REVIEW ARTICLE

Volume - 16 | Issue - 04 | April - 2026 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Nutrition

ADDRESSING THE ROLE OF MILLET-BASED SUPPLEMENTARY FOOD FOR GROWTH, DEVELOPMENT AND ANAEMIA IN CHILDREN AND ADOLESCENTS OF ASIAN INDIAN ORIGIN: A SYSTEMATIC REVIEW

Swati Mandal — Msc, Biomedical Research Laboratory, Department of Anthropology, Visva-Bharati (A Central University and An Institution of National Importance), Santiniketan 731235, West Bengal, India.

Dr. Arnab Ghosh — Associate Professor, Biomedical Research Laboratory, Department of Anthropology, Visva-Bharati (A Central University and an Institution of National Importance), Santiniketan 731235, West Bengal, India.

ABSTRACT **Introduction:** Childhood growth, malnutrition and anaemia are major public health problems in our country. Children are suffering from wasting, stunting, and micronutrient deficiencies. The review is motivated by the urgent need to explore millet-based supplementary foods as economically sustainable, nutritionally superior to combat childhood malnutrition and anaemia. The review paper can create impacts like promoting sustainable nutrition, raising public awareness of the health benefits of millets and their role in combating anaemia and malnutrition. In schools, millet-based supplementary food also have good health impact for school-going children. **Methodology:** This systematic review, using the PRISMA guidelines, 7 database was conducted for articles on millet that can improve the nutritional status. The findings specify that millet-based supplementary foods improve child growth, reduce anaemia and combat malnutrition. **Results:** Millets are rich in essential nutrients, making them effective in addressing nutritional status. Millet-based supplementary food is low-cost and effective for improving child growth, childhood anaemia and combating malnutrition. **Conclusion:** This review paper distinguishes the impacts of millet-based supplementation with cereal-based supplementary feeding programmes and evaluates the effect of millet-based dietary interventions for overall growth.

KEYWORDS : Millet-Based Diet, Millet-Based Diet For Growth And Development, Child Growth, Childhood Anaemia, Micronutrient Deficiency.

1. INTRODUCTION

BACKGROUND

Child malnutrition is a major public health challenge. Among the major nutritional problems are stunting, wasting, and micronutrient deficiencies. Millet-based supplementary food is a sustainable option that supports child growth, is affordable, and is culturally acceptable.

Millets, or Nutri-cereals, are high-energy foods. Millets are special for their high fibre, minerals, antioxidants, polyphenols, and phytochemicals, which help fight health-related disorders. Some important millets are finger millet, pearl millet, foxtail millet, proso-millet, barnyard millet, and Kodo millet. Millets are a very abundant source of nutrients because of their rich source of calcium, iron, phosphorus, and vitamins such as thiamine, riboflavin, and niacin that make them a perfect energy food. The millets are also rich in fats, and millet oil is a good source of oleic acid, linoleic acid, palmitic acid, and tocopherols that play a major role in our immune system. The millets are also a rich source of most essential amino acids like cysteine, methionine, and lysine, which provide special dietary benefits to vegetarians dependent on plant-based food for their dietary requirements (Jacob et al., 2024).

Children need the right foods at the right time to grow and develop their full potential. Country-wide surveys indicate that more than half of the Indian pre-school children (1-5 years) suffer from subclinical undernutrition as indicated by low weight for age. About 65 per cent of them are stunted (low height for age), which indicates that undernutrition is of long duration. Protein energy malnutrition is defined as a range of pathological conditions arising from a coincident lack of varying proportions of protein and calories occurring most frequently in infants and young children. A different type of protein energy malnutrition is kwashiorkor, like oedema of the face and lower limbs, failure to thrive, anorexia, diarrhoea, anaemia, and marasmus, which means children are not able to gain weight (B Srilakshmi,2014).

Anaemia is most common in all groups of girls; it is common in the low socioeconomic class since intake is poor, mainly due to the non-availability of healthy foods.

Millet is important for younger children's growth; children between 7 and 36 months from millet-consuming communities in Uganda had a higher weight-for-height Z-score (Isingoma et al., 2019).

Objectives of the Study

- Distinguish the impacts of millet-based supplementation from cereal-based supplementary feeding programmes.
- To evaluate the effect of millet-based dietary interventions on overall growth.

