Sustainability, Agri, Food and Environmental Research, (ISSN: 0719-3726), 12(X), 2024:
http://dx.doi.org/10.7770/safer-V12N1-art656

Impact of nutrition intervention on the nutritional status and cognitive function among children (6-12 years) – An Interventional study from South India.

Impacto de la intervención nutricional en el estado nutricional y la función cognitiva de los niños (6-12 años): un estudio intervencionista del sur de la India.

Dr. Anitha. R[1], Dr. Pa. Raajeswari[2]

[1] Assistant Professor (GL), Department of Foods and Nutrition, Muthurangam Govt Arts College (A), Vellore-632002, Tamilnadu, India.

anithadiet2008@gmail.com

[2] Associate Professor, Department of Food Science and Nutrition, Avinashilingam Institute of Home Science and Higher Education for Women, Coimbatore-641 043, India.

raajeswari_fsn@avinuty.ac.in

*Corresponding Author: Email: anithadiet2008@gmail.com

ABSTRACT

Good nutrition is a basic pillar for adequate health, productivity, and general functional capacity. Consuming safe, sufficient, and nutritious food is critical for child growth and development. Children who fail to grow adequately during this critical period may not make up for the growth loss even on an adequate diet, later in life. The present study aimed to provide nutritional supplementation using formulated nutritious health mix made out of selected potential ingredients and nutrition and health education on child nutrition to mother. This is an intervention study that included 90 children aged between 6 and 12 years based on the inclusion criteria. The children were subdivided in to three groups (CG, EGI and EGII) with 30 children in each group. The raw ingredients were procured, processed, powdered and mixed for preparing health mix for supplementation for three months. The children were able to consume 50gm of health mix per day in the form of ladoos as mid - morning and mid-evening snacks. The results revealed that the selected children in the Experimental Group II who received health mix supplementation along with health and nutrition education to mother improved in nutritional status and cognitive function. This study offers new insight for formulating policies and intervention programs in the future.

Keywords: Undernutrition, Intelligence, Health Mix, Supplementation, Nutrition Education.

RESUMEN

Good nutrition is a basic pillar for adequate health, productivity, and general functional capacity. Consuming safe, sufficient, and nutritious food is critical for child growth and development. Children who fail to

grow adequately during this critical period may not make up for the growth loss even on an adequate diet, later in life. The present study aimed to provide nutritional supplementation using formulated nutritious health mix made out of selected potential ingredients and nutrition and health education on child nutrition to mother. This is an intervention study that included 90 children aged between 6 and 12 years based on the inclusion criteria. The children were subdivided in to three groups (CG, EGI and EGII) with 30 children in each group. The raw ingredients were procured, processed, powdered and mixed for preparing health mix for supplementation for three months. The children were able to consume 50gm of health mix per day in the form of ladoos as mid - morning and mid-evening snacks. The results revealed that the selected children in the Experimental Group II who received health mix supplementation along with health and nutrition education to mother improved in nutritional status and cognitive function. This study offers new insight for formulating policies and intervention programs in the future.
Keywords: Undernutrition, Intelligence, Health Mix, Supplementation, Nutrition Education.

INTRODUCTION

Good nutrition allows young children to grow, develop, survive, play, learn, participate and involve. In contrast, undernutrition leaves children's lives hanging in the balance by robbing their future (Anitha and Raajeswari, 2022). Undernutrition is a multidimensional issue and one of the most pressing health concerns among children in low and middle-income countries, including India. The state of poor nutrition is derived from the lack of proper nutrition caused by insufficient food consumption, or the food not having substances required for health, growth and development (Raajeswari *et al*, 2022). It is categorized as stunting - low height for age, underweight - low weight for age, wasting - low weight for height and deficient in vitamins and minerals (micronutrient deficiencies) (Global Nutrition Report, 2018). Undernutrition worsens the immune system, which puts the children at greater risk of more serious, frequent and prolonged disease bouts. It also leads to the occurrence of repeated infections, which may further exacerbate the child's state of more significant nutritional needs at a time. This correlation of undernutrition with infection creates a vicious cycle of poor nutritional status and morbidity (UNICEF, 2019). Nutritional deficiencies impact brain development under two mechanisms. It has direct effects on brain functions and indirect effects on children's behaviour and perception (Prado and Dewey, 2014). The health status of children during school years impacts their nutritional status, cognitive development and subsequently affects their educational achievement (Karak *et al*., 2018). During this early stage, the brain has a high demand for nutrients, and nutritional inadequacies impair normal neurodevelopment, resulting in long-term cognitive deficits. Hence, it is crucial to comprehend metabolic factors and specific nutrients to establish successful nutrition intervention strategies (Spencer *et al*., 2017). The school children are consuming too much of sugary foods and beverages, processed grains, instead of including foods that help promote health, namely, whole grains, legumes, vegetables and fruits among school children predispose them to various health problems even at a younger age. New research

reveals that 69 per cent of over 23,000 packed food items have poor nutritional quality, with the highest proportion among low and middle-income countries than high-income countries (Global Nutrition Report, 2018).

