Chapter 2 Review of Literature

Health, nutrition and wellbeing of the population play a very important role in the development of a nation. Children and adolescents are future generations and their wellbeing can determine the future of a nation.

The term "adolescence" corresponds to a theoretical construct that is always evolving and is influenced by physiological, psychological, temporal, and cultural factors (Curtis 2015). As stated by Canadian Paediatric Society (2003), adolescence begins with the onset of puberty and ends with the acceptance of an adult identity and behaviour. This time period generally correlates the age between 10 to 19 years. The World Health Organisation has also defined adolescence as the age group of 10-19 years (WHO 2012). This age range falls within WHO's definition of young people, which refers to individuals between ages 10 and 24.

Adolescence- A Demographically Important Age group

Adolescent population today is the largest in history. Total population of adolescents is 1,253,463 thousand as reported in State of World's Children report for the year 2021 (UNICEF 2021). Regional data shows that it is the highest in South Asia (347,827 thousand) followed by East Asia and Pacific (306,037 thousand). According to the country wise data, India has the highest number of adolescents i.e.- 252,202 thousand. A total of 16% of the World's population and 18% of India's population is between 10 to 19 years of age according to the State of World's Population (2022). According to the CENSUS (2011) data, 359 million children in India are between 5 to 19 years of age which makes almost 30% of the total national population. Thus, adolescent population is almost one fifth of the total population of India.

Health and Nutrition during Adolescence

One of the most rapid stages of human development is adolescence. Although the order of the changes seems to be universal, the time and pace of development differ from person to person. These are influenced by both internal and external factors. Internal factors are the characteristics of individuals

whereas external factors are the environmental factors including nutrition, family background, etc.

Being a stage of multi-dimensional growth, adolescence requires special attention on the nutritional and health needs of individuals. To attain the physical as well as physiological growth and ensure good cognitive performance, adolescents' requirements of nutrient also increase during this phase. As cited by UNICEF (2020), because of a faster growth rate and higher gains in bone and muscle mass, adolescent boys have higher nutrient requirements than girls (Spear 2002).Whereas, owing to the onset of menstruation, adolescent girls require more iron than boys. They may also be more prone to malnutrition, as gendered cultural norms prevent females from having access to nutritious food, nutrition services, and educational opportunities (Ivers and Cullen 2011).

Growth and Puberty- Key Characteristics of Adolescence

Puberty and related growth spurt are the main characteristics of adolescence. An individual experiences peak of growth both in height and weight during adolescence. The increase and subsequent slowing of bone growth is a characteristic of puberty. During the phase of growth spurt, the onset, duration, and amount of growth vary greatly (Soliman et al. 2014).

According to Brasel, (1982) adolescents gain 65 percent of their body weight at the start of the period or 40 percent of their final weight, as well as 15 percent of their adult height. Boys and girls have equivalent proportions of fat and muscle in the prepubertal period, and both sexes have the same lean body mass. In comparison to girls, growing boys gain proportionately more muscle mass than fat, as well as more lean body mass (WHO 2006).

The onset of adult reproductive potential is referred to as puberty. Puberty is a significant milestone in human development, including fast changes in anatomy, physiology, and behaviour (Ellison et al. 2012). It is a major biological transformation that an individual experiences during adolescence. According to Patton and Viner (2007), puberty is characterised by fast physical growth, intellectual development, sexual maturation, and reproductive capacity. It is accompanied by many organ systems attaining maturity, as well as significant changes in the central nervous system and psychosocial behaviour (Viner et al.

2017). According to Hochberg and Belsky (2013), puberty onset is impacted by a variety of factors. These factors include genetics along with diet, nutrition, and economic development (Viner et al. 2017).

One of the most critical factors influencing pubertal growth is nutrition. Both onset as well as progression of puberty are affected by nutrition. Puberty, on the other hand, causes a growth spurt, which raises dietary requirements, both macro and micronutrients. During this important time of rapid growth, increased calorie, protein, iron, calcium, zinc, and folate requirements must be met (Soliman et al. 2014).

Majority of girls reach puberty between the ages of 8 and 13, while boys reach puberty between the ages of 10 and 15. Both over nutrition and under nutrition can affect pubertal onset negatively. There have been conflicting reports on the effects of over nutrition on puberty. Over nutrition is found to be responsible for early puberty or a delayed puberty. Whereas undernourished adolescents are exposed to higher probability of delayed pubertal growth (Soliman et al. 2014).

National Academies of Sciences, Engineering, and Medicine (2019) states that adrenarche and gonadarche, two biological components of puberty, are important in understanding the relationship between puberty and adolescent well-being. Adrenarche occurs in late childhood (starting from 6-9 years of age), and levels of adrenarchal hormones increase throughout adolescence. A peak in this occurs in early twenties (Blakemore et al., 2010). Gonadarche is a reactivation of the hypothalamic-pituitary-gonadal (HPG) axis that occurs in early adolescence, between the ages of 9 and 11 (Sisk and Foster, 2004). (National Academies of Sciences, Engineering, and Medicine 2019) Thus, both pre adolescence and early adolescence are important phases in puberty. Under nutrition might cause delays in puberty signals because endocrine factors are sensitive to it (Christian and Smith, 2018).

Nutrient Requirements during Adolescence

Nutrient requirements increase during adolescence to meet the requirements for growth spurt as well as sexual maturation. Adequate energy is required to support normal growth during adolescence. Adolescent growth is supported by 4% of total energy requirements (Christian and Smith, 2018), as cited by WHO

(2006), adolescents' calorie and protein requirements peak at the same time as their growth. Level of physical activity affects actual demands as well. Protein requirements are generally met, even in economically deprived communities, if caloric intake is enough. However, if energy intake is restricted, dietary protein may be utilised to meet energy requirements, leaving it unavailable for tissue synthesis or repair. Despite an apparent appropriate protein intake, this may result in a drop in growth rate and muscle mass (Spear 2002).

The energy requirements for India adolescents (RDA 2010 and EER 2020) show an increase with age. According to the latest recommendations (EER 2020), the energy requirements range from 2010 Kcal/day for 10-12 years old girls to 3020 Kcal/day for 16-18 years old boys. The requirements of energy are higher for boys than girls. The daily requirements of energy per Kg body weight is highest in 10-12 years of age (64 Kcal/Kg/day- boys, 57 Kcal/Kg/day- girls), which is usually linked with puberty onset. This requirement is almost double as compared to adults with sedentary lifestyle (Table 2.1) (ICMR-NIN 2020).

Protein requirements also increase with age during adolescence. It is 27 gm/day for both boys and girls for 10-12 years of age which increase to 45 gm/day for boys and 37 gm/day for girls in 16-18 years age group. Thus, it is considerably higher for boys than girls in late adolescence (Table 2.1).

Iron requirements peak during adolescence, according to Beard (2000), due to rapid growth with a significant increase in lean body mass, blood volume, and red cell mass, which increases iron requirements for myoglobin in muscles and haemoglobin in blood (WHO 2006).At the ages of 14–18, the iron requirement rises, especially for females. It is mostly due to the onset of menarche and the increasing iron requirements to compensate monthly loss of blood during menstruation (Christian and Smith, 2018).

According to Spear (2002) increasing muscular, skeletal, and endocrine development are responsible for higher calcium requirements throughout puberty and adolescence as compared to other age groups, with pregnancy being the exception (WHO 2006). The calcium requirements (EAR and RDA 2020) for Indian adolescents increase with age. It is same for both the genders throughout adolescence.

Table 2.1 Daily Nutrient Requirements for Adolescents- India

	10-12 Years		13-15 Years		16-18 Years	
	Boys	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
Recommended Dietary Allowances 2010						
Energy (Kcal)	2190	2010	2750	2330	3020	2440
Protein (gm)	39.9	40.4	45.3	51.9	61.5	55.5
Visible Fat (gm)	35	35	45	40	50	35
Calcium (mg)	800	800	800	800	800	800
Iron (mg)	21	27	32	27	28	26
Retinol (µg)	600	600	600	600	600	600
Ascorbic Acid (mg)	40	40	40	40	40	40
Estimated Average Requirements 2020						
Energy (Kcal)	2220	2060	2860	2400	3320	2500
Protein (gm)	27	27	36	35	45	37
Calcium (mg)	650	650	800	800	850	850
Iron (mg)	12	16	15	17	18	18
Retinol (µg)	360	370	430	420	480	400
Ascorbic Acid (mg)	45	44	60	55	70	57
Recommended Dietary Allowances 2020						
Protein (gm)	32	33	45	43	55	46
Calcium (mg)	850	850	1000	1000	1050	1050
Iron (mg)	16	28	22	30	26	32
Retinol (µg)	700	790	930	890	1000	860
Ascorbic Acid (mg)	55	50	70	65	85	70

Reference: ICMR-NIN 2010, ICMR-NIN 2020

Requirements of minerals important for bone mineralization, such as phosphorus and magnesium, are at their peak during adolescence, particularly in the 14–18 year old age groups (Christian and Smith, 2018). Other minerals such as zinc, iodine, copper, chromium, cobalt and fluoride are also important (WHO 2006).

Requirements of vitamins also increase during adolescence. The requirement for folic acid and vitamin B-12 increases as the pace of growth and sexual maturation increases (WHO 2006, Spear 2002, Haddad and Johnston, 1999). The accelerated rate of skeletal growth necessitates a higher intake of vitamin D. New cell growth requires increased amounts of vitamins A, C, and E (WHO 2006).

