

Impact of Anganwadi Nutrition on Child Growth and Development: A Quasi-Randomised Comparative Study

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Abstract: *Background:* Malnutrition continues to impede child health and development in India despite large-scale welfare programs. *Objectives:* To compare growth and developmental outcomes among children regularly receiving Integrated Child Development Services (ICDS) nutrition at Anganwadi centres versus children not enrolled in ICDS. *Methods:* “We conducted an analytical quasi-randomised study in the Urban Field Practice Area of a tertiary institute in Chennai (July 2023–June 2024). Eligible children aged ≤ 6 years were allocated to an intervention arm ($\geq 80\%$ utilisation of Anganwadi diets/supplements in the prior six months) or a control arm (never enrolled/receiving ICDS benefits). Growth indices were recorded and development assessed using Bayley-III and ASQ: SE. *Results:* One hundred participants were enrolled ($n=50$ per arm) with comparable baseline age, sex and socioeconomic strata. Children in the intervention arm achieved greater gains in weight (3.2 vs 2.5 kg), height (4.1 vs 3.5 cm) and BMI (0.9 vs 0.7 kg/m²). Developmental scores were higher for Bayley-III cognitive, language, motor, social-emotional and adaptive behaviour scales, while ASQ scores were lower (better) in the intervention arm. Illness episodes were fewer in the intervention group (mean 3.5 vs 4.2). *Conclusion:* Regular utilisation of Anganwadi-provided nutrition under ICDS was associated with superior growth, more favourable developmental profiles, and fewer illnesses compared with non-enrolled peers. These findings support strengthening coverage and adherence to ICDS nutrition in early childhood.

Keywords: Anganwadi centres, Nutritional supplementation, Malnutrition, Growth, Development, Cognition, India.

INTRODUCTION

Childhood malnutrition remains a central public health priority in India, contributing substantially to morbidity, mortality and impaired human capital formation.(1,2) The Integrated Child Development Services (ICDS) scheme, implemented through a nationwide network of Anganwadi centres, is designed to address these burdens by delivering supplementary nutrition alongside early childhood care to children under six years, pregnant women and lactating mothers.(3,4) Anganwadi platforms have historically served as the first point of contact for community-level nutrition support and early stimulation services, and evaluations suggest they can improve diet adequacy and promote growth when coverage and quality are high.(5) Yet, recent analyses raise questions about heterogeneity in utilisation, programme reach, and the comparative effectiveness of Anganwadi rations when juxtaposed with diets accessed outside ICDS, underscoring a need for empirical comparisons of outcomes between enrolled and non-enrolled children.(6,7) Beyond survival, a modern policy focus is to enhance holistic development—cognitive, language, motor and socio-emotional domains—because early deficits in these areas have lifelong consequences.(8) Against this background, we examined whether children with sustained exposure to Anganwadi diets and nutritional supplements demonstrate better growth and developmental outcomes than comparable children not enrolled in ICDS within an urban Indian setting.

MATERIALS AND METHODS

Study design and setting: This analytical study employed a quasi-randomised design in the Urban Field Practice Area of Saveetha Medical College and Hospital, Chennai, Tamil Nadu, India, from July 2023 to June 2024.

Ethics and consent: The Institutional Human Ethics Committee approved the protocol; parents/guardians provided written informed consent after explanation in the local language.

Participants and allocation: Children aged ≤ 6 years were allocated to the intervention arm if they had utilised Anganwadi diets/nutritional supplements for at least 80% of the preceding six months or attended the centre on $\geq 80\%$ of days; children never enrolled in Anganwadi or not receiving ICDS benefits were assigned to the control arm. Assignment employed stratified procedures to balance age, sex and socioeconomic status.(9)

Sample size: Assuming a 2.5-kg difference in weight gain between groups, $\alpha=0.05$, power=80%, absolute precision=7%, and 10% attrition, the minimum required sample was 50 per arm.

Measurements: A pre-validated questionnaire captured sociodemographics and morbidity episodes. Growth outcomes included weight, height and body mass index (BMI). Developmental outcomes were assessed using

Bayley Scales of Infant and Toddler Development, 3rd edition (Bayley-III: cognitive, language, motor, social-emotional, adaptive behaviour) and the Ages & Stages Questionnaires: Social-Emotional (ASQ:SE).(10–17)

Statistical analysis: Data were entered in Microsoft Excel and analysed in Stata v17. Descriptive statistics summarised baseline characteristics. Group comparisons used t-tests for continuous variables and Chi-square tests for categorical variables, with $p < 0.05$ considered statistically significant.