Commercial fortified foods are not available, particularly in rural areas or where they are always so expensive in developing or underdeveloped countries, beyond the reach of most families. The majority of supplementary foods used is therefore, grown locally and based on local staple foods, usually cereal processed into porridges. The most effective multigrain supplementation is a common and convenient way for food formulations used by combining different grains to make the end product more nutritious and richer in other health constituents. There is an absence of safe and healthy food choices for children in confronting with abundance of low-quality foods with high calories, low nutritious and processed foods cause the greatest risk of undernutrition (Sethy and Mogra, 2020). Schools are considered as an ideal environment for health promotion activities among children. The educational strategies in any combination, supported by the environment, promote the adoption of different dietary choices and nutritional behavior, facilitating good health and well-being. The nutrition education can be delivered through multiple venues and includes various actions for individuals, communities and policy levels (Contento, 2007).

The significance of the educational status of mother on child nutrition has been well demonstrated in various researches. The mother's education is highly associated with the child's health and nutritional status by improving the mother's socio-economic status. Imparting nutrition education to mother improved the knowledge on etiology, consequences, prevention and treatment of diseases (Makoka and Masibo, 2015). The children who had malnutrition in the early years may have a lower attendance percentage and secured poor cognitive test scores in school years compared to children with good nutrition (Haile *et al*., 2016). The state of nutrition and intelligence among children requires attention by all. Hence the present study was aimed to improve the nutritional status and cognitive functions of children through health mix supplementation and imparting nutrition education to mothers.

MATERIALS AND METHODS

Selection of the Area and Sample: It is an interventional study conducted in three public schools located in Vellore, Tamilnadu, India, during the months between November 2018 and March 2019 after getting official permission from the chief educational officer and school authorities and also obtained ethical approval from Institutional Human Ethics Committee of Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore (AUW/IHEC-18-19/FSN/FHP-07). The children for the intervention study were classified into three groups, such as Experimental Group I (EG I) who received nutrition education using PNEP and Experimental Group II (EG II) received supplementation of 50g of health mix along with PNEP and Control Group (CG) did not receive any intervention for the period of three months. The impact of nutrition intervention and nutrition education was assessed through nutritional anthropometry, clinical examination, dietary profile, assessment of cognitive function. The written informed consent was obtained from the parents after giving detailed instructions about the study. Grouping of children for nutrition intervention is shown in Figure 1.

Study Groups	Category of Selection	Interventions
Experimental Group I (EG-I) (N =30)	Underweight children + Sub-optimal IQ scores	PNEP
Experimental Group II (EG-II) (N =30)	Underweight children + Sub-optimal IQ scores	PNEP + Health Mix
Control Group (CG) (N =30)	Healthy children + Optimal IQ scores	No Intervention

Figure 1. Grouping of Children for Nutrition Intervention

Tools used for the study: A self-structured pre tested interview schedule was used for collecting general information. Anthropometric measurements such as height, weight, body mass index (BMI) of the children were recorded accurately before and after intervention and categorized the children's nutritional status based on 2007 WHO Growth Charts. Raven's Colored Progressive Matrices (RCPM) scale (Smirni, 2020) was administered to assess the intelligence quotient level of the children. The IQ level of the children was categorized into Optimal average (> 80) and Sub-optimal average (< 80) for easy comparison and correlation.

Selection of ingredients for health mix: Foods such as red rice, whole wheat, bajra, foxtail millet and rice flakes were the commonly used cereals and millets, being selected due to their higher potential dietary sources. Pulses including soya bean, green gram and roasted bengal gram dhal were used for their rich protein source. Brahmi leaves (Vallarai Keerai) (*Centella asiatica L.*) are natural brain boosters and are widely used worldwide. Brahmi leaves were incorporated in the health mix for its quality to enhance brain functions and memory. Jaggery was used for its sweet taste, palatability and high amount of iron. These ingredients were chosen due to their higher potential source of calorie, protein, fat, iron, calcium, zinc and selenium, which influence effective brain function.

