Child Development Services (ICDS) in India, drawing on NFHS-4 (2015-16) and NFHS-5 (2019-21) data for children below age five. Selection bias is addressed through propensity score-based inverse probability weighting, with entropy balancing applied as a robustness check. Adjusting for survey weights, the analysis estimates treatment effects separately across four caste categories (UC, SC, ST, OBC), seven geographic regions, and two age cohorts, distinguishing take-home rations (THR) for children under three years from hot cooked meals (HCM) for those aged three to five. The findings reveal sharp heterogeneity in SNP's impact across both social and geographic lines, with three broad patterns emerging. First, the programme's positive association shifted increasingly toward UC children across rounds, UC children showed no significant effect in NFHS-4 but a significant positive HCM association by NFHS-5, even as marginalised caste groups lost the positive associations they had earlier held. Second, pro-equity effects weakened over time; the one exception holding across both rounds is the positive OBC-THR association observed in Hilly states. Third, the THR component shows a persistent failure to benefit any caste group consistently, in any region, in either survey round, a gap affecting children under 36 months, precisely the window of most critical developmental risk. This failure is not new to NFHS-5; it was already evident in NFHS-4, and its persistence across two survey rounds points to a structural weakness in the delivery mechanism itself.

Keywords: Integrated Child Development Services, NFHS, Caste, HAZ score, Region, IPW.

1 Introduction

A substantial body of evidence from both developed and developing countries presents a strong association between early-life development to cognitive development, education, earnings and employment in later life (Alderman, 2006; Behrman & Hoddinott, 2002; Behrman & Rosenzweig, 2004; Glewwe et al., 2001; Koedel & Techapaisarnjareonkit, 2012). Among many indicators of child malnutrition, this study has taken Height-for-Age Z-Score (HAZ) as the variable of interest. Stunting, which is defined as the median HAZ score below -2 SD, is irreversible impact of prolonged nutritional deficiency during critical growth periods, particularly the first 1000 days of life. The prevalence of child stunting at the global level was 33.1 per cent in 2000, which reduced to 23.2 per cent in 2024. For India, the rate was 55.8 per cent in 2000, reduced to 36.1 per cent in 2019-21 (NFHS-5), substantially higher than the world average. Considering the substantial GDP growth rate of India in post reform period, the rate of reduction in child malnutrition is abysmally low. And shows the limitation of economic growth alone, in addressing the challenge of undernutrition in early childhood.

In the context of early childhood care and broader nutritional and cognitive development in India, the massive burden of child malnutrition underscores the importance of public nutrition programmes, such as the Integrated Child Development Services (ICDS), which aims to improve the nutritional and developmental outcomes of children at an early age. To eliminate malnutrition, ICDS adopts two different nutritional outreach approaches: first, by serving take-home rations (THR) for children under 36 months, and supplying hot cooked meals (HCM) at ICDS centres for children between 36 to 72 months.

The concept of nutrition is different from hunger. Moreover, the problem of malnutrition is not solely dependent on poor intake of nutritional food; it is equally affected by socioeconomic, behavioural and contextual factors of affected children.

There is a plethora of literature related to impact evaluation of ICDS on child malnutrition. However, depending on the methodology and data selection, a consensus on the magnitude and direction of effects has not been formed. Some earlier studies based on NFHS-1 and NFHS-2 found that both the placement and impact of ICDS were regressive across the states, and there is little impact of ICDS on child nutrition in the villages covered with ICDS

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and, at times, even a negative impact (Das Gupta et al., 2005; Lokshin et al., 2005). Core functions of ICDS, like non-formal pre-schooling, nutrition and health education, are not fully functional in the way they are supposed to be (Gupta et al., 2013), and the quality of services at ICDS centres needs to be improved to cater for the needs of heterogeneous communities (Chudasama et al., 2015). Some found limited positive association but noticed that progress in reducing malnutrition is highly uneven across states and socioeconomic strata (Alderman, 2006; Behrman et al., 2009; Behrman & Hoddinott, 2002; Behrman & Rosenzweig, 2004; Dixit et al., 2018; Glewwe et al., 2001; Jain, 2015; Kandpal, 2011; Koedel & Techapaisarnjaroenkit, 2012).

In India, traditionally, food has been the primary tool of practising caste based discrimination throughout the centuries. Moreover, it is highly prevalent even today and affecting larger socioeconomic aspects of life (Anderson, 2011; Borooah, 2005; Deshpande, 2011; PAL, 2016; Ruia et al., 2018).

The baseline anthropometric indicators vary significantly across the castes and states in India, so the reach and utilisation of programmes like ICDS. The interaction between caste-based economic deprivation and unequal access to public welfare services, such as ICDS, is widely studied across subjects. But including regional variation in caste ICDS interaction makes the picture complex. So to assess the differential impact ICDS on HAZ score of children of all four castes, across states (aggregated in geographical regions) for both age-cohort (6 to 36 months) and (37 to 59 months), reveals a new dimension of programme not explored yet.

To address the potential bias arising from endogenous programme placement, this paper employs inverse probability of weighting (IPW) (Hirano & Imbens, 2001), a slightly different from widely used propensity score matching (PSM) adopted in (Dixit et al., 2018; Kandpal, 2011; Lokshin et al., 2005), to eliminate the selection bias in programme utilisation.

To understand how caste based discriminatory practices affect the children who regularly utilise the SNP at ICDS centres (HCM cohort), or take home ration (THR cohort), differently, this study disaggregates the treatment effects by caste, region, and age cohorts. This granular analysis reveals how each SNP component, differentially affects specific caste groups across geographic regions, exposing critical cultural and administrative failures in reaching India's most marginalised children.

This study evaluates the caste and region-disaggregated programme associations of regular ICDS supplementary nutrition utilisation on child HAZ scores across two rounds of NFHS, using inverse probability weighting to address selection bias in programme participation. The results are in accordance with earlier studies on programme evaluation. At the national level, aggregate programme associations are small, largely insignificant for marginalised caste groups, and most of the programme benefits for marginalised children in NFHS-4 disappear by NFHS-5, while UC children emerge as the sole group with a meaningful positive HCM association in NFHS-5. One primary reason for the heterogeneous and regressive impact of ICDS on child malnutrition may be the mismatch between the requirements of different caste groups and the programme's outreach (Dixit et al., 2018; Kandpal, 2011; Lokshin et al., 2005; Singh et al., 2024).

The THR component, targeting children below 36 months, shows no detectable positive association for any caste group at the national level in either round. Results disaggregated at the regional level reveal that these are not evidence of programme ineffectiveness but rather a product of opposing regional effects that cancel at the aggregate level. In NFHS-4, South India shows the strongest programme associations, but in an anti-equity direction, UC children capture the entire HCM benefit while marginalised caste children attending the same centres show no measurable return. East India and Hilly states show isolated positive associations for ST and OBC children, respectively, representing the clearest cases of pro-equity delivery in the data. By NFHS-5, these pro-equity results of the programme have largely eroded, South India becomes entirely insignificant across both cohorts, East India loses its positive HCM associations for marginalised castes, and UC children consolidate their disproportionate share of programme results at both the national and regional levels. The one finding that is visible in both rounds is the positive OBC THR association in Hilly states, suggesting that stable pro-equity delivery is possible within ICDS but remains geographically isolated. Taken together, these results demonstrate that aggregate national evaluations of ICDS produce misleading inference, the near-null national effects mask a deteriorating and increasingly inequitable distribution of programme benefits across caste groups and geographic regions between the two survey rounds.

