

# Socio-economic factor impact on malnutrition in South Indian government school children

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## SUMMARY

India finds itself in a vulnerable position with the highest prevalence of malnutrition in the world. In this study, we investigated the various socio-economic factors affecting the amount and variety of calories consumed by children studying in government schools in South India. After a pilot study, we conducted an online survey of 214 children (boys=95, girls=119) between the ages of 13–16 years in three states of India. Overall, we found that 63% of the children had a caloric intake of less than 1,500 calories per day, which is lower than World Health Organization guidelines of 2,100 calories. Parental education, parental income, parental diet reminders, and geographical area were significant factors influencing the total calorie intake among the participants. Cohen's D test revealed a medium effect size for parental income and a large effect size for parental diet reminders. Chi-square test confirmed that geographical location, income, and parental education were not correlated with one another, affecting the total calorie consumption independently. Parental reminders and income had a significant influence across all components of total calories including carbohydrates, proteins, fats, and vitamins/minerals. To alleviate malnutrition, in addition to alleviating the income challenges, other initiatives include improving parental education and parental awareness of a balanced diet, such that parents can enable healthy diet habits among children.

## INTRODUCTION

Malnutrition is defined as the disproportionate intake of various nutrients such as carbohydrates, fats, and fiber that are needed for growth (1). Nearly 30% of the citizens in developing countries are affected by malnutrition according to the World Health Organization (WHO) (2). Malnutrition is the most serious consequence of a lack of food security. Food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life (3).

Malnutrition has three significant effects on children's growth. First, malnutrition makes young children more prone to infectious diseases, such as malaria and measles, and diarrhea caused by immune dysfunction or environmental exposures (4). Secondly, malnutrition hinders a child's mental development, as children with stunted growth due to

malnutrition were shown to be highest at risk for intellectual disability (5). A key example is protein malnutrition, which was seen to reduce brain size and hinder cell maturation, causing behavioral disabilities that continue throughout adulthood (6). Lastly, malnutrition increases the likelihood of abnormal behavior such as aggression, depression, and stress due to imbalanced production of neurotransmitters (7).

More than one third of the world's malnourished children live in India, despite India's 50% increase in gross domestic product (GDP) since 1991 (8). An analysis of 640 districts in India between 2015 and 2016 revealed that 38% of children's height in India was stunted and 35% were underweight (8). According to a World Bank report, the prevalence of underweight children in India is among the highest in the world (9). India finds itself in a vulnerable position with the prevalence of one of the highest malnutrition in the world despite improved food availability and poverty alleviation over the last few decades (9). Further, malnutrition in India has not decreased at a rate proportional to the growth of the Indian economy (8).

Recent studies highlight several factors impacting the nutritional status of children (10). Socio-economic determinants such as income, ethnicity, geographical location, and intra-household parental factors play a crucial role in the nutritional status of children (11). Even in a developed country like the US, a thirty-year trend in adolescent food consumption indicated vegetable consumption was below the recommended level for all children and mineral consumption below recommended levels for girls, indicating that the sex of a child also plays a role in their nutritional intake (12). Socioeconomic inequalities between households were identified as factors influencing malnutrition in underprivileged children in India (13).

Parental education was one of the most significant contributors towards child malnutrition, according to Abhishek Kumar & Divya Kumari (14). A study in the Indian state of West Bengal highlighted adolescent children of women with higher education were less likely to be malnourished than adolescent children of poor and uneducated women (15). Furthermore, a study in South India found the body mass index (BMI) of children was correlated with parental behavior such as working status and education (16). It was observed that children of parents who were educated and/or held a job are generally less malnourished and stunted in terms of growth (16). Another study observed the lifestyle and behavior of the child itself did not contribute to malnutrition, but rather the mother and/or caregiver's feeding practices affected the dietary intake of the child (17). Poverty was found to be an important contributor of malnutrition among the adolescents studied in West Bengal (15). Additionally, a study conducted in four Indian cities found household family income, related socioeconomic factors, and obesity in mothers as most

significantly associated with obesity in children (18). Lastly, another Indian study in West Bengal observed students' nutrition knowledge being significantly associated with their mother's educational status (19).