Preparation of health mix for supplementation: Acceptability trial and analysis of nutrients stated that Health Mix III had the highest overall rating scores and was being selected for supplementation. Raw ingredients of the Health Mix III were purchased in bulk from the local market. They were processed, mixed in an appropriate proportion and milled in the flour mill. Pretreatment and processing of health mix ingredients is given in Figure 2. The health mix powder was packed as 25g pockets for easy distribution.

Determination of quantity of health mix for nutrition intervention: The children were able to consume 50gm of health mix per day in the form of ladoos as mid - morning and mid-evening snacks. Each child in the Experimental Group II was given 6 packets of health mix in every three days intervals by which each pocket containing 25gm of health mix for 2 sessions in a day with the instruction that they should consume one pocket (25gm) per session.

Mothers were instructed to give the health mix for three months in the form of ladoos, which can be prepared using hot water (Fig. 3).

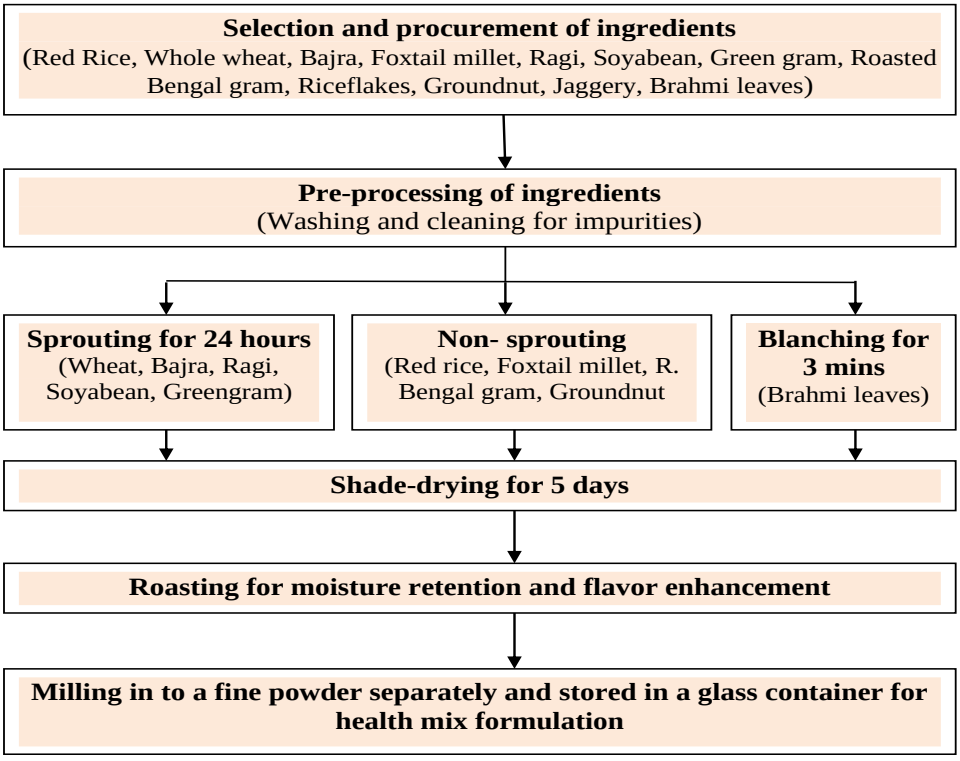

Figure 2-Pre-treatment and processing of health mix ingredients

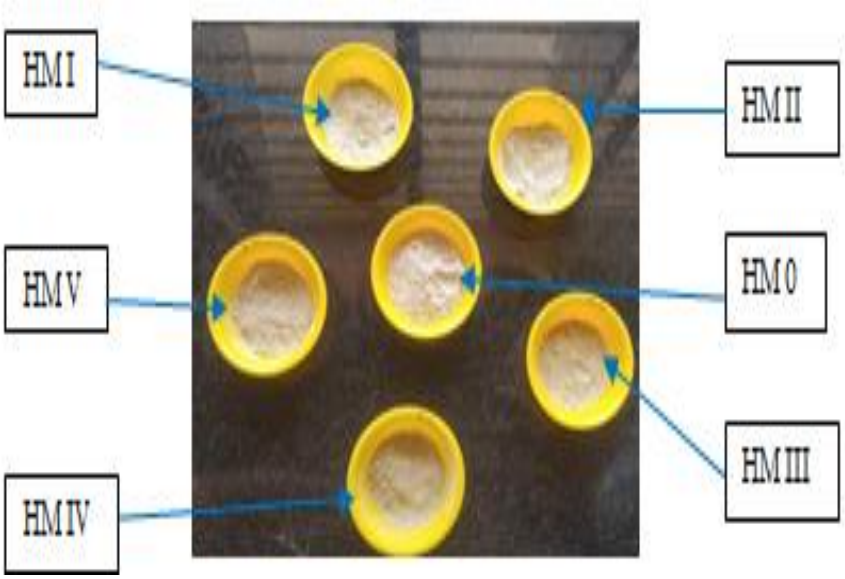

Figure 3. Formulated Health mixes

Conducting Nutrition Education Program to Mothers to the nutrition knowledge Regarding Child Nutrition: Personalized nutrition counselling was given to the mother of selected children about child nutrition. They were

asked to come every Monday to the school premises. The researcher made herself available to give the mother one-to-one nutrition counselling based on the children's requirement during the specified time for three months with the help of the prepared Personalized Nutrition Education Package (PNEP). Figure 4 express the Hypothesized Pathway to Increase the Maternal knowledge, Child Nutrition and Intelligence.

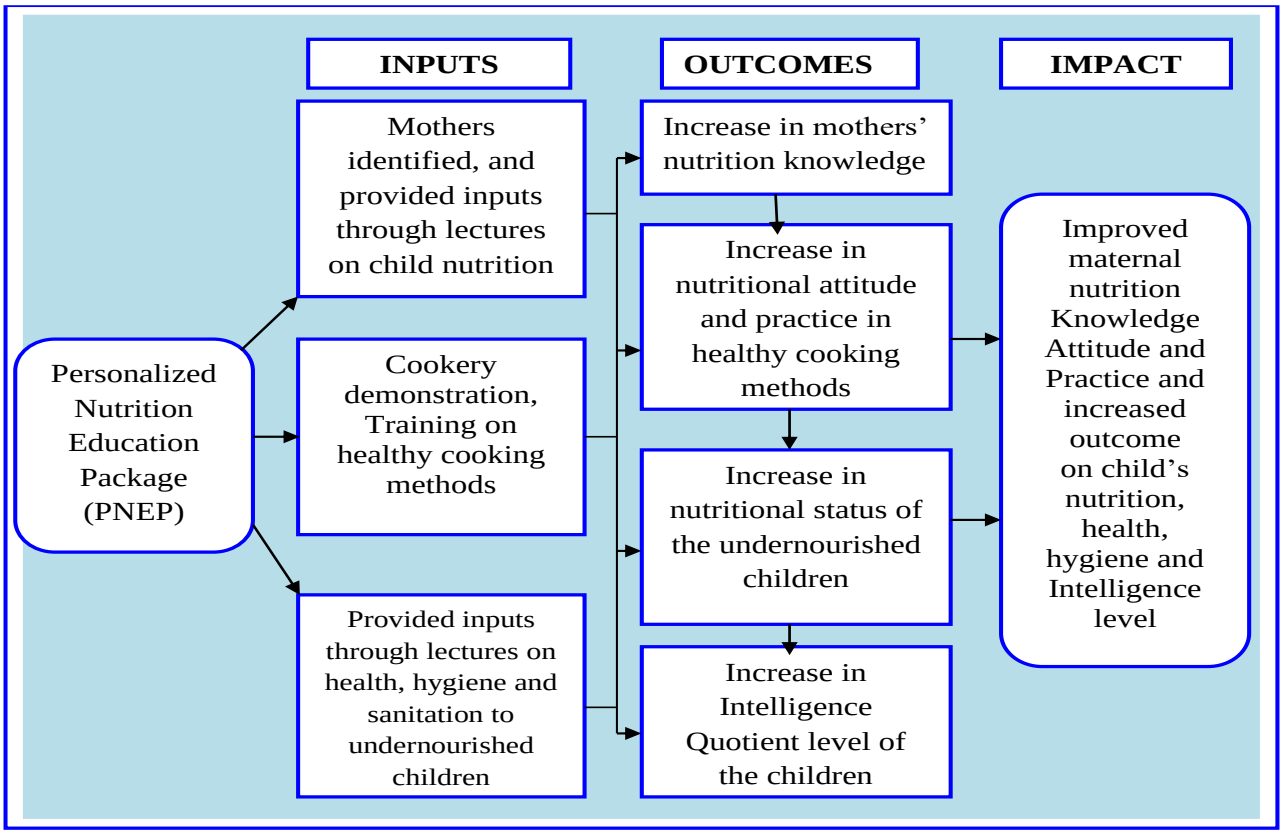

Figure 4. Hypothesized Pathway to Increase the Maternal KAP, Child Nutrition and Intelligence

