Impact of milk on malnutrition and cognitive skills among school children: Evidence from gift milk initiative from a tribal state of India

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Abstract

Background: The objective of this study was to assess the impact of fortified milk on various aspects of growth and development among school children in a tribal-predominant district of Jharkhand, India. Materials and Methods: A longitudinal study was planned in 16 schools (eight in intervention group and eight in control group) of Latehar district of Jharkhand in India. Out of the total 962 study participants, only 528 study participants were considered in study analysis, who were present both during baseline and endline study after 1 year of milk introduction. The study participants were assessed for nutrition, intelligence quotient, and hemoglobin levels with the help of study tools and instruments. Results: The decrease in malnutrition was more evident in the intervention group during endline assessment, with 95% confidence interval (95% CI; 7.37, 7.42) and 95% CI (10.63, 10.58) for the difference in proportion in the intervention and control groups for stunting and thinness, respectively. This was statistically significant (P < 0.05). Anemia also improved with better cognition in the intervention group, and the difference was statistically significant (P < 0.05). Conclusion: In our study, beneficial effects of milk on malnourished children were evident, particularly in combating stunting and thinness, and it also had a positive impact on cognitive skills in school children.

Keywords: Intelligence Quotient, malnutrition, milk, school children, tribal

Introduction

Malnutrition and anemia are rampant and afflict more than 50 million children in low-middle income countries like India. India contributes to more than 50% of all malnourished children across the world.¹ Children who survive and go to school after the age of 5 years have retarded physical growth parameters, low intelligence quotient (IQ), and overall diminished growth parameters according to global standards.² Perhaps the word “stunting syndrome,” which explains stunting as a never-ending continuum, puts things in perspective and reiterates the need of interventions which suit the population accordingly.³

In India, as per the National Family Health Survey (NFHS)-4 report, 38% of children under the age of 5 years are stunted, and the proportion is found to be higher in rural areas (41%) than urban areas (31%). The state of Jharkhand is ranked third with 45% of its children stunted, while it ranks first in the number of

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children under 5 years who are wasted and are underweight (29% and 48%, respectively).

Needless to emphasize, the state needs more than its current dietary interventions for these malnourished children when they come to their schools, in the form of mid-day meal scheme, which is facing criticism regarding its content, quality, and hygiene standards in various parts of the country, and no such evidence is available for the state as such.\cite{54}

Milk is probably the only intervention that can fulfill most of the Food and Agriculture Organization of the United Nations (FAO)-listed criteria to be a food item as a mass-level intervention for fighting malnutrition.\cite{7} Although milk is a nutritive food item with most nutrients, is a good source of energy, and is rich in phosphorus, calcium, and vitamin D, its value can be enhanced by fortifying it with minerals as it has been proved to be a good carrier of the micronutrients added in studies conducted in Indian population and elsewhere. Some researchers also emphasize the need of adding micronutrients when the children are not getting adequate diet and are already malnourished.\cite{8-11}

Studies have shown that adults who had daily milk servings during their childhood were having better protection against many noncommunicable chronic diseases.\cite{12-17} Recent evidences have shown milk to play a regenerative role in muscle repair and damages sustained during sporting events.\cite{18} The beneficial effects of milk on children's health in terms of increasing their height, weight, and providing better physical balance have been well established.\cite{19-21}

Our present study will be helpful for family physicians and primary health-care workers in understanding the benefits of milk and dairy product consumption beginning at the early stages of life for its various protective effects on noncommunicable diseases like hypertension, glycemic control, and hyperlipidemia. Considering malnutrition to be rampant in Jharkhand state and milk to be the best available intervention for any school-based nutrition program, this research study was conducted to assess the impact of fortified milk on various aspects of growth and development among school children in a tribal-predominant district of Jharkhand, India.

Materials and Methods

This was a longitudinal study conducted in Latehar, a tribal-preponderant district of Jharkhand. It was an initiative named as the Gift Milk Program, which was undertaken in the district by the National Dairy Development Board (NDB) Foundation for Nutrition (NFN), Anand, Gujarat along with Rural Electricity Corporation Limited (RECL), India. This study was started in November 2017 and was continued till December 2018. Under this program, with the efforts of Jharkhand Milk Federation (JMF), fortified milk was provided in 36 schools covering approximately 15,000 students of Latehar district. The fortified components were 77 and 55 IU of vitamin A and vitamin D per 100 ml of milk, respectively.

