

Effect of mid-day meal on nutritional status of adolescents: A cross-sectional study from Gujarat

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ABSTRACT

Objective: To evaluate the effect of mid-day meal (MDM) on the nutritional status of adolescents and compare it with healthy comparison group. **Settings and Design:** A cross-sectional study on apparently healthy adolescents (10-14 years) receiving MDM and not receiving MDM (comparison group) was conducted in two cities (Ahmedabad and Patan) of Gujarat, Western India, from January 2012 to March 2014. **Materials and Methods:** A total of 401 adolescents (200 boys) were selected randomly, using computerized random number generation, from two private and two municipal/government schools. Anthropometric measurements were performed. Height, weight, and body mass index Z scores were computed using ethnic data. Diet was recorded by 24 h recall and nutrient intakes were computed (C-diet V-2.1) as a percentage of the recommended dietary allowance (RDA). Student's *t*-test and Chi-square tests were used to compare differences in nutritional status. **Results:** Percentage of stunting (24% boys and 19% girls) and wasting (17% boys and 18% girls) was significantly higher in adolescents receiving MDM ($p < 0.001$), while the percentage of risk of being overweight, i.e., BMI for age Z (BAZ) > 1 or above 85th percentile (18% boys and 12% girls) was predominant in non-MDM receiving adolescents ($p < 0.001$). Compared to non-MDM, MDM receiving adolescents consumed significantly reduced quantity of nutrients ($p < 0.05$). On comparing RDA based on the 24 h dietary recall, it was seen that MDM receiving boys met 60% energy, 78% protein, 50% calcium, and 53% of micronutrient requirements while MDM receiving girls met 59% energy, 67% protein, 44% calcium, and 48% of micronutrient requirements. Non-MDM receiving adolescents had close to RDA or above intake for the most nutrients ($p < 0.05$ for all). **Conclusion:** Although MDM scheme restricted the percentage of stunting to some extent, the percentage of wasting was critical in terms of public health significance. MDM receiving adolescents were vulnerable to energy, protein, and micronutrient deficiencies.

Key words: Adolescents, Nutritional status, Micronutrients, Mid-day meal, Stunting, Wasting

Adolescence is a period of critical transition in human growth and development, characterized by a rapid growth rate, peak bone mass accrual and the onset of puberty [1,2]. The socio-economic status (SES) plays a major role in determining an individual's access to health-care facilities, housing, environmental factors, and education. Adolescents belonging to underprivileged SES have been reported to have inadequate nutrition, lower calcium intakes, poor access to health care, and failure to receive immunization [3,4]. Thus, adolescents belonging to lower SES are often undernourished, having impaired immunity and exhibit high susceptibility to infections along with an increased likelihood of stunting, iron deficiency and dental caries [3,5].

With an aim to overcome, these socio-economic differences, malnutrition, micronutrient deficiencies and providing the basic right to food along with right to education, the mid-day meal (MDM) Scheme, a national program for nutritional support to primary education in India, was started in August 1995 by the

then Prime Minister of India, P.V. Narsimha Rao and later revised in 2006; though it was introduced by K. Kamaraj in 1960s in Tamil Nadu [6-9].

Growth is a significant indicator of nutritional status and health as poor diet and frequent infections can lead to growth retardation [10]. Hence, to evaluate the effect of MDM program, it is important to assess the nutritional status of adolescents receiving MDMs. Most studies examining MDM are performed on children in a broad age group of 5-15 years [11-13]; we have focused on adolescence, a period that is marked by a rapid growth spurt along with an increased demand of nutrient intake. Good nutrition during adolescence is significant to meet the deficiencies that occur during childhood, for making up the demand of growth and development, for the provision of sufficient stores of energy for illnesses, and to prevent onset of nutrition-related diseases in adulthood [14]. Moreover, information on nutrient intake in adolescents receiving MDM and their status as compared to healthy adolescents is scarce [12,15]. Thus, the aims of this study

were to (1) evaluate the effect of MDM on the nutritional status of adolescents and (2) compare the nutritional status of adolescents receiving MDM with the healthy comparison group.