Statistical Analysis: The collected information was consolidated, and the results were compared between the groups. SPSS version 16.0 was used for the analysis of statistics including descriptive statistics, student t-test and correlation.

RESULTS AND DISCUSSION

Impact of Nutrition Intervention on Anthropometric Measurements of the Selected Children (Table 1): At the beginning of the nutrition intervention, the mean height of the children in EG II was 112.6 cm, which increased to 114.2 cm after three months of the health mix supplementation along with nutrition and health education using PNEP. Similarly, the mean height of the children in Experimental Group I increased from 112.2 cm to 113.4 cm after

three months due to the effect of nutrition and health education to the mothers. The mean height of the children in the control group was also increased from 121.4 cm to 121.9 cm after three months of observation. The changes in mean final height showed that the children had grown significantly (P = < 0.000) taller among all other study groups. However, the mean difference proved that the highest improvement was in EG-II (1.55 cm) followed by EG-I (1.2 cm) with the lowest being among the Control Group (0.5 cm). Christian *et al*., (2015) had stated that the small amounts of complementary foods provided daily for a year in rural Bangladesh among children along with nutrition education modestly increased linear growth and efficiently reduced stunting at 18 months. Osei *et al.*, (2017) also had revealed that the mean height for age of the treatment children was substantially higher at post-intervention relative to baseline survey due to the effect of an Enhanced Homestead Food Production (EHFP) particularly, home gardening, nutrition education and poultry raising in rural areas of Baitadi District, Nepal.

Table 1. Mean Anthropometric Measurements of The Selected Children Before and After Nutrition Intervention (N=90)

Study Groups	Before Mean ± SD	After Mean ± SD	Mean Difference	't' Value	Groups Compared	't' Value
			Height (cm)			
EG I	112.2 ± 4.3	113.4 ± 4.4	1.20	5.0***	CG Vs EG1	3.8***
EG II	112.6 ± 7.8	114.2 ± 7.3	1.55	5.9***	CG Vs EG2	4.9***
CG	121.4 ± 8.5	121.9 ± 8.4	0.50	2.4***	EG1Vs EG2	0.5^{NS}
			Weight (kg)			
EG I	16.8 ± 1.4	18.7 ± 1.7	1.82	10.1***	CG Vs EG1	4.6***
EG II	16.8 ± 2.4	18.9 ± 2.4	2.07	14.9***	CG Vs EG2	5.3***
CG	21.9 ± 3.2	22.2 ± 3.2	0.25	13.4***	EG1Vs EG2	0.4^{NS}
			Body Mass Index (BMI)			
EG I	13.4 ± 0.8	14.5 ± 1.1	1.07	6.88***	CG Vs EG1	1.2^{NS}
EG II	13.3 ± 0.8	14.6 ± 0.7	1.27	10.06***	CG Vs EG2	1.3^{NS}
CG	14.9 ± 1.9	14.9 ± 1.8	0.07	1.14^{NS}	EG1Vs EG2	0.4^{NS}

*** = P < 0.001; NS = Nonsignificant

The body weight of the children (Table 2) in EG-II increased on an average by 2.07kg after health mix supplementation accompanied with health and nutrition education to mothers and the selected children found maximum weight gain compared to other groups bringing out the benefits of health mix supplementation and nutrition education together for better outcome. The result of the present study is similar to the study findings of Durairaj *et al*., (2019) and revealed that the mean weight of the primary school children was increased by 2.65kg in the experimental group with the supplementation of multi millet health mix to primary school children in Coimbatore

District, Tamilnadu. In the present study, the EG I showed that the mean weight of the children was increased from 16.8kg to 18.7 kg after three months of nutrition and health education to mothers and the selected children. In comparison, the groups with nutrition intervention showed a significant difference at less than one per cent level between the control group and the experimental group whereas it was not significant between the two experimental groups. Kristjansson *et al*., (2015) had revealed in their meta-analysis of RCTs that supplemental feeding in children had a positive impact on growth and development over the course of six months and they gained 0.25kg more than control group.