A survey conducted among the rural population of over 20,000 households across 10 states of India revealed the dietary intake was significantly lower in adolescent girls and did not satisfy the nutrient distribution criteria percentage for carbohydrates, protein, and fat (20). Study of mid-adolescent girls in the Indian states of Andhra Pradesh and Telangana also demonstrated similar findings, that mid-adolescent girls consume less protein-filled and vitamin-rich foods compared to boys in the same house (21). A similar study in the state of Haryana found there was evidence of preferential treatment towards boys when it comes to providing nutrition (22). Another study across developing countries indicates that young adolescent females have worse health, nutrition, and micronutrient deficiencies than the males (23). Adding to this, a study of 4700 urban students found that a higher percentage of adolescent children (boys-17%, girls 15%) were found to be overweight (24). A study in North India, observed the probability of overweight and obesity three times higher among adolescent girls who reside in urban areas as compared to rural ones (25).

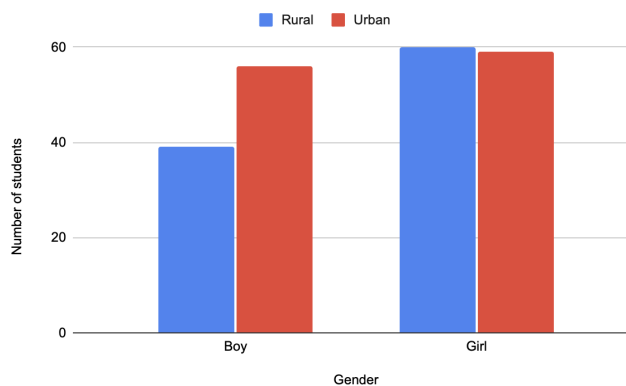
In this paper, we investigated socio-economic and awareness factors that influence the consumption of the total calories and specific calories components for children studying in government schools in South India consumed each day. Previous studies included socio-economic factors such as parental education, parental income, geographical location, awareness factors, and gender. We hypothesized that parental reminder with their children to consume a balanced diet and improve the child's awareness would have a positive influence on total calorie consumption. This research included two additional factors, namely, child self-awareness of a balanced diet, and parental reminders of their children to consume a balanced diet. In this study, we obtained primary data through a survey and performed bivariate analysis on each of the factors that we hypothesized would affect the number of calories consumed by children studying in government schools in South India. We found parental education, parental income, parental reminder, and geographic location to be significant in affecting the calories consumed by the children in the study. With this we recommend that information sessions are held to improve parental and children's knowledge of the importance of a balanced diet in South Indian government schools.

## RESULTS

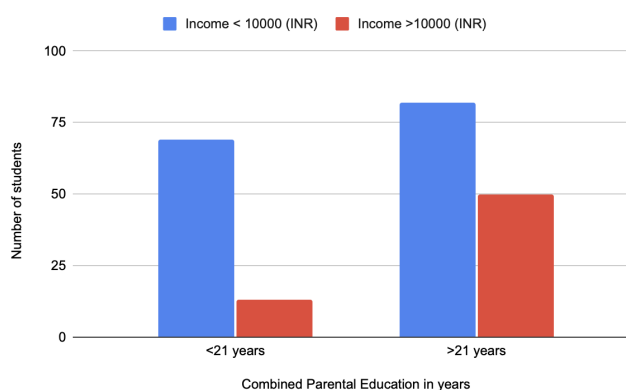
To measure the influence of socio-economic, geographical location, and awareness factors on calorie consumption, we surveyed a range of potential correlates using a set of 15 questions through an online survey. The respondents were 214 children in the age range of 13–16 years, across three states of India.

### Demographics and nutritional status of survey participants

Our sample group consisted of boys (44%) and girls (56%) across both rural (46%), and urban (56%) areas (Figure 1). We observed that 57% were underweight and 8% were overweight (Table 1). Carbohydrates (45%) were the most



**Figure 1: Distribution of surveyed children across gender and geographic locations.** Data is separated by rural (blue) versus urban (red). Total students surveyed = 214.