MATERIALS AND METHODS

A cross-sectional study in apparently healthy adolescents (n=401; age 10-14 years) receiving MDM (lower SES) and not receiving MDM (comparison group, upper SES) was conducted in two cities (Ahmedabad and Patan) of Gujarat, Western India, from January 2012 to March 2014. The input variables of the study comprised dietary intake by 24 h recall and the outcome variables included anthropometric measurement and blood hemoglobin estimation.

Study Subjects

A total of 401 adolescents (200 boys) were selected randomly from two private and two municipal/government schools. The sample size estimation was done using previous cross-sectional studies on growth [13,16] with power to be 90% and level of significance 5%. MDM scheme is implemented in government schools but not in private schools. Major regions of both the cities were screened, and a list of schools were prepared which included government schools and schools catering adolescents from upper SES. Out of them, a total of 8 schools including both private (4 schools) and government schools (4 schools) were randomly approached. All the schools provided their consent for conducting the study. Out of these eight schools, two private schools and two government schools were randomly selected. Participants with any chronic ailment, congenital diseases or any major surgery or taking any medications, were excluded from the study. Inclusion criteria comprised apparently healthy adolescents in the age group of 10-14 years. Out of those who satisfied the inclusion criteria, a total of 401 adolescents (stratified by gender; 201 girls and 200 boys) were randomly selected from two private schools (girls, n=101; boys, n=100) and two municipal schools (girls, n=100; boys, n=100). The selection of participants was done using computerized random number generation.

Ethical Approval and Consent

The purpose of the study and its importance was explained to the administrative authorities, principal and teachers of the schools along with adolescents and their parents. An informed written consent was obtained from the school authorities and parents, and an assent from adolescents participating in the study was also obtained. If the parents were illiterate, the information was read out to them in the local language (Gujarati) and if they agreed to participate in the study, then their thumbprint or signature was taken, witnessed by an independent witness, usually a senior school staff member. All the adolescents and parents who were approached agreed to participate in the study. Adolescents and parents, willing to take part in the study were interviewed to fill a screening questionnaire; the adolescents also underwent a clinical examination at the baseline, so as to ensure that they did not have

any major illness history in the past that might affect their health status. Ethical approval was granted by the Ethics Committee of Gujarat Medical Education and Research Society General Hospital, Gandhinagar, Gujarat.

SES

Adolescents were classified into upper and lower SES according to the modified Kuppuswamy's SES scale that takes into account the education, occupation, and family income [17]. The adolescents from government school receiving MDM belonged to lower SES, whereas that from private schools not receiving MDM belonged to upper SES. Adolescents from private school, the upper SES were selected as healthy comparison group to make a comparative analysis of nutritional status in underprivileged adolescents. Kuppuswamy's SES scale was used to confirm the selection of upper SES and lower SES adolescents.

Anthropometry

Height and weight were measured in light clothing without shoes. Standing height was measured to the nearest 1 mm, using a stadiometer (Leicester height meter, Child growth foundation, UK, range 6-207 cm). Weight to the nearest 0.1 kg was measured (SC240 MA, Tanita, India). Height, weight, and body mass index (BMI) Z scores were computed using ethnic data [18].

Diet

Diet was recorded through a 24 h diet recall, which was taken for three non-consecutive days (2 weekdays and a Sunday). MDM receiving adolescents received MDM once in their school during the recess time. The average menu comprised rice, wheat, pulses, vegetables, and oil prepared as different recipes such as dal dhokli, vegetable khichdi, vegetable dal, rice, and chapatti. MDM is designed to provide 450 kcal of energy and 12 g of proteins for primary classes (grade 1-5) while 700 kcal of energy and 20 g of proteins for upper primary classes (grade 6-8) [6,8]. A weekly menu for the school was pre-decided and accordingly the recipes were served throughout the week. Adolescents reported the quantity of the MDM recipes consumed through the MDM provided to them in their school, during their 24 h diet recall. The nutrient intakes were calculated using a cooked food database (c-diet version 2.1, Xenios technologies) and database of raw foods [19,20] as well as cooked foods [20,21]. The nutrient intakes were computed as percentage Recommended Dietary Allowance (RDA) consumption, for Indian population given by Indian Council of Medical Research (ICMR) and National Institute of Nutrition (NIN) [22].