Table 2 Categorization of Nutritional Status of the Selected Children Before and After Nutrition Intervention (N = 90)

Category	EG I			EG II			CG		
	Before %	After %	Df* (%)	Before %	After %	Df* %)	Before %	After %	Df* (%)
Stunting - Height for Age (HAZ)									
Healthy children	30.0 (9)	60.0 (18)	30.0 (9)	43.3 (13)	56.7 (17)	13.3 (4)	100 (30)	100 (30)	-
Moderate Stunting	56.7 (17)	33.3 (10)	23.3 (7)	43.3 (13)	36.7 (11)	6.7 (2)	-	-	-
Severe Stunting	13.3 (4)	6.7 (2)	6.7 (2)	13.3 (4)	6.7 (2)	6.7 (2)	-	-	-
Underweight - Weight for Age (WAZ)									
Healthy Children	-	50.0 (15)	50.0 (15)	-	63.3 (19)	63.3 (19)	100 (30)	100 (30)	-
Moderate Underweight	76.7 (23)	46.7 (14)	30.0 (9)	63.3 (19)	36.7 (11)	26.7 (8)	-	-	-
Severe Underweight	23.3 (7)	3.3 (1)	20.0 (6)	36.7 (11)	-	36.7 (11)	-	-	-
Thinness - Body Mass Index for Age (BMIA)									
Healthy Children	33.3 (10)	76.7 (23)	43.3 (13)	33.3 (10)	83.8 (25)	50.0 (15)	100 (30)	100 (30)	-
Mild Thinness	56.7 (17)	23.3 (7)	33.3 (10)	53.3 (16)	16.7 (5)	36.7 (11)	-	-	-
Severe Thinness	10.0 (3)	-	10.0 (3)	13.3 (4)	-	13.3 (4)	-	-	-

* df = Difference

The increment in Body Mass Index of the children was observed after the nutrition intervention in experimental group I and II. In contrast, the control group did not show a significant increment in BMI after three months proving the effect of health mix supplementation along with nutrition education. The BMI truly indicates the status of the weight of the children according to their current height. The children's BMI increased from 13.3 to 14.6 in Experimental Group II and obtained the highest significant (P = 0.0001) improvement in BMI with the mean difference at the range of 1.27 after the nutrition intervention. There was no significant improvement in BMI within the control group after three months of the study period. As far as the comparison between the groups is concerned,

there was no significant difference seen among the three groups. However, the highest 't' value of 1.2 and 1.3 reported an excellent difference between the control and experimental groups. Thus, the nutrition intervention was a highly influencing factor for improving nutritional anthropometry of the children. Gürlek Gökçebay *et al*., (2015) had reported that undernourished children require intensive care and nutritional intervention for their normal growth and development and also to improve their nutritional status. Chao *et al*., (2018) also reported in their study that taking 10 mg of zinc per day for 12 to 24 weeks can boost appetite, growth and weight gain in undernourished children and that zinc supplementation has a major impact on growth, appetite and development among children. Since the developed health mix in the present study is having potential source of zinc could improve the weight gain by increasing appetite among undernourished children in EG-II.

Categorization of Selected Children's Nutritional Status Before and After Nutrition Intervention: The prevalence of moderate stunting was reduced from 56.7 per cent to 33.3 per cent and severe stunting was reduced from 13.3 per cent to 6.7 per cent because of the effect of nutrition and health education in EG I. Around 30 per cent of the undernourished children changed in to healthy children category due to the effect of nutrition education. In EG II, the per cent of healthy children increased from 43.3 per cent to 56.7 per cent, moderate stunting was reduced from 43.3 per cent to 36.7 per cent, and severe stunting got reduced from 13.3 per cent to 6.7 per cent, which proved the tremendous efficacy of the health mix supplementation along with nutrition and health education. The rate of improvement in stunting was higher in EG II than EG I comparatively. The control group remained constant without having any changes after three months of evaluation.