**Figure 2: Distribution of children based on parental income and parental education.** Number of children with combined parental education <21 years and >21 years. Data is subset by parental income <10,000 INR (blue) and >10,000 INR (red).

prominent source of calories among the three nutrients (Table 1). We found that 64% of the children were consuming less than 15% protein calories against the recommended 15% to 20% of total calories in a day. Lastly, 48% of the students were not aware of the importance of a balanced diet (Table 1). We found that 71% of parents earned less than 10,000 INR (equivalent to 130 USD) per month. Our data revealed that 63% of families had a calorie intake of less than 1,500 per day compared to the WHO recommended 2,100 calories. We also found that 44% of the parents did not encourage children to consume a balanced diet daily. Parental education could be one of the reasons for this lack of a balanced diet, as 38% of parents have combined parental education of less than 21 years (Figure 2).

### Factors influencing calorie intake

We conducted regression analysis with the total calories the children consumed each day against parental education, parental income, parental reminders, child self-awareness, gender, and geographic location. Out of the six factors analyzed for regression, we found parental education, parental income, parental reminders, child self-awareness, and geographic location to be significant ( $p < 0.05$ , Figure 3). Gender was not a significant factor affecting the total calorie intake ( $p > 0.89$ , Figure 3E).

Factor	Categories of factors	Number of Children	Percentage of Total
Gender	Male	95	44%
	Female	119	56%
Family income per month	< 10,000 INR	151	71%
	> 10,000 INR	63	29%
Geographic Location	Rural	99	46%
	Urban	115	54%
Combined Parental Education	Up to Grade 10	82	38%
	> Grade 10 (high school)	132	62%
Parental Reminders on Balanced Diet	Daily	119	56%
	Not Daily	95	44%
BMI	Ideal	74	35%
	Underweight	122	57%
	Overweight	18	8%
Daily Calorie Intake	< 1500	135	63%
	1500 - 2400	31	14%
	> 2400	48	22%
Child's Self-Awareness of Balanced Diet	Aware	111	52%
	Not aware	103	48%
Average Calorie proportions as a part of total calories consumed per day by the surveyed students	Carbohydrates		45%
	Proteins		13%
	Fat		39%
	Vitamins and Minerals		3%

**Table 1: Percentage distribution of various factors.** Total number of children and percentage of children in various categories of factors evaluated. 10,000 INR is equivalent to approximately 130 USD.

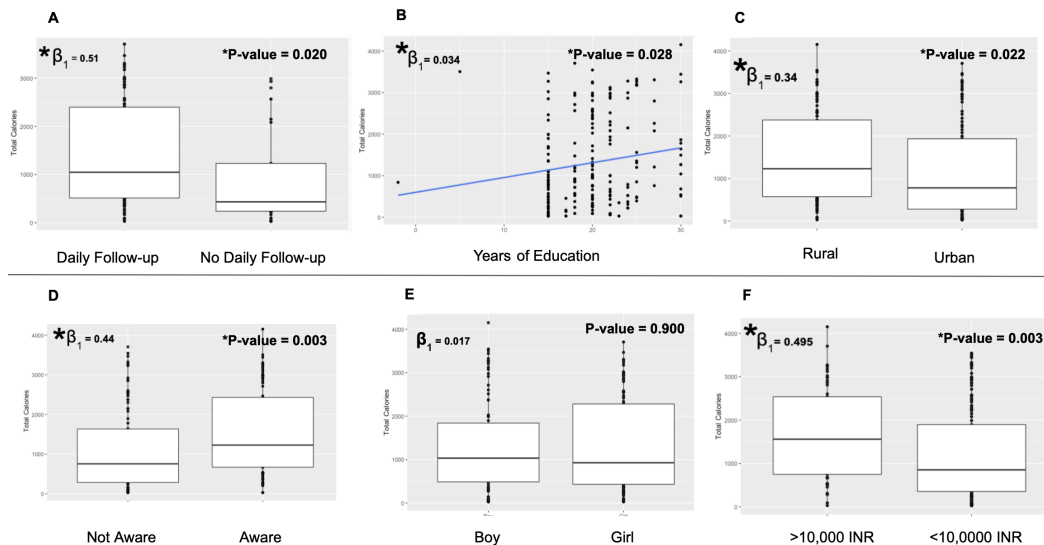
### Correlation between certain factors influencing calorie intake