Biochemical Estimations

In a sub-population (n=126), hemoglobin concentrations were measured by cyanmethemoglobin method (differential lysis with Beckman Coulter principle; Coefficient of variance=1.5%). The

normal range for hemoglobin concentrations in children and adolescents is 115 g/l or higher for age 5-11 years, and 120 g/l or higher for age 12-14 years. Hemoglobin concentrations between 110-114 g/l (5-11 years) and 110-119 g/l (12-14 years) represent the cutoff values for mild anemia, between 80 and 109 g/l (5-11 years and 12-14 years) represent the cutoff values for moderate anemia and below 80 g/l represent the cutoff values for severe anemia [23].

Statistical Analysis

Descriptive characteristics (mean and standard deviations) were computed for anthropometric measures and nutrient intakes in boys and girls belonging to MDM receiving and non-MDM receiving group. Student's *t*-test was used to compare the differences in nutritional status between MDM receiving and non-MDM receiving adolescents. Chi-square test was used to estimate the percentage of stunting, wasting, and anemia among MDM receiving and Non-MDM receiving adolescents. The analysis was stratified for gender. All analysis were performed using SPSS version 18.0 [24] and the statistical significance level was set at $p < 0.05$.

RESULTS

A total of 401 adolescents (10-14 years; 200 boys) were studied with a mean age of 12.2 ± 1.1 years. Table 1 summarizes the characteristics (mean \pm standard deviation) of MDM and non-MDM receiving adolescents stratified by gender; there were no gender differences observed within the MDM and non-MDM group for age as well as anthropometric parameters ($p > 0.05$ for all, Student's *t*-test). MDM receiving adolescents had significantly lower anthropometric measures as compared to non-MDM receiving adolescents. Non-MDM receiving boys and girls (comparison group) were taller and heavier than MDM receiving adolescents ($p < 0.05$, Student's *t*-test). In MDM receiving adolescents, the overall percentage of stunting was 21.5% (24% boys and 19% girls were stunted as judged by their height for age) while wasting was 17.5% (17% boys and 18% girls showed wasting as judged by their BMI for age), which was significantly predominant as compared to non-MDM receiving adolescents (percentage stunting: Boys: $\chi^2 = 18.9$, $p < 0.001$, girls: $\chi^2 = 18.2$, $p < 0.001$, percentage wasting: boys: $\chi^2 = 25.9$, $p < 0.001$, and girls: $\chi^2 = 25.9$, $p < 0.001$). In contrast, the non-MDM receiving adolescents showed significantly higher ($p < 0.001$) percentage of risk of overweight, i.e., BAZ > 1 or above 85th percentile (15% average; 18% boys and 12% girls as judged by their BMI for age) [25]. Only 1% adolescents from non-MDM group while none from MDM group were overweight.

Hemoglobin concentrations were significantly less in MDM receiving boys (122.7 ± 11.6 , $p < 0.05$) while in girls, it was marginally different (121.6 ± 11.4 , $p = 0.07$), when compared with Non-MDM receiving boys and girls; though the mean values in both the groups were above the cutoff range (115 g/l or higher for

age 5-11 years, and 120 g/l or higher for age 12-14 years). Anemia was more common in MDM receiving adolescents (30% girls and 27% boys were anemic) as compared to Non-MDM receiving adolescents (13% girls and 9% boys were anemic) (percentage anemia: Boys: $\chi^2 = 3.8$, $p < 0.05$; girls: $\chi^2 = 2.7$, $p = 0.1$) (Table 1).