Following the introduction, the paper is organised into five sections. Section 2 reviews the available literature, Section 3 describes the dataset, Section 4 sets out the methodology, Section 5 presents the results, and Section 6 concludes with a discussion of the findings and policy recommendations

2 Literature Review

Caste-based social discrimination, accompanied by baseline disadvantages, may hinder the effectiveness of public service delivery, as studies indicate that the consequences of past discrimination can outweigh egalitarian interventions in the presence of continued social discrimination (Loury, 2004). Another study analyses how caste and religious discrimination affect labour market accessibility and access to non-market transactions, such as education, primary healthcare, and fair price shops (Thorat & Neuman, 2012). In an Indian village, it was observed that the yield realisations of the lower caste group are substantially higher if they reside in a village with their own caste majority (Anderson, 2011). A meta-analysis comprised of 16 RCTs and 10 Controlled Before and After Studies found that supplementary feeding for malnourished children has a negligible impact on the growth parameters of children in low and middle-income countries (Kristjansson et al., 2015). Similarly, (Stifel & Alderman, 2006), in their study on the Peruvian Milk Subsidy Programme, found that the programme was well-targeted; however, it failed to achieve its nutritional objectives. However, in another context (Behrman & Hoddinott, 2002) using the child-fixed effect, they found that PROGRESA's nutritional supplements reduced stunting among children aged 12-36 months, especially in illiterate and poorer households. Moreover, chronic malnutrition, measured in terms of HAZ (height-for-age z-score), appears to be the most challenging parameter to improve. Studies showed that stunted and wasted children have a high risk of obesity, too, in the later stages of life, as chronic malnutrition slows down the metabolic rate and impairs the fat oxidation rate (Hoffman et al., 2000). Even with adequate food intake in later years of life, children who were stunted tend to accumulate more fat relative to lean mass as they age. This finding is important to understand the increasing obese population in low-income groups (Martins et al., 2004). Weight gained during the first two years of life had a substantial impact on schooling outcomes in later stages of life, whereas weight gain during the 2- and 4-year periods had a minimal relationship with schooling outcomes (Martorell et al., 2010; Martorell & Young, 2012). To eliminate chronic and acute malnutrition, supplementary nutrition should be provided in conjunction with improvements in long-term determinants of malnutrition, such as education, income, poverty, and women's empowerment (Bhutta et al., 2008). However, the impact of nutritional awareness programmes is not uniform across all the anthropometric parameters of children. A study conducted among low-income children in South Africa found that education programmes, combined with food aid, improved the weight of children under 5 years old but were unable to improve stunting rates (Walsh et al., 2002). Maternal education and household wealth were found to be strongly correlated with adequate and diversified food intake among Indian children (Agrawal et al., 2019).

In the context of utilisation of ICDS services, particularly SNP, which is centre based delivery, caste might be one of the significant determinants of accessibility and quality of services. Recent studies also cast doubts on the effectiveness of ICDS on child nutrition, particularly interstate variation in the effectiveness. Children in rural India who received ICDS were found to be more stunted and underweight than their counterparts who did not receive ICDS (Dixit et al., 2018). Although ICDS is well conceived to tackle malnutrition right from the foetal stage through age six, poor implementation on the ground keeps it from delivering on that design. Ineffective targeting of the poorest states with the highest burden of malnutrition and a less rigorous approach to targeting children under age 3 years result in high and chronic malnutrition (Gragnolati et al., 2005). Thus, these contrasting results highlight that the impact of supplementary nutrition programmes, such as ICDS, is highly context-dependent. The practical approach to addressing malnutrition in impoverished rural Asian communities lies in educating them about utilising available resources to bridge the caloric gap (Gopalan et al., 1973). However, take-home rations have a higher percentage of leakage than supplementation programmes implemented through daycare centres (Kristjansson et al., 2015).

Prevalence of state-level child stunting also varies highly across the states and several studies compared the child malnutrition status across the states and different factors working behind high differential burden of malnutrition. (Banerjee & Dwivedi, 2020) took Tamil Nadu as the reference state and found that high prevalence of child stunting in states such as Uttar Pradesh, Madhya Pradesh, Bihar, Odisha and Gujarat is not determined only by weaker policy orientation for addressing child malnutrition but poor community level sanitary practices are also responsible. In a recent study, (Singh et al., 2024) presented that ICDS utilization and prevalence of child underweight vary highly across states, socioeconomic and demographic characteristic. Using data from all NFHS rounds, (Chaudhuri et al., 2023) found substantial regional variation across states and alarmingly low level of reduction in undernutrition across most of the states during NFHS-1 to NFHS-5. Using data from last three rounds of NFHS, NFHS-3 to NFHS-5, (Sharma et al., 2025) explain that India struggles with dual burden of child wasting and stunting along with stark economic and regional disparities. While comparing two states, which differ substantially by level of economic growth over the decades, Gujarat and Bihar, (Ruia et al., 2018) arrived at the conclusion that during the period 2006-2015, Gujarat which is usually criticised for its development-less growth model achieved significant reduction in child malnutrition while Bihar languishes at the bottom with the highest prevalence of child malnutrition, despite of impressive economic growth rate.

National- and state-level evaluations of ICDS's impact on child nutrition are very common, but most overlook the sharp disparities in who actually uses the service and what benefit they are deriving out of it, particularly across caste groups in India, and particularly once SNP's different components are broken down at the regional level.

3 Description of Dataset

3.1 Integrated Child Development Services (ICDS)

Launched on 2nd October 1975, ICDS remains among the largest early childhood programmes anywhere in the world. Its design follows two broad objectives, improving the physical growth of the child, and supporting cognitive development through non-formal preschool education. Children aged six months to six years, together with pregnant and lactating mothers, are entitled under the scheme to a bundle of services, supplementary nutrition, immunisation, health check-ups, referral linkages, preschool education, and nutrition counselling, all delivered via the Anganwadi network. As of 31.12.2020, this network comprised 7,075 operational projects and 13.84 lakh Anganwadi Centres (Annual Report 2020-21, n.d.). Following the National Food Security Act (NFSA), 2013, the government notified the Supplementary Nutrition (under ICDS) Rules in 2017, fixing entitlements for every pregnant and lactating woman and every child below six years at 300 days a year, in line with the nutritional norms laid down in Schedule II of the NFSA.

