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Does Exposure to POSHAN Abhiyaan Reduce the Risk of Malnutrition among Children Aged 6-23 Months: Evidence from High-Burden Districts of Malnutrition in India, 2019-21

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Abstract

Childhood wasting, underweight, and anaemia are major health concerns in developing countries, especially during the critical "First 1,000 Days" from conception to age two. India's *POSHAN Abhiyaan*, launched in 2018, aimed to combat undernutrition among women and children through a multisectoral approach. This study assessed its impact on children aged 6–23 months in 315 priority districts using multivariate logistic regression and Propensity Score Matching (PSM). Results showed that children exposed to the programme had 25% lower odds of wasting, 13% lower odds of being underweight, and 24% lower odds of anaemia, though no significant effect was observed on stunting. PSM estimates confirmed a significant average treatment effect on the treated for these outcomes. *POSHAN Abhiyaan*'s success is attributed to innovations in service delivery, skill enhancement of frontline workers through the Incremental Learning Approach (ILA), and the use of digital tools like the POSHAN Tracker for effective monitoring and accountability.

Keywords

Malnutrition, 1000 days, POSHAN Abhiyaan, high burden, and, Intention-to-Treat

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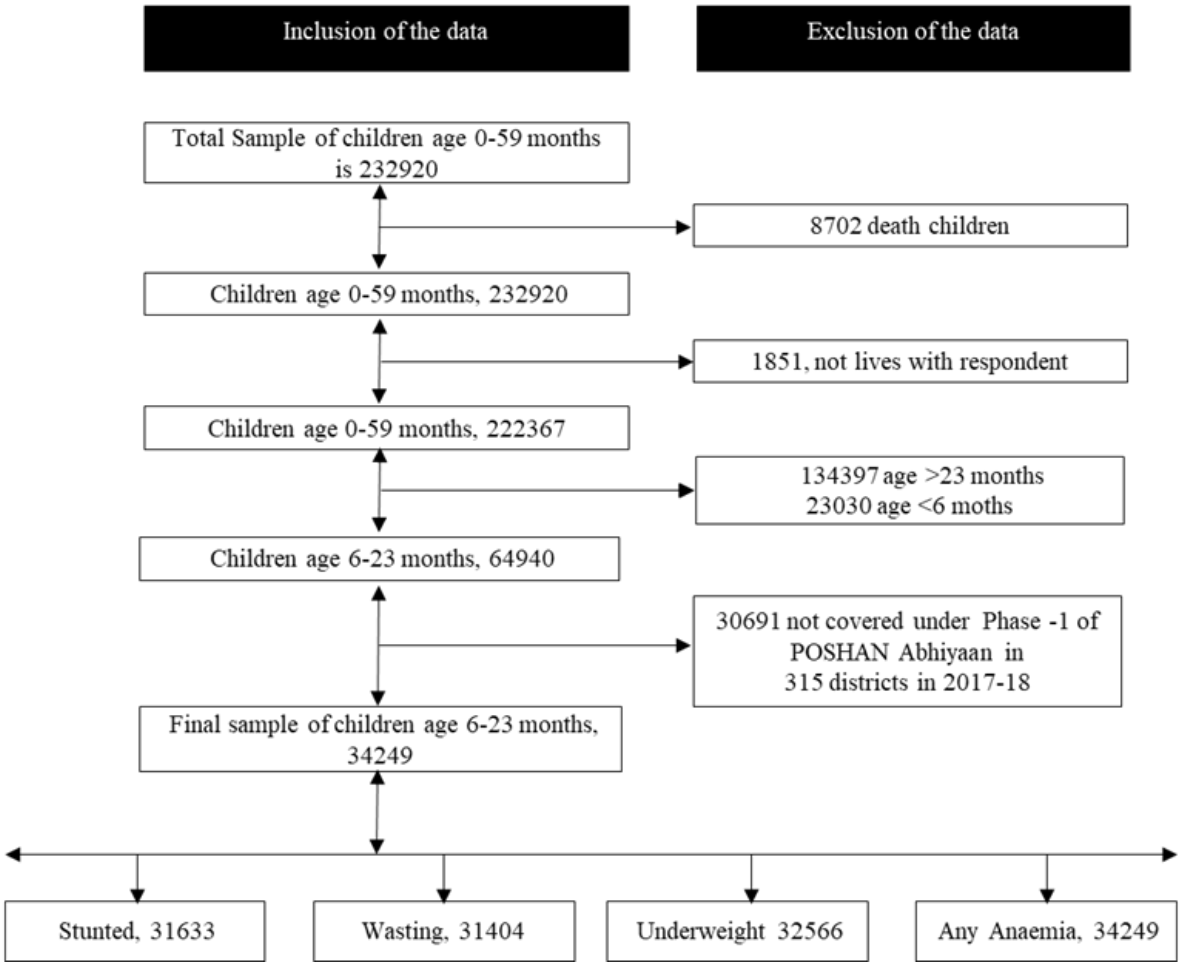
Introduction