We further analyzed the four variables associated with nutrition: parental education, parental reminders, family income, and geographic location using Chi-square test of independence. We observed that geographical location and parental reminders, geographical location and child's self-awareness, income and parental reminders, and income and parental education are each correlated with one another ( $p < 0.01$ ). While effect sizes of parental diet reminders (Cohen's  $D = 0.736$ ) and income (Cohen's  $D = 0.456$ ) indicate large to medium effect size, the two variables are correlated ( $p = 0.002$ ). We did not find correlation between geographical location, income, and parental education, affecting the total calorie consumption independently ( $p > 0.05$ ).

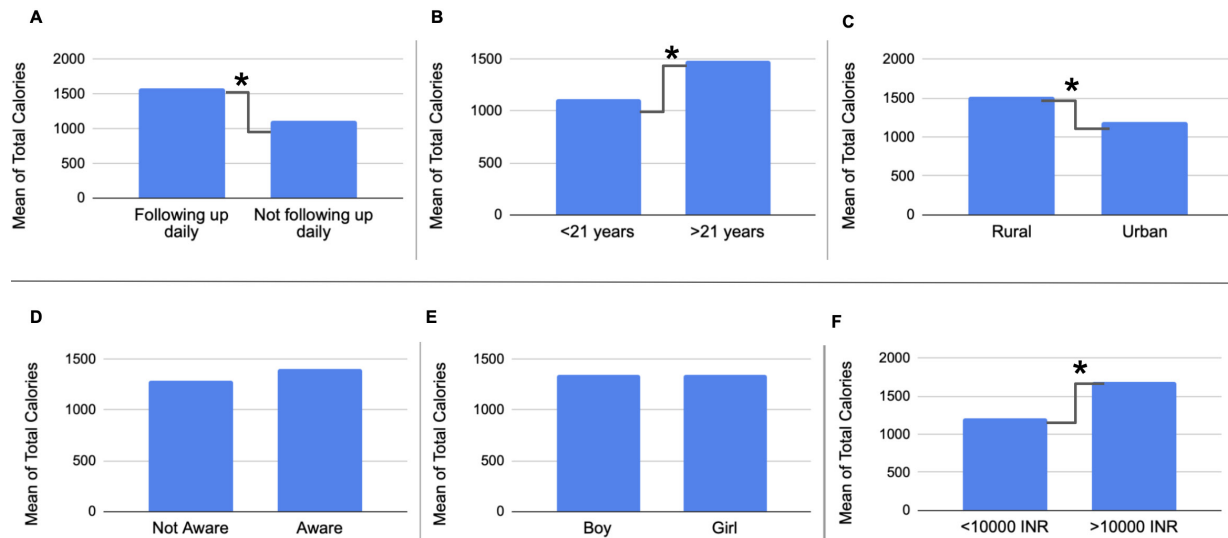
### Effect sizes of factors influencing calorie intake

Though we found through regression analysis that parental education, parental income, parental reminder, child self-awareness, and geographic location were significant, when further analyzed using an independent t-test, we found that only parental education, parental income, parental reminders, and geographic location were significant ( $p < 0.05$ , **Figure 4**). Two factors, children's self-awareness ( $p = 0.214$ ) and gender ( $p = 0.471$ ) were not significant with respect to the total calories consumed by the children (**Figure 4D and E**). Out of the four factors found to be significant, medium to large effect sizes were associated with parental income ( $D=0.456$ ) and Parental diet reminders( $D=0.736$ ) through Cohen's  $D$ . Small effect sizes were associated with geographical location ( $D=0.301$ ) and combined parental education ( $D=0.344$ ). Protein calories and vitamin/minerals were significantly associated with parental education ( $p < 0.05$ ).

