Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 2382-2390 | ISSN:2251-6727

Assessing the Impact of Different Diets/Nutritional Supplements on the Growth and Development of Children at Anganwadi Centres: A Quasi-Randomised Study

Dr Kousalya K S[1], Dr Shalini Priya Nandagopal[2], Dr Lavanya Panchatcharam[3*]

[1]Postgraduate, Department of Pediatrics, Saveetha Medical College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India

[2]Postgraduate, Department of Pediatrics, Saveetha Medical College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India

[3]Senior Resident, Department of Pediatrics, Saveetha Medical College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, India (Corresponding author)

(Received: 19 June 2025 Revised: 22 July 2025 Accepted: 12 August 2025)

KEYWORDS

Anganwadi centers, Nutritional supplementation, Malnutrition, Growth, Development, Cognition, India

ABSTRACT:

Background: Malnutrition remains a significant public health challenge globally, particularly affecting children in low- and middle-income countries like India.

Objectives: To assess the impact of different diets/nutritional supplements provided to children at Anganwadi centers on their growth and development.

Methods: This was an analytical study – quasi randomized study design conducted by the Department of Paediatrics, Saveetha Medical College and Hospital, Chennai, Tamil Nadu, India between July 2023 and June 2024. The children going to Anganwadi centers regularly were included in the intervention arm (provided they attended the Anganwadi centers on at least 80% of the past 6 months; or they utilized the diets/nutritional supplements provided by the Anganwadi centers on at least 80% of the past 6 months); and children never attended or receiving diets/nutritional supplements (not enrolled in the Anganwadi center for any benefits) provided by the Anganwadi centers were included in the control arm of the study.

Results: The study involved 100 participants evenly split between an intervention and a control group. Both groups had similar demographics in terms of age, gender distribution, and socioeconomic status. Participants in the intervention group exhibited significantly better growth outcomes, including weight gain (3.2 kg vs. 2.5 kg), height gain (4.1 cm vs. 3.5 cm), and BMI increase (0.9 kg/m² vs. 0.7 kg/m²), compared to the control group. Developmentally, the intervention group showed higher scores on cognitive, language, motor, social-emotional skills, adaptive behavior, and lower ASQ scores, indicating better overall developmental outcomes compared to the control group. Furthermore, participants in the intervention group reported fewer illnesses (mean 3.5) compared to the control group (mean 4.2), suggesting the intervention's potential in reducing illness incidence.

Conclusion: These results underscore the intervention's positive impact on both physical growth and developmental milestones among participants.

Introduction

Malnutrition remains a significant public health challenge globally, particularly affecting children in low- and middle-income countries like India.(1,2) In response to this issue, the Integrated Child Development Services (ICDS) program, implemented through Anganwadi centers,(3) plays a crucial role in providing essential nutrition to children under six years old, pregnant women, and lactating mothers.(4) These centers serve as

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 2382-2390 | ISSN:2251-6727

pivotal hubs for delivering supplementary nutrition aimed at addressing malnutrition and promoting early childhood development.(5) Despite the extensive reach and efforts of Anganwadi centers, questions persist regarding the comparative effectiveness of their nutritional interventions against alternative sources of nutrition available to children outside of these programs.(6,7) This study seeks to investigate the influence of varied diets and nutritional supplements on the developmental outcomes of children, comparing those enrolled in Anganwadi centers with those who do not benefit from these services.

Understanding the impact of different nutritional strategies on child development is essential for optimizing interventions aimed at reducing childhood malnutrition and promoting holistic growth. By examining developmental outcomes such as cognitive, language, motor skills, social-emotional development, and overall health indicators, this research aims to provide valuable insights. These insights can inform targeted interventions and policy decisions to enhance the effectiveness of nutritional programs like ICDS, ensuring that they effectively meet the diverse needs of children and families across India.(8)

Against this background, the aim of the present study was to assess the impact of different diets/nutritional supplements provided to children at Anganwadi centers on their growth and development.