Dietary Practices among Adolescents- Scenario in India

The Comprehensive National Nutrition Survey carried out in 2019 has covered all the age groups including adolescents. The report has published data on dietary practices among adolescents. The consumption of a range of food categories at least once per day and once per week was examined in CNNS to assess dietary diversity in adolescents.

The CNNS (2019) data showed that majority of the adolescents' ingested dark green leafy vegetables (90%) and pulses or beans (85%) at least one time in a week. Dairy products were consumed less frequently, with just two-thirds of school-aged children and adolescents drinking milk or curd at least once a week. Fruits, eggs, and fish, chicken, or meat were the least popular foods. Only 41 percent of adolescents reported to have eaten fruits, 35 percent consumed eggs, and 36 percent consumed fish, chicken, or meat. Gender wise pattern of food consumption was comparable for food items other than for milk or curd and eggs. These three foods were consumed more by boys as compared to their female counterparts. Household income and mother's education had influence on food consumption pattern among Indian adolescents. Increased levels of wealth and mother's education were related with higher consumption of milk or curd, fruits, eggs, and fish or chicken or meat (CNNS 2019).

Malnutrition among Adolescents

"Malnutrition is defined as poor nutrition caused by insufficient or excessive food, the use of the improper foods, and the body's response to a variety of viral diseases that result in nutrient malabsorption, or the inability to utilise nutrients properly to maintain health.," according to the World Health Organization (2001). Under nutrition, over nutrition, nutrition imbalance, and deficiency come under the broad umbrella of malnutrition (WHO 2001), Under nutrition is caused by a lack of food intake combined with a history of infectious infections. Stunting, underweight, thinness as well as vitamin and mineral deficiencies are examples of under nutrition (UNICEF 2006).

Physical development is an important sign of a child's health, and this is especially true during puberty. Thinness among children and adolescents – defined as less than 2 SDs from median for body mass index (BMI) by age and sex (WHO, 2007). Stunting defined as height-for-age below 2 SD from median during adolescence is a result of poor nutrition, illness, and environmental stress that has built up from foetal life until young adulthood (Christian and Smith, 2018).

Children and young people from the poorest and most marginalised communities bear the brunt of all forms of malnutrition, perpetuating poverty across generations.

Prevalence of Malnutrition among Adolescents Worldwide

Adolescents have a high prevalence of under nutrition, especially in lower and middle income countries, indicating that the opportunity of catch up growth is being missed at global level.

The global prevalence of thinness among 5–9 years old children and adolescents was examined in the report The State of Food Security and Nutrition in the World. Thinness (BMI less than 2 SD) was linked to a higher risk of infectious illnesses, delayed maturation, lower muscular strength, work ability, and bone density later in life in these age groups. Thinness was also linked to poor pregnancy outcomes and intrauterine development retardation in adolescent girls. Around the globe, 10% of 5–19 years old children have a BMI-for-age of less than 2 SD. There are considerable regional disparities in the

frequency of childhood obesity among children of this age group. For example, in South Asian countries such as India, Afghanistan, Bangladesh, Bhutan, Nepal, Pakistan, and Sri Lanka, the prevalence is more than 15%, compared to 2% in Latin America and the Caribbean, Northern America, Europe, and Oceania. Over the last decade, the global prevalence of thinness has remained rather stable (FAO, IFAD, UNICEF, WFP and WHO, 2018 as cited by Estecha Querol, 2020).

Data from the Global School-Based Student Health and Health Behaviour in School-Aged Children surveys, which included 129,276 adolescents aged 12–15 years and were conducted in 57 low and middle income countries between 2003 and 2013, were used to estimate the prevalence of stunting (height for age below 2 SD), thinness (BMI for age below 2 SD), and overweight (BMI for age above 1 SD). Stunting was seen in 10.2 percent of children worldwide, thinness in 5.5 percent, and overweight in 21.4 percent. In Pakistan, stunting was prevalent at 7.1 percent, thinness at 11.2 percent, and overweight at 6.4 percent in 2009. In India in 2007, 14.6 percent of children were stunted, 15.9 percent were thin, and 11.1 percent were overweight. In 2008, 25.6 percent of Sri Lankans were stunted, 31.5 percent were thin, and 4.8 percent were overweight (Caleyachetty et al. as cited by Estecha Querol, 2020).

Prevalence of malnutrition among adolescents an India was not given due attention in National databases until 2019, when the Comprehensive National Nutrition Survey report was published (MOFHW,2019). Prevalence of undernutrition among adolescents (10-19 years) is reported in CNNS 2019. Prevalence thinness and overweight and obesity, was 24% and 5% respectively, as measured by BMI for age. Thus, almost one fourth of the adolescents were thin. Thinness prevalence was 26% at10 years of age which decreased gradually during adolescence, reaching a prevalence of 12% by the age of nineteen years. Higher proportion of boys (29%) had low BMI for age as compared to their female counterparts (19%). As evaluated by Subscapular Skinfold Thickness, 6% of adolescents were overweight. Abdominal obesity was seen in 2% of adolescents (waist circumference for age >+1 SD). Prevalence of stunting among adolescents was 26.4% as reported in the CNNS report. The prevalence of stunting began to rise progressively from 10 years of

age, reaching 30% at the age of eighteen. As long bone growth is done by the conclusion of adolescence, no additional height can be gained. According to gender wise data, stunting grew dramatically among girls, reaching a high of 28% by the age of ten. However, because boys' growth spurts begin later, stunting began to rise around the age of 11. By the age of 13, 28 percent of boys were stunted, and by the age of 18, it had risen to 32 percent (MOFHW, 2019).

Research Studies on Prevalence of Under nutrition among Adolescents

Some recent studies across the globe have shown stunting prevalence amongst adolescents between 5% (Teferi et al. 2018) and 50% (Prince AK, 2014) at some places which indicate long term or chronic under nutrition amongst these children. Prevalence of underweight/ thinness also varied in different areas with as low as 4.7% (Teferi et al. 2018) to as high as 27.5% (Berhe et al 2019), demonstrating an urgent need for improving their nutritional status. Along with under nutrition, over nutrition was also observed in these areas with overweight and obesity ranging from 3.9% (Bhattarai and Bhusal, 2019) to 14.2% (Ribeiro-Silva et al. 2017). Studies have reported a higher prevalence of under nutrition in boys as compared to girls (Table 2.2).

Data from few studies carried out in India (Table 2.3) on adolescents showed that thinness ranged from 15.5% (Praveen and Subhashini, 2020) to 48.8% (Pal et al 2016) which depicts a vast difference in their nutritional status when compared to their geographical locations. Stunting prevalence ranged from 6.3% to 67% indicating a difference of almost 10 times between regions. Overweight and obesity coexisted with stunting and thinness and was reported between 2.7% (Kumavat et al., 2016) to 48% (Meher and Nimonkar, 2018). Rural areas had a higher burden of under nutrition whereas urban areas reported a higher prevalence of over nutrition. However, both the forms of malnutrition were present in rural as well as urban areas (Table 2.3).

Few of the departmental studies have reported stunting in Vadodara (Table 2.4) adolescents between 6.6% (Dhruv and Tripathi 2014) to as high as 70% (Iyer and Mistry 2013). Prevalence of underweight/ thinness was much higher in rural areas (as high as 90%) (Iyer and Mistry 2013) as compared to urban areas

Table 2.2 Prevalence of Undernutrition among School going Children and Adolescents- Studies across the Globe

Author and Year	Study Area	Subjects	Prevalence of Malnutrition	Standards used
Prince AK, 2014	Nkwanta south district – Volta region of Ghana	10-19 year	Stunting – 50.3% Thinness – 19.4%	WHO Z – scores
Ribeiro-Silva et al. 2017	Salvador, Bahia, Brazil	1496 school going adolescents	Normal- 77.2% Overweight/obesity- 14.2% Underweight- 8%	WHO reference, 2007 WHO 2006- reference for cut-offs (BAZ)
Teferi et al. 2018	Wolaita Sodo Town, Southern Ethiopia	690 School going Adolescents	Thinness- 4.7% Stunting- 5.2% Overweight/obesity- 5.7%	WHO reference, 2007 (WHO Anthroplus Software)
Demilew and Emiru 2018	Dangila Town, Northwest Ethiopia	424 school adolescents (15 years and above)	Stunting- 24.8% Severe Stunting- 8.1% Thinness- 7.1%	WHO reference, 2007 (WHO Anthroplus Software)
Bhattarai and Bhusal 2019	Dang District, Nepal	510 School going Adolescents, age: 14-17 years	Underweight- 21.8% Overweight- 3.1% Obesity- 0.8%	CDC BMI Percentile calculator software