Childhood malnutrition is a significant global health concern, particularly in developing countries, leading to increased morbidity and mortality. Malnutrition encompasses a range of nutritional imbalances including wasting, stunting, underweight, deficiencies in vitamins and minerals and overweight or obesity (WHO, 2024; Black et al., 2013). It is one of the leading causes of poor health and a significant impediment to personal development and achievement of full human potential worldwide (Vassilakou, 2021). The global prevalence was 29.1 percent for stunting, 6.3 percent for wasting, and 13.7 percent for underweight. While subgroup analyses suggested that Western Africa, Southern Asia, and Southeastern Asia had a substantially higher estimated prevalence of undernutrition than the global average estimates. (Ssentongo et al., 2021). Anaemia is also a significant global health challenge, affecting approximately 40 percent of children aged 6-59 months worldwide (Stevens et al., 2022). The South Asia region bears the world's highest burden of child malnutrition, manifesting as stunting, wasting, underweight, and micronutrient deficiencies (Akhtar, 2016; Menon, 2012; WHO, 2023). Growing evidence suggests that children in developing countries experience rapid growth faltering during the First 1,000 Days of life, with maternal and household factors being significant predictors of child nutrition (Rieger & Trommlerov, 2016). The timing of growth faltering has significant implications. Associations between socioeconomic conditions and child growth outcomes are stronger in older children (24-59 months) for height-for-age measures, while weight-for-height associations are stronger in younger children (0-23 months) (Alderman & Headey, 2018). The First 1,000 Days concept, spanning from conception to a child's second birthday, has gained traction in global health policy as a critical window for interventions to improve child health and development (Darling, 2020). This period is crucial for brain development, mental health, nutrition, and long-term economic benefits. However, the child-centric focus of these programmes may overlook the women's nutritional needs across their lifespan, particularly during adolescence, preconception, and later years (Flood, 2018; Fox et al., 2019). Nutritional interventions during this period can significantly impact child growth and development (Christian et al., 2015). Recent studies on child malnutrition in India reveal a complex picture. Meanwhile, the prevalence of stunting, underweight, and wasting has decreased between National Family and Health Survey 4 (NFHS-4, 2015-16) and NFHS-5 2019-21. NFHS-5 data indicates that 36 percent of children under five years were stunted (38 percent in NFHS-4), 19 percent were wasted (21 percent in NFHS-4), and 32 percent are underweight (36 percent in NFHS-4) (ICF IIPS, 2021; Singhal et al., 2022). Anaemia prevalence increased from 59 percent to 67 percent among children aged 6-59 months between 2015-16 and 2019-21. While there has been a decline in malnutrition since the 1990s , the progress appears to be quite slow. This highlights a persistent issue of malnutrition across the country. To improve the nutritional status of women and children in India, POSHAN Abhiyaan (the National Nutrition Mission) was launched by the Prime Minister on the International Women's Day, 8 March 2018, in Jhunjhunu, Rajasthan, India. POSHAN Abhiyaan was approved by the Government of India on 30 November 2017 and aims to reduce malnutrition, anaemia, and low birth weight among children through a convergent framework across sectors (NITI Aayog, 2018). Particularly, POSHAN Abhiyaan focuses on the crucial First 1,000 Days of life, recog-

nising the importance of early interventions to prevent stunting and underweight in children (NITI Aayog, 2018; Vir & Suri, 2023). A key component of POSHAN Abhiyaan and National Health Mission intervention is the Home-based Care for Young Child (HBYC) programme, which addresses barriers in infant and young child feeding practices (NITI Aayog, 2018, 2021) . In order to enhance service delivery and expand its reach, the POSHAN Abhiyaan intervention primarily utilized technology-based tools for frontline workers, augmented capacity-building initiatives, fostered inter-departmental collaboration, underscored the importance of behavior change communication (BCC), advocated for innovations, and incorporated mechanisms for grievance redressal (NITI Aayog, 2021). These initiatives aimed to enhance growth monitoring, ensure timely home visits, and disseminate reliable nutrition information. Additionally, community events, home visits, and targeted campaigns were crucial for instigating behavioural change and reinforcing improved nutritional practices (Avula et al., 2024). POSHAN Abhiyaan interventions were implemented in three phases, covering 315 districts in 2017-18, 235 districts in 2018-19, and the remaining districts in 2019-20, to reach all States and Union Territories (NITI Aayog, 2018, 2021). In the first phase, 315 districts identified in the descending order of prevalence of stunting from amongst 201 districts identified by NITI Aayog on the basis of National Family Health Survey-4 data, 162 ISSNIP (ICDS Systems Strengthening & Nutrition Improvement Program) districts and 106 districts of Scheme for Adolescent Girls. In this study, we aim to examine the impact of POSHAN Abhiyaan interventions on the risk of malnutrition in children aged 6 to 23 months who were born in January 2019 or later. The research focuses on the 315 districts identified by NITI Aayog as having the highest burden of stunting. Data and Methodology This study utilised data from NFHS-5 2019-21, marking the fifth iteration in the NFHS series. NFHS-5 is a comprehensive nationwide survey conducted in households across India, providing a rich dataset on factors such as fertility, infant and child mortality, maternal and child health, various nutrition and health services, and family welfare indicators. These data are stratified by demographic characteristics at both the national and state levels. NFHS asks for information on malnutrition indicators for children under five years from the interview days. The NFHS -5 was conducted in two distinct phases: the first phase occurred from June 2019 to January 2020, encompassing 17 states and 5 Union Territories, while the second phase took place from November 2020 to April 2021, covering 11 states and 3 Union Territories. The survey provides an opportunity to identify 309 out of the 315 districts that implemented POSHAN Abhiyaan in Phase I (2017-18). Since the NFHS-2019-21 began data collection in June 2019, it limited our inclusion to children who were at least 6 months old and born between January 2019 and June 2019. This provides an opportunity to examine the impact of POSHAN Abhiyaan on malnutrition indicators among children aged 6 to 23 months. The NFHS-5 survey collected data from 636699 households, including 724115 women and 101839 men. To meet the objective of this study, 34249 samples of children aged 6 to 23 months were included in the study after following the inclusion and exclusion criteria. The comprehensive data construction for the analysis is illustrated in Figure 1. For this analysis, specific samples were taken: 31633 for stunting, 31404 for wasting, 32566 for underweight, and 31225 for anaemia among children aged 6 to 23 months during the NFHS-5 survey conducted between June 2019 and April 2021.

Fig 1. Construction of the analytical sample from NFHS 2019-21



Outcomes Variable

In this study, four key indicators of malnutrition were selected to assess the nutritional status of children aged 6-23 months: wasting, stunting, underweight, and any anaemia. Stunting is measured as the percentage of children whose height-for-age falls below minus 2 standard deviations from the median height-for-age (Height-for-age ¡-2SD) of a reference population, indicating chronic malnutrition and long-term growth deficiencies (WHO, 2024). Underweight refers to children whose weight-for-age is below minus two standard deviations from the median weight-for-age of a reference population (Weight-for-age ¡ -2SD). This condition reflects a combination of both acute and chronic malnutrition. Wasting is defined as the percentage of children whose weight-for-height is below minus two standard deviations from the median weight-for-height of the reference population (Weight-for-height ¡ -2SD). Wasting indicates acute malnutrition or recent, severe weight loss. Anaemia in children under five years old is defined as a haemoglobin concentration of less than 11 g/dL (AMB, MoHFW, 2018). This indicates a common problem of iron deficiency and other related causes. All these indicators of malnutrition are classified as binary variables.