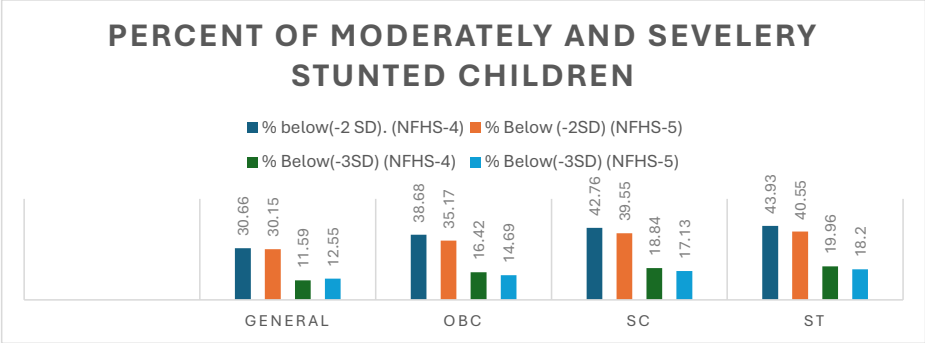
Nutrition under the programme reaches children through two distinct channels. Take-home rations (THR) cover children aged 6–36 months, adolescent girls, and pregnant and lactating women, while hot cooked meals (HCM) are meant for children between 37 and 72 months, again for 300 days annually. ICDS has since been included into the Prime Minister's Overarching Scheme for Holistic Nutrition (POSHAN Abhiyan), together forming Saksham Anganwadi and POSHAN 2.0. Cost-sharing for the SNP component is split evenly between the Centre and states, while other components follow a 60:40 split, except in the Northeastern and Himalayan states, where the Centre bears 90 percent (Ministry of Women and Child Development, 2024). The actual food basket under SNP is left flexible, adapting to what is locally available and culturally preferred, typically khichadi, pulses, rice-based preparations, seasonal fruit, eggs, jaggery, and Panjiri or similar ready-to-cook mixes, chosen to meet the calorific and nutritional benchmarks set for beneficiaries.

3.2 National Family Health Surveys (NFHS)

This analysis draws on two rounds of the National Family Health Survey, NFHS-4 (2015-16) and NFHS-5 (2019-21), which together offer nationally representative data on population, health, and nutrition indicators across Indian states and union territories, part of a series running since 1992-93. Both rounds share a common stratified two-stage sampling design, drawing on the 2011 Census as the sampling frame for Primary Sampling Units. NFHS-4 covered 28,586 PSUs and 601,509 households, NFHS-5 expanded this to 30,456 PSUs and 636,699 households. District-level estimates are available in both rounds for several key indicators, and the broad comparability of survey content across the two rounds is what allows results to be tracked over time. For this reason, the same covariate set has been retained for survey-weighting and analysis in both rounds, with covariate selection guided jointly by prior literature and statistical testing.

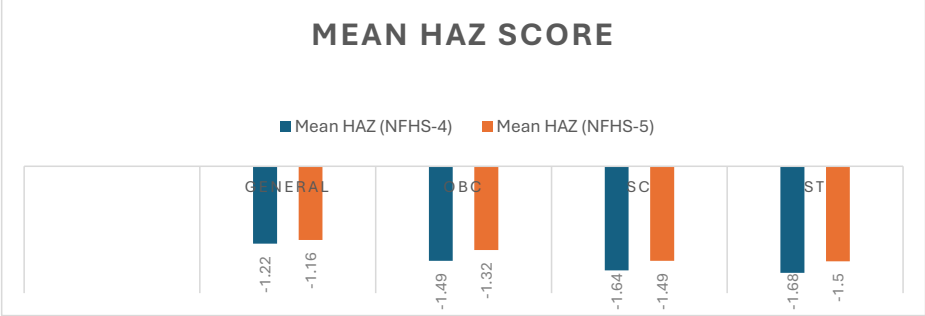
On stunting and underweight prevalence, NFHS-4 recorded 38 percent of children under five as stunted and 36.5 percent as underweight. By NFHS-5, stunting had fallen by only about 2 percentage points and underweight by roughly 4, with stunting among girls actually rising slightly and the rural-urban divide still intact. State-level gaps remained wide throughout, Bihar, Uttar Pradesh, Jharkhand, and Meghalaya continued to report stunting above 40 percent in both rounds, whereas Kerala, Goa, Puducherry, and Sikkim stayed in the 20-22 percent range. Caste-based gaps in nutritional status also carried over from one round to the next.

Figure 1. Caste-wise Prevalence of Stunting of Children >5 Years (NFHS-4 & 5)



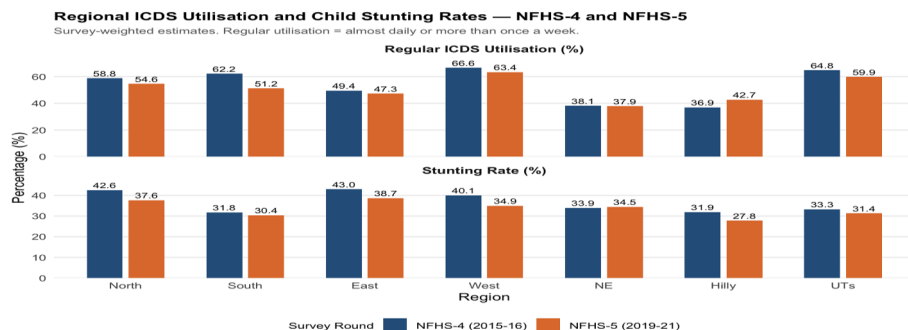
Notes: Based on NFHS-4 (2015-16) and NFHS-5(2019-21) survey datasets. Moderately Stunted(HAZ< -2SD), Severely Stunted(HAZ < -3SD)

Figure 2. Caste-wise Mean HAZ Score of Children >5 Years(NFHS-4 &5)



Notes: Based on NFHS-4(2015-16) and NFHS-5(2019-21) survey datasets

Figure 1 presents the percentage of children under 5 years, who were moderately stunted (HAZ < -2 SD) and severely stunted (HAZ < -3SD) across different caste groups in India. While prevalence of moderate stunting reduced across all four caste groups, the reduction was the lowest among UC children and even severe stunting slightly increased among these children. This regressive trend indicates that gain in the mean HAZ score of children is coming from comparatively better off children across all castes, while stunting is accentuating in worse off children irrespective of their castes. This mixed pattern of prevalence and rate of reduction of stunting, across the castes, raises the question about the role of programmes to address the malnutrition. Caste-based hierarchy in nutritional outcome of children is visible in these figure 2. It is evident that that the highest improvement in mean HAZ score is coming from ST children followed by OBC, SC, and UC (Upper Caste).

Figure 3. Regional ICDS Utilisation and Child Stunting Rate (NFHS-4 and NFHS-5)

Source: NFHS-4 (2015-16) and NFHS-5 (2019-21). NE = Northeast. UTs = Union Territories.

Note: Calculations based on NFHS-4 and NFHS-5 survey datasets. ICDS coverage is percentage of under 5 children who are receiving food at ICDS almost daily or more than once a week. Stunting is children with HAZ score < -2 SD

Following (Murthi et al., 1995), this paper clubs Haryana, Punjab, Uttar Pradesh, Madhya Pradesh and Chhattisgarh in North, Andhra Pradesh, Karnataka, Tamil Nadu, Telangana and Kerala in South, Bihar, Odisha, Jharkhand, West Bengal in East, Gujarat, Maharashtra and Rajasthan in West. Based on the cost sharing formula between centre and state, further, Arunachal Pradesh, Meghalaya, Manipur, Nagaland, Tripura, Sikkim and Assam are clubbed in North East (90:10 cost sharing), Himachal Pradesh, Uttarakhand and Jammu & Kashmir in Hilly (90:10 cost sharing) and Chandigarh, Goa, Delhi, Puducherry, Lakshadweep, A&N Islands, Ladakh, D&NH and D&D in Union Territories (100 percent centrally sponsored).