Continued

Author and Year	Study Area	Subjects	Prevalence of Malnutrition	Standards used
Berhe et al 2019	Ethiopia (Systematic review and meta-analysis)	Adolescents (22 studies)	Stunting- 20.7% Underweight- 27.5%	WHO 2006- reference for cut-offs: Height-for-age <-2SD- Stunting BMI for age <-2SD underweight (Standards not mentioned)
Maehara et al 2019	Klaten and Lombok Barat districts, Indonesia	2160 Adolescents	Stunting: Girls:25%, Boys:21% Thinness: Girls:5%, Boys:11% Overweight: Girls: 8%, Boys:8.3%% Obesity: Girls:2.9%, Boys:3.2%	WHO reference, 2007
Ismail et al 2020	Rural Tanzania-Chamwino district, Dodoma region	1226 Adolescents	Stunting: 18% Thinness: 14% Overweight and obesity: 5.23%	WHO reference, 2007 (WHO Anthroplus Software)
Berhe and Gebremariam 2020	Hawzen Woreda (District), Tigray regional state, Northern Ethiopia	398 adolescent girls (10–19 years old)	Underweight- 32.2% Stunting- 33.2% Underweight and Stunting- 8.8%	(Not mentioned)
Gazebo et al. 2020	South Ethiopia	729 Adolescent girls	Stunting- 29.6% Thinness- 19.5%	WHO reference, 2007 (WHO Anthroplus Software)

Continued

Author and Year	Study Area	Subjects	Prevalence of Malnutrition	Standards used
Ismail et al. 2020	Dodoma, Tanzania	6162 Adolescents	Thinness- 13.95% Severe thinness- 3.59% Stunting- 17.7% Severe stunting- 2.85% Overweight- 4.98% Obesity- 0.25%	WHO reference, 2007
Mersha et al. 2021	Mirab-Armachiho District, Northwest Ethiopia	706 school going adolescent girls (10–14 years old)	Wasting- 17.3% Stunting- 10.3%	WHO reference, 2007 (WHO Anthroplus Software)

Table 2.3 Prevalence of Undernutrition among School going Children and Adolescents- Studies across India

Author and Year	Study Area	Subjects	Prevalence of Malnutrition	Standards
Banerjee et al 2011	5 schools Northern belt of Goa	1015 adolescents	Thinness- 33.3% Severe thinness- 10.4%	WHO reference
Thakur and Gautam, 2014	Sagar, Madhya Pradesh	School going children- 5-18 years (N= Boys- 300, Girls- 312)	**Boys:**Stunting- 6.3% Underweight- 4.3% Undernutrition- 3.0% CAIF- 10.0% **Girls:**Stunting- 5.4% Underweight- 5.7% Undernutrition- 4.1% CAIF- 10.6%	NCHS Reference
Bhargava et al 2015	Dehradun Rural schools- 6 Urban schools- 4	Children from 1st to 12th class (5-18 years) N= 1808	**Urban:**Underweight (N=162)= 7.5% Stunting (N=888)- 14.8% Thinness (N=888)- 6.1% **Rural:**Underweight (N=328)= 23.7% Stunting (N=906)- 16.6% Thinness (N=906)- 25.9%	WHO reference, 2007

Continued

Author and Year	Study Area	Subjects	Prevalence of Malnutrition	Standards
Kumavat et al. 2016	Bikaner district of Rajasthan Rural and urban schools	6 to 14 years old school children N=720	Underweight (WAZ): 19.72% Overweight (WAZ): 0.70% Stunting (HAZ): 9.86% Thinness (BAZ): 22.22% Obesity (BAZ): 1.95%	Not Mentioned
Pal et al 2016	Rural areas of Hawra, Birbham and Midnapur, West Bengal	560 Adolescents	Thinness- 48.75% Overweight and obesity- 4.64% Stunting- 53.57%	WHO classification and NCHS standards, Thinness- NAENES-I reference population
Meher and Nimonkar, 2018	Government School Kolkata	School children of 9^{th} to 12^{th} Standard (N=440)	Underweight- 12% Overweight- 27.3% Pre-obese- 13.9% Obese- 6.8%	BMI

Continued

Author and Year	Study Area	Subjects	Prevalence of Malnutrition	Standards
Ahmed et al 2018	Government schools and intermediate colleges of Barabanki District, Uttar Pradesh	School going adolescent girls 10-19 years (N= 2400)	Underweight- 47.0% Overweight- 5.9% Obese- 2.7% Double burden of malnutrition- 55.6%	
Gunjan et al 2018	School going adolescents of Ghaziabad	Students of Higher Secondary school (N=550)	Underweight- 10.92% Overweight/Obese- 25.36%	BMI
Kulkarni et al 2019	10 Villages of tribal blocks of Palghar and Dahanu	Adolescent girls-12-18 years (N=240)	Wasting- 55% Severe wasting- 7.1% Stunting- 67%	WHO reference
Xavier and Ravishankar 2019	Rural area of Coimbatore- 5 villages	6 to 14 years old children N= 702	Thinness: 15.5% Stunting: 18.8%	WHO reference, 2007
Praveen and Subhashini 2020	Government and Private schools of Rural areas of Hassan, Karnataka	Adolescents from 5th to 12th standard N=830	Thinness- 15.8% Severe thinness- 21.3% Overweight- 5.8% Obesity- 2.1%	WHO reference, 2007

Continued

Author and Year	Study Area	Subjects	Prevalence of Malnutrition	Standards
Singh et al. 2021	Varanasi, Uttar Pradesh	418 adolescent girls from slums (13-19 years of age)	Underweight: 60.3%	BMI- Asia Pacific Classification for Adults

Table 2.4 Prevalence of Undernutrition among School going Children and Adolescents- Departmental Studies

Author and Year	Study Area	Subjects	Prevalence of Malnutrition	Standards used
Sengar and Sharma, 2013	Urban Vadodara	10-19 Years old students	Underweight – 5.7% Stunting – 14% Thinness-33%	CDC,2000 WHO,2007
Iyer and Mistry,2013	Rural Vadodara	5-18 Years old girls	Underweight - 90%, Stunting - 70% Thinness - 71%.	WHO growth standard 2007
Gandhi and Patel, 2013	Rural Vadodara	5-18 Years old boys	Underweight- 87%, Stunting - 71% Thinness -74%	WHO growth standard 2007
Dhruv and Tripathi, 2014	Rural blocks of Vadodara	6- 13 years old Girls	Prevalence of severe undernutrition, Underweight =23.76%, Stunting =6.65% Thinness =20.05% Prevalence of moderate undernutrition, Underweight - 37.18%, Stunting - 24.06% Thinness - 26.57%	WHO growth standard 2007
Gandhi, Desai 2014	Rural blocks of vadodara	6- 13 years old Boys	Severe undernutrition: Underweight -27.9%, Stunting 6.8% Thinness -24.0% Moderate undernutrition: Underweight - 34.9%, Stunting - 22.5%, Thinness - 28.6%	WHO growth standard 2007

Continued

Author and Year	Study Area	Subjects	Prevalence of Malnutrition	Standards used
Kantawala and Iyer, 2015	Urban Vadodara	Primary school children	Underweight- 54% Stunting- 38% Thinness- 33%	WHO growth standard 2007
Gandhi and Panchal, 2016	Urban and Rural Vadodara	Primary school children	Boys: Underweight-76.7% Thinness- 67.1% Stunting-46.3% Girls: Underweight- 71% Thinness- 57.9% Stunting-44.4%	WHO growth standard 2007

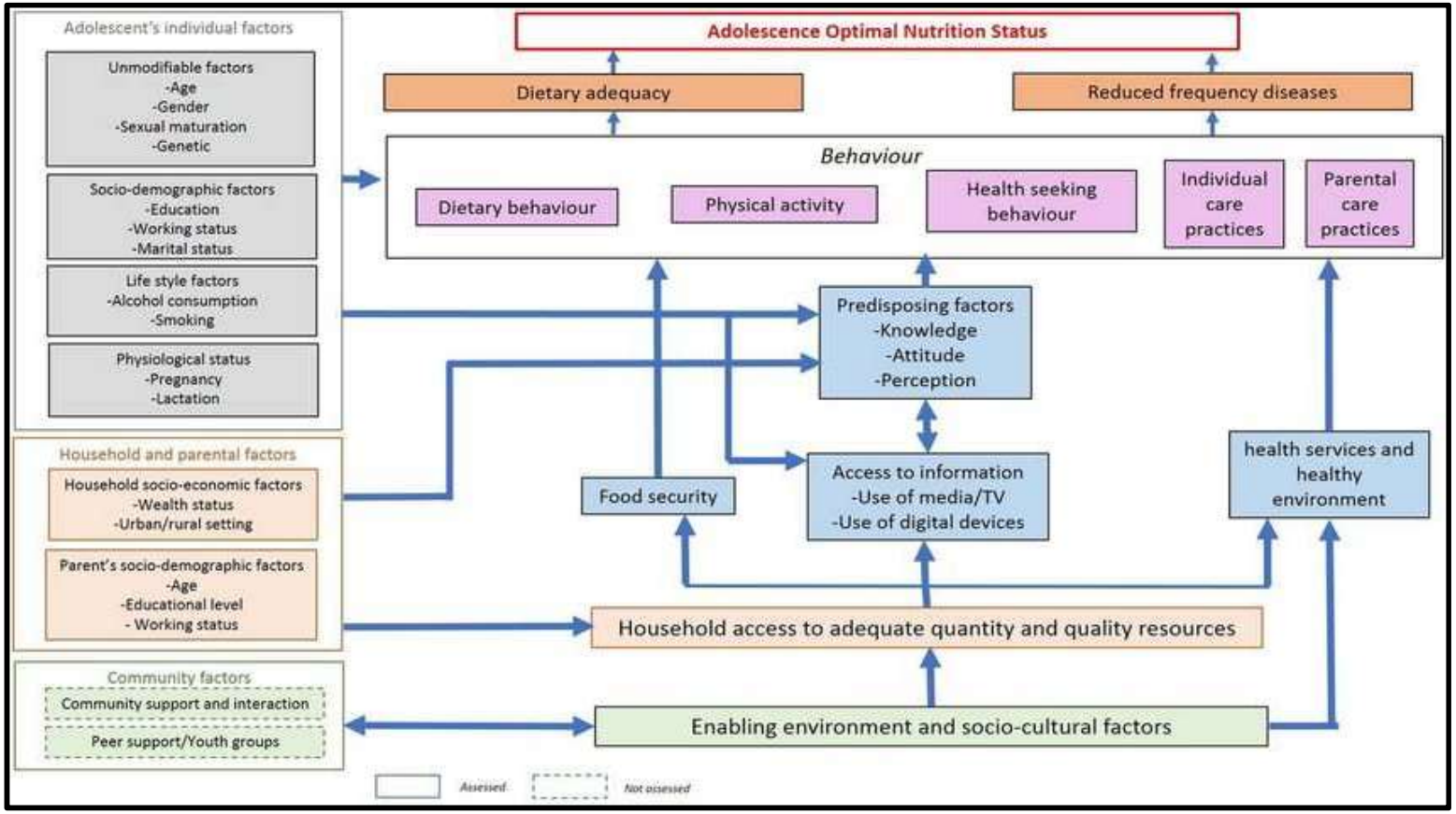
where it was reported as 5.7% (Sengar and Sharma, 2013). Boys were at a higher risk of being undernourished as compared to girls. Thus, the above datasets reveal a strong need for a comprehensive program in order to improve the nutritional status of adolescents and help them gain maximum benefits of the second window of opportunity in life.