Independent Variable

In this study, children's exposure to POSHAN Abhiyaan interventions is determined based on their birth year, distinguishing between those who fully benefited from the programme and those who did not. Children are classified as exposed to POSHAN Abhiyaan (coded as 1) if they were born in January 2019 or later and were at least 6 months old by June 2019, when the survey began. These children were likely conceived after March 2018, following the launch of the programme, and were expected to have received the full range of benefits from the POSHAN Abhiyaan interventions. This includes support during the critical First 1000 Days, covering both the prenatal period (conception to birth) and early childhood (6 to 23 months). Conversely, children are classified as not exposed to the POSHAN Abhiyaan (coded as 0) if they were born before January 2019 and were at least 6 months old by June 2019. While some of these children may have encountered limited aspects of the programme, their critical early developmental stages—pregnancy and infancy—occurred before POSHAN Abhiyaan was fully rolled out in the 315 districts across India. As a result, they are not considered to have received the full benefits of POSHAN Abhiyaan interventions. This classification enables a clear and robust comparison of nutritional outcomes between children who had full exposure to the programme and those who did not, offering a comprehensive evaluation of its real-world effectiveness impact. The other covariates are gender, child age, place of residence, institutional birth, birth order, maternal characteristics (age, education), socioeconomic factors (wealth quintile, social group), and religion.

Empirical Strategy

We employed a simple cross table to describe the relationship between the children's exposure to POSHAN Abhiyaan and the prevalence of wasting, stunting, underweight, and anaemia. We employed multivariate logistic regression to examine the impact of the children's exposure to POSHAN Abhiyaan on wasting, stunting, underweight, and anaemia. We controlled various covariates such as gender, child age, place of residence, birth order, maternal characteristics (age, education), and socioeconomic factors (wealth quintile, social group). By adjusting for these potential confounders, logistic regression provides a more precise estimate of the independent effect of POSHAN Abhiyaan exposure on malnutrition outcomes. Multivariate logistic regression is given as

$$Y_{idt} = \alpha + \beta \cdot \text{POA}_{idt} + \gamma \cdot X_{idt} + \epsilon_{idt} \quad (1)$$

Y_{idt} is the malnutrition outcomes (e.g., stunting, wasting, underweight, anaemia) for child in district d at time t. POA_{idt} is a binary variable indicating whether the child was born after December 2018 in a district covered by Phase I (1 = exposed, 0 = not exposed). X_{idt} represents a set of control variables such as socioeconomic status, gender, maternal education, wealth quintile, and birth order and ϵ_{idt} is the error term.

This study also employed a robust logistic regression (Model-II) to ensure accurate estimates of the relationship between POSHAN Abhiyaan exposure and nutritional outcomes, accounting for model misspecification and data clustering. A multivariate logistic regression was conducted on children aged 15 to 23 months. Those born in March 2018 or earlier were classified as not fully exposed (coded as 0), while those born in January 2019 or later were exposed (coded as 1), having likely received the programme full

benefits from conception through infancy. This approach enhances the validity and robustness of findings, ensuring reliable assessment of the impact of POSHAN Abhiyaan.

Treatment effect of POSHAN Abhiyaan on child malnutrition

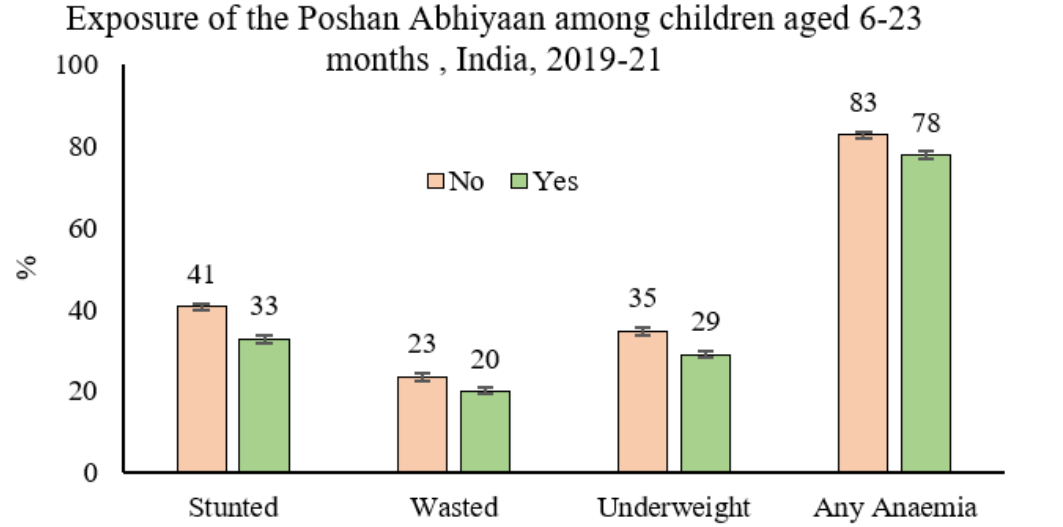
To measure the average treatment effect on treated (ATT) in this study, Propensity Score Matching (PSM) was used as a robust statistical technique to estimate the causal impact of POSHAN Abhiyaan on child malnutrition, specifically focusing on outcomes like stunting, wasting, underweight, and anaemia among children aged 6-23 months. PSM allows for the comparison of children exposed to POSHAN Abhiyaan interventions (those born in 2019 or after) with those not exposed (born before 2019) by accounting for differences in observable characteristics that may affect both exposure and outcomes. In the process of estimating the propensity score matching (PSM), a logistic regression model was first utilised to estimate the propensity score. This score indicates the likelihood of a child being exposed to parental overcrowding based on various observable characteristics, such as socioeconomic status, maternal education, gender, birth order, place of residence, and other demographic factors. After estimating the propensity scores, we utilised kernel matching to pair children in the treatment group with those in the control group. The propensity score matching (PSM) method assumes that there is sufficient overlap between the treatment and control groups in terms of their propensity scores (the likelihood of receiving treatment). We further assess whether there is common support or overlap in the propensity scores between the treatment and comparison groups. Our analysis demonstrates that the overlap range includes a sufficient number of treated and control units with similar propensity scores (Caliendo & Kopeinig, 2008), which permits valid comparisons of wasting, stunting, underweight, and any anaemia, as shown in Figure 4. We employ three different propensity score matching approaches: Kernel Matching, Nearest Neighbor Matching, and Caliper Matching. The kmatch command is used to apply propensity score matching and to estimate the Average Treatment effect on the Treated (ATT) using an Epanechnikov kernel, nearest neighbor matching, and a caliper method with a width of 0.05. For post-estimation evaluation of data balancing, we assess standardised mean differences and variances before and after matching covariates. The standardised mean difference (SMD) represents the difference in means of each covariate between treatment groups, standardised by a common factor to ensure comparability across all covariates (Figure 4). The standardisation factor is generally the standard deviation of the covariate in the treated group when targeting the ATT. Standardised mean differences close to zero indicate a good balance between the groups. The variance ratio is defined as the ratio of the variance of a covariate in one group to that in the other (Figure 4). Variance ratios close to 1 suggest good balance, as they imply that the variances of the samples are similar (Austin, 2009).