Comparing the nutrient intakes (expressed in % RDA) among both the groups, MDM receiving adolescents consumed significantly reduced quantity of nutrients as compared to Non-MDM receiving adolescents ($p < 0.05$ for all) (Fig. 1). As compared with the RDA, the 24 h dietary recall showed that MDM receiving boys met 60% of energy, 78% of protein, 50% of calcium, and 53% of micronutrient requirements while MDM receiving girls met 59% of energy, 67% of protein, 44% of calcium, and 48% of micronutrient requirements. The non-MDM receiving adolescents had close to or above RDA intake for all nutrients. Fat intake in both the groups was above RDA.

DISCUSSION

In adolescents receiving MDM, we found that stunting and wasting were significantly higher than in the non-MDM receiving group. Both groups were significantly different in nutritional status, nutrient intakes, and percentage of anemia. The possible explanation for low SES adolescents being the most affected may be attributed to various reasons such as poor economic conditions, exposure to unhygienic environment, increased morbidity along with the lack of proper care, and attention for adequate nutrition that is required during the growing years [3,26]. Moreover, they also showed the trend of skipping either breakfast or lunch due to the perception that MDM is a wholesome food rather than a supplement, thus leading to an increased vulnerability toward poor nutritional status.

As seen in our study, the difference in stature and weight between MDM and non-MDM groups and an increased

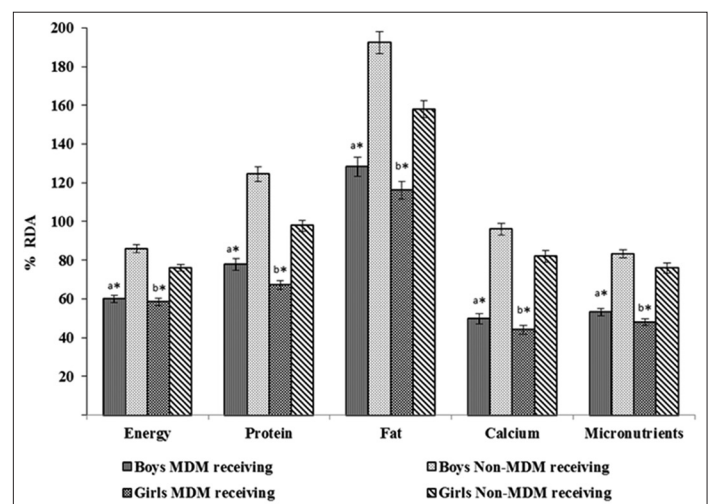


Figure 1: Nutrient intake of mid-day meal (MDM) receiving and non-MDM receiving adolescents of Gujarat, expressed in % recommended dietary allowance. a*Values are significantly different between MDM receiving and non-MDM receiving boys ($p < 0.05$). b*Values are significantly different between MDM receiving and non-MDM receiving girls ($p < 0.05$)

Table 1: Anthropometry and hemoglobin concentration estimates of MDM receiving and non-MDM receiving adolescents in 2 private and 2 government schools of Gujarat

Variables	Boys		Girls	
	MDM receiving (n=100)	Non-MDM receiving (n=100)	MDM receiving (n=100)	Non-MDM receiving (n=101)
Age (years)	12.4±1.3	12.2±0.9	12.1±1.2	12.1±1.1
Height (cm)	141.5±10.5*	149.2±8.9	140.8±8.3*	148.9±7.1
Weight (kg)	30.2±7.4*	41.3±11.7	30.1±6.7*	40.1±8.5
BMI (kg/m ²)	14.8±1.8*	18.3±3.9	15±2*	18±3.2
HAZ (% stunted)	-1.3±1* (24%)	-0.1±1.1 (3%)	-1.1±1* (19%)	0.1±0.9 (1%)
WAZ	-1.6±0.9*	-0.2±1.2	-1.5±0.9*	-0.1±0.9
BAZ (% wasted)	-1.3±0.7* (17%)	-0.2±1.1 (5%)	-1.3±0.8* (18%)	-0.2±0.9 (2%)
Hemoglobin (g/l) (% anemia)	122.7±11.6* (27%)	129.5±11.4 (9%)	121.6±11.4 [†] (30%)	127.1±12.2 (13%)