RESULTS

The study included 100 participants divided equally between the intervention arm and the control arm. Participants in both arms had a mean age of approximately 36.5 months (SD 3.2) and 36.8 months (SD 3.1), respectively, with no significant difference observed between groups ($p = 0.724$). In terms of gender distribution, the intervention arm comprised 26 males (52.0%) and 24 females (48.0%), while the control arm had 25 males (50.0%) and 25 females (50.0%), demonstrating no statistically significant difference ($p = 0.841$). Regarding socioeconomic status, 40.0% of participants in the intervention arm belonged to the lower socioeconomic group, compared to 44.0% in the control arm; 50.0% and 48.0% were in the middle socioeconomic bracket for intervention and control arms, respectively. A small proportion (10.0% in intervention, 8.0% in control) belonged to the upper socioeconomic class, with no significant difference between groups observed ($p = 0.702$).

Table 1: Baseline Characteristics of Intervention and Control Groups

		Intervention arm N = 50	Control arm N = 50	P value
		n (%)	n (%)	
Age (in months) Mean (SD)		36.5 (3.2)	36.8 (3.1)	0.724
Gender	Male	26 (52.0)	25 (50.0)	0.841
	Female	24 (48.0)	25 (25.0)	
Socioeconomic status	Lower	20 (40.0)	22 (44.0)	0.702
	Middle	25 (50.0)	24 (48.0)	
	Upper	5 (10.0)	4 (8.0)	

*Statistically significant at $p < 0.05$

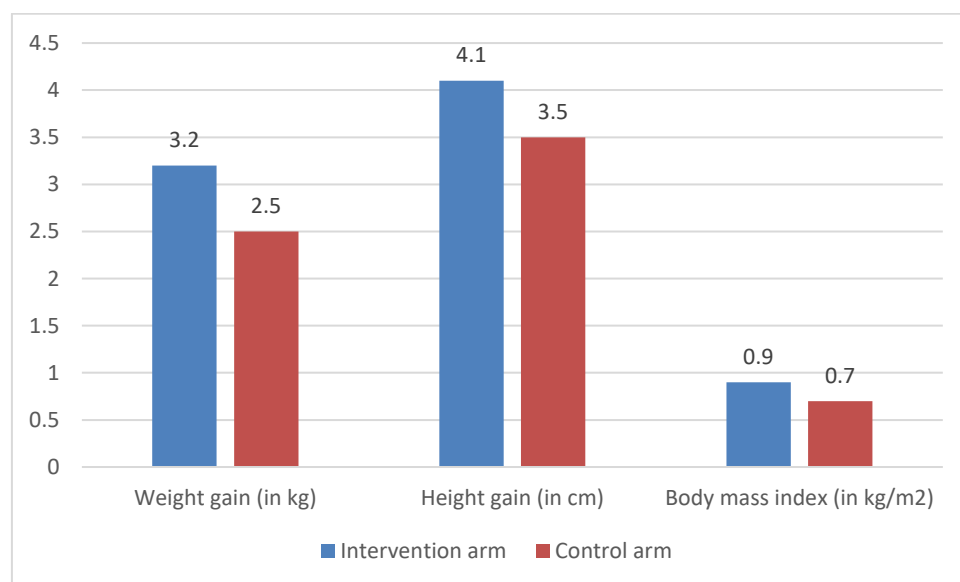


Figure 1: Comparison of Growth Measurements between Intervention and Control Groups

The growth outcomes were assessed in a study involving 100 participants, evenly split between the intervention arm and the control arm. Participants in the intervention arm showed a mean weight gain of 3.2 kg (SD 0.8), significantly higher than the control arm which had a mean weight gain of 2.5 kg (SD 0.6) ($p = 0.001$). Similarly, height gain was greater in the intervention arm with a mean of 4.1 cm (SD 1.2), compared to 3.5 cm (SD 1.0) in the control arm ($p = 0.012$). Body

mass index (BMI) gains also favored the intervention arm, where the mean increase was 0.9 kg/m² (SD 0.2), compared to 0.7 kg/m² (SD 0.3) in the control arm ($p = 0.025$). These results indicate statistically significant improvements in weight gain, height gain, and BMI among participants in the intervention group compared to those in the control group.