Results

We defined that children born in January 2019 or later may receive POSHAN Abhiyaan interventions from conception to birth (conception after March 2018) and during infant life from 6 to 23 months (born January 2019 to April 2021), defined as children's exposure to

the POSHAN Abhiyaan interventions. In contrast, children born in December 2018 or earlier did not receive exposure to the POSHAN Abhiyaan interventions compared to those born in 2019 or later. Table 1 summarizes the social and demographic characteristics of children by POSHAN Abhiyaan exposure, and Figure 2 displays a cross-table clustered column chart. The clustered column chart shows that children exposed to POSHAN Abhiyaan have low prevalence of stunting, wasting, underweight, and anaemia among children aged 6-23 months old.

Figure 2.



Note- Children with exposure had significantly better nutritional outcomes across all indicators—stunting (χ^2=151.31, p<0.001), underweight (χ^2=46.41, p<0.001), wasting (χ^2=23.91, p<0.001), and anemia (χ^2=25.57, p<0.001)—based on Chi-square tests

Table 2 shows the results of logistic regression analysis that investigates malnutrition in children aged 6 to 23 months, sampled from 309 priority districts. The analysis focuses on the effects of exposure to POSHAN Abhiyaan on key nutritional outcomes, including stunting (height-for-age), wasting (weight-for-height), underweight (weight-for-age), and anaemia (haemoglobin levels below 11.0 g/dL). Children who were exposed to POSHAN Abhiyaan interventions had no significant impact on stunting (OR: 0.96, 95% CI: 0.91-1.01) compared to those who were not exposed, indicating a small reduction in the likelihood of stunting; however, the result is not statistically significant. In contrast, children exposure to POSHAN Abhiyaan interventions was significantly associated with lower odds of wasting (OR: 0.75, 95% CI: 0.71-0.79), underweight (OR: 0.87, 95% CI: 0.82-0.91), and anaemia (OR: 0.76, 95% CI: 0.71-0.80). Children exposed to the programme had 25 percent lower odds of being wasted, 13 percent lower odds of being underweight, and 24 percent lower odds of having anaemia, with all results being statistically significant.

Table 1. Summary of the Socio-demographic characteristics by Exposure of the POSHAN Abhiyaan of children aged 6-23 months

	Exposure of the POSHAN Abhiyaan			
	No		Yes	
	%	Number	%	Number
Gender				
Boys	51.78	18257	51.91	17536
Girls	48.22	18257	48.09	17536
Children age	0.00		0.00	
6-12 months	24.95	18257	58.05	17536
13-18 months	40.10	18257	25.91	17536
19-23 months	34.95	18257	16.05	17536
Place of residence	0.00		0.00	
Urban	20.70	18257	22.30	17536
Rural	79.30	18257	77.70	17536
Birth order	0.00		0.00	
1 birth order	35.23	18257	38.18	17536
2-3 birth order	50.32	18257	47.10	17536
4-5 birth order	11.50	18257	11.71	17536
6+ birth order	2.96	18257	3.02	17536
Institutional Birth	0.00		0.00	
No	13.82	18257	11.38	17536
Yes	86.18	18257	88.62	17536
Mothers age at birth	0.00		0.00	
15-19 year	14.82	18257	8.75	17536
20-29 years	73.61	18257	76.55	17536
30 or more years	11.56	18257	14.70	17536
Mother education in years	0.00		0.00	
No education	26.62	18257	23.26	17536
< 5 years	5.42	18257	3.53	17536
5-10 years	42.65	18257	43.46	17536
11+ years	25.32	18257	29.76	17536
Wealth quintile	0.00		0.00	
Poorest	31.97	18257	28.01	17536
Poorer	24.32	18257	23.19	17536
Middle	18.96	18257	17.91	17536
Richer	14.98	18257	15.79	17536
Richest	9.78	18257	15.09	17536
Social groups	0.00		0.00	
Scheduled caste	23.16	18257	23.67	17536
Scheduled tribe	9.17	18257	11.00	17536
Other backward class	45.24	18257	47.62	17536
Other	22.43	18257	17.71	17536
Religion	0.00		0.00	
Hindu	79.03	18257	81.60	17536
Muslim	18.06	18257	15.86	17536
Other	2.91	18257	2.54	17536
Height-for-age (-2 SD)	0.00		0.00	
No	59.40	16301	67.28	15332
Yes	40.60	16301	32.72	15332
Weight-for-age (-2 SD)	0.00		0.00	
No	65.27	16781	71.08	15785
Yes	34.73	16781	28.92	15785
Weight-for-height (-2 SD)	0.00		0.00	
No	76.57	16214	80.07	15190
Yes	23.43	16214	19.93	15190
Any anaemia (<11.0 g/dl)	0.00		0.00	
No	17.41	16349	22.26	14876
Yes	82.59	16349	77.74	14876

Table 2. Logistic regression on malnutrition in children 6-23 months in India, 2019-21 (**Model-I**)