All in all, we found that the main factors affecting the total calories obtained by the sampled children each day were affected by the parental education, parental income, parental



**Figure 3: Regression analysis of six factors on total calorie consumption.** Regression visualization showing variables that are statistically significant and their beta values. The variables tested were: (A) Parental Diet Reminders, (B) Combined Parental Education, (C) Geographic Location, (D) Child's Self-awareness of Balanced Diet, (E) Gender, and (F) Family Income. Regression was modeled using a scatterplot for combined parental education, and boxplots for the other five variables. The beta coefficients with significant p-values ( $p < 0.05$ ) are highlighted using an asterisk.



**Figure 4: Differences between means of total calorie consumption for various factors based on independent t-test.** Average daily calorie consumption across: (A) Parental Diet Reminders, (B) Combined Parental Education in Years, (C) Geographic Location, (D) Child's Self-awareness of a Balanced Diet, (E) Gender, (F) and Family Income. Significant differences in mean from independent t-test with p-values <0.05 are highlighted using an asterisk.

reminder, child self-awareness, and geographic location as per regression analysis. After performing independent t-tests, we observed that parental education, parental income, parental reminders, and geographic location were significant in terms of effect size where gender and the child's self-awareness were not found to significantly affect daily calorie intake.

## DISCUSSION

The aim of this study was to understand the socio-economic factors influencing malnutrition among the government schools in South India. Our survey of 214 children showed that parental education, parental income, geographic area, and parental diet reminders were significant factors influencing the total calorie intake among participants.

Regression analysis in our study showed that for every additional year of parental education, children consumed more calories. However, Cohen's D showed that the effect size for parental education is small. This indicated that while the difference in the means of the two groups, parents who had a combined education of less than 21 years and parents who had a combined education of more than 21 years is significant, the effect of parental education on calorie intake was small. However, we found that protein calories and vitamin/mineral intake were significantly associated with parental education. A previous study of 50,000 children across rural states in India observed that maternal education has an influence on reducing the risk of stunting and being underweight, an indicator of malnutrition (26). Therefore, parental education appeared to be important while addressing malnutrition risks specially through improved consumption of protein and vitamins/minerals in this study.

Independent t-test confirmed a significant influence of parental income on total calories consumed, and Cohen's D effect size indicated a medium effect on calorie intake. Medium effect on Cohen's D indicated that the difference in the means of the two groups, those who earned less than 10,000 INR monthly and those who earned more than

10,000 INR monthly, is not only significant, but the effect of parental income on calorie intake was not small. It was previously observed that low-income families spend around half their income on food, and they consume more low-cost carbohydrate resources and relatively little of protein and fruits (2). It was observed that the quality of protein intake of rural and tribal populations in India was relatively low considering the high proportion of cereal-based diets (27). A previous study found that diets are negatively influenced in low wealth index households (28). Children in our study lacking enough vitamins and minerals in their diet were associated with the lack of income to purchase mineral rich food. According to a study, the per capita availability of strong protein sources in India have decreased over the years making it more difficult for the marginalized to purchase these foods (29). This is also reflected in a study of over 1000 adolescents in Kolkata, in which 30 percent of participants reported no consumption of vegetables and poor food consumption patterns (30). In our study, the effect size was the largest on vitamins and minerals, indicating that parents with higher income were able to encourage children to consume more vegetables.

We hypothesized that the number of parental reminders with the children to consume a balanced diet significantly affects the total calorie intake of the children each day. A study showed that the wealth index of a household does not contribute to the nutritional status of the children alone until and unless there is maternal awareness to leverage available wealth, indicating that parental reminder affects total calories consumed as without this, financial resources cannot be effectively utilized to increase total calorie intake (28). In our study, children of parents who did not remind their children daily consumed fewer calories than those children who were reminded daily to consume a balanced diet. Essentially, purchasing power did not appear to be a significant factor on calories consumed unless a parental reminder was present. Parental reminders had a significant influence on all components of the calories across carbohydrates, proteins, fats, and vitamins/minerals. The effect size of



parental reminders was medium to large across all the food categories. The independent t-test comparison of means did not indicate significant difference in the calorie intake based on children's self-awareness of a balanced diet. This was also true for calories from carbohydrates, fat, protein, and vitamins/minerals.