Approval for the study was taken from the Institutional Ethical Committee (IEC) of Rajendra Institute of Medical Sciences (RIMS) Ranchi, India. The sample size calculated was approximately 960, considering the prevalence of malnutrition to be 40% with a relative precision of 10% at 95% confidence interval (CI) and a design effect of 1.5 for this study. Sixteen schools were selected randomly for the study (eight schools for control and eight for the intervention group). One school was considered as a cluster. In each school, 60 students were selected from class 1 to 7 using stratified random sampling, 30 from each gender, preferably whose informed consent was obtained previously from their guardians as well as from the school administration and assent was also taken from the children wherever applicable.

The consent statements included basic information on how the anthropometry measurements and biochemical assessment will be conducted and assurances about the confidentiality of the results. The statements were read clearly to the parents in vernacular language if they were illiterate, so that the parent/caregivers can make an “informed” decision whether they want to be part of the study or not. Informed Consent Form had two parts: the first one was the information sheet (to share information about the research with the parent/caregiver of the children) and the second was certificate of consent (for signatures if the parent/caregiver agreed to take part).

In each school, the number of children was fixed to 60, considering the time and other resource constraints. Thus, a total of 962 school children were personally interviewed, clinically examined, and other parameters were evaluated using a pretested semi-structured questionnaire developed by the Department of Preventive and Social Medicine, RIMS. An electronic weighing scale (Omron HN 286; India) and a stadiometer (Seca 213; Seca, Hamburg, Germany) were used for taking anthropometric measurements. Weight for age (WFA), height for age (HFA), and body mass index (BMI) were calculated and categorized according to the World Health Organization (WHO) Z scores. A portable hemoglobinometer (Pocket Chem™; MiCo Biomed Co., Ltd, Gyeonggi, Korea) was used to estimate the hemoglobin (Hb) level of children. For assessment of cognitive skills of the children, Bhatia’s Battery of Performance Test of Intelligence (Prasad Psycho Corporation, India) (>10-year-old children) and the Wechsler Intelligence Scale (Psychological Corporation, APA, USA) (<10-year-old children) were used. These procedures were done by investigators (medical doctors) who were properly trained on the study tools and instruments used in this study. The instruments were calibrated on a daily basis to avoid any error or bias.

For accuracy in weight measurement, children were weighed with minimum comfortable clothing. For accurate measurement of height, shoes, socks, hair ornaments, and braids of children were removed and the measuring board was placed on a hard, flat (level) surface. It was ensured that the child's feet and knees were in the correct position and the child was standing straight. The Hb of school children was assessed after taking few drops...
of blood from their finger. Before taking blood, each child was made comfortable and asked to relax. Birth dates were obtained from the children’s records in schools, which were dependent on the Aadhaar card (Unique Identification Number provided by the Government of India).

The baseline data comprised socio-demographic profile, anthropometric measurements, IQ status, availability of milk in their diet, and Hb assessment. The school children of the intervention group were provided 200 ml of fortified milk on every working day of school after the baseline data was taken from all 16 selected schools. After 1 year, the follow-ups were scheduled in all the 16 schools (both intervention and control) and the same children were assessed, so that we can evaluate the impact of the milk on them. However, despite our best efforts, we were able to follow-up only 528 children from among those who were present in our baseline study [Figure 1]. Promotion and migration of children to other schools and chronic absenteeism were the main reasons for loss to follow-up. Children were marked as lost to follow-up if they were absent during two consecutive visits. After 1 year of milk introduction, the same questionnaire which was used during baseline was used to collect the data for the assessment of children.

All data collected were entered in MS Excel sheets (Microsoft, version 13). Quality of data was checked by investigators by randomly checking 10% of data. Data analysis was done using Statistical Package for Social Sciences, version 20.0 (SPSS; IBM Corp., Armonk, NY, USA). Mean was calculated for all continuous variables in the groups. Z score was calculated for difference between two proportions from baseline to endline intervention groups. Z score was calculated for difference between two proportions from baseline to endline assessment and the $P$ value and 95% CI were calculated and considered for assessing statistical significance in the study.

**Results**

During the baseline survey, a total of 962 school children from 16 visited schools were studied. The proportion of males and females was almost equal, and about 41% (397) of the school children belonged to tribal community during the baseline study. Almost all the school children (99.7%) were from below poverty line category. After 1 year of study, in our endline survey, we had 528 children from those who were also studied 1 year back in our baseline study. This was the sample size considered for analysis in the current study. Out of these, 282 (53.4%) were females and 246 (46.6%) were males. Males were equal in control and intervention schools, while we had 143 females in the intervention schools as opposed to 139 females in the control schools.