Background characteristic	Stunted Height-for-age (-2 SD)	Wasted Weight-for-height (-2 SD)	Underweight Weight-for-age (-2 SD)	Any anaemia (<11.0 g/dl)
Exposure of POA	**OR [95%, C.I]**	**OR [95%, C.I]**	**OR [95%, C.I]**	**OR [95%, C.I]**
No Ref.	1	1	1	1
Yes	0.96 [0.91,1.01]	0.75*** [0.71,0.79]	0.87*** [0.82,0.91]	0.76*** [0.71,0.80]
Gender				
Boys Ref.	1	1	1	1
Girls	0.78*** [0.75,0.82]	0.88*** [0.84,0.93]	0.79*** [0.76,0.83]	0.87*** [0.82,0.91]
Children age				
6-12 months Ref.	1	1	1	1
13-18 months	1.92*** [1.82,2.03]	0.76*** [0.72,0.81]	1.11*** [1.05,1.18]	1.13*** [1.06,1.21]
19-23 months	2.40*** [2.26,2.55]	0.71*** [0.66,0.76]	1.34*** [1.26,1.42]	0.95 [0.89,1.02]
Place of residence				
Urban Ref.	1	1	1	1
Rural	1.05 [0.99,1.12]	0.90*** [0.83,0.97]	0.93** [0.87,0.99]	0.98 [0.91,1.06]
Birth order				
1 birth order Ref.	1	1	1	1
2-3 birth order	1.13*** [1.08,1.20]	1.02 [0.96,1.08]	1.15*** [1.09,1.22]	0.98 [0.92,1.04]
4-5 birth order	1.34*** [1.23,1.46]	1.03 [0.94,1.14]	1.29*** [1.19,1.41]	0.97 [0.88,1.08]
6+ birth order	1.33*** [1.14,1.55]	1.06 [0.90,1.26]	1.26*** [1.09,1.46]	1.09 [0.90,1.32]
Institutional Birth				
No Ref.	1	1	1	1
Yes	0.91*** [0.85,0.97]	0.92** [0.85,1.00]	0.90*** [0.84,0.96]	1.00 [0.92,1.09]
Mothers age at birth				
15-19 year Ref.	1	1	1	1
20-29 years	0.81*** [0.76,0.88]	1.05 [0.96,1.14]	0.83*** [0.77,0.89]	0.98 [0.90,1.08]
30 or more years	0.75*** [0.67,0.83]	1.02 [0.91,1.15]	0.78*** [0.70,0.87]	0.90* [0.79,1.02]
Mother education in years				
No education Ref.	1	1	1	1
< 5 years	0.85*** [0.76,0.95]	0.89* [0.79,1.01]	0.83*** [0.74,0.93]	0.98 [0.85,1.14]
5-10 years	0.86*** [0.81,0.92]	0.88*** [0.82,0.94]	0.84*** [0.79,0.89]	0.92** [0.85,0.99]
11+ years	0.77*** [0.71,0.83]	0.83*** [0.76,0.90]	0.70*** [0.65,0.76]	0.78*** [0.71,0.86]
Wealth quintile				
Poorest Ref.	1	1	1	1
Poorer	0.86*** [0.81,0.92]	0.81*** [0.76,0.87]	0.75*** [0.70,0.79]	0.94 [0.87,1.02]
Middle	0.74*** [0.69,0.79]	0.73*** [0.67,0.79]	0.62*** [0.58,0.67]	0.91** [0.83,0.99]
Richer	0.62*** [0.57,0.67]	0.67*** [0.61,0.74]	0.52*** [0.47,0.56]	0.88*** [0.80,0.97]
Richest	0.52*** [0.47,0.57]	0.57*** [0.51,0.65]	0.39*** [0.35,0.43]	0.78*** [0.69,0.87]
Social groups				
Scheduled caste Ref.	1	1	1	1
Scheduled tribe	0.96 [0.88,1.04]	1.15*** [1.05,1.26]	1.10** [1.02,1.20]	1.20*** [1.08,1.34]
Other backward class	0.85*** [0.80,0.90]	0.91*** [0.86,0.98]	0.85*** [0.80,0.90]	0.89*** [0.83,0.95]
Other	0.78*** [0.72,0.84]	0.87*** [0.80,0.95]	0.75*** [0.69,0.80]	1.01 [0.92,1.10]
Religion				
Hindu Ref.	1	1	1	1
Muslim	1.20*** [1.12,1.28]	1.00 [0.92,1.07]	1.08** [1.01,1.15]	0.89*** [0.83,0.97]
Other	1.00 [0.87,1.15]	0.79*** [0.67,0.93]	0.82*** [0.71,0.95]	0.75*** [0.64,0.88]
Sample	**31633**	**31404**	**32566**	**31225**

Note- * p<0.05, ** p<0.01, *** p<0.001

Girls had significantly lower odds of stunting (OR: 0.78, 95% CI: 0.75-0.82), wasting (OR: 0.88, 95% CI: 0.84-0.93), underweight (OR: 0.79, 95% CI: 0.76-0.83), and anaemia (OR: 0.87, 95% CI: 0.82-0.91) compared to boys. Rural children were slightly more likely to be stunted (OR: 1.05, 95% CI: 0.99-1.12) but significantly less likely to be wasted (OR: 0.90, 95% CI: 0.83-0.97) and underweight (OR: 0.93, 95% CI: 0.87-0.99) than urban children, with no significant association found for anaemia. Higher birth order (2-3, 4-5, and 6+) increased the likelihood of stunting and underweight. For instance, children with a birth order of 4-5 had higher odds of stunting (OR: 1.34, 95% CI: 1.23-1.46) and underweight (OR: 1.29, 95% CI: 1.19-1.41). Children born in institutions were less likely to experience stunting (OR: 0.91, 95% CI: 0.85-0.97), wasting (OR: 0.92, 95% CI: 0.85-1.00), and underweight (OR: 0.90, 95% CI: 0.84-0.96) compared to those born at home, though no significant association was found for anaemia.