2. Methodology

Studies were included in the systematic review if they met the following conditions: research conducted among children and adolescents, focused on millet-based diet or millet-based supplementary foods, reporting outcome of growth, nutritional status, Hb or anaemia, articles published as original research, review articles, or observational or interventional studies. Studies were excluded based on the following conditions. Studies not involving millet or millet-based food products, articles not reporting outcomes related to child growth, nutritional status, anaemia, abstract-only publications, duplications, etc. The systematic review was conducted from 2000 to 2025 and is prepared using the Preferred Reporting Items for Systematic Review (PRISMA) guidelines. Under the search strategy used - Millet-based diet, Millet-based diet for growth and development, Child growth, Childhood anaemia, were searched in the major search engines, Pubmed, Google Scholar, Research Gate, American Journal of Nutrition, Clinical Journal of Nutrition databases. The details of these are presented in the PRISMA flowchart below.

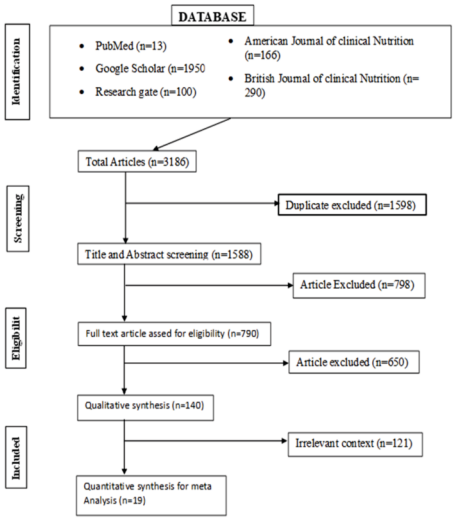

Fig.1 PRISMA flow diagram of studies' screening and selection

3. RESULTS

The Study based on various millet-based foods targeted at different age groups, identifying their significant role in improving child and adolescent nutrition. Across age groups from infants to adolescents, studies often show that millet-based products are essential for addressing nutritional deficiencies and improving overall health outcomes. (Table 1)

Table 1: Nutritional Impact of Different Millet-based Food Interventions by Different Age Groups

Type of Millet-Based Food	Study/Author	Target Group / Age	Major Nutritional Benefits
Millet-Rich Mid-day Meals	Anitha et al., 2019; Wangari et al., 2020	10–16 years	Improved nutritional status, Hb levels, and school program acceptability
Millet Biscuits (T5)	Choudhury et al., 2023	17–19 years girls	Increased haemoglobin levels
Pearl Millet Diet	Chande et al., 2021	5–12 years	Improved cognitive development, health, and intelligence
Germinated Cereal-Based Supplement	Tatala et al., 2007	7–12 years	Slight improvements in Hb and growth
Millet-Based Supplementary Food	Arokiamary et al., 2020	5–6 years	Improved biochemical and cognitive functions
General Millet-Based Diet (non-specific)	Mehta et al., 2017,; Anitha et al.,2024; etc.	All ages	Enhanced iron status, immune function, growth, and overall nutrition
Millet-Based Blended Flour in Bakery Products	Verma et al., 2023; Singh et al., 2025;	All ages	Enhanced iron and zinc; sustainable and easily digestible alternatives
Homemade Weaning Foods	Mosha et al., 2000	Under 5 years	High macro- and micronutrient value, energy-rich
Millet-Based Fortified Meals for Adolescents	Devulapalli et al., 2022	10–16 years old girls	Improved body weight, iron level, and Hb status

Anitha et al.(2024) and Mehta et al.(2017) found that millet is a nutrient-rich, easily digestible, and affordable grain that can play a vital role in addressing malnutrition, iron deficiency, and growth delays in infants and toddlers, making it an excellent component of early childhood feeding programs. (Table 2)

Table 2: For Infants

Author(s)	Study Area	Age Group	Impact of Millet-Based Products
Anitha et al.,2022	All over the world	3 months – 3.5 yrs	Improved growth in undernourished, stunting, and malnourished children
Mehta et al., 2017	India	12 – 18 months	Improved growth, nutritional status, and immune system
Mehta et al., 2022	Urban slums, Mumbai	12 – 18 months	Enhanced iron biomarkers and growth, improved haemoglobin levels

The review studies consistently identify the nutritional benefits of millet-based dietary intervention among children aged 5-12 years. (Table 3)

Table 3: Preschool Children (4-9Years)

Author(s)	Location	Age Group	Key Findings	Study Type
Datta et al., 2024	Telangana, India	3–6 years	A millet-based diet promotes dietary diversity and improves growth	Review
B et al., 2023	Tamil Nadu	4–6 years	Positive effects on growth and nutritional status; high acceptability among preschoolers	Review
Arokiamary et al., 2020	Madurai	5–6 years	Improved biochemical and cognitive profiles with millet supplementation	Article