In the present study, we had 482 students during baseline in the intervention schools, but in the endline, only 266 (55.1%) were present. In the control schools, we had 480 children in the baseline, while in the endline, only 262 (54.6%) children were present [Figure 1].

In the baseline survey, we observed that 42.9% of the children were stunted in the intervention group as compared to the school children in the control group (33.6%). During the endline assessment we found a significant increase in the proportion of Height for Age of normal nourished children from baseline, which was 8.7% in the intervention group compared to 1.3% in the control group, which was found to be statistically significant with a $P$ value of <0.0001 and 95% CI (7.37, 7.42). Difference in thinness (BMI) was also more in the intervention group between baseline and endline assessment and the $P$ value was <0.0001 with 95% CI (10.63, 10.58) [Table 1]. Thinness improved remarkably in the intervention group, whereas there was slight increase in the control group.

Similar finding was noted for the IQ levels; there was almost double increase in the IQ level in the intervention group compared to control group, with 95% CI (2.77, 2.82) and a $P$ value of <0.03. Also, a significant increase in the Hb levels was found in the intervention group, with CI (8.45, 8.54); it was also found to be statistically significant with a $P$ value of <0.0022 [Table 1]. After 1 year of milk consumption by school children, the findings of the study reflected changes in status of children’s health in the intervention schools. We saw the numbers of children having $<-2$ SD of HFA in the intervention schools to be on the lesser side, from 42.9% to 34.2%, while in control schools, the proportion of children who were $<-2$ SD for their HFA decreased marginally from 33.6% to 32.3%. We saw changes in the BMI category as well; BMI $<-2$ SD decreased in intervention schools from 42.9% to 33.5%, while in control schools, this malnourished category rose from 30.5% to 31.7% [Supplement Table1]. In the intervention schools, anemic children were reduced from 89.5% to 59.4%, while in control schools, we saw a reduction from 92% to 63.4%.

However, when $t$-test was applied for the control and intervention school children for the mean values of different parameters, the differences in mean values of baseline and endline findings were
increased in the intervention group school children compared to control school children [Supplement Table 2,3]. The difference was statistically significant, except for Hb levels [Table 2].

Discussion

There have been increasing evidences of the nutritional beneficial effects of fortified milk from across the globe in scientific literature.[22,23] It has been used to increase the concentration of vitamins A, D, and iron for fulfilling the micronutrient as well as macronutrient demand of the human body for normal growth and development. A school-based approach for inculcating dietary styles which might last lifelong has been advocated by WHO and the Centers for Disease Control and Prevention (CDC).[24,25] Considering this, this study focused on the impact of milk on nutritional assessment and cognitive skills in schoolgoing children.

Findings which directly attribute to changes in BMI, weight, or height for growing school children of age more than 6 or 7 years from rural and tribal areas are few in the literature. Although few earlier studies had well documented the beneficial effects of milk in children going to school,[26] their efforts were simultaneously replicated by others.[27] Baker, in 1980s, studied school children of age 6–7 years and reported increase in BMI and height due to milk consumption.[28] The results of the study conducted by Marsh et al.[28] on the effects of milk consumption on school children older than 10 years and in early adolescence stage are conflicting, as they found no effect of milk on BMI. This was attributable to loss of children from baseline data as expected in situations like we had in our study. However, we found that BMI and height changes in our study were statistically significant. In another study on school children at a young age, it was found that drinking milk had benefits in their BMI, Hb level, and weight gain.[29] In our study, we too saw the benefits of increasing BMI from a malnourished state to a healthy state in the intervention schools. The increase was also present in the control schools, but the difference was not that stark. A longitudinal study on adolescents with a large sample size of 12,000 students concluded that milk has its own beneficial effects on weight gain and BMI.[30] Studies have tried to evaluate the academic and intelligence factors related to milk consumption and the results have been inconclusive.[31,32] This was contradictory to our study where we saw changes in IQ levels in the intervention school children, and that change was almost double to that of control schools. So, we can conclude that milk was statistically associated with increase in IQ levels.

Although the difference in mean values of Hb was statistically insignificant, in regard to anemia levels, we saw statistically significant increase in the proportion of non-anemic children after 1 year of milk consumption compared to control schools. This was surprising for us as we were not able to find any other evidence like ours in other studies, but one meta-analysis concluded that nutrition-specific intervention can prevent anemia.[33] We attribute the change in Hb levels to more food intake owing to increased appetite induced by milk consumption. This may also be due to provision of good quality of protein through milk, which may be helpful in forming globin part of Hb in these malnourished children. But these are assumptions, and more studies are needed to support the hypotheses as anemia control program, deworming, and health education were also given concurrently in both groups of schools.