Materials and Methods

This was an analytical study – quasi randomized study design conducted by the Department of Paediatrics, Saveetha Medical College and Hospital, Chennai, Tamil Nadu, India between July 2023 and June 2024 in the Urban Field Practice Area (UFPA) of the institute. The study was approved by the Institutional Human Ethics Committee (IHEC). The children were enrolled in the study after deliberating the details of the study to their parents and/or guardians and obtaining informed written assent form. The children going to Anganwadi centers regularly were included in the intervention arm (provided they attended the Anganwadi centers on at least 80% of the past 6 months; or they utilized the diets/nutritional supplements provided by the Anganwadi centers on at least 80% of the past 6 months); and children never attended or receiving diets/nutritional supplements (not enrolled in the Anganwadi center for any benefits) provided by the Anganwadi centers were included in the control arm of the study. The diet/nutritional supplements were in line with the existing Integrated Child Development Services (ICDS) guidelines, Government of India.(9)

The sample size was computed using 5% alpha error, 20% beta error (or 80% power), 7% absolute precision, 10% dropout rate and assuming the difference in weight gain between the study groups to be 2.5 kilograms. The minimum estimated sample size was 50 children per group with 95% confidence. The children were matched between the study groups using stratified random sampling – the stratification was based on age, gender, and socioeconomic status. We used a predesigned, pre-validated questionnaire to capture the sociodemographic characteristics and study outcomes. The study outcomes included growth/physical development (including weight and height), incidence of illnesses, cognitive development (assessed using Bayley Scales of Infant and Toddler Development (Bayley-III)),(10–12) social and emotional development (assessed using Ages and Stages Questionnaires: Social-Emotional (ASQ)).(13,14)

The Bayley Scales of Infant and Toddler Development (Bayley-III) is a standardized tool designed to assess the developmental functioning of infants and toddlers from one month to 42 months old, evaluating cognitive, language, motor, social-emotional, and adaptive behavior skills. The Bayley-III comprises five primary scales: the Cognitive Scale, Language Scale, Motor Scale, Social-Emotional Scale, and Adaptive Behaviour Scale. Its psychometric properties are robust, ensuring high reliability and validity. The tool demonstrates strong internal consistency, test-retest reliability, and inter-rater reliability, with coefficients ranging from 0.70 to 0.95.(15) It also has strong content, construct, convergent, and discriminant validity, supported by significant correlations with other established measures of development and its ability to differentiate between typically developing children and those with developmental delays.(16) The Ages and Stages Questionnaires: Social-Emotional (ASQ:SE) is a screening tool designed to identify social-emotional development issues in children from one month to six years old. This parent-completed questionnaire focuses on seven key areas: self-regulation, compliance, social-communication, adaptive functioning, autonomy, affect, and interaction with people. It demonstrates high internal

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 2382-2390 | ISSN:2251-6727

consistency, with Cronbach's alpha coefficients typically above 0.80, indicating that the items reliably measure the same constructs.(17) Test-retest reliability and inter-rater reliability are also strong, ensuring consistency over time and between different raters. The ASQ:SE has robust content validity, as its items are derived from a thorough review of the literature and expert input in child development. Construct validity is supported through factor analyses, confirming the questionnaire's intended structure. Additionally, convergent and discriminant validity are established by significant correlations with other established measures of social-emotional development and its ability to distinguish between children with and without social-emotional difficulties.(14,17)

The data collected was manually entered into Microsoft Excel and analyzed using Stata v17. Descriptive statistics were employed to summarize the baseline characteristics of participants. Appropriate statistical tests, such as t-tests and chi-square tests, were utilized to conduct comparisons between the intervention and control groups.

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				

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 2382-2390 | ISSN:2251-6727

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 $p<0.05$			

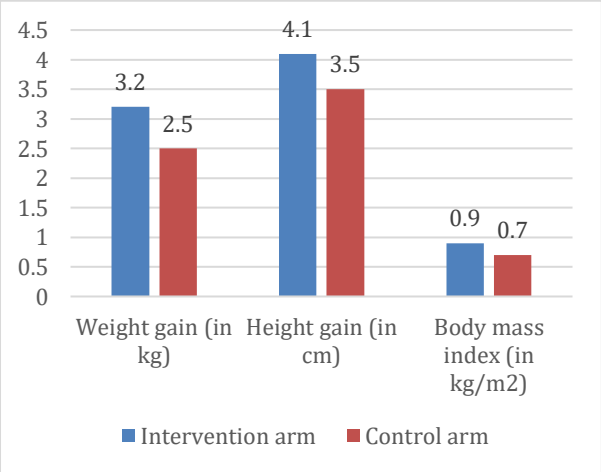

Figure 1: Comparison of Growth Measurements between Intervention and Control Groups

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 (Ages and Stages Questionnaire) (mean 22.5, SD 3.1) compared to the control arm (mean 24.3, SD 2.8), indicating better developmental outcomes ($p = 0.009$). These findings suggest that the intervention significantly enhances cognitive, language, motor, social-emotional skills, adaptive behavior, and overall developmental outcomes compared to the control group, as measured by the Bayley-III and ASQ scales.