3.3 ICDS Utilisation Pattern

Regular ICDS utilisation declined between rounds in most of the regions. The sharpest declines are in North, South, and UTs, where utilisation fell by roughly four to ten percentage points between NFHS-4 and NFHS-5. West India records the highest utilisation in both rounds, exceeding sixty percent in NFHS-4 and remaining above sixty percent in NFHS-5, the most stable region in terms of programme reach. Hilly states are the only region showing an increase in utilisation between rounds, moving from below forty percent in NFHS-4 to above forty percent in NFHS-5. NE records the lowest utilisation in both rounds. East India stays below fifty percent in both rounds, well below the national average, pointing to consistently weaker programme reach in this region despite its large child population.

Stunting Rate Pattern

Stunting declined across all seven regions between NFHS-4 and NFHS-5. However, the magnitude of decline is different across the regions. East India records both the highest stunting rate in NFHS-4 and the largest absolute decline between rounds, though it still carries the highest burden in NFHS-5. North India follows a similar pattern, with a high baseline stunting and a meaningful decline, but still above the national average in NFHS-5. South India and Hilly states record the lowest stunting rates in both rounds, but also show the smallest absolute declines. West India shows a notable decline despite maintaining high ICDS utilisation in both rounds, consistent with the regression results showing no significant positive programme associations for marginalised castes in West India in either round, suggesting the stunting decline is not attributable to ICDS.

3.4 The Central Paradox the Figure Reveals

Reading the two panels together exposes the core finding of the paper visually. Regions with the highest ICDS utilisation rates do not consistently show the lowest stunting rates or the largest stunting declines. West India has the highest utilisation in both rounds, but does not lead on stunting reduction. NE has the lowest utilisation and middling stunting rates. Hilly states show rising utilisation and the second largest stunting decline, but the regression results attribute the Hilly improvement to OBC children in THR specifically, not to the programme broadly. This disconnect between utilisation rates and stunting outcomes at the regional level is precisely what motivates the disaggregated caste and cohort analysis; aggregate utilisation rates conceal who is actually accessing the programme and whether those who do are seeing any nutritional return.

4 Methodology

This study evaluates whether regular feeding of supplementary food under ICDS improves child nutrition (HAZ scores), using inverse propensity weighting (IPW), adjusted for survey design. The analysis takes two approach for evaluation, first evaluating the treatment effect at aggregated level for all children for both programme

component, THR and HCM, second, disaggregated at caste, programme component across seven regions in India, to capture heterogeneous effects of programme.

The following subsections describe the variable construction, identification strategy, covariate balance checks, and model specification in turn.

4.1 Construction of Variables and Empirical Strategy

This study evaluated the following linear regression equation.

$$HAZ_i = \beta \cdot ICDS_i + \delta \cdot Caste_i + \gamma \cdot (Caste_i \times ICDS_i) + \kappa X_i + \varepsilon_i \quad (1)$$

The variable of interest in the study is the continuous HAZ score¹ of children under 59 months². HAZ is a measurement of deficit in cumulative growth and retardation of linear growth, children whose HAZ-score is below -2 SD of median of the reference population is considered to be stunted and, with a Z-score below -3 SD, are considered to be severely stunted. The coefficient of interest is the interaction term of Caste and ICDS, which captures the differential programme association across caste groups relative to reference group, which are UC children. ICDS, here is the frequency of receiving supplementary food from ICDS centres. In the survey questionnaire, it has six response categories. To evaluate the nutritional outcome of supplementary food, responses are recorded in binary variables. The categories "received food almost daily" and "at least once a week" are coded as 1, reflecting regular access to ICDS services and the rest of the responses are coded as 0. This dichotomy allows for a meaningful distinction between effective and ineffective exposure to ICDS. Caste variables in the dataset are classified into four major castes: Scheduled Caste(SC), Scheduled Tribe(ST), Other Backward Class(OBC) and None of Them.³ X_i in the equation 1, accounts for vector of control variables accounting for child, mother and household level characteristics. For the selection of control variables, timing of variables is taken into consideration. Included controls, measured before the variable of interest was determined are generally considered as good control (Angrist & Pischke, 2010). Based on earlier studies and statistical analysis⁴, age of child and mother, HAZ score of mother are taken as the continuous variables, while gender of child, current pregnancy of mother, education level of mother, religion, type of residence, wealth index, and state of residence is taken as the binary variable as presented in data. Number of children in household is converted in binary variable, 3 or fewer children as 0 and 1, otherwise. Following (Angrist & Pischke, 2010), that variables that are themselves dependent on other variables are bad controls, therefore, electrification, water facility, sanitation etc are omitted from equation as these variables are largely dependent on wealth index of the household. To evaluate the two different programme component of SNP, THR and HCM, the age of child is divided according to the threshold age limit of beneficiaries, 6-36 months for THR and 37-59 months for HCM.

4.2 Addressing Selection Bias: Inverse Probability Weighting

However, estimating equation (1) by OLS on the observed sample would produce biased estimates if programme participation is non-random, which in the case of ICDS it almost certainly is.

Even though ICDS is meant to be a universal entitlement, take-up on the ground differs considerably by household, social group, and state. Factors such as maternal awareness, service quality perception, distance from centres and household related priorities may affect the regular utilisation of SNP. These factors that influence ICDS utilisation may also independently affect child nutritional outcomes, creating potential selection bias in estimating equation (1).

To evaluate the impact of the programme in nonrandomized experiments, a direct comparison of treatment and control groups might be misleading (Angrist & Pischke, 2010; Duflo, 2020; Lee & Lee, 2022). To address this problem of endogeneity in programme utilisation, and to isolate the true causal impact of ICDS exposure, this study employs propensity score weighting technique (Austin, 2011; Austin & Stuart, 2015; Rosenbaum & Rubin, 1983). Because both groups might differ systematically from each other, balancing scores of covariates can be used to make the treatment and control groups comparable (Rosenbaum & Rubin, 1983). The propensity score

¹ HAZ scores below -6 or above +6 SD were excluded from the analysis to eliminate biologically implausible values, following WHO recommendations.

² Since NFHS collects data for children below 59 months only.

³ NFHS defines four major social groups, Scheduled Castes (SC), Scheduled Tribes (ST), and Other Backward.

Classes (OBCs) and 'None of Them'. 'None of Them' is a reasonable approximation of the Upper/General Castes and is the reference category.