Conclusion

In our study, we saw the beneficial effects of milk on malnourished children from a tribal population, with most children belonging to below poverty line. We recommend continuation of milk for the state or at least in all the schools of the district, as milk is not only beneficial to the young adults in many ways, but also can be made a sustainable commodity owing to existing resources like

![Table 1: Changes in the proportion of undernutrition, intelligence quotient, and hemoglobin levels between the control and intervention groups from baseline to endline (n=528)](image)

| Characteristics                  | Changes in control group | Changes in intervention group | 95% CI for difference in proportion between the intervention and control groups | Z score | P     |
|----------------------------------|--------------------------|-------------------------------|--------------------------------------------------------------------------------|---------|-------|
| Height for age (endline - baseline) | 1.3                      | 8.7                           | (7.37, 7.42)                                                                    | -5.5168 | <0.001|
| BMI (endline - baseline)          | -1.2                     | 9.4                           | (10.63, 10.58)                                                                  | -8.685  | <0.001|
| Intelligence quotient (endline - baseline) | 3.4                      | 6.2                           | (2.77, 2.82)                                                                    | -2.128  | 0.03  |
| Anemia (endline - baseline)       | 12.6                     | 21.1                          | (8.45, 8.54)                                                                    | -3.687  | <0.001|

*BMI=body mass index, CI=confidence interval*  

![Table 2: Comparison of mean of anthropometric measurement (mean±SD), intelligence quotient, and hemoglobin levels at baseline and endline in the control and intervention groups (n=528)](image)

| Characteristics                  | Changes in control group | Changes in intervention group | 95% CI for difference in mean between intervention and control groups | t (test statistics) | P     |
|----------------------------------|--------------------------|-------------------------------|---------------------------------------------------------------------|---------------------|-------|
| Height for age (endline - baseline) | 5.2±0.4                  | 5.3±3.5                       | (0.695, 0.872)                                                      | 0.652               | 0.15  |
| BMI (endline - baseline)          | 0.5±0.3                  | 1.0±0.6                       | (0.442, 0.557)                                                      | 14.304              | <0.0001|
| Intelligence quotient (endline - baseline) | 3.2±1.5                  | 5.4±3.0                       | (1.898, 2.501)                                                      | 54±3.0              | <0.0001|
| Hemoglobin levels (endline - baseline) | 1.1±1.3                  | 1.0±0.6                       | (0.470, 1.278)                                                      | -0.529              | 0.59  |

*BMI=body mass index, CI=confidence interval, SD=standard deviation*
habit of keeping cattle at home, farms, and so on. More studies from other states in our country in similar settings will render better understanding of the benefits of milk consumption in young Indian schoolgoing children.

Limitations of the study
A more detailed dietary history could be pursued to understand better the interactions of milk and other dietary components being taken by the child. We were also not able to ascertain the possible confounders. We also had attrition in the follow-up study, which was beyond our control.

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Ethical approval
The study was approved by the Institutional Ethics Committee of RIMS, Ranchi.

Declaration of patient consent
The authors certify that they have obtained all appropriate patient consent forms. The consent statements included the basic information on how the anthropometry measurements and biochemical assessment will be conducted and assurances about the confidentiality of the results. The statements were read clearly to the parents in vernacular language if they were illiterate, so that the parent/caregivers can make an “informed” decision whether they want to be part of the study or not. Informed Consent Form had two parts: the first part was the information sheet (to share information about the research with the parent/caregiver of the children) and the second was certificate of consent (for signatures if the parent/caregiver agree to take part).

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Conflicts of interest
There are no conflicts of interest.