Factors affecting Nutritional Status in Adolescents

Maehara et al. 2019 have cited a conceptual framework of nutritional status among adolescents given by UNICEF Indonesia (2017). (Figure 2.1) It is a complex interplay of various factors. The framework depicts that the immediate factors affecting nutritional status among adolescents are dietary adequacy and frequency of illnesses. The two most significant immediate causes of under nutrition-inadequate dietary intake and illnesses tend to affect each other and create a vicious cycle during childhood and adolescence. When an undernourished individual becomes ill, his or her resistance to illness is weakened, and the under nutrition worsens. Thus, they get trapped in this malnutrition-infection cycle. Therefore, these two must be addressed in order to control under nutrition. Both these factors are influenced by behavioural lifestyle choices. Adolescence is a phase known for a transition towards independent decision making behaviours. Individuals' behaviours related to diet, physical activity, health care seeking behaviour along with care practices- both individual as well as parental care affect the dietary intakes and health status. Inadequate or incorrect knowledge, attitude and practices in relation to nutrition, health and hygiene act as important influential factors for their behavioural choices. In addition to this food insecurity and a lack of access to health services and healthy environment play a major role. Household access to quality and quantity of resources and socio cultural factors are at the base of this framework.

The dietary and health related behaviours are directly influenced by individual factors. These factors include unmodifiable and modifiable factors. An individual's age, sex, sexual maturation and genetic factors are the unmodifiable factors that affect decisions made by them. The other individual related factors include socio demographic factors, life style choices and physiological factors which are modifiable to a great extent. Household and

Figure 2.1 Conceptual framework of nutritional status among adolescents (UNICEF Indonesia 2017)



(Maehara et al. 2019

parental socio economic status as well as community and peer supports are also major underlying factors to be considered.

By focusing on improvement of dietary practices, sanitation and hygiene practices as well as health service utilisation, we can address the problem of malnutrition in this age group. Providing appropriate knowledge and creating enabling environment for adolescents is important to improve their nutritional status. It will also enable them to take correct lifestyle decisions in their adulthood.

Social, Cognitive and Behavioural Changes during Adolescence

According to Coleman and Hendry (1990) Adolescence is a developmental stage in which the social self, identity, and perspective of oneself in relation to the social world are all consolidated (Choudhury et al. 2006). It is a phase of life when an individual's decision making skills evolve.

The brain of an individual also goes through considerable development including structural development during this phase of life. This may have an impact on cognitive functioning during adolescence. This is the stage of cognitive development when ideas and behaviour can be controlled and coordinated (Choudhury et al. 2006).

Why focus on adolescents?

Improving individual development and well-being, promoting overall socio-economic growth of families and communities, and meeting the Sustainable Development Goals (SDGs) all require addressing the difficulties of poor diets and malnutrition. In this setting, increasing nutrition investment so that children

all over the world can realize their full developmental potential has become a moral as well as an economic necessity (GLOPAN, 2015; FAO et al., 2019).

However, in low- and medium-income countries (LMICs), health and nutrition investments aimed towards middle childhood and adolescence are still in short supply compared to those aimed at the first 1000 days (UN General Assembly, 2015; Bundy et al., 2017).

This discrepancy reflects a missed chance to scale up and institutionalize effective interventions to prevent or treat malnutrition in the critical years following birth. Furthermore, it is detrimental to maintaining the gains obtained through early childhood treatments. Most critically, it obstructs the implementation of a life-cycle approach to optimum nutrition and health. Adolescents are susceptible to all forms of malnutrition, and meeting their nutritional needs, especially those of females, is critical to reaching the SDGs. The nutritional needs of adolescent females are included in SDG Target 2.2, however there is no indicator to track progress in this area. Similarly, the World Health Organization's (WHO) Global Targets are primarily focused on children under the age of five (except with regard to anaemia) (FAO, 2020).

The need of advocating for and investing in adolescent nutrition is becoming more widely recognized. This is due in part to global agendas and movements, as well as the commitment of various international organizations to devote resources and drive research in the area of improving adolescent nutrition, as well as to actively include adolescents in their own development processes (SPRING, 2018).

School as a Setting

In 2013, over 80% of children in lower secondary school around the world were enrolled in school (UNICEF 2017). Most children and adolescents are enrolled in school around the world, and a rising number of them continue from primary to secondary school (UNICEF, 2019).

Early childhood is the time when children gain basic knowledge and experiences that will shape their adult lifestyles and behaviours (Cooper et al, 2013). Over the last 20 years, school-based interventions have been helpful in preventing communicable diseases and other health problems such as worm infection, malaria, diarrhoea, iron deficiency, malnutrition, and oral diseases in low- and middle-income countries (WHO, 1996; Jukes et al 2008).

Schools are a unique environment for developing health, and they encompass a critical era for instilling good habits. However, there are still obstacles: estimates of worldwide mortality and morbidity imply that school-aged children are severely lacking in health promotion, preventive, and health-care services.

Schools can directly reach out to family members and the community by supporting healthy behaviour from early childhood and via school settings, thereby improving the lives of other family members and the community. Schools are increasingly being recognised as a critical environment for fostering children's and adolescents' health, well-being, and development (Thompson et al, 2020).

Schools, at their finest, provide a safe, secure environment where children may develop the information, attitudes, behaviours, skills, and experiences necessary to become healthy, educated, and involved citizens (WHO, 2020).

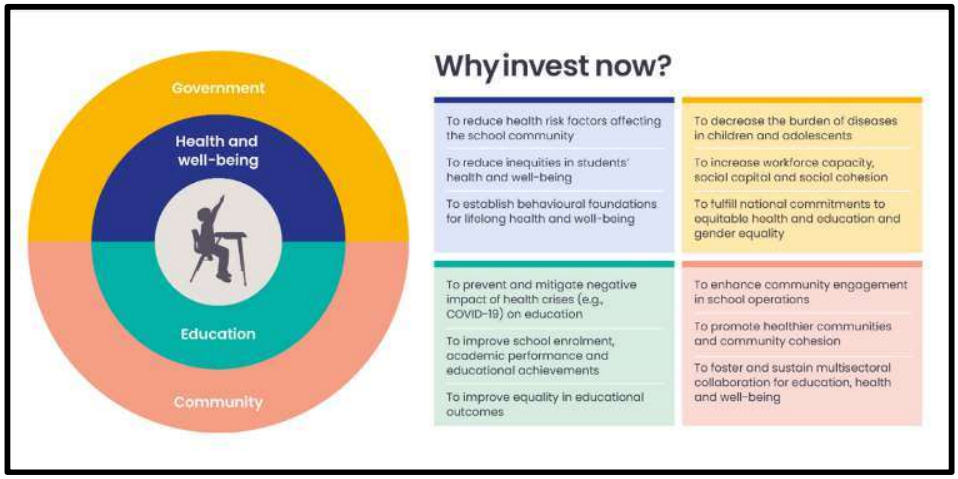
The wide linkages between health, well-being, and educational outcomes are also becoming acknowledged, as governments and school communities recognise that health and well-being are fundamental to the delivery and achievement of educational outcomes, and that they pervade all parts of school life (DOES,2019; MoHFW 2018).

Increased school attendance, engagement, and academic achievement are linked to improved student health and well-being, which includes health behaviours such as physical activity and healthy nutrition, as well as the development of social–emotional skills (Basch, 2011 ;Owen et al, 2018; Durlak et al, 2011).

A health-promoting school (HPS) approach was first introduced over 25 years ago by WHO and has since been promoted around the world; however, the goal of a fully embedded, sustainable HPS system has yet to be realised, and only a few countries have successfully implemented and sustained the approach at scale (WHO/UNESCO, 2021).

A health-promoting school is “a school that constantly strengthens its capacity as a safe and healthy setting for living, learning and working” (WHO, 2020). WHO defined six key characteristics or “pillars” of HPS: healthy school policies, healthy physical school environments, healthy school social environments, health skills and education, links with parents and the school community and access to school health services (IUHPE, 2009; WHO, 2000).