We also explored the differences between children from rural and urban settings. Those who lived in an urban environment consumed less calories than their rural counterparts. In a cross-sectional study of urban slum children in Bhopal, India, researchers observed that 63.4% of surveyed students had inadequate protein intake (31). In another study, Dwivedi et al., found that over 60% of the rural poor could not afford a nutritious diet recommended to them (32). However, in our study, we found that urban children consumed less calories than their rural counterparts. This could be due to the cost of a balanced diet being higher in urban areas. We found that the effect of geographic location area on total calories was significant, and Cohen's D indicated a small effect on the calorie intake. Geographic location had a significant influence on all components of the calories across carbohydrates, proteins, fats, and vitamins/minerals though the effect size was small.

The primary limitation of our study is that the study surveyed children using online methods in three out of the five states of South India due to convenience. Since data was collected using online methods, the responses from each student were not thoroughly verified through the interview process. An additional limitation is that, in this study, we used a simple linear regression model to assess the influence of various socio-economic, demographic factors on nutrition. As identified in the test of independence among parental education, parental income, parental reminder, child self-awareness, gender, and geographic location, some of the socio-economic factors are correlated and hence further research is needed in identifying the accurate beta coefficients of each of the studied variable in a multiple regression model. Overall, the four main socioeconomic factors that seemed to influence the calories children in government schools in India consume were parental education, parental income, parental reminder, and geographic location. Besides parental diet reminders, the other aforementioned factors were also observed in previous literature depicting similar results in areas other than Bangalore. Parental diet reminders seem to have significantly large effect size among all the factors influencing the total calorie intake. Efforts to reduce malnutrition in Tanzania show that while better nutrition is associated with higher income, income growth will have to be complemented by large scale program interventions (33). For this reason, efforts in Tanzania have focused extensively on improving maternal education in tandem with income (34). In addition to alleviating the income challenges, other initiatives to be coordinated include improving parental education and the children's knowledge of a balanced diet so that parents can enable healthy diet habits. Children's malnutrition has a significant impact on their physical, mental growth, and immunity. For India to continue to show economic development, it is critical to address the factors influencing malnutrition, as identified in this study.

## MATERIALS AND METHODS

### Survey and data collection

We created a survey containing 15 questions related to the socio-economic factors, demographics, calorie consumption, and awareness of balanced diet. We conducted an online survey from August to October 2020 of children aged 13–16 years, from government schools across Karnataka, Andhra Pradesh, and Tamil Nadu states in South India (**Appendix A**). The questionnaire was sent through Swabhiman Foundation, Vidyadaan, and UpUgo to government schools in Karnataka and through Sportz Village Foundation to government schools in Tamil Nadu and Andhra Pradesh. Government schools were selected for this survey due to high attendance from low-income families in India (35). This is corroborated by the fact that 71% of the families of each student surveyed had an income lower than 10,000 INR per month. This level of income is lower than the average per capita income of India (36). The type of sampling used was non-probability, convenience sampling. The sample was designed to take participants across three states, with children in both rural and urban areas across boys, girls, and children from ages 12 to 15 in the network of the not-for-profit organizations mentioned. Only students with internet connectivity could respond to our online survey, and we did not have data on the percentage of students who responded to the survey. No incentives were provided to collect the data either to the not-for-profit organizations or to the students. Data was collected on various food groups consumed during breakfast, lunch and dinner during a given day. No personally identifiable information was collected from the students. The form was initially created and sent to 10 children as a pilot. Based on the feedback from the pilot, the questionnaire was revised including pictures of the food groups and measurement sizes to collect accurate data.