References
1. GBD 2016 Causes of Death Collaborators. Global, regional, and national age‑sex‑specific mortality for 264 causes of death, 1980‑2016: A systematic analysis for the Global Burden of Disease Study 2016. Lancet 2017;390:1151‑210.
2. World Health Organization. The WHO Child Growth Standards. Geneva: World Health Organization; 2016. Available from: http://www.who.int/childgrowth. [Last accessed on 2021 Jan 21].
3. Prendergast AJ, Humphrey JH. The stunting syndrome in developing countries. Paediatr Int Child Health 2014;34:250‑63.
4. International Institute for Population Sciences (IIPS). National Family Health Survey (NFHS-4), 2015‑16. Mumbai: International Institute for Population Sciences; 2016. Available from: http://rchiips.org/nfhs/nfhs‑4Reports /India.pdf. [Last accessed on 2019 Mar 12].
5. Ramachandran P. School mid‑day meal programme in India: Past, present, and future. Indian J Pediatr 2019;86:542‑7.
6. Semiah S, Burman J, Dasgupta A, Paul B. Safety of food served in Mid‑Day Meal program: An in‑depth study in upper primary schools of Kolkata. J Family Med Prim Care 2019;8:938‑4.
7. Lunven P. Nutrition in Agriculture No. 3. Selecting Interventions for Nutritional Improvement—A Manual. Food and Agricultural Organization of the United Nations. Rome: FAO; 1983. Available from: http://www.fao.org/3/an494e/ an494e00.pdf. [Last accessed on 2021 Jan 21].
8. Matsuyama M, Harb T, David M, Davies PS, Hill RJ. Effect of fortified milk on growth and nutritional status in young children: A systematic review and meta‑analysis. Public Health Nutr 2017;20:1214‑25.
9. Sazawal S, Dhingra U, Dhingra P, Hiremath G, Sarkar A, Dutta A, et al. Micronutrient fortified milk improves iron status, anemia and growth among children 1‑4 years: A double masked, randomized controlled trial. PLoS One 2010;5:e12167.
10. Eichler K, Wieser S, Rüthemann I, Brügger U. Effects of micronutrient fortified milk and cereal food for infants and children: A systematic review. BMC Public Health 2012;12:506.
11. Eichler K, Hess S, Twerenbold C, Sabatier M, Meier F, Wieser S, et al. Health effects of micronutrient fortified dairy products and cereal food for children and adolescents: A systematic review PLoS One 2019;14:e0210809.
12. Haug A, Hostmark AT, Harstad OM. Bovine milk in human nutrition—A review. Lipids Health Dis 2007;6:25.
13. Thorning TK, Raben A, Tholstrup T, Soedamah‑Muthu SS, Givens I, Astrup A. Milk and dairy products: Good or bad for human health. An assessment of the totality of scientific evidence. Food Nutr Res 2016;60:32527.
14. Louie JC, Flood VM, Rangan AM, Burlutsky G, Gill TP, Gopinath B, et al. Dairy product consumption and metabolic diseases in the diabetes study. Nutrients 2013;23:816‑21.
15. Lago‑Sampedro A, Gracia‑Escobar E, Rubio‑Martín E, Pascual‑Aguirre N, Valdés S, Soriguer F, et al. Dairy product consumption and metabolic diseases in the diabetes study. Nutrients 2019;11:262.
16. Shin S, Lee HW, Kim CE, Lim J, Lee JK, Kang D. Association between milk consumption and metabolic syndrome among Korean adults: Results from the health examinees study. Nutrients 2017;9:1102.
17. Aro Y, Nakayama H. Preventive effects of dairy products on dementia and the underlying mechanisms. Int J Mol Sci 2018;19:1927.
18. Alcantara JMA, Sanchez‑Delgado G, Martinez‑Tellez B, Labayen I, Ruiz JR. Impact of cow's milk intake on exercise performance and recovery of muscle function: A systematic review. J Int Soc Sports Nutr 2019;16:22.
19. Geng T, Qi L, Huang T. Effects of dairy products consumption on body weight and body composition among adults: An updated meta‑analysis of 37 randomized control trials. Mol Nutr Food Res 2018;62. doi: 10.1002/mnfr.201700410.
20. Leighton G, Clark ML. Milk consumption and the growth of school children: Second preliminary report on tests to the Scottish board of health. Br Med J 1929;1:23-3.

21. Birnie K, Ben-Shlomo Y, Gunnell D, Ebrahim S, Bayer A, Gallacher J, et al. Childhood milk consumption is associated with better physical performance in old age. Age Ageing 2012;41:776-84.

22. Plessow R, Arora NK, Brunner B, Wieser S. Cost-effectiveness of price subsidies on fortified packaged infant cereals in reducing iron deficiency anemia in 6-23-month-old-children in urban India. PloS One 2016;11:e0152800.

23. Athe R, Rao M, Nair KM. Impact of iron-fortified foods on Hb concentration in children (<10 years): A systematic review and meta-analysis of randomized controlled trials. Public Health Nutr 2014;17:579-86.