Children born to mothers in the age group 20-29 years and 30+ years were significantly less likely to be stunted (OR: 0.81 and 0.75, respectively) and underweight (OR: 0.83 and 0.78, respectively) compared to those born to teenage mothers (15-19 years). Higher maternal education was associated with lower odds of malnutrition. Children whose mothers had 11+ years of education had significantly lower odds of stunting (OR: 0.77, 95% CI: 0.71-0.83), wasting (OR: 0.83, 95% CI: 0.76-0.90), underweight (OR: 0.70, 95% CI: 0.65-0.76), and anaemia (OR: 0.78, 95% CI: 0.71-0.86) compared to those whose mothers had no education. Similarly, children from wealthier households were less likely to be malnourished. Those from the richest quintile had significantly lower odds of stunting (OR: 0.52, 95% CI: 0.47-0.57), wasting (OR: 0.57, 95% CI: 0.51-0.65), underweight (OR: 0.39, 95% CI: 0.35-0.43), and anaemia (OR: 0.78, 95% CI: 0.69-0.87). Social and religious differences were also evident. Children from Other Backward Classes (OBCs) were less likely to be stunted, wasted, and underweight compared to those from Scheduled Castes (SCs). Muslim children had significantly higher odds of being stunted (OR: 1.20, 95% CI: 1.12-1.28) and underweight (OR: 1.08, 95% CI: 1.01-1.15) compared to Hindu children but were less likely to be anaemic (OR: 0.89, 95% CI: 0.83-0.97).

Table 3. Logistic regression for Interactive Effects of Poshan Abhiyaan Exposure and Residence on malnutrition in children 6-23 months in India, 2019-21

	Stunted Height-for-age (-2 SD)	Wasted Weight-for-height (-2 SD)	Underweight Weight-for-age (-2 SD)	Any anemia (<11.0 g/dl)
Exposure of POA* Residence area	**OR [95%, C.I]**	**OR [95%, C.I]**	**OR [95%, C.I]**	**OR [95%, C.I]**
No POA exposure* Urban[Ref.]	1	1	1	1
No POA exposure* Rural	1.05 [0.97,1.14]	0.88*** [0.80,0.96]	0.96 [0.88,1.04]	0.97 [0.88,1.07]
POA exposure* Urban	0.95 [0.86,1.06]	0.72*** [0.64,0.81]	0.93 [0.83,1.03]	0.74*** [0.66,0.84]
POA exposure* Rural	1.01 [0.93,1.10]	0.66*** [0.60,0.73]	0.82*** [0.75,0.89]	0.74*** [0.67,0.81]

Note- * p<0.05, ** p<0.01, *** p<0.001; adjusted variable are gender, age, birth order, institutional birth, mothers age at birth, mother education in years, wealth quintile, social groups and religions.

The results presented in Table 3 demonstrate the interactive effects of exposure to the Poshan Abhiyaan (POA) and place of residence on malnutrition outcomes among children aged 6–23 months. Specifically, children residing in rural areas who were exposed to POA had lower odds of being wasted (OR = 0.66, 95% CI: 0.60–0.73) and of being underweight (OR = 0.82, 95% CI: 0.75–0.89), both statistically significant, even after adjusting for other factors. Similarly, exposure to POA in both urban and rural areas was associated with substantially lower odds of anaemia. We utilized a second logistic regression (Model-II) to assess the robustness of the POSHAN Abhiyaan exposure. Children aged 15 to 23 months during their NFHS-5 interview (conducted from June 2019 to April 2021) were included in the analysis, Table 4. In this study, children born between January 2019 and January 2020 were classified as the exposed group, while those born in June 2018 or earlier were considered not fully exposed to the POSHAN Abhiyaan. Results indicate that children exposed to POSHAN Abhiyaan showed slightly lower odds of stunting (OR: 0.95, 95% CI: 0.88–1.03); however, this reduction was not statistically significant. Nevertheless, the POSHAN Abhiyaan programme demonstrated a significant effect on other outcomes, with children experiencing 33 percent lower odds of wasting (OR: 0.67, 95% CI: 0.61–0.75), 17 percent lower odds of underweight (OR: 0.83, 95% CI: 0.76–0.90), and 20 percent lower odds of anaemia (OR: 0.80, 95% CI: 0.72–0.88).

The evaluation of the average treatment effect of POSHAN Abhiyaan on malnutrition among children aged 6-23 months in India (2019-21) demonstrates a significant reduction in wasting, underweight, and anaemia in Table 4. The reported results are the differences in means between the children exposed to POSHAN Abhiyaan interventions and those not exposed to the programme. The analysis, employing Kernel matching, Nearest-neighbor matching, and Caliper matching (0.005), reveals mixed results regarding stunting. The programme led to a slight but statistically significant reduction in stunting under Kernel matching (Coef: -0.015, 95% CI: -0.029, -0.002) and Nearest-neighbor matching (Coef: -0.016, 95% CI: -0.032, -0.001). However, under Caliper matching, the effect on stunting was not statistically significant (Coef: -0.009, 95% CI: -0.022, 0.004), as the confidence interval includes zero. In contrast, POSHAN Abhiyaan significantly reduced wasting across all matching methods. The reduction was most pronounced under Kernel matching (Coef: -0.043, 95% CI: -0.056, -0.031), followed by Nearest-neighbor matching (Coef: -0.033, 95% CI: -0.048, -0.018) and Caliper matching (Coef: -0.031, 95% CI: -0.044, -0.019), all of which were highly significant (p ¡ 0.001). Similarly, underweight showed a notable decline due to programme exposure, with reductions ranging from -0.032 (Kernel matching) to -0.047 (Caliper matching), all statistically significant at p ¡ 0.001. POSHAN Abhiyaan also effectively reduced anaemia prevalence among children. The estimated coefficients for anaemia reduction ranged from -0.035 (Caliper matching) to -0.042 (Nearest-neighbor matching), all highly significant ($p < 0.001$).