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 2382-2390 | ISSN:2251-6727

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			

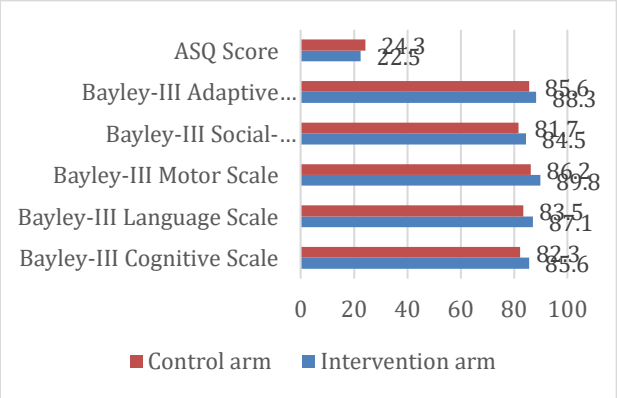

Figure 2: Comparison of Developmental Assessments between Intervention and Control Groups

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. These findings suggest that the intervention may contribute to a lower incidence of illnesses among participants, highlighting its potential health benefits in this regard.

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

	Intervention arm N = 50	**Control arm N = 50**	**P value**
	n (%)	**n (%)**	

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 2382-2390 | ISSN:2251-6727

Number of illness Mean (SD)	3.5 (1.2)	4.2 (1.5)	0.031*
*Statistically significant at p<0.05			

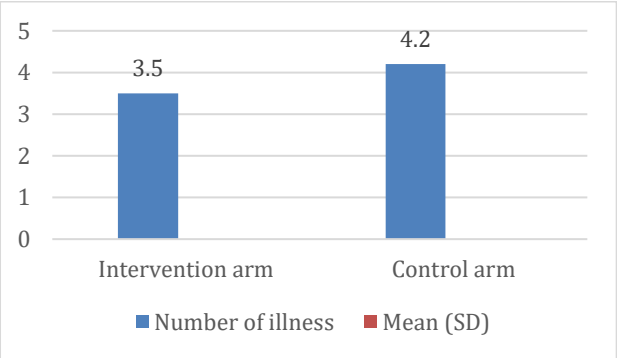

Figure 3: Comparison of Incidence of Illnesses between Intervention and Control Groups

Discussion

The study investigated the effects of nutritional interventions at Anganwadi centers on growth outcomes. Participants in the intervention arm exhibited a mean weight gain of 3.2 kg with a standard deviation (SD) of 0.8, whereas those in the control arm had a lower mean weight gain of 2.5 kg (SD 0.6). The difference was statistically significant. This indicates that the intervention was effective in promoting greater weight gain compared to the control condition. Weight gain in studies often reflects nutritional status and can be influenced by various factors such as dietary intake, metabolic differences, and physical activity levels.(18) The observed weight gain in the intervention group suggests that the intervention likely provided nutritional benefits or encouraged healthier eating habits that facilitated greater weight increase compared to the control group. Similarly, height gain was greater among participants in the intervention arm, with a mean increase of 4.1 cm (SD 1.2), compared to 3.5 cm (SD 1.0) in the control arm. Height gain is a critical indicator of growth in children and adolescents, influenced by genetics, hormonal factors, and nutritional adequacy.(19,20) The significant difference observed suggests that the intervention may have contributed to improved growth outcomes, potentially through enhanced nutritional support or other growth-promoting factors. 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. BMI is a measure of body fat based on height and weight, often used to assess nutritional status and health risks.(21) The greater increase in BMI among intervention participants indicates a more favorable change in body composition compared to the control group, further supporting the beneficial impact of the intervention on growth parameters.(22) Overall, the statistically significant improvements in weight gain, height gain, and BMI observed in the intervention group highlight the potential efficacy of the intervention in promoting growth and nutritional outcomes.(23,24) These findings are particularly relevant for settings where nutrition plays a crucial role in child and adolescent development, such as schools, communities with food insecurity, or populations at risk of malnutrition.