The Studies focus on School Children Prior to 10-19 years have shown that if the midday meal program is included in the school feeding program, then it improves the nutritional status of the school-going children. (Table 4)

Table 4: School-age Children (10-19 years)

Author(s)	Study Area	Age Group	Impact of Millet-Based Products
Anitha et al., 2019	Karnataka, India	10 – 16 years	The mid-day meal program improved nutritional status
Devulapalli et al., 2022	Telangana, India	10 – 16 years (girls)	Increased body weight, improved iron levels and nutritional status
Choudhury et al., 2023	Samastipur	17 – 19 years (girls)	Increased haemoglobin levels through millet biscuit supplementation for 45 days

4. DISCUSSION

The document indicates a systematic review of scholarly articles examining the impact of millet-based diets on children's health across multiple ages, locations, and ethnicities. It enhances a consistent body of evidence supporting millets as a nutritious, low-cost option for undernutrition and micronutrient deficiencies. Multiple studies show that millet-based meals in schools show positive health outcomes. If the infants consumed millets, they showed better anthropometric and health markers. Millet consumption also prevents diabetes. hormonal imbalance, antioxidant activity and millet are also future sustainable foods.

5. CONCLUSION

The combined results from different articles show that a millet-based diet plays a vital role in enhancing the nutritional condition of children in different age groups and low socioeconomic classes. Millet demonstrates the key role of health indicators, such as growth, haemoglobin levels, and overall nutritional status. They are also low in cost but high in micronutrients, especially in iron, which is beneficial for anaemia.

In addition, public health and institutional midday meal programs have also demonstrated practical and health benefits. Their role in maintaining balance, preventing disease, and promoting intellectual development is also being supported by new research. The potential of millet to provide sustainable and fortified food items is further highlighted by advancements in food Science. In conclusion, millets offer a multidimensional solution to the global challenge of child malnutrition and should be classified in dietary approaches, public health strategies, and food system reforms aimed at promoting child and adolescent health.

REFERENCES

1. Anitha, S., Givens, D. I., Subramaniam, K., Upadhyay, S., Kane-Potaka, J., Vogtschmidt, Y. D., Botha, R., Tsusaka, T. W., Nedumaran, S., Rajkumar, H., Rajendran, A., Parasannanavar, D. J., Vetriventhan, M., & Bhandari, R. K. (2022). Can feeding a Millet-Based diet Improve the growth of Children?—A Systematic Review and Meta-Analysis. Nutrients, 14(1), 225. https://doi.org/10.3390/nu14010225
2. Anitha, S., Kane-Potaka, J., Tsusaka, T. W., Tripathi, D., Upadhyay, S., Kavishwar, A., Jalagam, A., Sharma, N., & Nedumaran, S. (2019). Acceptance and impact of Millet-Based Mid-Day meal on the nutritional status of adolescent school going children in a Peri urban region of Karnataka state in India. Nutrients, 11(9), 2077. https://doi.org/10.3390/nu11092077
3. Anitha, S., Tsusaka, T. W., Givens, D. I., Kane-Potaka, J., Botha, R., Sulaiman, N. L. B., Upadhyay, S., Vetriventhan, M., Rajendran, A., Parasannanavar, D. J., Longvah, T., Subramaniam, K., & Bhandari, R. K. (2024). Does millet consumption contribute to raising blood hemoglobin levels compared to regular refined staples?: a systematic review and meta-analysis. Frontiers in Nutrition, 11, 1305394. https://doi.org/10.3389/fnut.2024.1305394
4. Arokiamary, S., Senthilkumar, R., & Kanchana, S. (2020). Impact of pearl millet based supplementary food on biochemical and cognitive profiles of school children (5-6 year old). European Journal of Nutrition & Food Safety, 24–34. https://doi.org/10.9734/ejnfs/2020/v12i730245
5. Srilakshmi, B. (2014) Dietetics. 7th Edition, New Age International Publisher, New Delhi, 313.
6. Chande, M., Muhimbula, H., Mremi, R., Muzanila, Y. C., Kumwenda, N. C., Msuya, J., Msere, H., Bekunda, M., Okori, P., & Gichohi-Wainaina, W. N. (2021). Drivers of millet consumption among school aged children in central Tanzania. Frontiers in Sustainable Food Systems, 5. https://doi.org/10.3389/fsufs.2021.694160
7. Choudhury, S. S., & Chaudhary, G. (2023). Impact of Iron Rich Millet Biscuits in Alleviating Anaemia among Adolescent Girls of Samastipur District. Asian Journal of Dairy and Food Research, Of. https://doi.org/10.18805/ajdfr.dr-2071
8. Devulapalli, D., & Gokhale, D. (2022). Impact of Millet-Based interventions on weight, body mass index and haemoglobin of School-Going adolescent Girls. Indian Journal of Science and Technology, 15(20), 983–988. https://doi.org/10.17485/ijst/v15i20.2068
9. Isingoma, B. E., Mbugua, S. K., & Karuri, E. G. (2019b). Nutritional status of children 7–36 months old from millet consuming communities of Masindi District, Western Uganda. BMC Nutrition, 5(1), 11. https://doi.org/10.1186/s40795-019-0273-z
10. Jacob, J., Krishnan, V., Antony, C., Bhavyasri, M., Aruna, C., Mishra, K., Nepolean, T., Satyavathi, C. T., & Visarada, K. B. R. S. (2024b). The nutrition and therapeutic potential of millets: an updated narrative review. Frontiers in Nutrition, 11, 1346869. https://doi.org/10.3389/fnut.2024.1346869

