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Original Research Article

Trends of high fat, salt and sugar food consumption and its impact on nutritional status of school children

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ABSTRACT

Background: India is currently in a phase of nutrition transition. Increased consumption of food high in fat, sugar and salt (HFSS) is contributing significantly to prevalence of triple burden of malnutrition among children.
Methods: In this study, the nutritional status and frequency of HFSS food consumption were assessed in 360 school children (boys n=171, girls n=189) aged between 6-16 years using standard tools and techniques.
Results: From the results, it was evident that the frequency of consumption of HFSS food among children of both the age group 6-10 years and 11-16 years was significantly high ($p \leq 0.05$). Children aged between 6-10 years were more prone to under nutrition (38%) and they were consuming more snacks such as chips, biscuits, packaged fruit juices high in sodium, saturated fat and sugar. On the other hand, adolescents aged between 11-16 years show a higher prevalence of both under nutrition and overweight (10%), potentially linked to their consumption of bakery products, street foods, sugary drinks and carbonated beverages.
Conclusions: The nutrition transition shift is towards consumption of refined, ultra processed, high sodium and fat foods. The age-based trend is a nutritional challenge among children and adolescents. The findings of this study emphasized the urgent need for early screening of nutrient deficiencies, comprehensive interventions to address the triple burden of malnutrition among school children. Efforts should focus on promoting healthy dietary behaviours, enhancing nutritional literacy among children, parents and care givers, improving access to nutritious foods, and regulating the marketing and availability of HFSS foods.

Keywords: Children, HFSS foods, Nutrition education, Nutrition transition, Triple burden of malnutrition

INTRODUCTION

The ongoing process of urbanization, globalization and rising living standards are leading to nutrition transition, the shift from traditional, locally sourced, nutritious diet to consumption of high or empty calories, nutrient-poor foods.[1,2] This transformation in eating habits poses a multifaceted challenge of triple burden of malnutrition, with under nutrition, hidden hunger (micro-nutrient deficiency) and overweight or obesity due to nutritional imbalance.[3] The global rise in highly refined, ultra processed and fast food consumption is evident as indicated by a multi-country study encompassing 0.73 M children aged 6-7 years from 17 nations and 0.2 M adolescents aged 13-14 from 36 countries. The study revealed that 51.3% of participants reported the prevalence of consuming junk food, the consumption in adolescents was frequent (38.7%) and 12.6% very frequent.[4,5] The Indian government has implemented various intervention programs to address malnutrition among children e.g. mid-day meal (MDM) program, integrated child development services (ICDS), reflecting a commitment to improving the health and well-being of the younger population.[6] These schemes have improved the under nutrition status, but due to nutrition transition and increased access to foods the challenges of childhood

obesity and hidden hunger are rising as significant health concerns. As per the recent report of National Family Health Survey 5 (2019-21), the nutrition indicators for children under 5 years have improved as compared with NFHS-4 (2015-16).[7,8] Stunting has reduced from 38.4% to 35.5%, wasting has reduced from 21% to 19.3% and underweight prevalence has reduced from 35.8% to 32.1%. But, there is a rise in anemia 58.6% to 67% and the proportion of overweight and obesity are increased from 2.1% to 3.4%.

There are many factors which can contribute to changing nutrition scenario in India. One of the main contributors can be consumption of high fat, salt and sugar foods (HFSS) increasingly prevalent in modern society and significantly impacts the health of children. HFSS foods are consistently and significantly associated with overweight and obesity.[9] Children aged 9-13 years who are transitioning to adolescence have a higher average intake of foods high in sugar, fat and sodium compared to other age group.[10] Nuclear family, television watching, global advertising, emotional eating, lack of nutritional literacy, accessibility and affordability of junk foods are the common factors that responsible for adopting the unhealthy food habit and lifestyle of the children.[11-13]