The severe underweight rate was reduced from 23.3 to 3.3 per cent by means of the nutrition and health education. The moderate underweight per cent reduced from 76.7 per cent to 46.7 per cent and made 50 per cent of the children into the normal category in EG I. Due to the effect of health mix supplementation, the number of severe underweight children got decreased totally, and the moderate underweight rate reduced from 63.3 per cent to 36.7 per cent. The effect of supplementation of health mix along with nutrition and health education improved the health status of 63.3 per cent of the undernourished children in to healthy category, which is good evidence for improvement in EG II. Regarding the impact of intervention on children's weight, the health mix supplementation and nutrition education program was very effective and successful in the management of underweight among children. Grover *et al.,* (2020) had revealed that the supplementation of maize protein-based biscuits to the children significantly reduced the incidence of the severe underweight rate of 23.34 per cent to zero which is on par with the results of the present study. The prevalence of severe thinness was totally eradicated in both the two experimental groups (EG I and EG II). After the nutrition intervention program, the ratio of healthy children increased by 43.3 per cent in EG I and 50 per cent in EG II after the intervention program. The severe thinness prevalence among the selected children was totally eliminated both in EG I and EG II, but, the highest improvement was observed in EG III in comparison between these two groups. Overall, the nutrition intervention strategies efficiently reduced the incidence of stunting, underweight and thinness among children in the selected groups and helped to improve children's nutritional status.

Impact of Nutrition Intervention on the Intelligence Quotient Level of the Children (Table 3): The optimal intelligence quotient level of children in Experimental Group I increased from 36.7 per cent to 73.3 per cent after nutrition intervention with the help of the PNEP, whereas the optimal intelligence quotient level of children in Experimental Group II increased from 33.3 per cent to 90 per cent with the effect of health mix supplementation to children along with health and nutrition education to mother. The per cent of sub-optimal intelligence decreased from 63.3 per cent to 26.7 per cent in EG I and 66.7 per cent to 10 per cent in EG II, showing the effect of the intervention program. Though the two experimental groups had a significant positive effect on the intelligence quotient level, the EG II had the highest per cent of difference before and after intervention than EG I. The overall findings of the study revealed that the supplementation of health mix along with the health and nutrition education had a significant positive impact on the children's intelligence quotient level. Roberts *et al*., (2020) had also studied the effect of blended fortified food supplementation to improve the children's working memory and to increase the cerebral blood flow in undernourished children living in low-income countries. The results of their study had reported an improvement in executive function, brain health of the children and helped them to get better nutritional status which is at par with the results in the present study. De Moura *et al*., (2013) also reported a significant positive improvement in cognitive abilities and academic performance among school children with zinc supplementation.

TABLE 3 Intelligence Quotient (IQ) Level of the Children Before and After Nutrition Intervention

(N = 90)

Groups	Optimal IQ			Sub-optimal IQ		
	Before (%)	After (%)	Difference (%)	Before (%)	After (%)	Difference (%)
EG I	36.7 (11)	73.3 (22)	36.7 (11)	63.3 (19)	26.7 (8)	36.7 (11)
EG II	33.3 (10)	90.0 (27)	56.7 (17)	66.7 (20)	10.0 (3)	56.7 (17)
CG	80.0 (24)	93.3 (28)	13.3 (4)	20.0 (6)	6.7 (2)	13.3 (4)

CONCLUSION

From the preceding discussions, it could be concluded that the nutritional supplementation combined with health education resulted in the highest growth potentials in anthropometric measurements. Along with growth, it was heartening to note that there were enhancements in the cognitive function in terms of the intelligence quotient level and improvement in academic performance. The diets prepared at home of all the children, although hailing from middle income families in rural and urban areas was deficient in almost all nutrients. Regular supplementation

of nutritious health mix could bridge the existing gap to a great extent and pave the way for a significantly improved nutritional status, cognitive function and academic activities. The same inference was observed by the teachers and parents, and they expressed that the children whoever consuming the supplement showed improvement and signs of alertness in-class activities.

ACKNOWLEDGMENTS

The authors are thankful to all the study participants for their kind cooperation. Authors are also grateful to authors/ publishers of all those articles from where the literature for this article has been reviewed and discussed.

REFERENCES

Anitha, R. (2022). Nature, Prevalence, and Impact of Undernutrition on Intelligence Among School Children: A Cross-Sectional Study from South India. ECS Transactions, 107(1), 637.

Pa, Raajeswari., Subapriya, M. S., & Anitha, R. (2022). Prevalence of Severe Acute Malnutrition among Under Five Children in Selected Tribal Population: Malnutrition among tribal children. Journal of Food and Dietetics Research, 2(2), 8-15.

Global Nutrition Report. Shining a light to spur action on nutrition. Retrieved from Bristol. UK (2018).

UNICEF, E. M. (2019). de la Infancia, The State of the World's Children 2019.