Table 4. Logistic regression on malnutrition in children 15-23 months in India, 2019-21, (**Model-II**)

Background characteristic	Stunted Height-for-age (-2 SD)	Wasted Weight-for-height (-2 SD)	Underweight Weight-for-age (-2 SD)	Any anaemia (<11.0 g/dl)
Exposure of POA	OR [95%, C.I]	OR [95%, C.I]	OR [95%, C.I]	OR [95%, C.I]
No	1	1	1	1
Yes	0.95 [0.88,1.03]	0.67*** [0.61,0.75]	0.83*** [0.76,0.90]	0.80*** [0.72,0.88]
Gender				
Boys Ref.	1	1	1	1
Girls	0.79*** [0.74,0.86]	0.87*** [0.79,0.95]	0.82*** [0.76,0.89]	0.85*** [0.78,0.93]
Children age in months	1.02** [1.00,1.03]	0.97*** [0.95,0.99]	1.02** [1.00,1.03]	0.97*** [0.95,0.99]
Place of residence				
Urban Ref.	1	1	1	1
Rural	1.07 [0.96,1.19]	0.88* [0.77,1.01]	1.00 [0.89,1.13]	0.97 [0.85,1.11]
Birth order				
1 birth order Ref.	1	1	1	1
2-3 birth order	1.19*** [1.09,1.30]	1.01 [0.90,1.12]	1.26*** [1.15,1.38]	1.03 [0.92,1.15]
4-5 birth order	1.40*** [1.22,1.62]	1.04 [0.87,1.23]	1.51*** [1.30,1.75]	1.14 [0.95,1.36]
6+ birth order	1.30** [1.00,1.69]	1.03 [0.76,1.40]	1.12 [0.86,1.46]	1.02 [0.74,1.39]
Institutional Birth				
No Ref.	1	1	1	1
Yes	1.02 [0.90,1.14]	1.00 [0.87,1.15]	0.93 [0.83,1.04]	1.06 [0.91,1.22]
Mothers age at birth				
15-19 year Ref.	1	1	1	1
20-29 years	0.76*** [0.67,0.86]	1.09 [0.94,1.27]	0.87** [0.77,0.99]	0.99 [0.85,1.16]
30 or more years	0.71*** [0.60,0.85]	1.04 [0.84,1.29]	0.74*** [0.62,0.89]	0.75*** [0.61,0.93]
Mother education in years				
No education Ref.	1	1	1	1
< 5 years	0.78*** [0.65,0.94]	0.90 [0.72,1.13]	0.77*** [0.63,0.93]	0.95 [0.75,1.22]
5-10 years	0.81*** [0.73,0.90]	0.90* [0.80,1.01]	0.82*** [0.74,0.91]	0.87** [0.76,0.99]
11+ years	0.73*** [0.64,0.82]	0.80*** [0.68,0.93]	0.71*** [0.62,0.81]	0.67*** [0.58,0.79]
Wealth quintile				
Poorest Ref.	1	1	1	1
Poorer	0.82*** [0.74,0.91]	0.87** [0.77,0.99]	0.79*** [0.71,0.88]	1.07 [0.93,1.22]
Middle	0.74*** [0.66,0.84]	0.78*** [0.67,0.90]	0.63*** [0.56,0.72]	0.95 [0.82,1.10]
Richer	0.56*** [0.49,0.64]	0.65*** [0.55,0.77]	0.50*** [0.43,0.57]	1.29*** [1.08,1.53]
Richest	0.50*** [0.42,0.59]	0.56*** [0.45,0.70]	0.41*** [0.34,0.49]	1.01 [0.83,1.24]
Social groups				
Scheduled caste Ref.	1	1	1	1
Scheduled tribe	0.89* [0.77,1.02]	1.34*** [1.14,1.57]	1.04 [0.91,1.19]	1.02 [0.85,1.21]
Other backward class	0.75*** [0.68,0.82]	0.92 [0.82,1.04]	0.75*** [0.68,0.83]	0.86** [0.76,0.97]
Other	0.70*** [0.62,0.80]	0.86* [0.74,1.00]	0.68*** [0.59,0.77]	0.91 [0.78,1.06]
Religion				
Hindu Ref.	1	1	1	1
Muslim	1.22*** [1.09,1.36]	1.04 [0.90,1.18]	1.07 [0.95,1.19]	0.88* [0.77,1.00]
Other	0.98 [0.79,1.22]	0.75** [0.56,0.99]	0.83 [0.66,1.04]	0.85 [0.65,1.10]
Sample	**10637**	**10558**	**10880**	**10478**

Note- * p<0.05, ** p<0.01, *** p<0.001

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Table 5. Average treatment effect of POSHAN Abhiyaan on malnutrition among children 6-23 months, India, 2019-21

Types of undernutrition	Kernel matching	Nearest-neighbour matching	Caliper(0.005) matching
	Coef. [95% C.I]	Coef. [95% C.I]	Coef. [95% C.I]
Height-for-age (-2 SD)	-0.015* [-0.029,-0.002]	-0.016* [-0.032,-0.001]	-0.009 [-0.022,0.004]
Weight-for-height (-2 SD)	-0.043*** [-0.056,-0.031]	-0.033*** [-0.048,-0.018]	-0.031*** [-0.044,-0.019]
Weight-for-age (-2 SD)	-0.032*** [-0.046,-0.019]	-0.041*** [-0.055,-0.027]	-0.047*** [-0.059,-0.036]
Any anaemia (<11.0 g/dl)	-0.041*** [-0.052,-0.030]	-0.042*** [-0.054,-0.030]	-0.035*** [-0.045,-0.024]