The study investigated the developmental outcomes of 100 participants, evenly distributed between an intervention arm and a control arm. Participants in the intervention arm demonstrated significantly higher scores on the Bayley-III Cognitive Scale, with a mean score of 85.6 (SD 5.2), compared to 82.3 (SD 4.8) in the control arm. Cognitive development, as assessed by standardized scales like the Bayley-III, reflects abilities such as problem-solving, memory, and attention.(25) The observed higher cognitive scores suggest that the intervention may have positively influenced cognitive development among participants. Scores on the Bayley-III Language Scale were also higher in the intervention arm (mean 87.1, SD 6.1) compared to the control arm (mean 83.5, SD 5.5). Language skills are crucial for communication and socio-emotional development in children.(25,26) The significant difference in language scores suggests that the intervention may have facilitated better language development outcomes compared to the control group. Similarly, participants in the intervention arm scored higher on the Bayley-III Motor Scale, with a mean score of 89.8 (SD 7.3), compared to 86.2 (SD 6.5)

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 2382-2390 | ISSN:2251-6727

in the control arm. Motor skills encompass physical abilities such as coordination and movement, which are essential for overall development.(27) The higher motor scores indicate that the intervention likely supported improved motor development among participants. Scores on the Bayley-III Social-Emotional Scale were higher in the intervention arm (mean 84.5, SD 5.8) compared to the control arm (mean 81.7, SD 4.9). Social-emotional skills encompass aspects such as self-regulation, empathy, and social interactions, which are critical for adaptive functioning.(28) The higher scores suggest that the intervention may have enhanced social-emotional development, promoting better social interactions and emotional well-being among participants. Participants in the intervention arm also demonstrated higher scores on the Bayley-III Adaptive Behaviour Scale, with a mean score of 88.3 (SD 6.5), compared to 85.6 (SD 5.7) in the control arm. Adaptive behavior refers to the ability to function independently in everyday life and adapt to changing circumstances.(28,29) The higher adaptive behavior scores indicate that the intervention may have supported better adaptive skills and functional outcomes among participants. Participants in the intervention arm scored lower on the ASQ, with a mean score of 22.5 (SD 3.1), compared to 24.3 (SD 2.8) in the control arm ($p = 0.009$). The ASQ is used to assess developmental milestones in children across different domains.(30) A lower score suggests better developmental outcomes, indicating that the intervention may have facilitated reaching developmental milestones more effectively compared to the control condition.(31) Overall, the significant improvements in cognitive, language, motor, social-emotional skills, adaptive behavior, and overall developmental outcomes in the intervention group highlight the efficacy of the intervention in promoting comprehensive developmental benefits. These findings underscore the importance of early interventions in supporting children's developmental trajectories, particularly in areas critical for future academic and social success.

The results indicate a significant difference in the number of illnesses experienced between the two groups. Participants in the intervention arm reported a mean of 3.5 illnesses with a standard deviation (SD) of 1.2, whereas those in the control arm reported a higher mean of 4.2 illnesses (SD 1.5). The difference between the groups was statistically significant, suggesting that the intervention had a beneficial effect in reducing the number of illnesses experienced compared to the control condition. The lower incidence of illnesses in the intervention group may be attributed to various factors. Interventions targeting health behaviors, hygiene practices, or nutritional improvements can bolster immune function and reduce susceptibility to infections.(32) Enhanced health education or access to healthcare services could also contribute to better illness management and prevention.

Conclusion

This study comprehensively examined the effects of a targeted intervention on various health and developmental outcomes among 100 participants, evenly distributed between intervention and control groups. Participants in the intervention arm exhibited higher rates of weight gain, height gain, and BMI increase, indicating the intervention's positive impact on nutritional status and physical development. Significant enhancements were observed in cognitive, language, motor, social-emotional skills, adaptive behaviour, and developmental screening scores among participants in the intervention group, underscoring the intervention's effectiveness in promoting holistic child development. Moreover, the intervention led to a notable reduction in the number of illnesses reported by participants, highlighting its role in improving overall health and reducing illness burden. These findings underscore the importance of early and targeted interventions in optimizing growth, development, and health outcomes in diverse populations. By understanding the mechanisms through which these improvements occur, policymakers and healthcare providers can better tailor interventions to address specific needs and promote long-term health and well-being.