E. L. Prado, and K.G. Dewey, Nutrition and brain development in early life, Nutrition reviews, 72 (4), 267-284, (2014).

Karak, P., Maiti, R., Das, P., and Karmakar, A. (2018). Assessment of nutritional status of school children in rural and urban areas of Bankura, West Bengal. Int J Pharm Sci Res, 9 (1), 338-45.

Spencer, S. J., Korosi, A., Layé, S., Shukitt-Hale, B., and Barrientos, R. M. (2017). Food for thought: how nutrition impacts cognition and emotion. NPJ Science of Food, 1(1), 1-8.

Sethy, S., and Mogra, R. (2020). An Assessment of Nutritional Status of under-five Children in Rural Area, Udaipur, Rajasthan, India. Int. J. Curr. Microbiol. App. Sci, 9 (6), 3947-3953.

Contento, I. R. (2007). Nutrition education: linking research, theory, and practice, Jones and Bartlett Publishers, Sudbury, Canada.

Makoka, D. and Masibo, P.K. (2015). Is there a threshold level of maternal education sufficient to reduce child undernutrition? Evidence from Malawi, Tanzania and Zimbabwe. BMC Pediatrics, 15 (1), pp.96.

D. Haile, D. Nigatu, K. Gashaw, and H. Demelash, Height for age z score and cognitive function are associated with Academic performance among school children aged 8–11 years old, Archives of Public Health, 74 (1), p.17, (2016).

WHO. (2007). World Health Organisation, Growth reference data for 5-19 years, https://www.who.int>growth ref

D. Smirni, The Raven's Coloured Progressive Matrices in Healthy Children, A Qualitative Approach. Brain Sciences, 10 (11), 877, (2020).

Christian, P., Shaikh, S., Shamim, A. A., Mehra, S., Wu, L., Mitra, M., and West Jr, K. P. (2015). Effect of fortified complementary food supplementation on child growth in rural Bangladesh: a cluster-randomized trial. International journal of epidemiology, 44(6), 1862-1876.

Osei, A., Pandey, P., Nielsen, J., Pries, A., Spiro, D., Davis, D., and Haselow, N. (2017). Combining home garden, poultry, and nutrition education program targeted to families with young children improved anemia among children and anemia and underweight among non-pregnant women in Nepal. Food and Nutrition Bulletin, 38 (1), 49-64.

Durairaj, M., Gurumurthy, G., Nachimuthu, V., Muniappan, K., and Balasubramanian, S. (2019). Dehulled small millets: The promising nutricereals for improving the nutrition of children. Maternal and child nutrition, 15, e12791.

Kristjansson, E., Francis, D. K., Liberato, S., Jandu, M. B., Welch, V., Batal, M.,and Petticrew, M. (2015). Food supplementation for improving the physical and psychosocial health of socio-economically disadvantaged children aged three months to five years: a systematic review. Campbell Systematic Reviews, 11(1), 1-226.

Gürlek Gökçebay, D., Emir, S., Bayhan, T., Demir, H. A., Gunduz, M., & Tunc, B. (2015). Assessment of nutritional status in children with cancer and effectiveness of oral nutritional supplements. Pediatric hematology and oncology, 32(6), 423-432.

Chao, H. C., Chang, Y. J., and Huang, W. L. (2018). Cut-off Serum Zinc Concentration Affecting the Appetite, Growth, and Nutrition Status of Undernourished Children Supplemented with Zinc. Nutrition in Clinical Practice, 33(5), 701-710.

Grover, K., Arora, S., and Choudhary, M. (2020). Development of quality protein product using biofortified maize to combat malnutrition among young children. Cereal Chemistry, 97(5), 1037-1044.

Roberts, S. B., Franceschini, M. A., Silver, R. E., Taylor, S. F., de Sa, A. B., Có, R.,and Muentener, P. (2020). Effects of food supplementation on cognitive function, cerebral blood flow, and nutritional status in young children at risk of undernutrition: Randomized Controlled Trial. BMJ, 370.

De Moura, J. E., de Moura, E. N. O., Alves, C. X., de Lima Vale, S. H., Dantas, M. M. G., de Araújo Silva, A., and Brandão-Neto, J. (2013). Oral zinc supplementation may improve cognitive function in schoolchildren. Biological trace element research, 155(1), 23-28.

Received: 15th February 2023; Accepted: 21th April 2023; First distribution: 18th September 2023