Note- * p<0.05, ** p<0.01, *** p<0.001

Discussion and Conclusion

According to NITI Aayog (2018), the POSHAN Abhiyaan program aimed to improve the nutritional status of children by delivering a package of interventions with sufficient coverage, continuity, intensity, and quality, focusing on the First 1000 Days of a child's life. This study investigated how exposure to the program affected the undernutrition status of children between the age group of 6 to 23 months in 315 Indian districts that NITI Aayog determined had the worst undernutrition prevalence (NITI Aayog, 2018). First, the logistic regression based odds ratio results show that exposure to POSHAN Abhiyaan strongly impacts wasting, underweight, and anemia in children aged 6–23 months. However, the effect of POSHAN Abhiyaan on stunting was negligible at the time. However, findings indicate that the Poshan Abhiyaan has positively improved child nutrition outcomes, particularly among rural populations. Similarly, the robustness check and the treatment effects of exposure to POSHAN Abhiyaan significantly reduce the risk of wasting, being underweight, and anemia in children. Using the Lives Saved Tool (LiST) model, NITI Aayog's projections evaluate how POSHAN Abhiyaan can speed up current trends of decline in stunting, wasting, and anemia by expanding coverage of key interventions (WCD Division, NITI Aayog, 2020). They emphasize improving complementary feeding using both behaviour change interventions and the complementary food supplements in ICDS to lower child stunting and wasting. Enhancing Sam and MAM screening and referral systems, as well as expanding the quality and availability of ICDS food supplements, are essential measures for lowering the prevalence of waste (WCD Division, NITI Aayog, 2020). Although estimates for child anemia are not included in the LIST model, the models indicate that increasing health sector efforts would only result in slight improvements in anemia in women who are of reproductive age (WCD Division, NITI Aayog, 2020). Improved anemia status in children may result from the Anameia Mukat Bahrt's September 2018 launch, which is anticipated to highlight the importance of providing IFA supplements to a variety of populations, including children and pregnant women (Joe et al., 2022, 2024). A study conducted by Avula et al. (2024) indicated that under the Poshan Abhiyaan coverage of essential interventions in the first 1000 days, including during pregnancy, delivery, postpartum period, and early childhood, with significant increases observed from 2016 to 202 (Avula et al., 2024). Avula et al. (2024) demonstrated that these advancements were brought about by NNM (Poshan Abhiyaan) monitoring, technology, and community mobilization. Growth monitoring and counselling coverage improvements were more pronounced in states that received more incentives and monitoring under NNM. Insights from Christopher et al. (2023) indicate that between 2016 and 2021, the reach of health and nutrition interventions in India significantly expanded, particularly during preconception, pregnancy, delivery care, and child-feeding practices, as well as the postnatal and early childhood stages. These interventions include food and micronutrient supplementation, nutrition education and counselling, and growth monitoring and promotion (Christopher et al., 2023). Overall evidence from these studies supports our study findings that Exposure of the POSHAN Abhiyaan may reduce the risk of wasting, underweight and anemia in the children. Finding of this study indicated that children with higher birth orders were more likely to be at high risk of stunting, wasting, and be-

ing underweight at ages 6 to 23 months. Research consistently shows that higher birth order is associated with an increased risk of child undernutrition. Studies in Bangladesh and India found that children of third order or higher were significantly more likely to be stunted and underweight compared to firstborns (Dharmaraj et al., 2021; Ghimire & Dharmaraj, 2020; Rahman, 2016). The possible explanation may be derived from previous studies that illustrated that higher birth order children receive less parental health investment, with lower participation in preventive screenings (Pruckner et al., 2021) mothers being less likely to take prenatal vitamins and receive early prenatal care for higher-order births, and breastfeeding rates decreasing significantly with each subsequent child (Buckles & Kolka, 2014). These findings highlight the need for targeted interventions to support health investments across all birth orders. Our findings also indicated that children aged 6-23 months from the Scheduled Tribe (ST) of social groups had a higher risk for wasting, underweight and anaemia. These findings are consistent with the previous studies of India (Adhikari et al., 2021; Sengupta et al., 2020; Sonowal, 2010) . Tribal populations in India face significant challenges in accessing adequate nutrition and healthcare services, leading to poor health outcomes, particularly for women and children. Geographic isolation, extreme poverty, and limited healthcare infrastructure contribute to reduced access to medical facilities and nutritional support (Bharti et al., n.d.; Madankar et al., 2024). Studies have shown high rates of undernutrition, anemia, and micronutrient deficiencies among tribal women and children (Ghosh-Jerath et al., 2013; Rao et al., 2006) . Adhikari et al. (2021) analysed nutritional status of under-3 children, revealing that tribal children from poorer households, with less-educated mothers, in rural areas, and in Central India had higher odds of undernutrition. All studies highlight the complex interplay of social, economic, cultural, and geographical factors affecting maternal and child health in tribal communities, emphasizing the need for tailored, culturally appropriate interventions to improve health outcomes (Adhikari et al., 2021; Cáceres et al., 2023; Sengupta et al., 2020). This study has some limitations in its analysis. The NFHS 2019-21 survey did not gather direct information on antenatal and child health services related explicitly to POSHAN Abhiyaan. Additionally, since the NFHS 2019-21 is a cross-sectional dataset, it does not allow for causal analysis, making it difficult to establish direct cause-and-effect relationships. However, it is unclear how the program affected the sample taken after the COVID-19 period because it is likely that COVID-19 affected the way services related to mother and child health were delivered. In conclusion, our study provides evidence that POSHAN Abhiyaan significantly enhanced the children undernutrition outcomes- particularly wasting, underweight and anaemia, during first 1000 days of life. POSHAN Abhiyaan intervention mainly promotes new service delivery approaches, builds frontline worker capacity through the Incremental Learning Approach (ILA), and uses technology to better monitor and manage nutrition services using the POSHAN Tracker (previously ICDS-CAS). The program also emphasizes rejuvenate counselling and behavior change communication through Jan Andolan, a national campaign for mobilization of communities that combines mass media and grassroots engagement. These initiatives under POSHAN Abhiyaan may increase the coverage of nutritional interventions during pregnancy, postpartum, and early childhood, leading to a reduction in undernutrition outcomes for children. Furthermore, this study acknowl-

edges the necessity for further research to evaluate the impact of the POSHAN Abhiyaan on the undernutrition outcomes of children.

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Appendix

Figure 3. Overlap in the support of covariates

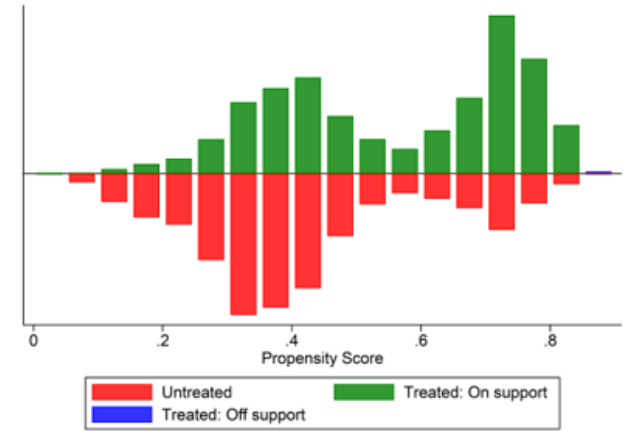

Figure 4. Standardized Mean difference and variance ratio of Covariates: Raw and Matched