⁴ Result of Wald test is included in Appendix table A1.

can be defined as conditional probability of assignment to a particular treatment given a vector of observed covariates (Austin, 2011; Rosenbaum & Rubin, 1983). By reweighting observations using the inverse of this probability, IPW creates a pseudo-population in which treatment assignment is independent of the observed covariates, allowing unbiased estimation of the average treatment effect on the treated.

$$p(X_i) = \Pr(ICDS_i = 1 | X_i) \quad (2)$$

A balancing score $b(X)$ is a function of observed covariates, X , such that the conditional distribution of covariates given $b(X)$ is similar across treatment and control units

$$X \perp D_i | b(X) \quad (3)$$

For the calculation of the propensity score, this study conducted logit regression. Based on the binary nature of the treatment variable (ICDS participation) and no assumption about the distribution of data, logit regression is a better approach to calculating propensity scores.

$$Pr(Treatment = 1/X) = \frac{e^{0+1X_1+2X_2+\dots}}{1+e^{0+1X_1+2X_2+\dots}} \quad (4)$$

Then, weights are computed based on the estimated probabilities (propensity scores)

$$w_i = \{1 \text{ if treated}, \frac{p_i}{1-p_i} \text{ if untreated}\} \quad (5)$$

To adjust for selection bias in the assignment of treatment status, this paper used inverse probability weighting (IPW) based on estimated propensity scores. Inverse probability of treatment weighting (IPTW) using the propensity score allows one to obtain unbiased estimates of average treatment effects (Austin & Stuart, 2015)⁵. This method creates a pseudo-population where the distribution of observed covariates is not dependent on the assignment of treatment, thus estimating an unbiased average treatment effect on the treated (ATT). ATT represents the expected difference in outcomes between the treated and the counterfactual untreated observations for those who actually received the treatment.

To calculate the effect of treatment on treated (ATT),

$$ATT = E[Y_{1i} - Y_{0i} | D_i = 1] = E\left[\frac{D_i - p(X_i)Y_i}{(1-p(X_i))p(D_i=1)}\right] \quad (6)$$

Where,

Y_{1i} represents the potential outcome of individual i if treated.

Y_{0i} represents the potential outcome of individual i if not treated.

D_i is the binary treatment indicator, $D_i=1$ if individual i receives the treatment and $D_i=0$ otherwise.

X_i are the control variables of the saturated model.

4.3: Covariate Balance and Robustness Check

Lack of balance is common in extensive observational studies. Balancing weights incorporates the propensity scores of treatment and control groups to an analyst-selected target population (Li et al., 2018). To check the effectiveness of propensity score weighting in achieving a balance of covariates of treatment and control groups, post-weight balance adjustments are made. The metric used for the balance check is the Standardised Mean Difference (SMD) for each covariate, both before and after weighting. The SMD measures the difference in means between groups in standard deviation and is independent of sample size. Following the guidelines in the literature, an SMD value of less than 0.1 is considered to indicate adequate covariate balance (Austin & Stuart, 2015), the

⁵ Propensity score matching (PSM) is usually associated with nearest-neighbor or kernel-based matching techniques, but this paper instead based on inverse probability weighting (IPW), a weighting-based alternative for addressing selection bias. Weights were generated in R using the `weightit()` function with `method = "ps"`, combined with survey design weights. A key advantage of IPW over matching-based approaches is that it does not discard unmatched units; instead, all observations are retained and reweighted to achieve covariate balance between treatment and control groups.

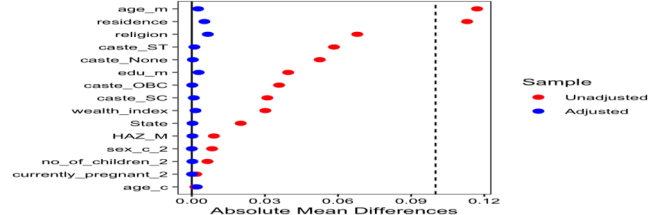
threshold is widely accepted in applied research. Covariate balances are visualized using love plots, which present adjusted and unadjusted SMDs for all covariates. Standard errors of the models are adjusted for heteroscedasticity, clustering at the Primary Sampling Unit (PSU) level, stratification effects, and include both survey weights and propensity score weights.

To assess whether results are sensitive to the choice of balancing method, the analysis is replicated using entropy balancing (EBAL) as an alternative to IPW. EBAL reweights control units to achieve covariate balancing without relying on estimated propensity scores.⁶ Comparison tables for both methods (IPW and EBAL) are provided in tables A2 and A3 in Appendix.

4.4: Model Specification and Estimation

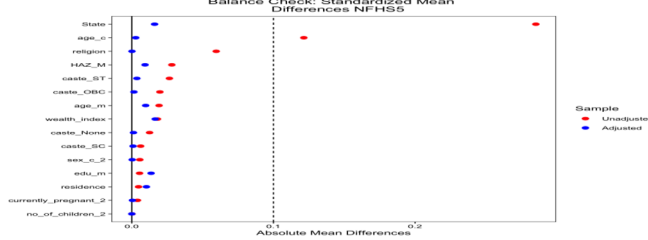
Following propensity score estimation, covariate balance between treatment and control groups was assessed using standardised mean differences (SMDs) for each covariate, visualised in the love plots below.

Figure 5. Plot of Standard Mean Difference for NFHS-4



Note: This figure presents the standardised mean differences (SMDs) for covariates before (red) and after (blue) applying the IPTW based on propensity scores.

Figure 6. Plot of Standard Mean Difference for NFHS-5



Note: This figure presents the standardised mean differences (SMDs) for covariates before (red) and after (blue) applying the IPTW based on propensity scores.

The love plots displayed in figure 5 and 6, indicate that covariate balance was successfully achieved after applying propensity score weighting, as all the standardised mean differences (SMDs) fall well below the commonly accepted threshold of 0.1.

With covariate balance confirmed, linear regression adjusted for both propensity score weights and survey weights was estimated to obtain the Average Treatment Effect on the Treated (ATT). Three model specifications were run, first, a fully adjusted national model with socioeconomic and demographic covariates along with interaction terms; second, the same specification estimated separately for the THR cohort (below 36 months) and the HCM cohort (37-59 months); and third, seven region-specific models disaggregated by caste and age group to capture regional heterogeneity in ICDS impacts on child HAZ scores. A Wald test was used to check model specification which indicated nonlinear relationships between HAZ and several covariates, child age, maternal HAZ, maternal education, maternal age, and wealth index (table A1 in Appendix). Quadratic terms for each of these were therefore added to the models to capture these nonlinearities. The following section presents results from these models for both NFHS-4 and NFHS-5.

⁶ Rosenbaum bounds are difficult to integrate with survey-weighted data, as a robustness check, this study therefore complements the primary IPW analysis with entropy balancing (EBAL). Unlike propensity score methods, EBAL directly reweights observations to achieve exact mean balance on covariates. It does not test for unobserved confounding, but its tighter covariate balance adds some credibility to the estimates given that formal sensitivity testing was infeasible here. Tables for IPW and EBAL are given in the Appendix tables A2 and A3.

5 Results

Table 1 and 2 present the results of the full model for NFHS-4 and NFHS-5, respectively. The results incorporate ICDS-caste interaction terms along with comprehensive set of control variables for child, maternal, households and geographic characteristics. To account for nonlinear association of some key variables, like maternal age, education, HAZ score and household wealth with child HAZ, quadratic specifications were introduced.