HFSS foods are often calorie dense but lack in essential micronutrients. Fast food often exceeds recommended daily allowances for children, with its energy density being more than twice the recommended intake.[14] Excessive intake of sugars and unhealthy fats can contribute to insulin resistance, a key factor in the development of cardio-metabolic risk at later age.[9,15] Most of the ultra-processed foods contain high amount of sodium. Excessive sodium can disrupt the delicate balance of electrolytes in the body, leading to increased fluid retention and higher blood pressure. High sodium intake can lead to impaired kidney function over time.[16] This is particularly important in children, as their organs are still developing. HFSS foods have been linked to changes in behaviour and cognitive function in children. High sodium and sugar may affect neurotransmitter function and potentially influencing mood and attention.[7] Early exposure to HFSS foods can shape a child's taste preferences and eating habits in later stages of life. Children exposed to unhealthy, calorie dense option, this can result in poor diet quality, making it challenging to transition to a healthier diet in adulthood.[14] Excess body weight during childhood can contribute the early onset of cardio-metabolic disturbances like insulin resistance, high blood pressure and altered lipid profile.[9,15,17] These factors increase the risk of developing non-communicable diseases such as cardio-vascular disease, non-alcoholic fatty liver disease (NAFLD), diabetes, cancer etc. later in life.[18] Rapid shift in dietary and lifestyle habits, significant nutrition transition, it is imperative to study the implications of nutrition transition in most vulnerable group i.e. children.

With this background the study aimed to assess nutritional status using non-invasive techniques among school children. Assess the dietary pattern and high fat, sugar and salt (HFSS) consumption pattern and to determine the relation between HFSS food intake and nutritional status in subjects.

METHODS

The present cross-sectional study was conducted in selected government and private schools in and around Mysore district in Karnataka, to assess the trends of junk food consumption and its impact on the nutritional status of the school children. The study duration was for a period of nine months i.e. April 2023 to December 2023. The sample size was determined at 95% confidence level and 80% power of study. The study population (total N=360, girls n=189 and boys n=171) selection criteria included healthy children aged between 6-16 years. Ethical clearance was obtained from host institute (JSSMC/IEC/240323/06 NCT/ 2022-23) and permission and consent was obtained from school authority. In the present study subjects were evaluated for nutritional status by assessing anthropometric measurements such as height, weight and BMI using standard tools and techniques. The data was subjected for analysis of height for age and BMI for age using WHO anthroplus. Standard HFSS questionnaire of FSSAI was modified and used for assessing the HFSS food consumption pattern. Questionnaire included eight categories of HFSS foods and drinks, GP1- fried and packed foods such as chips; GP2- biscuits, cookies and chocolates; GP3- carbonated beverages; GP4- packaged fruit juices and ice-cream; GP5- bakery food; GP6- instant foods; GP7- chats and street foods; GP8- meat based fried foods. Each section was self-reported by the subjects (Figure 1).

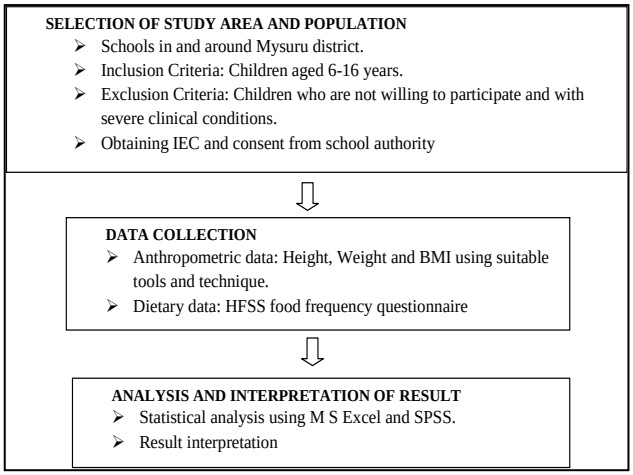


Figure 1: Flow chart of methodology of the study

Statistical analysis

The mean, SD of HAZ, BAZ and frequency of HFSS data were analysed using Microsoft excel, the significance was

determined using one way ANOVA in SPSS software. P value <0.05 were considered statistically significant.

RESULTS

A total of 360 children were screened to assess their nutritional status and dietary intake pattern. The anthropometric characteristics of the study population, stratified by sex and age described in Tables 1 and 2. Among them, there were boys n=171 and girls n=189. Further to refine analysis, the subjects were categorized based on two distinct age groups: 6 to 10 years (boys n=69; girls n=60) and 11 to 16 years (boys n=102; girls n=129), ensuring a comprehensive representation across developmental stages. Anthropometric measurements such as height, weight, body mass index (BMI) and dietary data were recorded using standard tools and results are presented below. Comparative data of height for age of the subjects of both the age group are presented in Table 1. Majority of the boys i.e. 62% in 6 to 10 years and 50% in 11 to 16 years are fall within the range of normal height for their age. Girls from both the age group were found to have mild stunting (20% and 40% respectively). The 11-16 years age group had a higher percentage of moderate stunting in boys (22%) and girls (13%). 7% of boys from 11-16 years age group and 2% girls from both the age group were fall within the range of severe stunting category (Table 1).