Figure 2.2 Why Invest in School-going Adolescents



Source WHO/ UNESCO, 2021

Thus, interventions done at school levels are considered to be effective in addressing health and nutrition related problems in school age children and adolescents. School feeding is one such strategy which has been used since many years to address the problems of short-term hunger, malnutrition as well as barriers to education.

School Feeding

School feeding approach is included in the interventions identified by WHO (2013) for improving nutritional status in various phases of life-cycle. School feeding works toward improved nutrition among children aged 5-15 years. Along with dietary advice for adolescents, school feeding contributes to nutritional status of adolescents of 10-15 years of age (WHO 2013).

School feeding programmes are social safety nets that give educational and health benefits to children who are the most vulnerable (World Bank 2012). Food for education programmes were traditionally designed to encourage children to attend school as well as parents to enrol and send their children to school on a regular basis (Lawson 2012). School eating is a successful approach for increasing involvement in school and enhancing test performance (Snilstveit et al., 2016).These programmes have proven to be effective in not only in addressing the problem of illiteracy but also in tackling hunger and malnutrition among children (Lawson, 2012).

School feeding programmes are implemented in different formats in various countries across the globe. These programmes are divided into two broader categories: 1. In school feeding and 2. Take home ration. As the name suggests, children are fed meals, either breakfast, mid day meals, lunch or a combination of meals in the schools. Children are provided high energy snacks in the school under some school feeding programmes. Take-home

ration entails a conditional transfer of food resources to families in consideration for their children's enrolment in school and regular attendance (Bundy et al. 2009).On-site school meals provide a better motivation for students to come to school every day (Lawson, 2012).

The “State of School Feeding Worldwide” report states that in at least 161 nations, one out of every 2 children, or 388 million children, receives school meals every day. The number of children receiving school meals increased by 9% globally and by 36% in low-income countries between 2013 and 2020 (WFP 2020).

Impact of school feeding

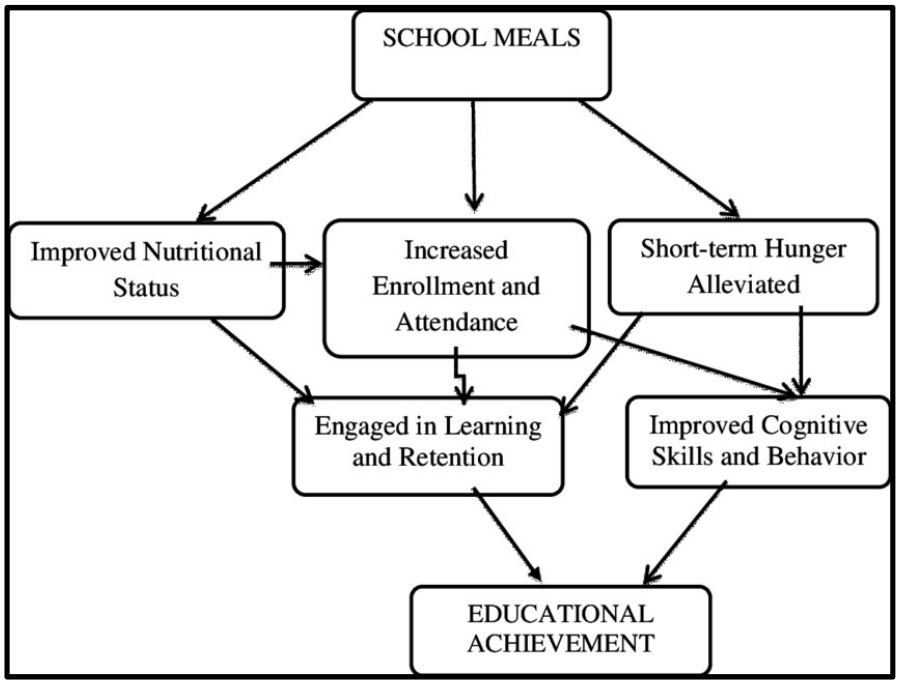
School feeding has been identified to address many gaps or issues. School enrolment, attendance, high dropout rates, poor learning outcomes, malnutrition, unhealthy diets are some of the concerns addressed by school feeding programmes. The framework of school feeding programme explaining how school feeding contributes to educational achievements in school children shows that providing school meals to children helps in ensuring increase in school enrolment and attendance, it addresses the issue of short-term hunger and brings about improvement in their nutritional status. This in turn contributes to cognitive development and learning among children. It also ensures that children are well engaged in the learning at school. Both these factors contribute to educational achievements among school children (Lawson, 2012 and Yendaw and Dayour, 2015). (Figure 2.3)

Role of School Feeding in Disaster Relief and Humanitarian Assistance

As cited by Tull (2018), the school feeding system has the potential to be a valuable resource for disaster relief and humanitarian assistance. Despite concerns regarding capacity, ‘food for education’ has demonstrated flexibility in crisis situations. WFP and its partners, on the other hand, are currently providing the system's flexibility. Governments can only adapt their school food programmes to respond to an emergency provided they can handle two additional capacity requirements that this would entail: additional material resources and timely financing (O'Brien et al., 2018).

Gentilini (2016) have reported that School feeding and Food for Education (FFE) programmes are frequently meeting increased school attendance and reduction in school dropout targets in crisis settings (Tull, 2018).

Figure 2.3 Conceptual framework on school feeding programme



Adopted from Adapted from Grantham-McGregor et al. (1998) and Jacoby and Pollitt (1998) (Lawson, 2012 and Yendaw and Dayour, 2015)

School Feeding- An Effective Strategy to Address the Problem of Malnutrition

School meals do not only bridge the gap in the intake and requirements of macronutrients but they also contribute to micronutrient intake as well as dietary diversity among children. This contribution is especially valuable in children of disadvantaged communities. Jomaa et al. (2011) have reported that school feeding has generally given consistent positive impacts on energy intake, micronutrient status, school enrolment, and attendance of children who participate in school feeding programmes compared to non-participants. This review further demonstrated that the influence of school feeding on development, cognition, and academic achievement was less conclusive (Lawson, 2012).

School feeding programmes can contribute to overall micronutrient status and reduction in anaemia prevalence in children studying in primary schools and adolescent girls by delivering nutritious balanced meals (Shrestha et al., 2020).

School feeding programme in the slums of Nairobi (Kenya) is an example of this. The programme in Nairobi contributed to reduction in anaemia and malnutrition Improvement in child growth (Neervoort et al, 2016).

Contribution of School Feeding Programmes to Local Economic Development

School feeding programmes provide an excellent opportunity to boost local agriculture and support economy. The World Food Programme has adopted home grown school feeding initiative. Local farmers are linked to the school meal programme under this strategy. This ensures inclusion of a variety of local fresh foods in school meals. It also ensures a steady income to the local farmers and small scale sellers which in turn strengthen local economy.

India's Mid Day Meal Programme also enforces purchase of food items from local vendors. Rice and wheat are provided through the FCI godowns in this programme. These grains are directly purchased from the farmers by Government.

Opportunity of Education

School feeding programmes often attract parents to enrol their children in schools. Not only that, these programmes also help in ensuring good attendance and lower rate of dropouts, especially among girls and children of the poorest strata. Reduction of dropout rates in girls helps to prevent early marriage and early pregnancy. These programmes are social safety net programmes that reduce barriers to education of children. It is especially beneficial for the children from lower socio economic background living in compromised environment.

A study in Somalia on School feeding by Aregawi et al. (2012) showed a positive and significant increase in enrolment but no significant change in dropout. School feeding programme in Kenya, showed high academic achievement among children in early childhood development centres (Chepkwony et al. 2013). Mwavula et al (2014) reported an enhanced enrolment, attendance, active participation in class and reduction in dropouts in Kenya as a result of school feeding programme. A study done in Nigeria also reported that school feeding programmes contributed to school enrolment, retention, regularity and punctuality in attendance (Taylor and Ogbogu, 2016).

School breakfast providing 30% energy requirement, 60% requirements of vitamins and minerals with 100% requirements of iron given to school children (9 to 11 years) in Peru did not show any improvement in scores of cognitive tests. However, it improved short-term memory of the children with compromised nutritional status (Pollitt et al, 1996).

According to Snilstveit et al. (2016) while school feeding is most successful in boosting better learning outcomes, it has limited impact in locations where there is no malnutrition and school participation is already strong (Tull, 2018).

Gender Equality

Access to safe and adequate food is a basic human right. Food for education programmes or school feeding programmes contribute to fulfilment of this right. In addition to this, school feeding programmes also promote gender equality, which is a focus of Sustainable Development Goal 5. Gender equality ensures

both in terms of food supplementation as well as increase opportunity of education for both boys and girls (Bundy et al., 2009)

Reduction in Hunger

The sustainable development goal 2, is to end hunger, achieve food security and improved nutrition and promote sustainable agriculture. The school feeding programmes, both in school feeding and take home ration provides safe and nutritious food supplements to bridge the gap between the availability and requirement of nutrients. These programmes address the problem of hunger in schools.

Community based school feeding given to school children for one year in Lebanon who were Palestinian refugees showed a significant improvement in the dietary diversity score and mean haemoglobin levels. However, no significant contribution of the intervention to food insecurity, mean BAZ, mean HAZ, odds of anemia, overweight, obesity and stunting was observed (Jamaluddine et al, 2022).