Table 2: Comparison of Growth Measurements between Intervention and Control Groups

Growth outcomes	Intervention arm N = 50	Control arm N = 50	P value
	n (%)	n (%)	
Weight gain (in kg)	3.2 (0.8)	2.5 (0.6)	0.001*
Height gain (in cm)	4.1 (1.2)	3.5 (1.0)	0.012*
Body mass index (in kg/m ²)	0.9 (0.2)	0.7 (0.3)	0.025*

*Statistically significant at $p < 0.05$

The developmental outcomes of 100 participants, split evenly between an intervention arm and a control arm, were assessed across various scales. Participants in the intervention arm showed significantly higher scores on the Bayley-III Cognitive Scale (mean 85.6, SD 5.2) compared to those in the control arm (mean 82.3, SD 4.8) ($p = 0.003$). Similarly, scores on the Bayley-III Language Scale were higher in the intervention arm (mean 87.1, SD 6.1) than in the control arm (mean 83.5, SD 5.5) ($p = 0.012$), as were scores on the Bayley-III Motor Scale (intervention mean 89.8, SD 7.3; control mean 86.2, SD 6.5; $p = 0.018$), the Bayley-III Social-Emotional Scale (intervention mean 84.5, SD 5.8; control mean 81.7, SD 4.9; $p = 0.007$), and the Bayley-III Adaptive Behavior Scale (intervention mean 88.3, SD 6.5; control mean 85.6, SD 5.7; $p = 0.025$). Additionally, participants in the intervention arm scored lower on the ASQ (mean 22.5, SD 3.1) compared to the control arm (mean 24.3, SD 2.8), indicating better developmental outcomes ($p = 0.009$).

Table 3: Comparison of Developmental Assessments between Intervention and Control Groups

Developmental outcomes	Intervention arm N = 50	Control arm N = 50	P value
	n (%)	n (%)	
Bayley-III Cognitive Scale	85.6 (5.2)	82.3 (4.8)	0.003*
Bayley-III Language Scale	87.1 (6.1)	83.5 (5.5)	0.012*
Bayley-III Motor Scale	89.8 (7.3)	86.2 (6.5)	0.018*
Bayley-III Social-Emotional Scale	84.5 (5.8)	81.7 (4.9)	0.007*
Bayley-III Adaptive Behaviour Scale	88.3 (6.5)	85.6 (5.7)	0.025*
ASQ Score	22.5 (3.1)	24.3 (2.8)	0.009*

*Statistically significant at $p < 0.05$

ASQ, Ages and Stages Questionnaire

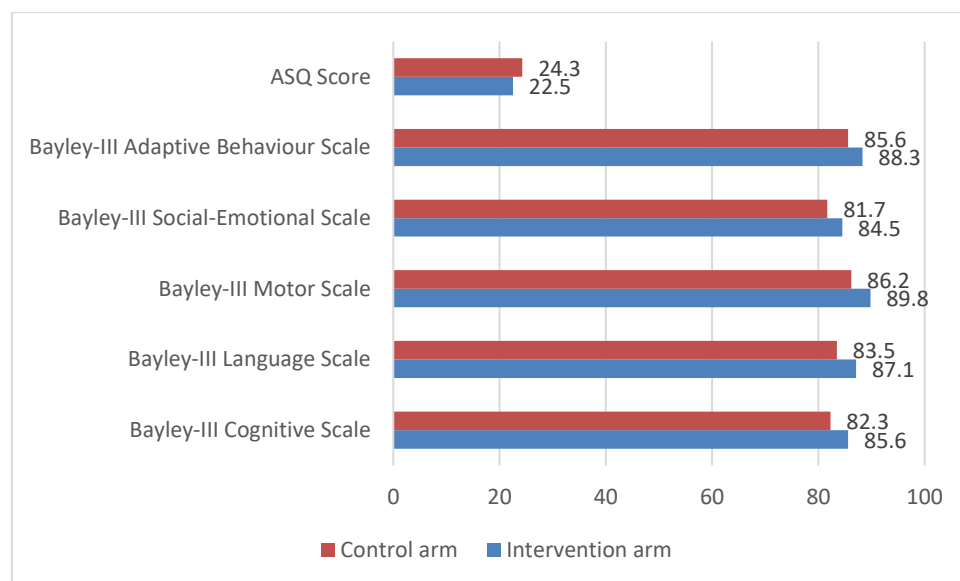


Figure 2: Comparison of Developmental Assessments between Intervention and Control Groups

In this study involving 100 participants evenly distributed between an intervention arm and a control arm, the number of illnesses experienced by each group was assessed. Participants in the intervention arm reported a mean of 3.5 illnesses (SD 1.2), whereas those in the control arm reported a higher mean of 4.2 illnesses (SD 1.5). This difference was statistically significant ($p = 0.031$), indicating that the intervention had a beneficial effect in reducing the number of illnesses experienced compared to the control condition.