Table 1: ICDS Impact on Child HAZ: NFHS-4 and NFHS-5

	<i>Dependent variable:</i>	
	Height-for-Age Z-score (HAZ)	
	NFHS-4 (2015-16)	NFHS-5 (2019-21)
ICDS (UC ref)	-0.0271 (0.0287)	0.0701* (0.0347)
Caste: SC	-0.1733** (0.0283)	-0.0803** (0.0303)
Caste: ST	-0.1367** (0.0325)	-0.0047 (0.0382)
Caste: OBC	-0.1242** (0.0245)	-0.0088 (0.0272)
Child age (linear)	-0.0700** (0.0015)	-0.0534** (0.0016)
Child age (quadratic)	0.0009** (0.00002)	0.0007** (0.00002)
Female child	0.0895** (0.0113)	0.0869** (0.0119)
Maternal education (linear)	0.0828* (0.0358)	0.0258 (0.0358)
Maternal education (quadratic)	0.0144† (0.0080)	0.0186* (0.0075)
Maternal age (linear)	0.0341** (0.0099)	0.0368** (0.0112)
Maternal age (quadratic)	-0.0005** (0.0002)	-0.0005** (0.0002)
Maternal HAZ (linear)	0.1487** (0.0148)	0.1518** (0.0152)
Maternal HAZ (quadratic)	-0.0383** (0.0034)	-0.0341** (0.0037)
No. of children in HH	-0.1700** (0.0349)	-0.2144** (0.0390)
Currently pregnant	-0.1477** (0.0209)	-0.1313** (0.0236)
Wealth index (linear)	0.1112** (0.0236)	0.1080** (0.0250)
Wealth index (quadratic)	0.0023 (0.0040)	0.0002 (0.0043)

Religion	-0.0002 (0.0058)	-0.0057 (0.0080)
Residence	0.0161 (0.0153)	-0.0270 (0.0170)
State FE	0.0008 (0.0006)	0.0011 (0.0008)
ICDS × SC	0.1169** (0.0372)	-0.0342 (0.0427)
ICDS × ST	0.0419 (0.0428)	-0.0757 (0.0495)
ICDS × OBC	0.0693* (0.0336)	-0.0822* (0.0388)
Constant	-0.8706** (0.1627)	-0.9084** (0.1830)
Survey Design	Yes	Yes
IPW Weights	Yes	Yes
State Fixed Effects	Yes	Yes
Sample Period	2015-16	2019-21
Observations	123,302	134,257

Note: † p<0.10, * p<0.05, ** p<0.01, *** p<0.001
Standard errors in parentheses, clustered at PSU level
Survey weights and IPW weights applied
All models include polynomial terms and state fixed effects

Table 2 : Net Programme Effects of Regular ICDS Utilisation on Child HAZ :NFHS-4 and NFHS-5

Survey Round	Caste	Estimate	Std. Error	95% CI	p-value	Sig.
NFHS-4 (2015-16)						
NFHS-4 (2015-16)	SC	0.0899***	(0.0244)	[0.0421, 0.1376]	0.0002	***
NFHS-4 (2015-16)	ST	0.0149	(0.0317)	[-0.0472, 0.0770]	0.6388	NS
NFHS-4 (2015-16)	OBC	0.0423*	(0.0180)	[0.0069, 0.0776]	0.0191	*
NFHS-5 (2019-21)						
NFHS-5 (2019-21)	SC	0.0359	(0.0258)	[-0.0146, 0.0864]	0.1633	NS
NFHS-5 (2019-21)	ST	-0.0056	(0.0355)	[-0.0752, 0.0639]	0.8736	NS
NFHS-5 (2019-21)	OBC	-0.0121	(0.0190)	[-0.0494, 0.0251]	0.5231	NS

Notes: Net effects = ICDS main effect + caste interaction term ($\beta + \gamma$), representing the total programme association for each caste group. Standard errors account for covariance between main and interaction terms using the variance-covariance matrix. Models use IPW weights combined with survey design weights, with state fixed effects and full covariate controls. Outcome: continuous HAZ score. Reference category: Upper Caste (UC). NS = Not Significant. Significance: † p<0.10, * p<0.05, ** p<0.01, *** p<0.001. Results are robust to the choice of balancing method, entropy balancing (EBAL) produces estimates within 0.003 SD of the IPW estimates across all caste groups and both rounds (see Appendix Tables A2 and A3).

The caste main effect in NFHS-4 confirms a steep caste hierarchy in height of children of all three marginalised castes relative to UC children, even after controlling for maternal and household level socioeconomic characteristics. The ICDS association for UC children is negative and insignificant. The caste ICDS interaction terms for SC and OBC are positive and significant, while for ST remains insignificant. The net effects, presented in table 2, ($\beta + \gamma$, from equation 1), for SC and OBC children is small (0.089 SD for SC, and 0.042 SD for OBC) but positive, shows regular utilisation of ICDS supplementary food is associated with slightly larger HAZ score of these children. However, ST children show no detectable return in this round.

Among the control variables, age of child shows a strong and nonlinear association with HAZ score of children in both rounds, consistent with well-documented pattern of staggering growth in first 1000 days of life. Female children have slightly higher HAZ score than their male counterparts. Strong association with maternal HAZ confirms intergenerational transmission of nutritional status. Household wealth also carries a significant and positive association, but with diminishing results, highlighting role of factors other than wealth in the growth of children. More children in household dilute the per child available resources so are negatively associated. Currently pregnant mothers are negatively associated with developmental indicator of child, possibly reflecting competing nutritional and time demands. Maternal age show a positive but nonlinear association. As widely documented, maternal education shows a significant positive association in both rounds. Religion and place of residence show no significant independent association with HAZ score of child after controlling for other covariates.

The comparison of results of both rounds shows that the baseline caste penalties weakened considerably by NFHS-5, though gap of SC children relative to UC children remained significant, while gap with ST and OBC children became statistically indistinguishable from UC children. The programme association for UC children become positive and significant in NFHS-5. While the direction of interaction terms for all three caste turned negative, with statistically significant for OBC. The net effects during NFHS-5 tell a clear story, no marginalised caste group shows significant association with programme. The positive net returns visible for SC and OBC in NFHS-4, have completely disappeared. The control variable associations broadly remain stable across rounds, with wealth, maternal HAZ, child's and mother's age and household size retains their size and significance, confirming that shift in programme associations between rounds, is not dependent upon covariate structures.

During NFHS-4, SC and OBC children witnessed small but significant and positive net association with programme utilisation, however, by NFHS-5, these associations are vanished. The net effect for all three marginalised caste turns insignificant, while UC children emerge as the only group with positive and significant programme association.

To see whether the results are robust to the choice of balancing method, analysis is replicated using Entropy Balancing (EBAL) method, as alternative to IPW. Results of EBAL are presented in Appendix tables A2 and A3. Very small difference in values of coefficients and similar level of significance and direction of coefficients shows that results are robust for the choice of balancing method.