Table 1: Distribution of height for age (HAZ) of subjects (N=360).

HAZ status	6 to 10 years (n= 129)		11 to 16 years (n=231)		Total	
	Boys (n=69)	Girls (n=60)	Boys (n=102)	Girls (n=129)	6-10 years (n=129)	11-16 years (n=231)
Normal (≥-1 and ≤+1 SD)	43^{ap} (62)	38^{ap} (63)	51^{ao} (50)	53^{ao} (41)	81^{bp} (63)	104^{ap} (45)
Mild undernutrition (≥-2 and ≤-1 SD)	17^{ao} (25)	12^{ao} (20)	19^{an} (19)	51^{bo} (40)	29^{ao} (22)	70^{bo} (30)
Moderate undernutrition (≥-3 <-2 SD)	7^{an} (10)	7^{ano} (12)	23^{an} (22)	17^{an} (13)	14^{an} (11)	40^{bn} (17)
Severe undernutrition (<-3)	0^{am}	1^{am} (2)	7^{am} (7)	3^{am} (2)	1^{am} (0.7)	10^{bm} (4)
Over nutrition (>+1 SD)	2^{am} (3)	2^{am} (3)	2^{am} (2)	5^{am} (4)	4^{am} (3)	7^{am} (3)

*Values in parenthesis represent number of subjects in percentage. Superscripts carrying values a, b… horizontally differ significantly for same age groups (p<0.05). Superscripts carrying values m, n, o… vertically differ significantly within the same age group (p<0.05).

Table 2: Distribution of BMI for age (BAZ) of the subjects (N=360).

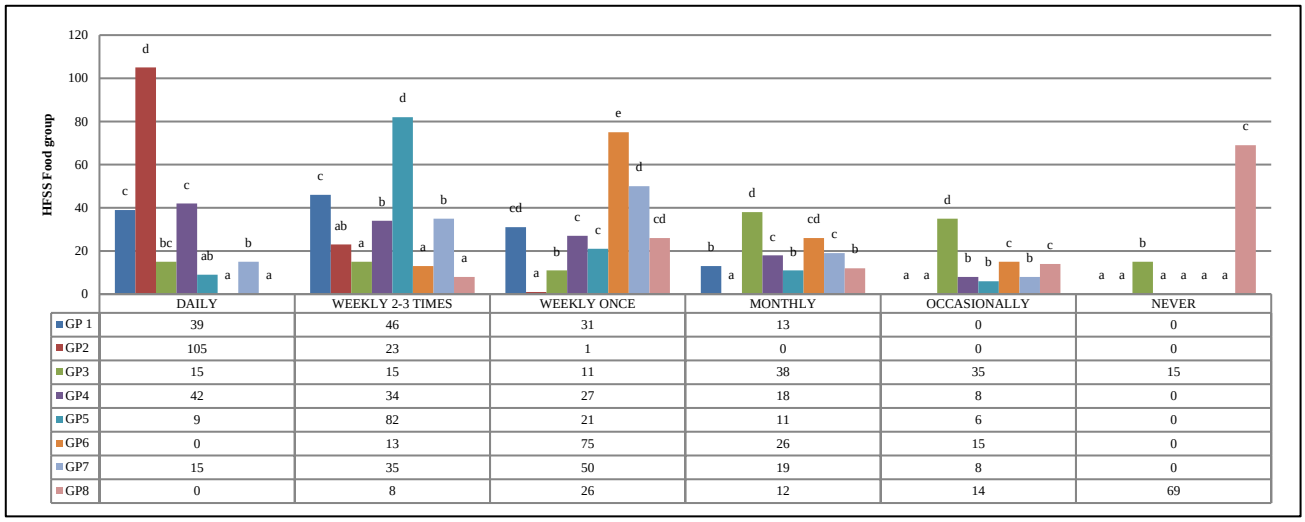
BAZ Status	6 to 10 years (n=129)		11 to 16 years (n=231)		6-10 years (n=129)	11-16 years (n=231)
	Boys (n=69)	Girls (n=60)	Boys (n=102)	Girls (n=129)		
Normal (≥-1 and ≤+1 SD)	14^{an} (20)	15^{ano} (25)	29^{ao} (28)	63^{bo} (49)	29^{ao} (22)	92^{bo} (40)
Mild undernutrition (≥-2 and ≤-1 SD)	17^{an} (25)	32^{bp} (33)	24^{bno} (23)	18^{amn} (14)	49^{bp} (38)	42^{an} (18)
Moderate undernutrition (≥-3 and <-2 SD)	18^{bn} (26)	10^{an} (17)	24^{ano} (23)	20^{an} (15)	28^{ao} (21)	44^{an} (19)
Severe undernutrition (<-3)	16^{bn} (23)	2^{am} (3)	16^{an} (16)	13^{am} (10)	18^{an} (14)	29^{am} (13)
Over nutrition (>+1 SD)	4^{am} (6)	1^{am} (2)	9^{am} (9)	14^{am} (11)	5^{am} (4)	23^{am} (10)