Table 4: Comparison of Incidence of Illnesses between Intervention and Control Groups

	Intervention arm N = 50	Control arm N = 50	P value
	n (%)	n (%)	
Number of illness Mean (SD)	3.5 (1.2)	4.2 (1.5)	0.031*
*Statistically significant at $p < 0.05$			

DISCUSSION

This quasi-randomized comparison demonstrates that sustained use of Anganwadi-based ICDS nutrition is associated with measurable improvements in linear growth, ponderal gain and BMI during early childhood.(18,19,20,21) The direction and magnitude of effects across anthropometric indices are consistent with the biological premise that steady access to energy, high-quality proteins and micronutrients corrects dietary shortfalls common in vulnerable urban communities.(8,19,20) In settings where household food insecurity and diet monotony persist, centrally procured rations and fortified mixes can stabilize intake and reduce growth faltering, particularly when adherence exceeds predefined thresholds.(6,7,8,9)

Developmental benefits observed on Bayley-III—spanning cognition, language, motor ability, social-emotional functioning and adaptive behaviour—suggest that nutrition support layered onto early stimulation and caregiver counselling at Anganwadi platforms may confer synergistic effects on neurodevelopment.(10,11,25-30) Multiple mechanisms plausibly contribute; adequate macro- and micronutrient intake fuels synaptogenesis and myelination; protein-energy sufficiency protects against illness-mediated catabolism; and structured play, responsive caregiving and peer interaction at centers enrich language exposure and executive function precursors.(20,25,27,28,29) Lower ASQ:SE scores in the intervention arm further align with improved socio-emotional competencies that are sensitive to nurturing care and stable routines.(28,30) The lower mean number of illness episodes among regularly attending children may reflect better diet adequacy, growth-mediated immune competence, and auxiliary health-education messages commonly delivered through Anganwadis regarding hygiene and safe feeding practices.(32) Reduced morbidity can, in turn, preserve energy for growth and learning, creating a virtuous cycle wherein fewer infections and better appetite amplify the developmental returns of nutrition investment.(18,20)

Programmatically, these findings argue for continued strengthening of ICDS along three fronts: coverage,

quality and utilization.(6,7,9) First, increasing regular attendance and adherence (for example, through behaviourally informed reminders and caregiver engagement) is likely to maximize dose-response benefits for growth and development. Second, quality improvements—menu diversification, fortification standards, and timely supply—can elevate nutrient density, particularly for iron, zinc and essential fatty acids that shape neurocognitive trajectories.(8,20) Third, integrated early childhood development activities (storytelling, goal-oriented play, caregiver coaching) should be safeguarded alongside nutrition delivery to sustain gains observed on Bayley-III domains.

Our results complement national equity analyses showing gaps in ICDS utilization and heterogeneity by socioeconomic status, underscoring the need to target under-served neighbourhoods and migrant families through mobile outreach and flexible session timings. Embedding simple monitoring dashboards in routine supervision could help track attendance, ration uptake and developmental screening coverage, allowing course correction in real time.

A notable strength of this study is the concurrent appraisal of growth and multidomain development with validated tools, enabling a more holistic inference about early-life function rather than height or weight alone. While the quasi-randomized allocation and balanced baseline profiles mitigate overt selection bias, residual confounding by unmeasured home stimulation or genetic factors cannot be fully excluded.(31) Nevertheless, the internal consistency across anthropometry, Bayley-III improvements and lower illness burden strengthens the plausibility of a true programme effect in this urban context.”(32)

CONCLUSION

Regular receipt of Anganwadi-based ICDS nutrition was linked to superior physical growth, enhanced cognitive, language, motor and socio-emotional development, better adaptive behaviour, and fewer illnesses compared with non-enrolled peers. Strengthening equitable access and sustained utilisation of ICDS services should remain

a priority to optimise early growth and developmental trajectories in Indian children.

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