Table 3: ICDS Net Effects on Child HAZ by Region, Cohort and Caste : NFHS-4

			UC (ref)		SC		ST		OBC	
Region	Cohort	N	UC	SE	SC (net)	SE	ST (net)	SE	OBC (net)	SE
National										
All India	THR (<36m)	77358	-0.058	(0.039)	0.097**	(0.033)	-0.035	(0.040)	0.023	(0.024)
All India	HCM (≥36m)	45944	0.003	(0.039)	0.074*	(0.032)	0.059	(0.045)	0.050*	(0.025)
North										
North	THR (<36m)	27598	-0.145*	(0.061)	-0.017	(0.046)	0.047	(0.072)	0.045	(0.033)
North	HCM (≥36m)	15596	-0.104	(0.065)	-0.086†	(0.049)	0.118	(0.074)	-0.008	(0.036)
South										
South	THR (<36m)	7924	-0.104	(0.136)	0.199*	(0.087)	0.231	(0.144)	0.047	(0.060)
South	HCM (≥36m)	4974	0.379*	(0.158)	-0.058	(0.083)	0.052	(0.190)	-0.001	(0.062)
East										

			UC (ref)		SC		ST		OBC	
Region	Cohort	N	UC	SE	SC (net)	SE	ST (net)	SE	OBC (net)	SE
East	THR (<36m)	18817	- 0.188*	(0.078)	0.131*	(0.066)	-0.095	(0.076)	0.031	(0.050)
East	HCM (≥36m)	10591	- 0.155*	(0.072)	0.156*	(0.061)	0.176*	(0.083)	0.140**	(0.050)
West										
West	THR (<36m)	9349	-0.010	(0.106)	-0.150	(0.129)	-0.018	(0.109)	-0.027	(0.077)
West	HCM (≥36m)	5928	- 0.166†	(0.095)	0.112	(0.102)	0.036	(0.118)	0.013	(0.075)
NE										
NE	THR (<36m)	8387	-0.076	(0.145)	0.190	(0.189)	- 0.131†	(0.075)	0.110	(0.134)
NE	HCM (≥36m)	5914	-0.138	(0.116)	0.174	(0.176)	- 0.185**	(0.065)	-0.056	(0.108)
Hilly										
Hilly	THR (<36m)	4337	0.017	(0.085)	-0.255†	(0.134)	-0.063	(0.168)	0.414**	(0.152)
Hilly	HCM (≥36m)	2337	0.046	(0.088)	-0.011	(0.125)	-0.208	(0.199)	0.001	(0.175)
UTs										
UTs	THR (<36m)	946	-0.069	(0.239)	-0.212	(0.235)	0.630†	(0.375)	0.133	(0.262)
UTs	HCM (≥36m)	604	-0.604	(0.419)	-0.100	(0.292)	0.553†	(0.335)	0.148	(0.201)

Notes: Net effects = ICDS main effect + caste interaction term ($\beta + \gamma$), representing the total programme association for each caste group relative to Upper Caste (UC) children. Standard errors in parentheses, clustered at PSU level. Survey design weights and IPW weights applied in all models. Full covariate controls include child age (quadratic), maternal HAZ (quadratic), maternal education (quadratic), maternal age (quadratic), wealth index (quadratic), gender, religion, residence, household size, current pregnancy, and state fixed effects. Significance: † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$. THR = Take-Home Ration (children 6–36 months); HCM = Hot Cooked Meal (children 37–59 months); N = number of observations in each regional cohort. UC = Upper Caste; SC = Scheduled Caste; ST = Scheduled Tribe; OBC = Other Backward Class. Source: NFHS-4 (2015–16)

5.1 NFHS-4 Results

Results for NFHS-4, disaggregated at regional, caste and age levels are presented in table 3. At the national level, SC children show positive and significant association with programme in THR and HCM cohorts, while for OBC children association is positive and significant in HCM cohort only. While for all other children programme association remains inconclusive.

North India

North India, the largest populous region among all regional groups, could not produce any positive and significant association for any caste group in either cohort. Programme association is significant and negative for UC children in THR cohort, and SC children in HCM cohort. Ineffective execution of ICDS in this region is reflected in slow reduction of malnutrition at national and increasing incidence of stunting and wasting in some these states during NFHS-4 and NFHS-5.

			UC (ref)		SC		ST		OBC	
Region	Cohort	N	UC	SE	SC (net)	SE	ST (net)	SE	OBC (net)	SE
National										
All India	THR (<36m)	83481	0.023	(0.045)	0.056†	(0.034)	-0.001	(0.047)	-0.015	(0.025)
All India	HCM (≥36m)	50776	0.147** *	(0.044)	0.034	(0.033)	-0.054	(0.043)	-0.033	(0.025)
North										
North	THR (<36m)	29311	0.090	(0.065)	0.043	(0.049)	-0.097	(0.079)	0.073†	(0.038)
North	HCM (≥36m)	17500	0.081	(0.062)	-0.017	(0.050)	-0.065	(0.081)	0.009	(0.039)
South										
South	THR (<36m)	6884	0.277	(0.286)	0.065	(0.112)	0.171	(0.160)	-0.038	(0.072)
South	HCM (≥36m)	4396	-0.076	(0.225)	0.048	(0.095)	0.144	(0.238)	-0.038	(0.069)
East										

Table 4: ICDS Net Effects on Child HAZ by Region and Cohort — NFHS-5

			UC (ref)		SC		ST		OBC	
Region	Cohort	N	UC	SE	SC (net)	SE	ST (net)	SE	OBC (net)	SE
East	THR (<36m)	1751	-0.144	(0.102)	0.129	(0.072)	0.221	(0.105)	-0.093	(0.065)
East	HCM (≥36m)	9919	0.144†	(0.084)	0.044	(0.070)	-0.094	(0.088)	-0.059	(0.057)
West										
West	THR (<36m)	1078	0.080	(0.107)	-0.051	(0.101)	-0.096	(0.119)	0.003	(0.063)
West	HCM (≥36m)	6396	0.341*	(0.155)	0.011	(0.098)	0.123	(0.090)	0.008	(0.072)
NE										
NE	THR (<36m)	9327	-0.318	(0.224)	-0.208	(0.159)	-0.169†	(0.087)	0.063	(0.141)
NE	HCM (≥36m)	6834	0.137	(0.216)	0.344*	(0.174)	-0.076	(0.073)	0.199	(0.126)
Hilly										
Hilly	THR (<36m)	4146	0.183	(0.120)	0.030	(0.160)	-0.188	(0.351)	0.483*	(0.178)
Hilly	HCM (≥36m)	2568	0.188	(0.115)	0.206	(0.171)	-0.275	(0.309)	0.213	(0.244)
UTs										
UTs	THR (<36m)	5515	0.275*	(0.128)	-0.129	(0.143)	0.274	(0.265)	0.074	(0.091)
UTs	HCM (≥36m)	3163	0.137	(0.133)	0.014	(0.134)	0.025	(0.260)	-0.038	(0.100)

Notes: Net effects = ICDS main effect + caste interaction term ($\beta + \gamma$), representing the total programme association for each caste group relative to Upper Caste (UC) children. Standard errors in parentheses, clustered at PSU level. Survey design weights and IPW weights applied in all models. Full covariate controls include child age (quadratic), maternal HAZ (quadratic), maternal education (quadratic), maternal age (quadratic), wealth index (quadratic), gender, religion, residence, household size, current pregnancy, and state fixed effects. Significance: † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$. THR = Take-Home Ration (children 6–36 months); HCM = Hot Cooked Meal (children 37–59 months); N = number of observations in each regional cohort. UC = Upper Caste; SC = Scheduled Caste; ST = Scheduled Tribe; OBC = Other Backward Class. Source: NFHS-5 (2019–21), IIPS

5.2 NFHS-5 Results

Results for NFHS-5 are presented in table 4.