Hunger affects individuals and nations negatively. Hunger in children interferes with their cognitive development affecting their productivity in future as adults. This results in vicious cycle of poverty and under nutrition. Safety net programmes like school feeding programmes help nations to break this cycle of under nutrition and poverty (Yendow and Dayour, 2015).

Mid Day Meal Programme of India

The ‘National Programme of Nutritional Support to Primary Education', also known as the Mid-Day Meal Scheme, is India's school feeding programme. It covers all the children studying in primary or upper primary sections (I to VIII standard) in Government and Government-Aided Schools. It is now known as PM POSHAN (Poshan Shakti Nirman) Yojana (MHRD 2021).

In Madras Municipal Corporation, a school feeding programme for poor children was established in 1925. Gujarat, Kerala, Tamil Nadu, and the UT of Pondicherry, had universalized a cooked Midday Meal Program utilizing their own resources for children in primary school by the mid-1980s. Thus, Gujarat was one of the three states where Mid Day Meal programme was

started by Government in the year 1984. By the year 1990-91, twelve states had implemented the midday meal programme by their own resources on a universal or large scale. This programme was launched later on 15th August 1995 as a Central Government sponsored scheme NPNSPE. However, it was only being implemented in 2408 blocks as a pilot at that time; which was later implemented throughout the country from the year 1997-98.The Supreme Court of India in 2001 converted the MDM scheme into a legal entitlement and directed the provision of Hot Cooked meals to children (MHRD, 2021). Children are given hot cooked meals providing 450 Kcal energy and 12 gm protein to children studying in 1st to 5th standards and 700 Kcal energy and 20 gm protein to children studying in 6th to 8th standard of Government run primary schools (MHRD, 2006).Major goals of this programme are improvement in child nutrition, social equity and educational advancement. MDMP is viewed as an opportunity to inculcate hygiene and sanitation practices among children. The NP-NSPE guidelines (MHRD, 2006) said that meals should be prepared at the school level kitchens by the cook-cum-helpers. However, the guidelines also had a provision for involving voluntary non-government organisation under public private partnership model. According to the guidelines these organisations can be involved in setting up and running centralised kitchens. Meals can be provided by these centralised kitchens to a group of schools where there is a limitation of space for a kitchen (MHRD, 2006). Schools in villages that are connected with the city area with good roads can also be sent meals through the centralised kitchens under PPP model (MHRD, 2010).

Water, sanitation and hygiene are important for ensuring a healthy school environment. A special focus should be laid on ensuring good hygiene in programmes involving food supplementation. The global recommendations of improved hygiene practices at school level have been incorporated in the MDM guidelines in the years 2013 which enforces compulsory hand-washing with soap before MDM consumption and to have facilities for the same. (MHRD, 2013) All students must wash their hands with soap everyday at school before consuming MDM, according to the guidelines. Hand-washing should be given a specific period of about 15 minutes before MDM, according to the guidelines. It should be assured that all children have access to sufficient soap to wash

their hands in school on a daily basis. The guidelines also state that adequate number of functional hand-washing stations should be present in every school. The guidelines further state that all the hand-washing stations should have adequate supply of water and proper drainage. The stations should be clean, safe and fit to use by the students. (MHRD, 2013)

Impact of Mid Day Meal Programme

A comparative study done on recipients of MDM in Government primary schools vs. students of private schools, bringing their own lunch at school showed that MDM contributed to higher caloric intake in the afternoon meal consumed at school (Souza et al,. 2021).

A study done in Karnataka (Minj et al., 2014) showed an improvement in nutritional status of school children and reduction in stunting and underweight as a result of MDM consumption.

Studies have also shown that MDM have been instrumental in improving enrolment, attendance, classroom performance, retention. It also helps in lowering dropout rate and classroom hunger. MDM programme also promotes social equity (Table 2.5).

Intergenerational Benefits of Mid Day Meal Programme of India

Chakrabarty et al. 2021 have cited that prevalence of stunting in children under five years was lower in the years 2016 in states that reported high coverage of Mid Day Meal in the year 2005. They have also cited that along with increase in Mid Day Meal coverage, a reduction in number of out of school children was also reported between the years 2000 to 2015. They conducted a retrospective analysis of stunting prevalence in children under five years with state level coverage of Mid Day Meal as well as mothers' birth years. The results have demonstrated that maternal MDM coverage had a positive effect on the nutritional status of children as assessed by anthropometry, especially on the linear growth of children.

School meals provide an improved opportunity of education and improvement in nutritional status of girls. It further delays the age of marriage and fertility.

Table 2.5 Studies on the Impact of Mid Day Meal on various Parameters

Enrolment	Attendance	Classroom Performance	Retention	Dropout Rate	Classroom Hunger	Social Equity	References
↑	↑	↑	↑	↓		↑	NIPCCD 2007
↑							Nangia and Poonam 2011
↑							Bond 2012
↑	↑	↑	↑	↓	↓	↑	Paul and Mondal 2012
↑	↑		↑	↓		↑	SCERT 2014
↑	↑						Singh and Gupta 2015
↑	↑				↓		Sharma and Saini 2015
↑	↑					↑	Tyagi and Siddiqui 2015
↑							Jayaraman and Simroth 2015
↑	↑		↑				Nath and Nath 2015
↑	↑		↑				Mondal 2017
↑	↑					↑	Manzoor 2017
↑	↑	↑	↑				Panigrahi 2018
↑	↑		↑				Roy and Roy 2018
	↑						Deka 2021

Lowered probability of early marriage combined with better health care utilisation can contribute to reduced risk of malnutrition in the next generation.

Gaps in implementation and outcomes of Mid Day Meal

Mid Day Meal programme aims at improving nutritional and educational outcomes in children through provision of nutritious meals. However, many studies have found that there is a gap in nutritional contribution of MDM. It often becomes a substitute to meals instead of supplementing the diets. Also, the MDM intakes among children often cannot meet the nutrient norms of the programme.

Nutrition Foundation of India (2003) reported that MDM becomes a substitute than being a supplement to the home diet. MDM provided only 1/3rd of the RDA of energy and protein to children as reported in this paper. Also, the meals given under the programme focus only on macro-nutrients (NFI 2003). Kantawala and Iyer (2015) also found that average consumption of MDM by children could not meet the nutrition norms for energy and protein despite of good quality food served by an NGO. A study carried out in Koraput district of Odisha by Sahu an Pati (2018) also found that Mid Day Meals could not meet nutritional requirements of 10-13 years old primary school children.

Other gaps and limitations in MDMP reported by various studies are poor infrastructure, inadequate staff, lack of separate space for cooking, compromised teaching time and quality, monotonous menu, poor quality of raw as well as cooked food, poor frequency of meal distribution, and unavailability of soap for hand-washing (Table 2.6)

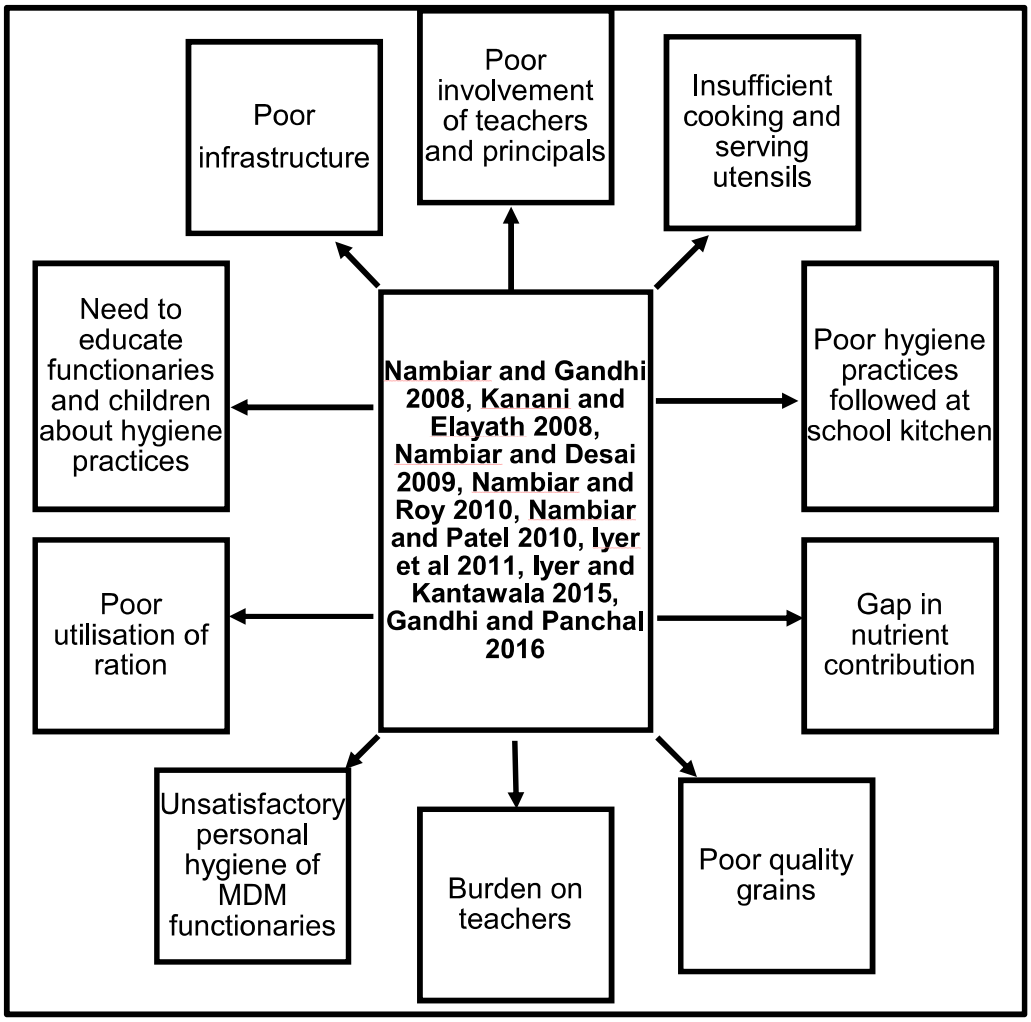
Studies done in Vadodara have also reported poor infrastructure facilities, including kitchen equipment and utensils, poor hygiene practices followed at school kitchen as well as poor quality of grains were limiting factors to effective implementation of MDM. In addition to this, there was a lack of active involvement of teachers in supervision of MDM serving and in motivating children to consume MDMs at schools. (Figure 2.4)