References

1. India State-Level Disease Burden Initiative Malnutrition Collaborators. The burden of child and maternal malnutrition and trends in its indicators in the states of India: the Global Burden of Disease Study 1990-2017. Lancet Child Adolesc Health. 2019 Dec;3(12):855–70.

2. Singh S, Srivastava S, Upadhyay AK. Socio-economic inequality in malnutrition among

children in India: an analysis of 640 districts from National Family Health Survey (2015-16). Int J Equity Health. 2019 Dec 27;18(1):203.

3. Sachdev Y, Dasgupta J. INTEGRATED CHILD DEVELOPMENT SERVICES (ICDS) SCHEME. Armed Forces Med J India. 2001 Apr;57(2):139–43.

4. Debata I, Ranganath TS. Evaluation of the Performance of Anganwadi Workers in Delivering Integrated Child Development Services in the Rural Field Practice Area of a Tertiary Medical College in South India. Cureus. 2023 Jan;15(1):e34079.

5. Kapil U, Pradhan R. Integrated Child Development Services scheme (ICDS) and its impact on nutritional status of children in India and recent initiatives. Indian J Public Health. 1999 Jan-Mar;43(1):21–5.

6. Rajpal S, Joe W, Subramanyam MA, Sankar R, Sharma S, Kumar A, et al. Utilization of Integrated Child Development Services in India: Programmatic Insights from National Family Health Survey, 2016. Int J Environ Res Public Health [Internet]. 2020 May 4;17(9). Available from: http://dx.doi.org/10.3390/ijerph17093197

7. Govender I, Rangiah S, Kaswa R, Nzaumvila D. Malnutrition in children under the age of 5 years in a primary health care setting. S Afr Fam Pract . 2021 Sep 7;63(1):e1–6.

8. Müller O, Krawinkel M. Malnutrition and health in developing countries. CMAJ. 2005 Aug 2;173(3):279–86.

9. Chakrabarti S, Raghunathan K, Alderman H, Menon P, Nguyen P. India's Integrated Child Development Services programme; equity and extent of coverage in 2006 and 2016. Bull World Health Organ. 2019 Apr 1;97(4):270–82.

10. Balasundaram P, Avulakunta ID. Bayley Scales Of Infant and Toddler Development. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2022.

11. Del Rosario C, Slevin M, Molloy EJ, Quigley J, Nixon E. How to use the Bayley Scales of Infant and Toddler Development. Arch Dis Child Educ Pract Ed. 2021 Apr;106(2):108–12.

12. Ganuthula VRR, Sinha S. The Looking Glass for Intelligence Quotient Tests: The Interplay of Motivation, Cognitive Functioning, and Affect. Front Psychol. 2019 Dec 17;10:2857.

13. Bian X, Xie H, Squires J, Chen CY. ADAPTING A PARENT-COMPLETED, SOCIOEMOTIONAL QUESTIONNAIRE IN CHINA: THE AGES & STAGES QUESTIONNAIRES: SOCIAL-EMOTIONAL. Infant Ment Health J. 2017 Mar;38(2):258–66.

14. Vaezghasemi M, Eurenius E, Ivarsson A, Richter Sundberg L, Silfverdal SA, Lindkvist M. The Ages and Stages Questionnaire: Social-Emotional-What Is the Optimal Cut-Off for 3-Year-Olds in the Swedish Setting? Front Pediatr. 2022 Feb 9;10:756239.

15. Yu YT, Hsieh WS, Hsu CH, Chen LC, Lee WT, Chiu NC, et al. A psychometric study of the Bayley Scales of Infant and Toddler Development - 3rd Edition for term and preterm Taiwanese infants. Res Dev Disabil. 2013 Nov;34(11):3875–83.

16. Azari N, Soleimani F, Vameghi R, Sajedi F, Shahshahani S, Karimi H, et al. A Psychometric Study of the Bayley Scales of Infant and Toddler Development in Persian Language Children. Iran J Child Neurol. 2017 Winter;11(1):50–6.