11. Mehta, S., Finkelstein, J. L., Venkatramanan, S., Huey, S. L., Udipi, S. A., Ghugre, P., Ruth, C., Canfield, R. L., Kurpad, A. V., Potdar, R. D., & Haas, J. D. (2017). Effect of iron and zinc-biofortified pearl millet consumption on growth and immune competence in children aged 12–18 months in India: study protocol for a randomised controlled trial. BMJ Open, 7(11), e017631. https://doi.org/10.1136/bmjopen-2017-017631
12. Mehta, S., Huey, S. L., Ghugre, P. S., Potdar, R. D., Venkatramanan, S., Krisher, J. T., Ruth, C. J., Chopra, H. V., Thorat, A., Thakker, V., Johnson, L., Powis, L., Raveendran, Y., Haas, J. D., Finkelstein, J. L., Udipi, S. A., Rajagopalan, K., Iyer, S. R., Sonawane, J., . . . Kalogi, V. D. (2022). RETRACTED: A randomized trial of iron- and zinc-biofortified pearl millet-based complementary feeding in children aged 12 to 18 months living in urban slums. Clinical Nutrition, 41(4), 937–947. https://doi.org/10.1016/j.clnu.2022.02.014
13. Mosha, T., Laswai, H., & Tetens, I. (2000). Nutritional composition and micronutrient status of home made and commercial weaning foods consumed in Tanzania. Plant Foods for Human Nutrition, 55(3), 185–205. https://doi.org/10.1023/a:1008116015796
14. Saikat, D., Victor, A., Aravazhi, S., Priyanka, D., Anitha, S., Tamilselvi, N., Nancy, G. D., Harshvardhan, M., Suchiradipta, B., Nedumaran, S., Anitha, R., Roopa, B., Jyosthnaa, P., & Disha, B. (2024). Effectiveness of Millet–Pulse–Groundnut based formulations in improving the growth of Pre-School tribal children in Telangana State, India. Nutrients, 16(6), 819. https://doi.org/10.3390/nu16060819
15. Shravanthi, A. (2023). Impact of Millet Food on the Nutritional Status of Preschool Children in Coimbatore, tamil Nadu. Economic Affairs, 68(Special Issue). https://doi.org/10.46852/0424-2513.5.2023.9
16. Singh, P., Singh, S., Tiwari, A., Mishra, S., & Yadav, V. (2025). Review on Nutritional and Functional Benefits of Replacing Refined Wheat Flour with Millet Flour in Bakery Products. Journal of Advances in Food Science & Technology, 12(2), 35–42. https://doi.org/10.56557/jafsat/2025/v12i29216
17. Tatala, S., Ndossi, G., Ash, D., & Mamiro, P. (2007). Effect of germination of finger millet on nutritional value of foods and effect of food supplement on nutrition and anaemia status in Tanzania children. Tanzania Journal of Health Research, 9(2), 77–86. https://doi.org/10.4314/thrb.v9i2.14308
18. Verma, C., & Sonkar, S. (2023). Nutritional and sensory quality of millet fortified energy bar. International Journal of Science and Technology Research Archive, 5(2), 142–149. https://doi.org/10.53771/ijstra.2023.5.2.0102
19. Wangari, C., Mwema, C., Siambi, M., Silim, S., Ubwe, R., Malesi, K., Anitha, S., & Kane-Potaka, J. (2020). Changing Perception through a Participatory Approach by Involving Adolescent School Children in Evaluating Smart Food Dishes in School Feeding Programs – Real-Time Experience from Central and Northern Tanzania. Ecology of Food and Nutrition, 59(5), 472–485. https://doi.org/10.1080/03670244.2020.1745788