*Values in parenthesis represent number of subjects in percentage. Superscripts carrying values a, b… horizontally differ significantly for same age groups (p<0.05). Superscripts carrying values m, n, o… vertically differ significantly within the same age group (p<0.05).

The Table 2 shows varying degrees of undernutrition across age groups and genders. While mild under nutrition (≥-2 and ≤-1 SD) is common, particularly among younger girls (33%) and younger boys (25%), moderate under nutrition (≥-3 <-2 SD) and severe under nutrition (<-3) were also notable, especially among younger boys (26% and 23%, respectively). Over nutrition (>+1 SD) was observed, although to a lesser extent compared to under nutrition. This was more prevalent among older boys (9%) and older girls (11%). The children aged between 6-10 years exhibited significantly (p<0.05) high prevalence (38%) of mild under nutrition, whereas there was prevalence of moderate to severe under nutrition among all age groups. On contrary, it was observed that the prevalence of overweight and obesity (10%) was significantly (p<0.05) high for adolescent subjects aged between 11-16 years. The observations reveal that, there is an urgent need for proper awareness education on balanced diet, nutrition and physical activity in the target age group, with special reference to adolescent age group (Table 2).

The HFSS food consumption pattern of subjects of both the genders according to the age category is shown in Figures 2 and 3. Figure 2, provides the insights into HFSS food frequency of subjects aged between 6-10 years. Observations reveal that, among boys (n=60) there was a significantly high consumption (80%) of group 2 (GP2) foods which includes biscuits and cookies on regular basis. Foods in group 1 category like chips, fried and packed foods were consumed daily (37.7%) and 2-3 times in a week (40.5%) since they were affordable and accessible near school vicinity or community. Bakery

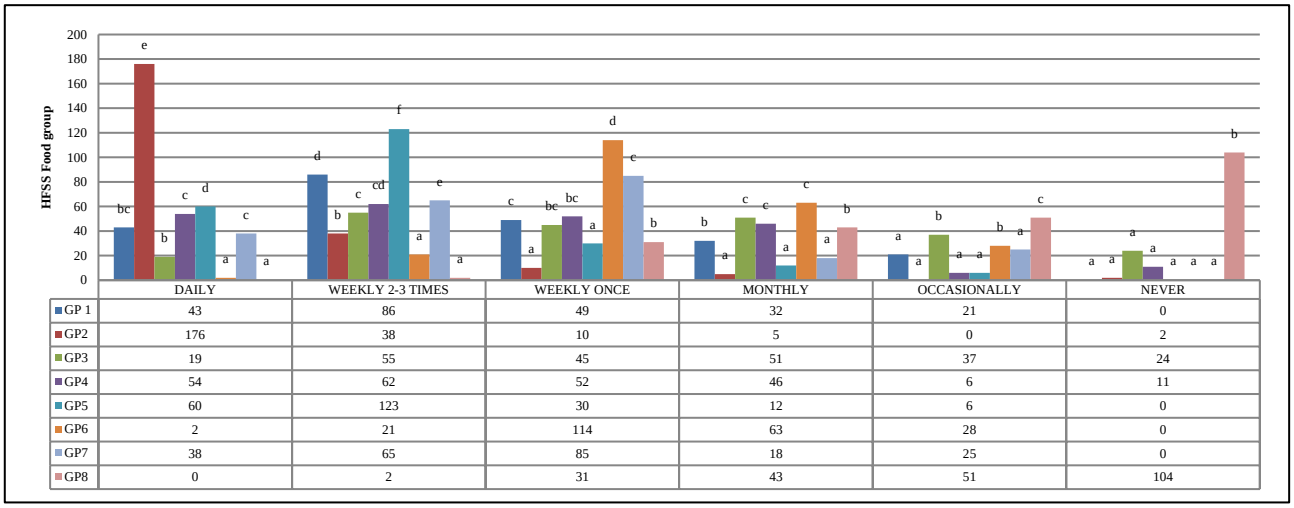
products (GP5) such as cake, bun etc. are consumed by 65% of the respondents of this group at least 2-3 times in a week. GP4 including packed fruit juice has diverse consumption frequency with considerable percentage (49%) consuming it on a weekly or monthly basis. Instant foods (GP6) like noodles are consumed at least once in a week (38%). On the other hand, most of the girls aged between 6-10 years (n=69) were consuming GP1 products regularly i.e. 22% of girls were consuming daily and 65% of them were consuming it on a weekly basis. GP2 products were consumed by 83% of girls every day as evening snack. Packed fruit juices (GP4) were consumed by 31.6% of them every day. 62% were reported consumption of GP5 bakery products at least 2-3 times a week. Instant foods (GP6) and roadside chats (GP7) were consumed once in a week by 61.6% and 43% of subjects respectively (Figure 2).