National Level

The national picture of NFHS-5 is in sharp contrast with NFHS-4 results. In the THR cohort, no caste groups shows a significant positive net association except SC children, but in smaller magnitude than NFHS-4. The HCM cohort tells a more concerning story, positive association of programme is concentrated in UC children only, while for all three marginalised caste groups return net effect is insignificant. The national results in NFHS-5 therefore present a picture where the only meaningful programme association at the aggregate level is limited to SC children in THR cohort and, UC children in HCM cohort, while other all other children remained effectively excluded from any detectable programme return in either delivery component.

North India

North India produces significant and positive net association only for OBC children in the THR cohort. This is a positive change from NFHS-4. The HCM cohort in North India remains entirely insignificant across all caste groups.

South India

South India, which produced the strongest regional results in NFHS-4, becomes entirely insignificant in NFHS-5. Neither the THR nor HCM cohort produces a significant association for any caste group in this round. The large positive association of programme with UC in NFHS-4, has disappeared, as have the SC and ST positive associations in THR cohort. South India shows a complete reversal from its dominant role in NFHS-4.

East India

East India retains one significant finding in NFHS-5, from NFHS-4, as SC and ST children in THR cohort show a marginally significant and positive net association. And in HCM cohort, positive association was visible only for UC children.

West India

West India witness a significant positive UC association in the HCM cohort, a reversal from the negative association in NFHS-4. While all marginalised caste children of both age cohort remained unaffected by programme benefits in NFHS-5.

Hilly States

The positive OBC association with programme in THR cohort in NFHS-4, persisted in NFHS-5, too. This is the most stable and consistent positive finding across both rounds. The results remained insignificant for all other castes in both cohorts.

Northeast and UTs

Northeastern states produce two significant results in NFHS-5. ST children in THR cohort show a significant and negative association. SC children in HCM cohort show a significant and positive association, the only group in Northeast across either rounds. However, the size of coefficients in NE states should be treated cautiously given the small sample size in each caste group. UTs show a significant and positive association in the THR cohort in NFHS-5. Given the very small size of observations, this result should not be interpreted substantively.

6 Conclusion and Policy Recommendations

Three broad trends define the shift from NFHS-4 to NFHS-5.

The first is the consolidation of programme benefits among UC children. The significant positive UC HCM associations in South India in NFHS-4 and the strong national UC HCM association in NFHS-5 together suggest that over time, the programme's measurable returns have become increasingly concentrated among the caste group that was already better off.

The second is the erosion of pro-equity effects. The broad positive associations for marginalised children in East India's HCM cohort in NFHS-4, the clearest evidence of the programme reaching its target population, have largely disappeared by NFHS-5. SC positive associations at the national level in both cohorts in NFHS-4 have weakened substantially. The only pro-equity finding that survives across both rounds is the OBC THR association in Hilly states.

The third is the persistent failure of the THR component. No region, no caste group, and no survey round produces a consistent positive THR association for the children below 36 months who represent the most critical developmental window. This failure is not new in NFHS-5, it was already present in NFHS-4, and the absence of any improvement between rounds points to a structural weakness in the delivery mechanism that two successive survey rounds have failed to address.

To achieve the Mission POSHAN 2.0 target of reducing stunting by 2 percent per annum, here are some policy recommendations. Firstly, ICDS must move beyond a "one-size-fits-all" model. SNP should be customised to meet the needs of marginalised castes, with region-specific food items that align with local dietary practices. Secondly, financial allocations should be revised to ensure not only caloric sufficiency but also nutritional value. The menu should include eggs, milk, fruits, and pulses in both THR and HCM. Thirdly, since THR showed relatively better effects, especially among OBCs, states should focus on improving THR distribution regularity, quality, and monitoring to maximise its benefits. Fourthly, ICDS must establish strong social audit mechanisms, similar to MGNREGA, to identify caste-based discrimination in service delivery. Awareness and grievance redressal systems at the community level should be institutionalised. Fifthly, huge understaffing (30 percent of

CDPOs and 28 percent of supervisors in 2018–19) hinders programme effectiveness. States should prioritise recruiting trained staff and leveraging contractual staff for service gaps. And lastly, formation of multi-level stakeholder groups, from state to Anganwadi Centre (AWC), can help track regional disparities, ensure accountability, and enable continuous programme improvement.

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Appendix:

Table A1: Results of Wald test for Model Specifications.

Variable	F-statistic	p-value
Child Age	1392.40	<0.001
Maternal HAZ	1535.84	<0.001
Maternal Education	270.92	<0.001
Wealth Index	250.09	<0.001
Maternal Age	18.56	<0.001

Note: Survey-adjusted Wald tests from `regTermTest()` within the full `svyglm` model accounting for complex survey design. All tests conducted at the multivariate level, bivariate tests for maternal age and wealth index were non-significant, highlighting the necessity of multivariate functional form testing.

Table A2: Robustness Check: IPW vs EBAL - NFHS-4 National Level

		IPW		EBAL		
Variable		IPW	SE	EBAL	SE	Difference
Interaction Coefficients						
ICDS (UC ref)		-0.027	(0.029)	-0.030	(0.029)	-0.0028
ICDS × SC		0.117**	(0.037)	0.119**	(0.037)	0.0018
ICDS × ST		0.042	(0.043)	0.046	(0.043)	0.0036
ICDS × OBC		0.069*	(0.034)	0.074*	(0.034)	0.0049
Net Programme Effects						
Net SC effect:		0.090***	(0.024)	0.089***	(0.024)	-0.0010
Net ST effect:		0.015	(0.032)	0.016	(0.032)	0.0008
Net OBC effect:		0.042*	(0.018)	0.044*	(0.018)	0.0021

Notes: . p < * 0.10; ** p < 0.05; *** p < 0.01 (Standard errors in parentheses)
Survey-weighted regression with PSM weights Data: NFHS-4 (2015-16)
SC = Scheduled Caste; ST = Scheduled Tribe; OBC = Other Backward Caste

Table A3: Robustness Check: IPW vs EBAL - NFHS-5 National Level

		IPW		EBAL		
Variable		IPW	SE	EBAL	SE	Difference
Interaction Coefficients						
ICDS (UC ref)		0.070*	(0.035)	0.072*	(0.034)	0.0021
ICDS × SC		-0.034	(0.043)	-0.037	(0.043)	-0.0031

Table A3: Robustness Check: IPW vs EBAL - NFHS-5 National Level

	IPW		EBAL		
Variable	IPW	SE	EBAL	SE	Difference
ICDS $\times$ ST	-0.076	(0.049)	-0.079	(0.049)	-0.0032
ICDS $\times$ OBC	-0.082*	(0.039)	-0.084*	(0.039)	-0.0021
Net Programme Effects					
<i>Net effect: SC</i>	<i>0.036</i>	<i>(0.026)</i>	<i>0.035</i>	<i>(0.026)</i>	<i>-0.0010</i>
<i>Net effect: ST</i>	<i>-0.006</i>	<i>(0.035)</i>	<i>-0.007</i>	<i>(0.036)</i>	<i>-0.0011</i>
<i>Net effect: OBC</i>	<i>-0.012</i>	<i>(0.019)</i>	<i>-0.012</i>	<i>(0.019)</i>	<i>0.0000</i>

Notes: . $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$ (Standard errors in parentheses)

Survey-weighted regression with PSM weights Data: NFHS-5 (2019-21)

SC = Scheduled Caste; ST = Scheduled Tribe; OBC = Other Backward Caste

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