HAZ: Height for age Z score, WAZ: Weight for age Z score, BAZ: BMI for age Z score, MDM: Mid-day meal, SD: Standard deviation. All values are mean±SD. Percentage of stunted, wasted and anemic adolescents from MDM receiving and non-MDM receiving group are shown in parentheses. Pearson Chi-square values for: Percentage stunting (boys: $\chi^2=18.9$, $p<0.001$, girls: $\chi^2=18.2$, $p<0.001$), percentage wasting (boys: $\chi^2=25.9$, $p<0.001$, girls: $\chi^2=25.9$, $p<0.001$) and percentage anemia (boys: $\chi^2=3.8$, $p<0.05$, girls: $\chi^2=2.7$, $p>0.05$). *Mean values are significantly different between MDM receiving and non-MDM receiving group ($p<0.05$). [†]Mean values are marginally different between MDM receiving and non-MDM receiving group ($p<0.1$)

percentage of undernutrition/stunting and wasting in MDM receiving adolescents and overweight in Non-MDM receiving adolescents has also been reported by others [11,12]. The percentage of stunting and wasting found in our study population was less than that reported by others [11,12]; when compared to the prevalence cut-off values for public health significance (WHO), the percentage of stunted adolescents was medium (20-29%); however, the percentage of wasted adolescents fell under the critical category ($\geq 15\%$) [10].

We also observed that both the groups were significantly different in their nutrient intakes; the intake of energy, protein, calcium and other micronutrients for non-MDM receiving adolescents was close to or more than RDA, while MDM receiving adolescents met only half of the RDA. A similar deficiency in energy, protein and micronutrients consumption by children receiving MDM has been reported by others [12,15]. These differences in the nutrient intakes might be possibly due to the consumption of appropriate and frequent meals by the non-MDM receiving adolescents that provided adequate nutrition along with appropriate RDA for the majority of the nutrients.

Almost the third of the MDM receiving adolescents were found to be suffering from anemia as compared to one tenth of non-MDM receiving adolescents who were anemic. In line with our study results, NIN and ICMR have also documented a high prevalence of anemia in adolescents [22]. According to the prevalence cutoff values for public health significance (WHO), the prevalence of anemia in our study adolescents would be considered as a moderate public health problem (20-39.9%) [10]. This restriction in the percentage of anemia may possibly be contributed to national iron plus initiative (NIPI), a government of India initiative to combat anemia [27,28]. Nevertheless, MDM receiving adolescents though supplemented on weekly basis with elemental iron and folic acid under NIPI showed increased incidence of anemia compared to non-MDM receiving adolescents; this difference may be attributed to various factors such as failure to receive the supplement due to absenteeism or

other micronutrient deficiencies such as vitamin B₁₂ deficiency or high morbidity due to frequent infections.

The strength of our study is that we have studied a critical period of growth, i.e. adolescence, as also the nutritional status of adolescents belonging to underprivileged SES who are prone to malnutrition, high morbidity, and increased the probability of stunting and iron deficiency. To the best of our knowledge, the deficit of micronutrients intake in MDM receiving adolescents in contrast to the healthy adolescents has not been reported earlier. Our main limitation is that our study is cross-sectional, and we have relied on the history obtained from study subjects about ingestion of meals; therefore, a longitudinal interventional trial on a larger cohort would be required to confirm and emphasize the effect of MDM.

CONCLUSION

Healthy comparison group in the study showed better nutritional status than MDM receiving adolescents. Although MDM program restricted the percentage of stunting to some extent among MDM receiving adolescents, the percentage of wasting was critical in terms of public health significance. MDM receiving adolescents were still vulnerable to energy, protein, and micronutrient deficiencies. Our study shows that though the MDM program acts as a supplement, however, it is not the sole source of RDA. Thus, there is an urgent need to reassess the MDM program, in light of findings of the present and similar studies.

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