	DAILY	WEEKLY 2-3 TIMES	WEEKLY ONCE	MONTHLY	OCCASIONALLY	NEVER
GP 1	39	46	31	13	0	0
GP2	105	23	1	0	0	0
GP3	15	15	11	38	35	15
GP4	42	34	27	18	8	0
GP5	9	82	21	11	6	0
GP6	0	13	75	26	15	0
GP7	15	35	50	19	8	0
GP8	0	8	26	12	14	69

Figure 2: High fat, salt and sugar food (HFSS) consumption pattern among subjects. (6-10 years, N=129).

*The values a, b, c,… differ significantly (p<0.05)for HFSS food groups under each frequency. (GP1- fried and packed foods such as chips; GP2- biscuits, cookies and chocolates; GP3- carbonated beverages; GP4- packaged fruit juices and ice-cream; GP5- bakery food; GP6- instant foods; GP7- chaats and street foods; GP8- meat based fried foods).



	DAILY	WEEKLY 2-3 TIMES	WEEKLY ONCE	MONTHLY	OCCASIONALLY	NEVER
GP 1	43	86	49	32	21	0
GP2	176	38	10	5	0	2
GP3	19	55	45	51	37	24
GP4	54	62	52	46	6	11
GP5	60	123	30	12	6	0
GP6	2	21	114	63	28	0
GP7	38	65	85	18	25	0
GP8	0	2	31	43	51	104

Figure 3: High fat, salt and sugar food (HFSS) consumption pattern among subjects (11-16 years N=231).

*The values a, b, c,… differ significantly (p<0.05)for HFSS food groups under each frequency.

Frequency of HFSS food consumption among subjects aged between 11-16 years is represented in Figure 3. Around 84% and 16.6% of boys (n=102) consumed biscuits or cookies (GP2), GP 1 products every day respectively, and 38% were consuming G1 foods at least 2-3 times a week. Frequency of fruit juice (GP3) consumption was 22.5% daily and 33.3% weekly 2-3 times. It was observed that, aerated beverages (GP4) were consuming daily by 12.7 % and weekly once by 28.4% of subjects of this age group. 65.7% of the subjects were consuming bakery products 2-3 times in a week. Instant foods (GP6) were consumed once in a week by most of

the subjects (54.9%). 25.5% of the subjects were reported that they consume GP7 i.e. chat items such as Manchurian, panipuri etc. every day and 45% of them were consuming 2-3 times a week. Only 12% reported consumption of meat based fried foods weekly once. Among girls (n=129), 20% reported consumption of GP1 products daily and 36.4% of them were consuming 2-3 times a week. 70% of the subjects in this group were consuming biscuits and cookies (GP2) daily. 43% of them were consuming bakery products at least 2-3 times in a week. 24% of the subjects were drinking packed fruit juices daily and instant foods (GP6) were consumed once in a week or month. Most of them were consuming chat items once in every week (49.6%). There was significantly ($p<0.05$) higher consumption of biscuits among all the subjects, followed by chips and packaged fruits juices among 6-10 years boys. In boys between age of 11 to 16 years, there was significant high consumption of bakery products and chaats or street foods, packaged fruits juices, and carbonated beverages weekly 2-3 times and instant foods such as noodles at least once in a week. There was significantly ($p<0.05$) higher consumption of bakery products, ice cream, packaged fruit juices and chips among all the girls (Figure 3).