To gauge the child's awareness of the importance of consuming a balanced diet, the survey consisted of two questions, question 6 and 8 (**Appendix A**). If the answer to either of the above questions was correct, children were deemed aware of the importance of a balanced diet. If the answer was incorrect for both the questions, they were considered unaware. The calorie estimation from food consumption was categorized into four main nutrients: carbohydrates, proteins, fats, and vitamins/minerals. Calories from vitamins and minerals were estimated as the calories received from vegetables. Survey had the provision to report any consumption of fruits under the 'other' category. Students did not report consumption of fruits in the survey.

### Data analysis

The data was collected using a Google form, organized, and cleaned using a Google sheet. After the data collection and cleaning, data was analyzed for 214 respondents. Percentage analysis was done using Google sheets (**Table 1**).

### Statistical analysis

Regression analysis was done using R and SPSS. Regression was done using the `lm()` function which outputs a regression table depicting the mean difference between two levels of the categorical explanatory variable. Additionally, the function also displays the p-values and respective confidence intervals of the analysis. In the scenario where there were

more than one level of categorical variables, the subsequent levels were coerced into two so as to meet the requirements of the lm() function. The dependent variable chosen was the total calorie intake and distribution of calories from different food groups received each day. The dependent variable was regressed with gender, parental education, parental income, parental reminder, child's self-awareness, and geographic location. A positive beta value indicates a positive association wherein a one unit increase on either the parental education, parental income, parental reminder, child self-awareness, gender, and geographic location, led to a proportional increase in the total calories the children consumed each day. The same applies for a negative beta value but with a decrease in the total calories the children consumed each day for an increase in the six variables.

Independent t-tests were conducted using SPSS to assess significance in the mean differences as well as effect size. We further analyzed total calories for carbohydrates, fat, proteins, vitamins, and minerals for significant differences using independent t-tests. Chi-square test was done using Excel to assess the collinearity between the independent variables. Regression, Cohen's D, Chi-square, and independent t-test results were considered significant if p-values were less than 0.05.

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## Appendix A

### List of Questions used in the online survey

1. What did you eat for breakfast yesterday or today (or in general) and how much? (If solid food, specify the number of servings; 1 Idly is 1 serving; 1 dosa is one serving; one bowl of rice is one serving. If liquid food, specify quantity in number of cups example: 2 cups of milk, 1 cup of juice etc.. )
2. What did you eat for lunch yesterday or today (or in general)? Mention the quantity - 1 spoon, 2 spoons, 3 spoons for vegetables, Dal; For rice, curd, rasam and sambar mention 1 cup, 2 cups, 3 cups; For Chapathi or Egg mention 1 number, 2 number etc.
3. What did you eat for dinner yesterday or today (or in general)? Mention the quantity - 1 spoon, 2 spoons, 3 spoons for vegetables, Dal; For rice, curd, rasam and sambar mention 1 cup, 2 cups, 3 cups; For Chapathi or Egg mention 1 number, 2 number etc.
4. If you mentioned Other in the above questions, please specify
5. How many glasses of water did you consume yesterday or today (or in general per day)
6. How many times do you believe one should consume a balanced diet?
7. How much exercise or play do you believe is needed per day?
8. One boy eats 5 meals a day and out of that, two are on a balanced diet. He thinks that is good to be healthy. Do you agree with him?
9. What all activities did you do today or yesterday (or in general) from 8am to 12pm? Select all that apply and make sure total time adds to 4 hours.
10. What all activities did you do today/yesterday (or in general) from 2 PM to 5 PM? Select all that apply and make sure total time adds to 3 hours.
11. What all activities did you do today/yesterday (or in general) from 5 PM to 10 PM? Select all that apply and make sure total time adds to 5 hours.
12. Fathers Education
13. Mothers Education
14. How many children do you have in your family (How many brothers and sisters including you)?
15. Total monthly family income in rupees (Please check with your parents)
16. How often do your parents tell you to eat a healthy diet?
17. How often do your parents tell you to exercise/play?
18. Are you interested in joining our program to improve your health and fitness?
19. What is your medium of instruction at school?
20. What is your class or grade?
21. Your height in centimeters? (typically, 125 cms to 170 cms)
22. Your weight in kilograms?
23. Gender
24. School Name, Village, City