24. Centers for Disease Control and Prevention (CDC). Guidelines for school health programs to promote lifelong healthy eating. J Sch Health 1997;67:9-26.

25. World Health Organization (WHO). Nutrition Friendly Schools Initiative (NFSI). Geneva: WHO; 2012. Available from: http://www.who.int/nutrition/topics/nutrition_friendly_schools_initiative/en/index.html. [Last accessed on 2021 Mar 30].

26. Agostoni C, Turck D. Is cow’s milk harmful to a child’s health? J Pediatr Gastroenterol Nutr 2011;53:594-600.

27. Baker IA, Elwood PC, Hughes J, Jones M, Moore F, Sweetnam PM. A randomised controlled trial of the effect of the provision of free school milk on the growth of children. J Epidemiol Community Health 1980;34:31-4.

28. Marsh S, Jiang Y, Carter K, Wall C. Evaluation of a free milk in schools program in New Zealand: Effects on children's milk consumption and anthropometrics. J Sch 2018;88:596-604.

29. Novotny R, Daida YG, Acharya S, Grove JS, Vogt TM. Dairy intake is associated with lower body fat and soda intake with greater weight in adolescent girls. J Nutr 2004;134:1905-9.

30. Berkey CS, Rockett HRH, Willett WC, Colditz GA. Milk, dairy fat, dietary calcium, and weight gain: A longitudinal study of adolescents. Arch Pediatr Adolesc Med 2005;159:543-50.

31. Kim SH, Kim WK, Kang MH. Relationships between milk consumption and academic performance, learning motivation and strategies, and personality in Korean adolescents. Nutr Res Pract 2016;10:198-205.

32. Han SS, Kim HY, Kim WK, Oh SY, Won HS, Lee HS, et al. The relationships among household characteristics, nutrient intake status and academic achievements of primary, middle and high school students. Korean J Nutr 1999;32:691-704.

33. da Silva Lopes K, Yamaji N, Rahman MO, Suto M, Takemoto Y, Garcia-Casal MN, et al. Nutrition-specific interventions for preventing and controlling anaemia throughout the life cycle: An overview of systematic reviews. Cochrane Database Syst Rev 2021;9:CD013092.
### Supplement Table 1: Comparison of frequency of anthropometric measurement, intelligence quotient and hemoglobin levels between control and intervention group at baseline and end line

| Characteristics         | Baseline          | Endline          | P       |
|-------------------------|-------------------|------------------|---------|
|                         | Normal            | Abnormal         |         |
| Height for age Control  | 174 (66.4%)       | 88 (33.6%)       | 0.028   |
| Intervention Control    | 152 (57.1%)       | 114 (42.9%)      |         |
| BMI Control             | 182 (69.5%)       | 80 (30.5%)       | 0.002   |
| Intervention Control    | 152 (57.1%)       | 114 (42.9%)      |         |
| Intelligence Quotient   | 215 (82.1%)       | 47 (17.9%)       | 0.123   |
| Control                 | 198 (74.4%)       | 68 (25.6%)       |         |
| Intervention Control    | 214 (80.5%)       | 52 (19.5%)       |         |
| Hemoglobin Levels       | 63 (24.0%)        | 199 (76.0%)      | 0.21    |
| Control                 | 52 (19.5%)        | 214 (80.5%)      |         |

*WHO Anthroplus software categorizes weight for age up to 10 years

### Supplement Table 2: Comparison of mean of anthropometric measurement, intelligence quotient and hemoglobin levels at baseline and end line in control group

| Variables               | Mean±SD       | P        |
|-------------------------|---------------|----------|
| Height for age           | 137.9±8.8     | 143.1±9.2| <0.001   |
| BMI                     | 15.3±1.5      | 15.8±1.8 | <0.001   |
| Intelligence Quotient   | 79.8±8.9      | 85.2±5.9 | <0.001   |
| Hemoglobin Levels        | 10.5±1.3      | 11.6±3.6 | 0.002    |

### Supplement Table 3: Comparison of mean of anthropometric measurement, intelligence quotient and hemoglobin levels at baseline and end line in intervention group

| Variables               | Mean±SD       | P        |
|-------------------------|---------------|----------|
| Height for age           | 135.9±10.8    | 141.2±10.7| <0.001   |
| BMI                     | 14.8±1.6      | 15.8±2.2 | <0.001   |
| Intelligence Quotient   | 82.7±9.2      | 85.9±7.7 | <0.001   |
| Hemoglobin Levels        | 10.3±1.5      | 11.3±1.6 | <0.001   |