17. Velikonja T, Edbrooke-Childs J, Calderon A, Sleed M, Brown A, Deighton J. The psychometric properties of the Ages & Stages Questionnaires for ages 2-2.5: a systematic review. Child Care Health Dev. 2017 Jan;43(1):1–17.

18. Oukheda M, Bouaouda K, Mohtadi K, Lebrazi H, Derouiche A, Kettani A, et al. Association between nutritional status, body composition, and fitness level of adolescents in physical education in Casablanca, Morocco. Front Nutr. 2023 Nov 7;10:1268369.

19. Kim K, Melough MM, Kim D, Sakaki JR, Lee J, Choi K, et al. Nutritional Adequacy and Diet Quality Are Associated with Standardized Height-for-Age among U.S. Children. Nutrients [Internet]. 2021 May 16;13(5). Available from: http://dx.doi.org/10.3390/nu13051689

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 2382-2390 | ISSN:2251-6727

20. Inzaghi E, Pampanini V, Deodati A, Cianfarani S. The Effects of Nutrition on Linear Growth. Nutrients [Internet]. 2022 Apr 22;14(9). Available from: http://dx.doi.org/10.3390/nu14091752

21. Khanna D, Peltzer C, Kahar P, Parmar MS. Body Mass Index (BMI): A Screening Tool Analysis. Cureus. 2022 Feb;14(2):e22119.

22. Yasasve M, Saravanan M, Muralidharan M. Presence of cachexia in the treatment phase of head and neck cancer: a chronic nutritional condition in patients undergoing cancer therapy. Int J Surg. 2023 Feb 1;109(2):145–6.

23. Chakraborty S, Chandran D, Chopra H, Akash S, Dhama K. Advances in artificial intelligence based diagnosis and treatment of liver diseases - Correspondence. Int J Surg. 2023 Oct 1;109(10):3234–5.

24. Sadeer NB, El Kalamouni C, Khalid A, Abdalla AN, Zengin G, Van Khoa Bao L, et al. Secondary metabolites as potential drug candidates against Zika virus, an emerging looming human threat: Current landscape, molecular mechanism and challenges ahead. J Infect Public Health. 2023 May;16(5):754–70.

25. Lobo MA, Galloway JC. Assessment and stability of early learning abilities in preterm and full-term infants across the first two years of life. Res Dev Disabil. 2013 May;34(5):1721–30.

26. Arts E, Orobio de Castro B, Luteijn E, Elsendoorn B, Vissers CTWM. Improving social emotional functioning in adolescents with Developmental Language Disorders: A mini review and recommendations. Front Psychiatry. 2022 Dec 9;13:966008.

27. Sutapa P, Pratama KW, Rosly MM, Ali SKS, Karakauki M. Improving Motor Skills in Early Childhood through Goal-Oriented Play Activity. Children [Internet]. 2021 Nov 2;8(11). Available from: http://dx.doi.org/10.3390/children8110994

28. Dussault M, Thompson RB. Fundamental Themes in Social-Emotional Learning: A Theoretical Framework for Inclusivity. Int J Environ Res Public Health [Internet]. 2024 Apr 19;21(4). Available from: http://dx.doi.org/10.3390/ijerph21040506

29. Tassé MJ, Kim M. Examining the Relationship between Adaptive Behavior and Intelligence. Behav Sci [Internet]. 2023 Mar 13;13(3). Available from: http://dx.doi.org/10.3390/bs13030252

30. Lockhart M, Chaux R, Chevin M, Celle M, Raia-Barjat T, Patural H, et al. Classification Performance of the Ages and Stages Questionnaire: Influence of Maternal Education Level. Children [Internet]. 2023 Feb 25;10(3). Available from: http://dx.doi.org/10.3390/children10030449

31. Willoughby EA, McGue M, Iacono WG, Lee JJ. Genetic and environmental contributions to IQ in adoptive and biological families with 30-year-old offspring. Intelligence [Internet]. 2021 Aug 25;88. Available from: http://dx.doi.org/10.1016/j.intell.2021.101579

32. Mirzay-Razaz J, Hassanghomi M, Ajami M, Koochakpoor G, Hosseini-Esfahani F, Mirmiran P. Effective food hygiene principles and dietary intakes to reinforce the immune system for prevention of COVID-19: a systematic review. BMC Nutr. 2022 Jun 3;8(1):53.