The mean nutrient density, collected from nutrition labels of commonly consumed HFSS foods are presented in Table 3. WHO recommends maximum 1% of total calories from trans fatty acids (TFAs). Saturated fatty acid intake should not exceed 8-10% of total energy.[6] GP1, GP2, GP6, GP7 and GP8 products are high in fat content The recommended dietary allowances (RDA) for sodium varies by age, but for children it ranges from 1200-1500 mg per day. However, many children surpass limit regularly. A single fastfood meal such as foods included in GP1 (fried and salty foods such as chips), and GP6 (instant foods) can easily exceed a child's entire daily sodium allowance and may lead to non-communicable diseases (NCDs) in later ages. To reduce the risk of unhealthy weight gain, tooth decay, the WHO recommends reducing free sugars less than 5% of total energy intake.[5] But aerated beverages and packed fruit juices etc. contains more than recommended values of sugar in a serving. GP2 (biscuits, cookies, etc.), GP3 (carbonated beverages), GP4 (packaged fruit juices) and GP5 (bakery products, ice cream) have notably high sugar content which may contribute to development of obesity and diabetes, tooth decay and behavioural changes. Potential consequences of regular consumption of commonly used HFSS foods are mentioned in Table 4.

Table 3: Nutrient composition of commonly consumed HFSS foods.

HFSS food group	Nutrients (per 100 gm)							
	Energy (kcal)	Chol. (gm)	Sugar (gm)	Protein (gm)	Fat (gm)	Sat. fat (gm)	Na (mg)	K (mg)
GP1	561±8.1↑	52.5±3.2	1	7.5±1.3	35.2±0.77	12.8±6.6↑	701±165↑	350±25↑
GP2	476.5±31.6↑	70±8.9	20±6.9	7.35±0.75	16.1±10.7	8.5±4↑	298 ±126	89.2 ±45
GP3	47±3.6	-	12.35±0.89↑	-	-	-	-	-
GP4	64±9.3	-	15.5±3.7↑	-	-	-	9	-
GP5	225±120	43±17	48.8±15 ↑	6±2.3	9.3±3.6	1.5 ±0.63	900±260 ↑	-
GP6	443±35.5↑	61.5±2.2	2.6±1.2	9.4±0.7	17..7±2.8	4.1±1.2	1380±468↑	-
GP7	284.6± 97	27.9±6.5	4.9±1.2	2.4±0.86	18.0±1.5	9±0.89↑	-	-
GP8	100	12.39	0.5	10±5.5	21±12	13.3±7.2↑	390±134↑	-

*GP1- fried and salty foods such as chips; GP2- biscuits, cookies and chocolates; GP3- carbonated beverages; GP4- packaged fruit juices and ice-cream; GP5- bakery food; GP6- instant foods; GP7- chats and street foods; GP8- meat based fried foods.

Table 4: Potential consequences of common HFSS foods.

HFSS Food Group	Nutritive Content	Increased risk for
GP1 - Fried and salty foods such as chips	High in calorie, saturated fat, sodium and additives	Obesity, high BP, CVD, dental issues
GP2- Biscuits, cookies and chocolates	High in calorie, added sugar and fat	Obesity, diabetes, high BP, CVD
GP3- Carbonated beverages	High calorie, high sugar	High BP and CVD, dental caries
GP4- Packaged fruit juices and ice-cream	High calorie, sugar and artificial colour, flavour, preservatives, lack of fiber	Obesity, dental caries, diabetes
GP5- Bakery food	Low fiber, high refined sugar, fat	Diabetes, CVD
GP6- Instant foods	High level of Sodium, unhealthy fat and preservatives	High BP, Obesity, CVD
GP7- Chats and roadside fried foods	Unhealthy fat, salt, artificial flavour and colour	Digestive issues, High BP, obesity
GP8- Meat based fried foods	Saturated fat, calories	CVD, Obesity