These gaps focus on the need of system strengthening as well as awareness generation activities that can ensure active involvement of teachers and

Table 2.6 Gaps and Limitations in MDMP reported in Studies

Poor Infrastructure	Inadequate staff	Lack of Separate Cooking Space	Compromised Teaching Time and Quality	Monotonous menu	Poor Quality and frequency of meal distribution	Unavailability of soap for handwashing	References
√	√	√	√	√			Rani and Sharma 2008
			√		√		CSD 2010
	√					√	Kumar and Sharma 2011
			√				Uma 2013
							Mehta, Grover and Kaur 2013
				√			SCERT 2014
√			√			√	Acvida 2014
				√		√	SCERT 2014
√							Sahoo 2015
√							Dowarah 2020

Figure 2.4 Gaps and Limitations in MDMP Reported in Various Studies in Vadodara



optimum utilisation of the programme by children. These activities may help in achieving the goals of the programme.

Involvement of NGOs in MDM under Public Private Partnership

Mid Day Meal are prepared at the school in the kitchen facility. However, many non-government organisations are also involved in functioning of centralised kitchens for providing cooked meals to schools of designated clusters in many parts of the nation. Currently, four non-governmental organisations (NGOs): Akshaya Patra, Stri Shakti, Paras Agro, and Nayak Foundation are serving prepared food under the MDM Scheme from their centralised kitchens in nine districts, including 3346 schools as reported in the Annual Work Plan & Budget of National Programme of Mid Day Meal in Schools (MDMS) for the year 2020-21 (Government of Gujarat 2020).

According to Chauhan and Milind (2011), adopting Public Private Partnership model under Mid Day Meal programme can effectively address the issues of compromised teaching-learning activities due to extra work load on teachers leading to negative attitude of teachers towards MDMP, unhealthy atmosphere of schools and students' involvement in cooking process. Various studies have shown a better improvement in enrolment, attendance, classroom performance, retention, nutritional status as well as reduction in dropout rates among children in the areas where NGOs are involved in MDMP (Table 2.7)

Sharma et al. (2010) reported that a reduction in the prevalence of Vitamin A and Vitamin D deficiency among children as a results of MDMs provided by NGOs kitchen. TISC (2014) has also reported a positive impact of MDMS given through centralised kitchen on health and academics of the children.

Iyer and Dhaundiyal (2011) reported that NGO run centralised kitchen had better infrastructure, machinery, storage facility, manpower, sanitation, hygiene, food handling, menu, cooking process and transportation facilities as compared to school level kitchens. Gandhi and Panchal (2016) also reported in their study carried out in Vadodara that school level kitchens lack cleanliness and hygiene. Poor food handling practices and poor personal hygiene of cooks were also reported in school level kitchens as compared to the centralised kitchen.

Table 2.7 Impact of Mid Day Meal with NGO intervention

Place	Enrolment	Attendance	Classroom Performance	Retention	Dropout Rate	Nutritional Status	Social Equity	Reference
Puri, Orissa	↑	↑						Nielsen 2010
Nayagarh		↑						
Bhilai	↑	↑				↑		
Ahemdabad	↑	↑						
Bangalore	↑	↑	↑			↑		
Mangalore		↑	↑		↓			
Gwalior, Madhya Pradesh	↑	↑		↑	↓		√	Chauhan and Milind 2011
Odisha and Andhra Pradesh	↑	↑		↑		↑	√	Kusuma Trust 2012
8 States of India	↑	↑						Sigma 2014

Studies on impact of NGO intervention have shown mixed results with respect to impact on the nutritional status of school children. Studies carried out on the areas where centralised kitchen were newly started in Gujarat showed a significant increase in mean weight, height and BMI of the children after one year of intervention. Even among severely thin children, significant reduction in the prevalence of underweight, stunting, thinness and anaemia was seen (Iyer and Dhaundiyal, 2011; Kantawala and Iyer, 2015).

A comparative study on centralised and decentralised kitchen showed no difference in the mean anthropometric measurements of children in both the settings. Higher prevalence of under nutrition in schools receiving MDM from centralised kitchen was reported than the schools having decentralised kitchens.

Thus, there are mixed results pertaining to impact of NGO based kitchens on nutritional status of children. There is still a gap in nutrient contribution of MDM as compared to the nutrient norms. However, the centralised kitchen model has been successful in addressing issues such as disturbances to teaching learning activities and food safety. Providing nutrition health education by awareness generation activities can help in improving utilisation and outcomes of MDM in areas where the meals are served through centralised kitchen model.

Nutrition Health Education

Nutrition education is a comprehensive concept that includes teaching tactics as well as environmental support to encourage the adoption of healthier, more sustainable food choices and eating habits. It goes beyond providing knowledge to encourage critical thinking, attitude transformation, and practical skills, as well as coordinated actions to support and enable health-promoting eating behaviours and surroundings. Nutrition education takes place in a number of settings, with different populations being targeted and a range of channels, tools, and materials being used (Piscopo S, 2019).

Nutrition Health Education- Effective strategy for behaviour change

School going children and adolescents are an age group where an individual starts taking independent decisions on choices related to food, hygiene,

physical activity, lifestyle as well as health related behaviours. This provides an opportunity to equip them with correct and complete information which can aid them in taking care of their health. Nutrition Health Education can be considered an effective mode of bringing about positive changes in their knowledge, beliefs, habits and behaviours. Nutrition Health Education helps in Capacity building of children to promote and manage their own health and development. Further, it helps to fosters positive change in their behaviour as well as in their knowledge and attitude. Providing NHE to the children can help spread awareness throughout the communities using children as a medium.

How effective is Nutrition Health Education?

Food and nutrition education (FNE) has been shown to improve the nutrition behavioural impact of interventions in a variety of domains, including social protection and food security, with a special focus on infant and young child feeding. The evidence for the latter has backed up the international recommendation to include FNE as part of a comprehensive package to reduce stunting in children under the age of five (Bhutta et al., 2013; Lamstein et al., 2014; Kuchenbecker et al, 2017).

Nutrition instruction in schools is very minimal, with an average of only five hours per year in the United States (Kann., 2007). The existing Indian secondary school curriculum has been chastised for failing to provide teenagers with appropriate, skills-based food and nutrition education. The food and nutrition curriculum were found to raise student awareness regarding the need of eating healthy. However, the study pointed out certain flaws in the curriculum which included a lack of practical assignments, an outdated and constrained curriculum that failed to engage students in critical thinking and was contradicted by sales techniques in the school cafeteria (Rathi et al, 2017).

Nutrition specialists, on the other hand, advocate for more extensive and comprehensive approaches, citing data that at least 50 hours of nutrition instruction per year is required to induce behaviour change (Briggs, 2010).

"Stepping Up School-Based Food and Nutrition Education: Exploring Challenges, Finding Solutions, and Building Partnerships," an international expert consultation co-hosted by the United Arab Emirates University, brought

together 63 experts from over 25 countries, representing various fields in education, communication, food systems, and nutrition, to lay the groundwork for reshaping and carrying forward SFNE work, as well as to develop a shared vision for effective SFNE and its future in LMICs (FAO, 2019a).

The SFNE white paper proposed and was built around a simplified theory of change (Figure 2.5) that depicted how SFNE can help a population adopt health-promoting and sustainable eating behaviours and outlooks.

State and local education agencies should guarantee that sequential food literacy and nutrition science education, encompassing grades K-12, is implemented and monitored based on authoritative food and nutrition guidelines (IOM, 2012).