DISCUSSION

Adolescence marks a period of rapid growth and development, coupled with changing dietary habits and increased independence in food choices. As depicted in the results, children tend to consume processed foods more frequently. The adoption of foods high in fat, salt, and sugar among children and adolescents can be attributed to various key determinants. Firstly, working parents and the nuclear family structure often leads to time constraints and reliance on easily accessible, processed meals additionally, limited nutritional literacy among caregivers.[19] The attractiveness, palatability and sensory appeal of these foods can overshadow considerations of long-term health consequences. Improper eating behaviours, such as emotional eating triggered by stress or boredom can drive the preference for palatable, energy-dense options. The influence of targeted marketing and advertising, particularly through multimedia channels, can significantly shape children's food preferences and consumption patterns.[17,20-22] Furthermore, the widespread availability of high-fat, high-sugar, and high-salt foods near schools and communities makes it challenging to promote healthier dietary habits among the younger population, ultimately contributing to the prevalence of these unfavourable dietary trends.[6] In this study, it was evident that the frequency of consumption of HFSS food among children of both the age group 6-10 years and 11-16 years was significantly high. Children aged between 6-10 years were more prone to under nutrition (38%) and they were consuming more snacks such as salty chips, biscuits, packaged fruit juices high in sodium, saturated fat and sugar. On the other hand, adolescents aged between 11-16 years show a higher prevalence of both under nutrition and overweight (10%), potentially linked to their consumption of bakery products, street foods, sugary drinks and carbonated beverages which are often high in calories, sugar and low in nutritional value, which can impact the quality of food intake and daily dietary pattern, eventually leading may lead low nutrient absorption, both macro and micro and increase the risk of triple burden of malnutrition. According to recent research findings, in India the fast-food industry is growing by 40% each year.[6] In India per capita sugar consumption increased from 22 gm/day in 2000 to 55.3 gm/day in 2010; salt intake ranged between 9 and 12 gm/capita/day and total fat consumption increased from 21.2 gm/day in 2000 to 54 gm/day in 2010.[23] The nutrient composition analysis of commonly consumed HFSS foods highlights their detrimental effects on health. These foods are often high in calories, saturated fats, added sugars, and sodium, while lacking essential micronutrients such as vitamins, minerals, and dietary fiber. High consumption of HFSS foods and drinks are associated with increased body fat, waist circumference, BMI, blood pressure and serum uric acid, and TAG level and the high risk of metabolic syndrome such as insulin resistance in adolescents.[5,24-27] A study reported that the total prevalence of hypertension was 21.5% among 400 school children, also found that high prevalence of hypertension among overweight and obese children when compared to children with normal weight.[28,29] Barker's hypothesis underscores the significance of adequate nutrition during the phase of growth and development. Nutritional deficiencies or imbalances during this period can have long lasting effects on health, potentially increasing the risk of chronic diseases later in life such as diabetes, cardiovascular disease and other NCDs.[30] By prioritizing a balanced diet that meets a child's nutritional needs, can ensure that they grow into a healthy individual. Early nutritional assessment and educating children, parents, caregivers and communities about the significance of proper nutrition during childhood is essential for building a healthier future generation.

Strength of the study

The data collected was direct response from the subjects through self-administered standardized questionnaire under the research team guidance. The study helps in determining the actual nutrition transition pattern i.e. shift in dietary consumption among school children. This is an evidence-based comparison of frequency and impact of HFSS foods on the nutritional status, growth and development between group of children (6-10 years) and adolescents (11-16 years) subjects. This is one of the first studies to relate nutritional status and HFSS Food consumption in selected study area.

Limitations of the study

The study represents the nutrient intake data from HFSS food consumption; however, 24-hour dietary recall data is needed to ascertain the nutrient intake adequacy and extent triple burden of malnutrition. The study is limited to representative sample size in selected study area, larger number of subjects at different geographical location is underway to establish the risk of malnutrition and trends of nutrition transition.

CONCLUSION

The present study focusing on the impact of the high fat, salt and sugar (HFSS) food consumption on the nutritional status of school children. In this study there is a notable age-based trend in nutritional challenges among children and adolescents. The findings of this study emphasize the urgent need for early screening of nutrient deficiencies, comprehensive interventions to address the triple burden of malnutrition among school children. Efforts should focus on promoting healthy dietary behaviours, enhancing nutritional literacy among children, parents and care givers. The study also emphasises on the policy strategies to improve access to nutritious foods, and regulating the marketing and availability of HFSS foods, especially near school premises. Additionally, school-based interventions, such as nutrition education programs and healthy school meal initiatives play a crucial role in promoting healthy eating

habits and preventing the adverse effects of junk food consumption. By addressing these challenges holistically, we can safeguard the nutritional status and overall health of school children, laying the foundation for a healthier future generation.

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