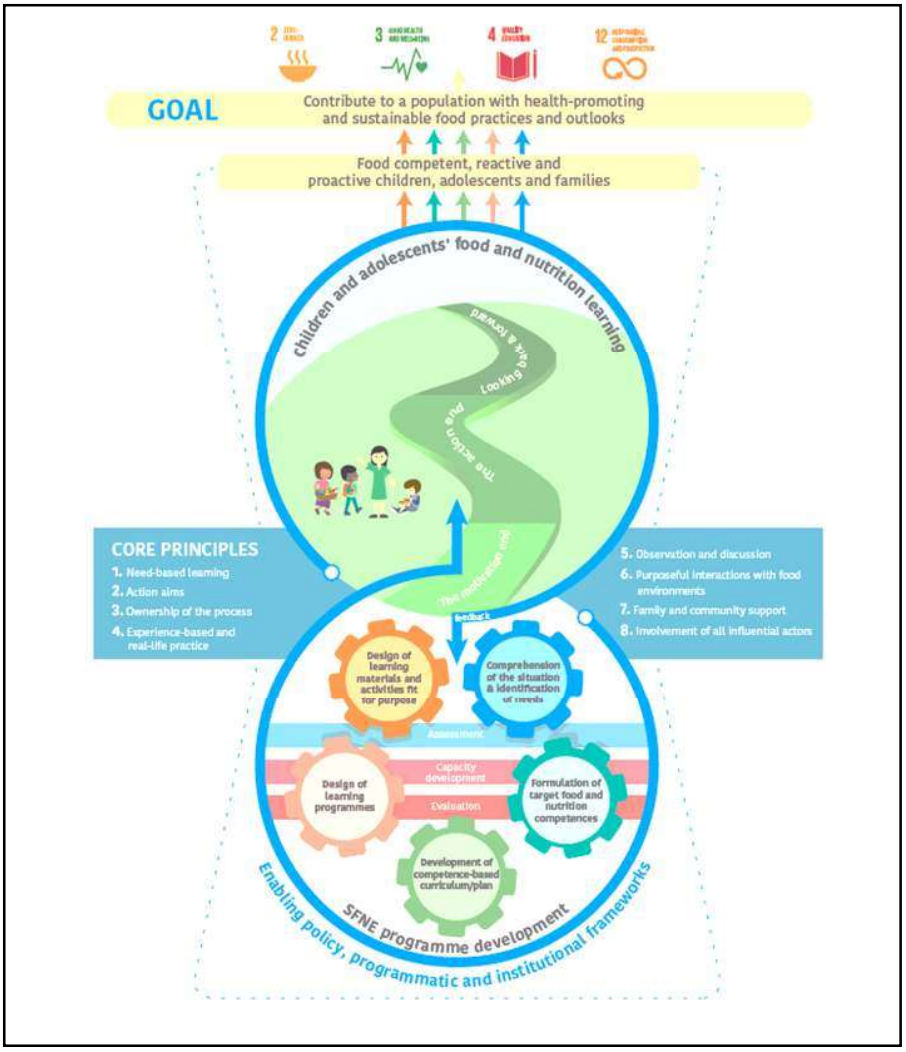
Several studies have demonstrated a shift in health-nutrition behaviour among elementary school kids as a result of health-nutrition education. One of the Scotland based study on assessing the impact of a school-based nutrition education intervention on fruit and vegetable intake reported significantly higher intake of fruits and vegetables in intervention group post nutrition education program (Anderson A. et al, 2007).

According to Haldar et al (2012), continuous nutrition supplementation at the expense of the government should not be considered a long-term solution. The most cost-effective strategy to make a genuine difference in the problem is to instil healthy life styles and eating habits. Grassroot health workers and school teachers can lead a well-coordinated effort monitored by other stakeholders.

A systematic review of randomised control trials in 12 countries found that high-quality SFNE interventions boosted fruit and vegetable consumption and reduced the prevalence of overweight and obesity in children and adolescents. The interventions that were found to be beneficial had a length of more than one year, were integrated into regular school activities, had parental involvement, included SFNE into the regular curriculum, and provided fruits and vegetables by school food services (Silveira et al., 2011).

Another review of 11 randomized controlled trials in high-income countries found that multi-strategy food and nutrition education interventions that are

Figure 2.5 School-based food and nutrition education (SFNE) Theory of change



Source: FAO 2020

behaviourally focused, include theory-based learning strategies, are delivered by school staff and teachers, and include parental involvement have statistically significant effects on anthropometric measures and dietary intake of adolescents (Meiklejohn, Ryam and Palermo, 2016).

The duration and intensity of interventions were identified as critical variables of effectiveness in a review of reviews (Amini et al., 2015).

A systematic review of 22 school-based interventions from LMICs (controlled trials with or without randomization) found that those that were effective in enacting changes in food practices and nutritional status were multicomponent, with a strong education component facilitated by teachers and additional physical activity sessions or integrated classes about healthy foods, nutrition, or physical activity. Parents' commitment and duration of more than a year were also important factors in the project's success (Verstraeten et al., 2012).

A separate global comprehensive evaluation of randomised controlled trials and quasi experimental studies discovered that school-based programmes including food, physical exercise, and home outreach were beneficial in avoiding overweight (Bleich et al., 2017).

FAO conducted a scoping analysis of SFNE design, implementation, and evaluation processes in LMICs, and found that 28 interventions improved their desired results statistically significantly versus 12 that were not able to achieve a significant change on expected outcomes. Dietary behaviours (increased eating of fruits, vegetables, and breakfast; reduced consumption of foods high in fat, salt, and sugar) and behavioural variables were the most common outcomes. Authors stressed the need to utilize more trustworthy tools, expand intervention length, and enhance overall design in individuals who reported no meaningful changes (including parent involvement and complementary food environment components) (FAO, 2019 b).

According to the findings of a review by Seth, effective nutrition intervention and education strategies based on behaviour therapy are required to encourage adolescents to adopt a healthy eating and physical activity lifestyle. It was also determined that schools can serve as good venues for encouraging healthier lifestyle habits among students through a variety of strategies, as well as

improving adolescent eating patterns and nutrition status for nation-wide healthy citizens (Seth U, 2021).

Including a nutrition-focused lesson as well as a practical demonstration will help a lot. In addition, schools provide a convenient location for interventions aimed at children and parents to encourage a healthy lifestyle.

There was an improvement in eating habits of participating children, following nutrition education intervention in Sri Lankan study. Significant change in eating habits were reported among children of all BMI categories. Furthermore, > 90% of parents and > 95% of educators strongly agreed that the intervention was simple to execute, that it engaged children, and it resulted in a visible increase in healthy eating habits (Seneviratne et al, 2021).

A study from Bangladesh showed that just around half of the adolescent girls correctly selected high-protein foods such as lentils (21%), beef (32%), and fish (43 %) and concluded that adolescents' general health and nutritional knowledge and status may be improved through adolescent-friendly nutrition and health education (Alam et al, 2010).

Another school based interventional study providing nutrition health education to adolescent in Urban slums of Delhi reported a significant rise (mean difference was 1.7890 ± 0.1434) in the knowledge related to nutrition of the participants after the intervention (P< 0.001) (Raikar K et al, 2020).

A study conducted in the state of Uttarakhand found that adolescents' knowledge levels increased by 41% post nutrition education. It may be concluded that nutrition education has a favourable impact on nutritional awareness, and that it will assist adolescents in understanding the needs of their age group, allowing them to live happy and healthy lifestyles for the rest of their lives. The study concluded that nutrition education improved the nutritional status and health-related behaviour of adolescent girls with limited understanding of nutrition and health (Singh P et al, 2019).

Medical education for children/Adolescents for Realistic prevention of obesity and diabetes and for healthy ageing' (MARG) intervention study reported that at baseline there were significant inequalities in urban Asian Indian children's,

parents', and teachers' understanding and behaviour when it comes to health and nutrition. Low baseline knowledge and behaviour scores were reported in 75-94 % Government and 48-78 % private school children, across all age groups. Following MARG education intervention, all children's knowledge and behaviour scores improved significantly as compared to baseline ($P<0.05$) irrespective of the type of school (Shah P et al, 2010).

Table 2.8 shows various departmental studies carried out on the impact of NHE among school children. The findings of the studies revealed that NHE had an impact on the nutritional status of school children with respect to their weight and haemoglobin. NHE also brought a positive change in their sanitation and hygiene practices as well as the improved their dietary practices especially the increased use of vegetables in MDM.

In India, there are significant gaps in health and nutrition-related knowledge and behaviour among schoolchildren, their parents, and educators. A comprehensive educational intervention, which could be included into future school-based health and nutritional education programmes, is the need of the hour. Studies done in Vadodara on impact of NHE given to school children have also shown favourable results.

Thus, the review of literature suggested that there should be continuous ongoing monitoring and evaluation of Mid-Day Meal programme and different strategies need to be worked out to strengthen and improve the nutritional status of the children.

Table 2.8 Departmental Studies on Impact of NHE

Authors	Major Findings
Nair and Chitre, 2007	Interpersonal counselling along with DFS-positive impact on Hb of anemics.
Nambiar & Subramaniam, 2008	• Increased awareness among parents, children and the MDM staff about the nutritional food. • Significant improvement in weight height • Reduction in undernutrition, Vit A deficiency, anemia • Significant improvement in cognitive scores
Nambiar and Desai, 2009	• Improvement in sanitation and hygiene practices • Participation of teachers in MDM • Safe food handling and storing practices • Improvement in sanitation and hygiene • Increased use of vegetables in MDM • Adherence to cyclic menu
Kuruvilla and Hanjra 2012	NHE- through multimedia package- significant improvement in knowledge scores (NHE scores) in hearing impaired children
Dhruv and Karbhari, 2012	Positive change in the sanitation and hygiene practices among the children and MDM compliance
Sengar and Sharma 2013	Nutrition communication program- improvement in knowledge and dietary practice among school children
Surabhi and Mehan 2013	Nutrition Health Promotion programme- reduction in malnutrition, sub optimal BP, dyslipidaemia and improvement in lifestyle behaviours
Desai and Nambiar 2014	NHE-BCC- improvement in nutritional status, improvement in Hb, reduction in BP, TBF, cholesterol and TG